Spring 4-2024

TECHNICAL SPECIFICATIONS - Silver Bow Creek Conservation Area - 60% SUBMITTAL April 2024

Atlantic Richfield Company

TECHNICAL SPECIFICATIONS

60% SUBMITTAL

April 2024

Atlantic Richfield Company

SECTION 00 01 10
TABLE OF CONTENTS

DIVISION 43 – PROCESS GAS AND LIQUID HANDLING, PURIFICATION, AND STORAGE EQUIPMENT

Section 43 21 40 – Submersible Solids Handling Pumps

END OF SECTION

SECTION 00 72 00
GENERAL CONDITIONS

PART 1 - GENERAL

1.01 DEFINITIONS

A. Wherever used in the Contract Documents, the following terms shall have the meanings indicated which shall be applicable to both the singular and plural thereof:
   1. BID – The proposal of the Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.
   2. BIDDER – Any individual, partnership, firm, or corporation submitting a Bid for the Work.
   3. CHANGE ORDER – Written order to the CMGC by Atlantic Richfield Company authorizing an addition, deletion, or revision in the Work, which may require an adjustment in the Contract Sum or Contract Time.
   4. COMPLETION – The finishing of all Work of the Contract and certification to same by Atlantic Richfield Company, and the beginning of the guarantee and/or warrantee period by the CMGC. (See "Substantial" Completion.)
   5. CONSTRUCTION AGREEMENT – Agreement for Construction between Atlantic Richfield Company and the CMGC.
   6. CONTRACT – A written Agreement provided by the Atlantic Richfield Company setting forth the obligations of the parties thereunder, for the performance of all Work and obligations defined in the Contract Documents.
   7. CONTRACT DOCUMENTS – The Request for Proposal (RFP) for the SBCCA Program, Agreement for Construction of the SBCCA Program, General Provisions, Drawings, Change Orders, Technical Specifications, and other documents issued to the CMGC for bid and/or construction.
   8. CONTRACT SUM, CONTRACT PRICE, BID FORM(S) – The total monies due and payable to the CMGC by Atlantic Richfield Company for performance of the Work under the Contract Documents.
   9. CONTRACT TIME – The number of calendar days stated in the Contract Documents for the completion of the Work.
   10. CONSTRUCTION MANAGEMENT GENERAL CONTRACTOR (CMGC) – The individual, partnership, firm, or corporation with whom Atlantic Richfield Company has executed the Agreement for the performance of the Work. CMGC is responsible for construction and shakedown of SBCCA and all associated remedy and end land use systems, features, amenities, and supporting appurtenances.
   11. ENGINEER – Woodard and Curran (W&C), Pioneer Technical Services, Inc., (PTS), or Stantec are the organizations licensed to practice engineering with whom Atlantic Richfield Company has executed an Agreement for the design for the Work described in this RFP. Design Engineers are responsible for the final construction plans and specifications.
   12. EXTRA WORK – The term “Extra Work” shall include work required by Atlantic Richfield Company, which in the judgment of Atlantic Richfield Company, involves changes in, or additions to, the Drawings and Specifications in their Contract form.
   13. NOTICE OF AWARD – The written notice issued by Atlantic Richfield Company to the successful Bidder.
   14. NOTICE TO PROCEED – The written notice to the successful Bidder that authorizes the start of the project scope of work.
   15. OWNER – Atlantic Richfield Company, for whom the Work is to be performed.

16. PREVAILING AGREEMENT – A written agreement between Atlantic Richfield Company and the CMGC.
17. PROGRAM – The complete undertaking as specified in the Contract Documents, of which the Work may be all or a part thereof.
18. SHOP DRAWINGS – All drawings, diagrams, illustrations, brochures, schedules and other data requested under the terms of the Contract Documents and submitted by the CMGC, which are prepared by the CMGC, manufacturer, or distributor and which indicate specifications for materials, equipment, fabrication and installation.
19. STANDBY TIME – Time the CMGC is unable to proceed with the Work due to conditions or events out of their control, such as force majeure type events.
20. SUBCONTRACTOR – An individual, partnership, firm, or corporation having a direct contract with the CMGC or with any other Subcontractor for the performance of a part of the Work. All Subcontractors shall be approved, in advance by Atlantic Richfield Company.
21. SUBSTANTIAL COMPLETION – The finishing of the Work, in accordance with the Contract Documents, so Atlantic Richfield Company may occupy or use the Work or designated portion thereof for the use for which it is intended. (See “Completion”.)
22. SUPPLEMENTAL GENERAL CONDITIONS – Modifications to General Conditions as included in the Contract Documents.
23. SUPPLIERS – Any individual, partnership, firm or corporation supplying materials or equipment to be incorporated in the Work.
24. UNIT PRICE – The price for each item of Work (when requested) which will be compensation in full for all labor, material, equipment, supervision, tools, scaffolding, appurtenances, insurance, engineering, freight, travel, job expenses, telephone, overhead and profit, guarantees, sales taxes, etc.
25. WORK – All labor, material and equipment required to complete the remedial construction and End Land Use (ELU) additions in the SBCCA Program required by the Contract Documents.
26. WORK HOURS – Normal business hours of 6:00 am to 4:00 pm., Monday through Friday for non-residential project areas. 7:00 am to 5:00 pm, Monday through Friday for project areas in the vicinity of residential properties. Work to be performed outside Work Hours requires preapproval by Atlantic Richfield Company.
27. WRITTEN NOTICE – Written notice shall be deemed to have been duly served if delivered in person to the individual, or member of the firm, or to an officer of the corporation for whom it was intended, or if delivered at or sent by registered or certified mail to the last business address known to him who gives the notice.

1.02 CMGC

A. Conduct of the Work:
   1. The CMGC and their subcontractor(s) shall conduct the Work in such manner as to interfere as little as possible with public automotive and pedestrian traffic on public right-of-ways surrounding project sites, and the CMGC shall observe all regulations and requirements relating to obstructing traffic.
   2. The CMGC and his subcontractor(s) shall conduct the Work in such manner as to interfere as little as possible with other Atlantic Richfield Company remediation and construction activities throughout the city of Butte. The CMGC will coordinate with Atlantic Richfield Company for all anticipated interference with on-going remedial activities.
   3. The CMGC shall provide railings or suitable barricades, signs and lights as required by Atlantic Richfield Company to prevent accidents or injury to persons, vehicles or animals. The CMGC shall also provide traffic directional personnel to direct traffic should conditions warrant same, at no additional cost to Atlantic Richfield Company.

4. The CMGC shall take every precaution to minimize and control all vapors, odors, smoke, noise, dust, nuisance, vibration or disturbances caused by machinery, pumping, compressing, trucking, or by any of the CMGC's and Subcontractor's operations, and the CMGC shall be liable for all damage thereof or for violations of any and all present and future laws, ordinances or regulations relating to same until completion of the Work. The CMGC shall provide dust control and air monitoring in accordance with the provided Further Remedial Element Projects Quality Assurance Project Plan (QAPP).
5. The CMGC shall schedule and conduct operations to minimize erosion of soil and to prevent muddying of streams, rivers, impoundments, and lands adjacent to or affected by the Work. Construction of drainage facilities and other Contract Work which will contribute to erosion and sedimentation shall be carried out in conjunction with earthwork operations or as soon thereafter as practicable so that the area of bare soil exposed at any one time by the remedial action construction will be kept to a minimum. The conduct of all Work to be performed under this Contract shall be carried out in accordance with all laws, ordinances and regulations relating to soil erosion and water pollution control, and the CMGC shall be held liable for violation of any and all such laws, ordinances and regulations. CMGC shall construct required soil erosion and/or sedimentation controls according to associated permits and the Soil Erosion and Sediment Control specifications.
6. Materials, supplies or equipment to be incorporated into the Work shall not be purchased by the CMGC or Subcontractors subject to a chattel mortgage or under a conditional sales contract or other agreement by which an interest is retained by the seller.
7. Materials and equipment shall be stored to ensure the preservation of their quality and fitness for the Work. Stored materials and equipment which are to be incorporated in the Work shall be located and stored in a manner that will facilitate prompt inspection by Atlantic Richfield Company.
8. Material which is stored on the site or material that has been installed and incorporated into the Work that is not in conformance with the Contract Documents shall be considered to be defective. Upon written order by Atlantic Richfield Company, material considered to be defective shall be removed and replaced with material which conforms with the Contract Documents, and at no additional cost to Atlantic Richfield Company.
9. Should any work be covered or installed so that inspection and tests cannot be made in accordance with the requirements as specified under the various Sections of the Specifications, then the CMGC will be required to uncover or remove portions of the finished work as necessary so that these inspections and tests can be made and replace same in accordance with the Specifications to the satisfaction of Atlantic Richfield Company. The uncovering, taking down, and replacing shall be at the expense of the CMGC.
10. Manufactured articles, materials and equipment shall be applied, installed, connected, erected, used, cleaned and conditioned as directed by the manufacturer.
11. Upon completion of the Work, the CMGC shall demonstrate that the performance criteria as specified are achieved. The demonstration of performance criteria shall be observed and reviewed by Atlantic Richfield Company. The work will be considered complete upon final acceptance of the work by Atlantic Richfield Company.
12. Upon completion of all the Work and before final payment is made, the CMGC shall remove from the site and all public and private property all excess material undesired by Atlantic Richfield Company, debris, temporary structures, tools, and equipment resulting from the CMGC's operations, and shall leave the entire premises in a neat condition to the satisfaction of Atlantic Richfield Company.

B. Subsurface Conditions:
   1. The CMGC shall promptly, and before such conditions are disturbed, except in the event of an emergency, notify Atlantic Richfield Company by Written Notice, in the event:
      a. Subsurface or latent physical conditions at the site differ materially from those indicated in the Contract Documents.
      b. Unknown physical conditions at the site, of an unusual nature, differ materially from those ordinarily encountered and generally recognized as inherent in the Work of the character provided for in the Contract Documents.
   2. Atlantic Richfield Company shall promptly investigate the conditions, and if they find that such conditions do so materially differ, such that they will cause an increase or decrease in the cost of, or in the time required for, performance of the Work, an equitable adjustment shall be made and the Contract Sum and/or Contract Time shall be modified by a Change Order. Any claim of the CMGC for adjustment hereunder shall not be allowed unless they have given the required written Notice, provided that Atlantic Richfield Company may, if they determine the facts so justify, consider and adjust any such claims asserted before the date of final payment.

C. Access to the Work:
   1. Atlantic Richfield Company or and their representatives shall at all times have access to the Work. The CMGC shall provide proper access facilities for observation, inspection, and testing of the Work as required by Atlantic Richfield Company.
   2. If any Work is covered from view contrary to the Specifications or the written request of Atlantic Richfield Company, or contrary to laws, ordinances, rules and regulations of public or private authorities having jurisdiction, it must, if requested by Atlantic Richfield Company, be uncovered for observation, corrected if necessary, and recovered at the CMGC's expense.
   3. If any Work has been covered from view which is not contrary to the Specifications or laws, ordinances, rules and regulations of public or private authorities having jurisdiction, and which Atlantic Richfield Company has not specifically requested to observe prior to its being covered, and if Atlantic Richfield Company considers it necessary or advisable that said covered Work be inspected or tested by others, the CMGC, upon request, shall uncover, expose or otherwise make available for observation, inspection or testing as may be required, that portion of the Work in question, furnishing all necessary labor, materials, tools and equipment. If it is found that such Work is defective, the CMGC shall bear all the expenses of such uncovering, exposure, observation, inspection and testing and of satisfactory reconstruction. If, however, such Work is not found to be defective, the CMGC will be allowed an increase in the Contract Sum or an extension of the Contract Time, or both, directly attributable to such uncovering, exposure, observation, inspection and testing, and an appropriate Change Order will be issued.

D. Inspection and Testing:
   1. All materials and equipment used in the Work shall be subject to adequate inspection and testing as specified in the Contract Documents and as directed by Atlantic Richfield Company.
   2. All inspection and testing as specified in the Contract Documents shall be paid for by the CMGC. Atlantic Richfield Company may, at its expense, provide additional inspection and testing services not specifically required by the Contract Documents.
   3. If the Contract Documents and/or laws, ordinances, rules, regulations, or orders of any private or public authority having jurisdiction require any work specifically to be inspected, tested, or approved by persons or parties other than the CMGC, then the CMGC shall upon completion of that portion of the Work serve notice to Atlantic

Richfield Company that said portion of the Work is ready for testing. The CMGC shall be responsible for obtaining the required certificates of inspection, testing or approval and delivering same to Atlantic Richfield Company.

4. Neither observations by Atlantic Richfield Company, nor inspections, tests or approvals by persons or parties other than the CMGC shall relieve the CMGC from his obligations to perform the Work in accordance with the requirements of the Contract Documents.

E. Performance Testing:
   1. Performance testing following installation of the Work shall be performed by Atlantic Richfield Company with support from the CMGC as described in the Contract Documents for the SBCCA Program. Successful demonstration of the Work performance is required prior to final acceptance of the Work by Atlantic Richfield Company.

1.03 PROTECTION OF PERSON AND PROPERTY

A. Safety Precautions:
   1. The CMGC shall be responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the Work. The CMGC shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to all employees on the Work and other persons who may be affected thereby, all the Work and all materials or equipment to be incorporated therein, whether in storage on or off the site, and other property at the site or adjacent thereto, including, but not limited to, trees, shrubs, lawns, walks, pavements, roadways, structures and utilities not designated for removal, relocation or replacement in the course of the Work.
   2. The CMGC shall comply with all applicable safety laws, ordinances, rules and regulations and orders of any agency having jurisdiction. The CMGC shall erect and maintain, as required by the conditions and progress of the Work, all necessary safeguards for safety and all damage, injury or loss to any property caused, directly or indirectly, in whole or in part, by the CMGC, any Subcontractor or anyone directly or indirectly employed by any of them or anyone for whose acts any of them be liable.
   3. In emergencies affecting the safety of persons or the Work or property at the site or adjacent thereto, the CMGC, without special instruction or authorization from Atlantic Richfield Company, shall act to prevent threatened damage, injury, or loss. The CMGC shall give Atlantic Richfield Company prompt Written Notice of any significant changes in the Work or deviations from the Contract Documents caused thereby, and a Change Order will thereupon be issued covering the changes and deviations involved, if such were required because of provisions of the Contract Documents.

B. Laws, Ordinances, Rules and Regulations:
   1. The CMGC shall obtain Permits and Licenses, as necessary and required for the prosecution of the Work, unless specifically stated otherwise in the Contract Documents. It is the responsibility of the CMGC to confirm applicability of Permits and Licenses and attain said Permits and Licenses in a manner so as not to impact implementation of the Work.
   2. The CMGC shall give all notices and comply with all permits, laws, ordinances, rules and regulations as required by all authorities having jurisdiction bearing on the conduct of the Work as specified.
   3. If any of the CMGC's work is performed contrary to such permits, laws, ordinances, rules and regulations, and/or without the required notices, the CMGC shall bear all costs arising therefrom.

1.04 SHOP AND RECORD DRAWINGS

A. Shop Drawings:
   1. The CMGC shall submit to Atlantic Richfield Company for approval submittals as called out in the various Sections of the Specifications in accordance with Section 01 33 00 – Submittal Procedures.
   2. The CMGC shall examine Shop Drawings and other submitted data before forwarding them to Atlantic Richfield Company, and again when they are returned, in order to determine whether the work shown conforms with the Drawings, Specifications and job conditions and the CMGC shall so certify that they have done so on an accompanying letter of transmittal. He shall coordinate the work shown thereon with the work of all Subcontractors.
   3. The CMGC shall submit Shop Drawings and other data in accordance with the Project Schedule and in the material specifications' sequence so that each item can be delivered and installed when necessary, taking into consideration the time required for delivery after approval of submitted material. The submittal review periods are specified in Section 01 33 00 – Submittal Procedures.
   4. Three copies of all Shop Drawings shall be submitted. One (1) copy will be retained by Atlantic Richfield Company, and two (2) copies will be returned to the CMGC.
   5. Atlantic Richfield Company shall review Drawings and other submitted data with respect to design submittals and request such changes and corrections thereto as they deem necessary.
   6. Atlantic Richfield Company's review of the Shop Drawings does not relieve the CMGC in any way of his sole responsibility for correctness of all calculations, dimensions and quantities, fitting to other work, and conformance to all specifications.
   7. If the reviewed Drawings indicate that Atlantic Richfield Company has reviewed dimensions, it shall be understood that this review is based upon the Construction drawings, and the dimensions shall be verified by the CMGC with actual field dimensions and conditions.
   8. Drawings and other submitted data that is returned "CONFORMS WITH DESIGN REQUIREMENTS" need not be resubmitted. If returned "CONFORMS AS NOTED", then the CMGC may proceed with the work thereon as per added notations and corrections. The Drawings and other data shall, however, be corrected and reissued to Atlantic Richfield Company, and to others who are involved in the Work. Drawings and data that are stamped "REVISE AND RESUBMIT" shall be revised as indicated, and then re-submitted. This procedure shall be repeated at no additional cost to Atlantic Richfield Company until the Drawings and data are in conformance as determined by Atlantic Richfield Company.
   9. If the CMGC feels that the Atlantic Richfield Company notations to Shop Drawings and other submitted data will incur hardship or additional costs that the CMGC feels he should not bear, he shall so inform Atlantic Richfield Company in writing, and not proceed with the changes until the problems are settled.
   10. Portions of the Work requiring a Shop Drawing or other submission shall not begin until the Shop Drawing or submission has been reviewed for conformance by Atlantic Richfield Company. A copy of each reviewed Shop Drawing shall be kept in good order by the CMGC at the site and shall be available to Atlantic Richfield Company.

B. Record Drawings:
   1. Concurrently with the progress of the Work, the CMGC shall keep on the site a set of "as-built" Record Drawings, consisting of a reproducible marked set of the Drawings with the additional sketches as required, denoting and dimensioning accurately and neatly all changes and conditions that are variations from the Drawings. Additionally,

the CMGC shall keep an electronic copy of the set of “as-built” Record Drawings produced by software capable of marking up existing drawings (i.e. Bluebeam).

2. An accurate record shall also be kept of all existing site items which are reworked or relocated under the Contract.
3. The "as-built" drawings shall be available for examination at the site at all times. Upon completion of the Work, the CMGC shall deliver to Atlantic Richfield Company Drawings with the additional sketches as required, denoting and dimensioning accurately and neatly all changes and conditions that are variations from the Drawings, to be used by Atlantic Richfield Company in developing a reproducible set of the Record Drawings.
4. The CMGC's attention is directed to the fact that submission of the reproducible sets of "as-built" Record Drawings is a prerequisite for final payment.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

(NOT USED)

END OF SECTION

SECTION 01 32 00
GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. This section describes general requirements of the project, such as coordination, site access, and weekly meetings. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 COORDINATION AND ACCESS TO SITE

A. The Atlantic Richfield Representative shall provide agency coordination to assist the CMGC in completing the work with a minimum of interference and inconvenience. Access to private property shall be available during construction. If access must be impacted, the CMGC shall notify the Atlantic Richfield Representative 48 hours in advance. Only the Atlantic Richfield Representative shall coordinate with private property owners. The closure, or impact, shall be for no more than 8 hours, unless otherwise coordinated and approved by the Atlantic Richfield Representative and the property owner.

1.03 UTILITIES

A. Utilities identified in the Construction Drawings are in approximate locations unless otherwise specified and may not include or identify all utilities present at the Site. The CMGC is responsible for calling One-Call at 811 or 800-398-3285 prior to starting construction. The CMGC shall adhere to the Remediation Management (RM) Defined Practice for Ground Disturbance. This will include all pot holing and blind sweeps required to comply with the RM Defined Practice for Ground Disturbance. The CMGC shall locate and protect all utilities and repair at CMGC's expense any damage to utilities caused by the CMGC. The CMGC shall be responsible for protecting existing structures including all existing historical features, and monitoring wells within and external to the construction area. Damage to existing structures shall be corrected by the CMGC at no additional cost to Atlantic Richfield.

B. The CMGC shall notify the Atlantic Richfield Representative of all buried utilities encountered during the Work and shall leave discovered utilities exposed until the type, size, location, and owner of the utility is recorded and mapped under the requirements of Section 01 78 10 – As-Built Records.
   1. Utility Outages: The CMGC shall coordinate utility outages with utility companies and the Atlantic Richfield Representative at least 7 calendar days in advance of expected disruption of service. The CMGC shall notify all businesses and residences affected by utility outages 24 hours prior to an outage. Outages shall be kept to a minimum and any one outage shall not last more than 8 hours.
   2. Communications with Utilities: The CMGC shall provide copies of all written communications with the utility owner(s) to the Atlantic Richfield Representative. The CMGC shall notify the appropriate utility owner(s) at least five days in advance of excavating near any utility within the construction area. The CMGC shall meet and coordinate with the appropriate utility representatives to determine exact locations, crossing requirements, and schedules. The CMGC shall provide the Atlantic Richfield Representative with at least 48 hours advance notice of meetings scheduled with utility owner(s). The CMGC shall adhere to RM Defined Practice for Ground Disturbance.

1.04 WEEKLY COORDINATION MEETINGS

A. The CMGC, Atlantic Richfield, and Agency representative shall meet weekly as described in Section 01 32 10 – Progress Schedule. A meeting time and place shall be mutually agreed upon. At a minimum, the CMGC's on-site Project Manager, Health and Safety Manager, and appropriate field personnel shall be present at the progress meetings. The CMGC shall develop the agenda and topics shall include but not be limited to:
   1. Health and safety issues;
   2. Status of work items initiated to date;
   3. Scheduled items for the following 2 weeks;
   4. Overall Project Schedule;
   5. Quality Control and Quality Assurance;
   6. Problems encountered and proposed solutions;
   7. Submittal Registry review to include identification of items recently approved and items anticipated in the following 2 weeks;
   8. Modifications to the Remedial Action Work Plan (RAWP) and potential Requests for Change (RFCs); and
   9. Other items identified by Atlantic Richfield or the CMGC.

B. The CMGC shall submit minutes of the meetings within 3 working days for review and acceptance by the Atlantic Richfield Representative.

1.05 ACCESS CONTROL

A. The CMGC shall implement an appropriate program to protect the work in progress and Atlantic Richfield's operations from theft, vandalism and unauthorized entry, such as restricting access at primary entry points.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

(NOT USED)

END OF SECTION

SECTION 01 32 10
PROGRESS SCHEDULE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Construction Management General Contractor (CMGC)shall furnish all labor, materials, equipment, and incidentals required to prepare and update a project progress schedule for its own work. CMGC shall; also, cooperate with the Atlantic Richfield Company Representative with the preparation of a comprehensive project schedule, and is required to promptly furnish the Atlantic Richfield Company Representative with such data as may be requested. The CMGC shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 SUBMITTALS

A. Atlantic Richfield Company approval is required for all submittals. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-01 Preconstruction Submittals:
      a. Progress Schedule:
         1) The Progress Schedule shall be included as part of the CMCG's project-specific Construction Execution Plan (CEP). Submit the Progress Schedule defining the CMGC's planned operations for the entire project duration for approval within 10 calendar days after the Notice to Proceed (NTP) is acknowledged. The Progress Schedule must include all the required Plan and Program preparations, submittals and approvals identified in the contract (for example, Quality Control Plan, Construction Site Plan, and Environmental Protection Plan, etc.) as well as permitting activities, and other non-construction activities intended to occur within the project duration.
         2) Project Milestone Dates: Show dates on the diagram for start of project, any contract required interim completion dates, and contract completion dates.
         3) Critical Path: Clearly show the critical path.
   2. SD-03 Product Data:
      a. Periodic Schedule Updates:
         1) Submit a Periodic Schedule Update not later than 4 working days after the schedule update meeting, reflecting only those changes made during the previous update meeting.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.01 PROGRESS SCHEDULE

A. Prepare for approval a Progress Schedule. Show in the schedule the sequence in which the CMGC proposes to perform the work and dates on which the CMGC contemplates starting and completing all schedule activities. The scheduling of the entire project is required. The progress schedule shall be a forward planning and a project monitoring tool.

1. Level of Detail Required:
    a. Develop the Progress Schedule to an appropriate level of detail. Failure to develop the Progress Schedule to an appropriate level of detail, as determined by the Atlantic Richfield Company Representative, will result in its disapproval. The Atlantic Richfield Company Representative will consider, but is not limited to, the following characteristics and requirements to determine appropriate level of detail as discussed below.
        1) Activity Durations:
            (a) Reasonable activity durations are those that allow the progress of ongoing activities to be accurately determined between update periods. Less than 2 percent of all non-procurement activities shall have Original Durations (OD) greater than 20 workdays or 30 calendar days. Procurement activities are defined herein.
        2) Procurement Activities:
            (a) The schedule must include activities associated with the submittal, approval, procurement, fabrication and delivery of long lead materials, equipment, fabricated assemblies and supplies. Long lead procurement activities are those with an anticipated procurement sequence of over 90 calendar days. A typical procurement sequence includes the string of activities: submit, approve, procure, fabricate, and deliver.
        3) Mandatory Tasks:
            (a) The following tasks must be included and properly scheduled:
                (i) Submission and approval of record survey and as-built drawings.
                (ii) CMGC's pre-final inspection.
                (iii) Punchlist from CMGC's pre-final inspection.
                (iv) Atlantic Richfield Company and Agency’s pre-final inspection.
                (v) Punch list from Atlantic Richfield Company and Agency’s pre-final inspection.
                (vi) Final inspection.
                (vii) Budgeted adverse weather days for each month.
        4) Atlantic Richfield Company Activities:
            (a) Show Atlantic Richfield Company activities that could impact progress. These activities include, but are not limited to: inspections and NTP for phasing requirements.
        5) Activity Responsibility Coding:
            (a) Assign responsibility Code for all activities to the Prime CMGC, Subcontractor, or Atlantic Richfield Company Representative responsible for performing the activity. Activities coded with an Atlantic Richfield Company Responsibility code include, but are not limited to: Atlantic Richfield Company approvals and NTP for phasing requirements. Code all activities not coded with an Atlantic Richfield Company Responsibility code to the Prime CMGC or Subcontractor responsible to perform the work. Activities shall not have more than one Responsibility code.
2. Schedule Interval and Activity Calendars:
    a. The schedule interval shall extend from NTP date to the required contract completion date. The first scheduled work period shall be the day after NTP is acknowledged by the CMGC. If the CMGC intends to perform physical work less than seven days per week, schedule the associated activities on a calendar with non-work periods identified including weekends and holidays. Original durations must account for anticipated normal adverse weather. Atlantic Richfield Company will interpret all work periods not identified as non-work periods on each calendar as meaning the CMGC intends to perform work during those periods.

3. Milestones:
    a. The schedule must include milestone activities for each significant project event.
4. Adverse Weather Days:
    a. The schedule must reflect CMGC's anticipated delays due to adverse weather and must show that the critical path will not be affected by seasonally normal adverse weather. The schedule must include the budgeted adverse weather days for each month. A request for time extension will only be considered in the event that unusually severe weather causes an actual delay to the completion of the project.

3.02 WEEKLY PROGRESS MEETINGS

A. Prepare and provide a schedule status report (i.e., electronic file in pdf format) to the Atlantic Richfield Company representative at least 1 day prior to each weekly progress meeting.

B. Atlantic Richfield Company and the CMGC shall meet weekly (or as otherwise mutually agreed to) between the meetings for the purpose of jointly reviewing the actual progress of the project as compared to the as-planned progress and to review planned activities for the upcoming two weeks. The then current and approved schedule update shall be used for the purposes of this meeting and for the production. The CMGC's Project Manager and the Atlantic Richfield Company Representative shall attend. The weekly progress meeting will address the status of RFI's, RFP's, and Submittals.

C. Atlantic Richfield Company and the CMGC shall jointly review the Schedule Status. If it appears that activities on the longest path(s), which are currently driving the calculated completion date (driving activities), are not progressing satisfactorily and therefore could jeopardize timely project completion, corrective action shall be taken immediately. Corrective action includes but is not limited to: increasing the number of work crews; increasing the number of work shifts; increasing the number of hours worked per shift; and determining if Atlantic Richfield Company responsibilities require Atlantic Richfield Company corrective action.

3.03 PERIODIC SCHEDULE UPDATE MEETINGS

A. Conduct periodic schedule update meetings for the purposes of reviewing the CMGC's proposed out of sequence corrections, determining causes for delay, and maintaining schedule accuracy. Meetings shall occur at least monthly and after the CMGC has updated the schedule with Atlantic Richfield Company concurrence respecting actual start dates, actual finish dates, remaining durations and percent complete for each activity it intends to status.

3.04 PERIODIC SCHEDULE UPDATES

A. Based on the result of the meeting, specified in Paragraph 3.03 above, submit periodic schedule updates. These submittals will enable the Atlantic Richfield Company Representative to assess the CMGC's progress. If the CMGC fails or refuses to furnish the information and Progress Schedule data, which in the judgment of the Atlantic Richfield Company Representative is necessary for verifying the CMGC's progress, the CMGC shall be deemed not to have provided an estimate upon which progress payment may be made.

3.05 REQUESTS FOR TIME EXTENSIONS

A. In the event the CMGC believes it is entitled to an extension of the contract performance period, completion date, or any interim milestone date, furnish the following for a determination by the Atlantic Richfield Company Representative: justification, Progress

Schedule data, and supporting evidence the Atlantic Richfield Company Representative may deem necessary. Submission of proof of excusable delay is a condition precedent to any approvals by Atlantic Richfield Company. In response to each Request for Proposal issued by Atlantic Richfield Company, the CMGC shall submit a schedule impact analysis demonstrating whether or not the change contemplated by Atlantic Richfield Company impacts the critical path.

B. The Progress Schedule shall clearly display that the CMGC has used, in full, all the float time available for the work involved with this request. The Atlantic Richfield Company Representative's determination as to the number of allowable days of contract extension shall be based upon the Progress Schedule updates in effect for the time period in question, and other factual information. Actual delays that are found to be caused by the CMGC's own actions, which result in a calculated schedule delay, will not be a cause for an extension to the performance period, completion date, or any interim milestone date.

3.06 DIRECTED CHANGES

A. If the NTP is issued for changes prior to settlement of price and/or time, submit proposed schedule revisions to the Atlantic Richfield Company Representative within 2 weeks of the NTP being issued. The Atlantic Richfield Company Representative will approve proposed revisions to the schedule prior to inclusion of those changes within the Progress Schedule. If the CMGC fails to submit the proposed revisions, the Atlantic Richfield Company Representative may furnish the CMGC with suggested revisions to the Progress Schedule. The CMGC shall include these revisions in the Progress Schedule until revisions are submitted and final changes and impacts have been negotiated. If the CMGC has any objections to the revisions furnished by the Atlantic Richfield Company Representative, advise the Atlantic Richfield Company Representative within 2 weeks of receipt of the revisions. Regardless of the objections, the CMGC shall continue to update the schedule with the Atlantic Richfield Company Representative's revisions until a mutual agreement in the revisions is reached. If the CMGC fails to submit alternative revisions within 2 weeks of receipt of the Atlantic Richfield Company Representative's proposed revisions, the CMGC will be deemed to have concurred with the Atlantic Richfield Company Representative's proposed revisions. The proposed revisions will then be the basis for an equitable adjustment for performance of the work.

3.07 OWNERSHIP OF FLOAT

A. Float available in the schedule, at any time, shall not be considered for the exclusive use of either Atlantic Richfield Company or the CMGC.

END OF SECTION

SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Submittal requirements are specified below. Submittals are identified by submittal descriptions (SD) numbers and titles as follows. Some submittals listed below may not be required. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1. SD-01 Preconstruction Submittals:
    a. Agency Reviewed Preconstruction Submittals:
        1) Health and Safety Plan - CMGC shall prepare a Site-Specific Health and Safety Plan (SSHASP) describing all activities to be performed to protect on-site personnel and area residents from physical, chemical, and all other hazards posed by the Work. EPA does not approve the HASP but will review it to ensure that all necessary elements are included and that the plan provides for the protection of human health and the environment. Included in the SSHASP shall be a Site-Specific Emergency Response Plan. The Emergency Response Plan (ERP) must describe procedures to be used in the event of an accident or emergency at the Site (for example, power outages, water impoundment failure, treatment plant failure, slope failure, etc.). The CMGC shall prepare an ERP specific to the project area in which work activities are being performed. The ERP must include:
            (a) Name of the person or entity responsible for responding in the event of an emergency incident.
            (b) Plan and date(s) for meeting(s) with the local community, including local, State, and federal agencies involved in the cleanup, as well as local emergency squads and hospitals.
        2) Preliminary List of Submittals – CMGC shall prepare a list of anticipated submittals for the work at each project site (e.g. Buffalo Gulch, Diggings East, Butte Reduction Work, etc.) for Atlantic Richfield's review and approval. Included in the preliminary List of Submittals shall be relative estimations when the submittal is anticipated in the construction process (e.g., pre-construction, prior to material placement, prior to concrete placement, etc.). Upon Atlantic Richfield's satisfaction, the list shall be provided to the Agencies for their consideration and comment.
    b. Contractual Preconstruction Submittals:
        1) Prior to construction at a project site, the CMGC shall prepare contractual (i.e. contractual between Atlantic Richfield and it's CMGC) preconstruction documents and plans for Atlantic Richfield review and approval. These plans are intended to assure Atlantic Richfield that the CMGC understands the contractual and regulatory requirements to complete the work (e.g. CMGC conducting work consistent with Agency approved work plans, other state, federal and local regulation, Atlantic Richfield contract requirements, etc.). Upon preparation of these plans to Atlantic Richfield's satisfaction, these plans shall be submitted for final Atlantic Richfield approval through the Submittal Register. Through access to the Submittal Register, Agencies shall have access to approved Preconstruction Submittals for their verification.

2) The following is a list of anticipated preconstruction submittals. CMGC and Atlantic Richfield may mutually determine to combine plans, modify plan names, or omit plans, as applicable;
   (a) Project-Specific Construction Execution Plans (CEP) scoped towards specific project sites (e.g., Buffalo Gulch, Diggings East, Butte Reduction Works, etc.) describing at a minimum the following construction components for the project site:
      (i) Project Schedule and Sequencing requirements.
      (ii) Construction Site Access, Staging, and Security.
      (iii) Utility and Existing Infrastructure Protection.
      (iv) Demolition and Disposal.
      (v) Construction Dewatering.
      (vi) Excavation, Waste Management, and Disposal.
      (vii) Backfill and Grading.
      (viii) Stormwater Detention/Retention Conveyance System Construction
      (ix) End Land Use Features and Site Amenities
      (x) Revegetation and Planting.
      (xi) Winterization.
      (xii) Traffic Control Plan (including state and county approval as necessary) as a standalone attachment.
      (xiii) Dust Control Plan as a standalone attachment.
      (xiv) Stormwater Pollution Prevention Plan (SWPPP) as a standalone attachment.
   (b) CMGC Environmental Protection Plan (assumed to be consistent to all project sites).
   (c) CMGC Quality Control Plan (assumed to be consistent to all project sites).
   (d) Additional plans may be developed as Atlantic Richfield deems necessary.
3) Preconstruction submittals are generally indicated in the Paragraph SUBMITTALS in each Technical Specification Section, when applicable, and in the preliminary List of Submittals.

B. SD-02 Shop Drawings:
   1. Drawings, diagrams, and schedules specifically prepared to illustrate some portion of the work.
   2. Diagrams and instructions from a manufacturer or fabricator for use in producing the product and as aids to the CMGC for integrating the product or system into the project.
   3. Drawings prepared by or for the CMGC to show how multiple systems and interdisciplinary work will be coordinated.

C. SD-03 Product Data:
   1. Catalog cuts, illustrations, schedules, diagrams, performance charts, instructions and brochures illustrating size, physical appearance and other characteristics of materials, systems or equipment for some portion of the work.
   2. Samples of warranty language when the contract requires extended product warranties.

D. SD-04 Samples:
   1. Fabricated or unfabricated physical examples of materials, equipment or workmanship that illustrate functional and aesthetic characteristics of a material or product and establish standards by which the work can be judged.

2. Color samples from the manufacturer's standard line (or custom color samples if specified) to be used in selecting or approving colors for the project.
3. Field samples and mock-ups constructed on the project site establish standards by which the ensuring work can be judged. Includes assemblies or portions of assemblies which are to be incorporated into the project and those which will be removed at conclusion of the work.

E. SD-05 Test Reports:
1. Report signed by authorized official of testing laboratory that a material, product or system identical to the material, product or system to be provided has been tested in accordance with specified requirements. (Testing must have been within one (1) year of date of contract award for the project.)
2. Report which includes findings of a test required to be performed by the CMGC on an actual portion of the work or prototype prepared for the project before shipment to job site.
3. Report which includes finding of a test made at the job site or on a sample taken from the job site, on portion of work during or after installation.
4. Daily logs and checklists.
5. Final acceptance test and operational test procedure.

F. SD-06 Certificates:
1. Statements printed on the manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements. Must be dated after award of project contract and clearly name the project.
2. Document required of CMGC, or of a manufacturer, supplier, installer or subcontractor through CMGC, the purpose of which is to further the quality of orderly progression of a portion of the work by documenting procedures, acceptability of methods or personnel qualifications.

G. SD-07 Closeout Submittals:
1. Special requirements necessary to properly close out a construction contract. For example, Record Drawings, manufacturer's help and product lines necessary to maintain and install equipment. Also, submittal requirements necessary to properly close out a major phase of construction on a multi-phase contract.

1.02 SUBMITTALS

A. Atlantic Richfield Representative's approval is required for extensions of design, critical materials, variations/deviations, an "or equal" decision, equipment whose compatibility with the entire system must be checked, architectural items such as Color Charts/Patterns/Textures, and other items as designated by the Atlantic Richfield Representative. All variations/deviations in design are subject to AR-RM Integrity Management Practices.

1.03 LIST OF SUBMITTALS

A. A preliminary List of Submittals listing the basic contract submittal items will be provided by Atlantic Richfield as an excel spreadsheet. CMGC shall expand the List of Submittals as necessary to track Project and Material Submittals for the project. Atlantic Richfield shall provide the preliminary Submittal List to the Agencies prior to the Pre-construction Meeting for discussion in the meeting.

B. CMGC shall utilize the preliminary List of Submittals to develop an electronic Submittal Register (e.g., ProjectSight by Trimble or equivalent) to process and manage material and other project submittals. The electronic Submittal Registry shall list and archive all approved submittals for Agency verification. The submittal registry will be reviewed by the CMGC in weekly progress meetings to include providing a list of anticipated forthcoming approved submittals.
    1. Submittal Review Periods:
        a. In preparing the submittals, adequate time (minimum of 10 working days) shall be allowed for the Atlantic Richfield Representative review and approval, and possible resubmittal of each item on the register. Submittals shall be submitted within the time frame required by the Atlantic Richfield Representative. The preliminary List of Submittals shall be coordinated with the progress schedule and submitted prior to the pre-construction meeting.

1.04 APPROVED SUBMITTALS

A. Submittals are approved by Atlantic Richfield to confirm the CMGC is conducting the work and procuring materials consistent with contractual requirements and Agency approved work plans. The approval of submittals by the Atlantic Richfield Representative shall not be construed as a complete check but will indicate only that the general method of construction, materials, detailing, and other information are satisfactory. Approval will not relieve the CMGC of the responsibility for any error which may exist, as the CMGC under the Contractor Quality Control (CQC) requirements of this contract is responsible for the dimensions and design of adequate connections, details, and satisfactory construction of all work. After submittals have been approved by the Atlantic Richfield Representative, no resubmittal for the purpose of substituting materials or equipment will be given consideration unless accompanied by an explanation as to why a substitution is necessary.

1.05 DISAPPROVED SUBMITTALS

A. The CMGC shall make all corrections required by the Atlantic Richfield Representative and promptly furnish a corrected submittal in the form specified for Atlantic Richfield Representative's approval. If the CMGC considers any correction indicated on the submittals to constitute a change to the contract, notice as required under the Contract, shall be given promptly to the Atlantic Richfield Representative.

1.06 WITHHOLDING OF PAYMENT

A. Payment for materials incorporated in the work will not be made if required approvals have not been obtained.

1.07 PAYMENT

A. Separate payment will not be made for submittals, and all costs associated therein shall be included in the applicable unit prices or lump sum prices contained in the schedule.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

A. Prior to submittal, all items shall be checked and approved by the CMGC's CQC and each item of the submittal shall be stamped, signed, and dated. Each respective transmittal form shall be signed and dated by the CMGC's CQC certifying that the accompanying submittal complies with the contract requirements. This procedure applies to all submittals. Each submittal shall be complete and in sufficient detail to allow determination of compliance with contract requirements. Submittals shall be scheduled and made prior to the acquisition of the material or equipment covered thereby.

B. The Atlantic Richfield Representative may request submittals in addition to those listed when deemed necessary to adequately describe the work covered in the respective sections. The CMGC shall maintain a complete and up-to-date file of all submittals/items on-site for use by both the CMGC and the Atlantic Richfield Representative.

3.02 LIST OF SUBMITTALS

A. The preliminary List of Submittals for all Divisions shall be reviewed by the CMGC prior to the Pre-Construction Meeting. During the Pre-Construction Meeting, the List of Submittals will be reviewed. The CMGC shall review the list to ensure its completeness and may expand general category listings to show individual entries for each item. When a conflict exists between the List of Submittals and a submittal requirement in the technical sections, the technical section shall govern unless otherwise approved by the Atlantic Richfield Representative.

3.03 SCHEDULING

A. Submittals covering component items forming a system, or items that are interrelated shall be coordinated and submitted concurrently. Certifications shall be submitted together with other pertinent information and/or drawings. No delays, damages, or time extensions will be allowed for time lost due to the CMGC not properly scheduling and providing submittals.

3.04 TRANSMITTAL FORM

A. A transmittal form shall be used for submitting both Atlantic Richfield Representative Approved and Information Only submittals in accordance with the contract documents and as directed by the Atlantic Richfield Representative. This form will be furnished to the CMGC by Atlantic Richfield. This form shall be properly completed by filling out all the heading blank spaces and identifying each item submitted. Special care will be exercised to ensure proper listing of the specification paragraph and/or sheet number of the Construction Drawings pertinent to the data submitted for each item. The Atlantic Richfield Representative reserves the right to refuse submittals which are improperly completed.

3.05 SUBMITTAL PROCEDURE

A. Submittals shall be made as follows:
   1. General:
      a. Transmittal forms shall be initiated by the CMGC in accordance with the instructions herein and as described in the Contract, or as directed by the Atlantic Richfield Representative. A standard transmittal form will be furnished by Atlantic Richfield for the CMGC. Each submittal item shall be listed separately on the form naming subcontractor, supplier, or manufacturer, applicable specification

paragraph number(s), drawing/sheet number, pay item number, and any other information needed to identify the item, define its use, and locate it in the work.

2. Approval of Submittals:
   a. All submittals shall be CMGC approved and approved by Atlantic Richfield Representatives as required.
   b. Before submission, CMGC shall review and correct shop drawings prepared by subcontractors, suppliers, and itself, for completeness and compliance with Construction Drawings and Technical Specifications. CMGC shall not use red markings for correcting material to be submitted. Red markings are reserved for Atlantic Richfield Representative's use. Approval by CMGC shall be indicated on each shop drawing submitted by the CMGC.
3. Variations:
   a. For submittals which include proposed variations requested by the CMGC, it shall be documented in the transmittal form. The CMGC shall set forth in writing the justification for any variations and annotate such variations on the submittal. Normally, variances are not approved unless there is an advantage to Atlantic Richfield. The Atlantic Richfield Representative reserves the right to rescind inadvertent approval of submittals containing unnoted deviations. Variances or modifications that are deviations from Agency approved components of the work (e.g. deviation from approved Work Plans) shall be communicated to the Agencies in the progress meeting. Upon Agency concurrence, deviation items deemed insignificant or like kind deviation, shall be documented in the submittal form and approved by Atlantic Richfield. Items deemed as significant deviations shall be provided to the Agencies for review and approval through the Request for Change (RFC) process.
   b. RFC shall be prepared by Atlantic Richfield, supported by the CMGC as needed. RFCs shall be submitted and signed by Atlantic Richfield and approved by the EPA's project representatives, done in consultation with DEQ, and notated in the daily log.
4. Submittal Completeness:
   a. Submittals provided by the CMGC which do not have all the information required to be submitted, including deviations, are not acceptable and will be rejected by Atlantic Richfield.

END OF SECTION

SECTION 01 34 00
SAFETY, HEALTH, AND EMERGENCY RESPONSE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section requires the Construction Management General Contractor (CMGC) to implement practices and procedures for working safely and shall perform all work in compliance all applicable federal, state, and local regulations, in addition to all Occupational Safety and Health Administration (OSHA), Mine Safety and Administration (MSHA), Atlantic Richfield Company (AR) Remediation Management (RM) Health, Safety, Security, and Environment (AR-RM HSSE) Management System Practices and Procedures and Guidance, and AR Control of Work (CoW).

B. Some of the tasks to be performed under this contract will involve potential exposure to heavy metals, demolition debris containing asbestos, and hydrocarbons contamination throughout the site. The requirements of this specification section address both types of activities. The critical element for compliance with this specification is performance of activity/job hazard analyses for each task and making sure they are specific to the work site and tasks to be performed.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
   1. American National Standards Institute (ANSI):
      a. ANSI Z358.1 - Emergency Eyewash and Shower Equipment.
   2. U.S Department of Labor – Occupational Safety and Health Administration (OSHA):
      a. 29 CFR 1904 - Recording and Reporting Occupational Injuries and Illnesses.
      b. 29 CFR 1910 - Occupational Safety and Health (OSHA) Standards.
      c. 29 CFR 1910.120 - Hazardous Waste Operations and Emergency Response.
      d. 29 CFR 1910.141 - Sanitation.
      e. 29 CFR 1910.146 - Permit-required Confined Spaces.
      f. 29 CFR 1910.147 - Control of Hazardous Energy (Lock Out/Tag Out).
      g. 29 CFR 1910.212 - Safety Standard for Machinery and Machine Guarding.
      h. 29 CFR 1910.1030 - Bloodborne Pathogens.
      i. 29 CFR 1910.1200 - Hazard Communication.
      j. 29 CFR 1926 - Safety and Health Regulations for Construction.
      k. 29 CFR 1926.24 - Fire Prevention and Prevention.
      l. 29 CFR 1926.56 - Illumination.
      m. 29 CFR 1926.62 - Lead.
      n. 29 CFR 1926.65 - Hazardous Waste Operations and Emergency Response.
      o. 29 CFR 1926.651 - Specific Excavation Requirements.
      p. 29 CFR 1926.400 - Electrical Safety.
      q. 29 CFR 1926.500 - Fall Protection.
      r. 29 CFR 1926.1118 - Inorganic Arsenic.
      s. 29 CFR 1926.1127 - Cadmium.
      t. 49 CFR 172 - Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements.
      u. OSHA 125G - Metal and Metalloid Particulates in Workplace Atmospheres (ICP

Analysis).

3. National Institute for Occupational Safety and Health (NIOSH):
    a. NIOSH 0500 - Particulates Not Otherwise Regulated, Total 0500.
    b. NIOSH 7300 - Elements by ICP (Nitric/Perchloric Acid Ashing) 7300

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
    1. SD-01 Preconstruction Submittals:
        a. Site Specific Health and Safety Plan (SSHASP):
            1) A SSHASP shall be submitted that meets the requirements of this specification section. Addendums shall be submitted to address work-site/task specific safety and health issues (such as Task Risk Assessments, exposure assessment, Personal Protective Equipment (PPE), decontamination facilities, work zones, spill contingency plan, changes in CMGC personnel, pre-work area dust monitoring, etc.) and may reference extensively the initial contract SSHASP. The addendums shall also include specific procedures and methods for protecting worker and public health and safety. No work shall begin until the SSHASP has been deemed acceptable by the CMGC and Atlantic Richfield Company.
            2) The following shall be submitted as part of the SSHASP:
                (a) Field Authorization Form (FAF) - Record of each entry and exit into the site, as specified. These forms shall be periodically submitted as requested by the Atlantic Representative and with final closure documents.
                (b) Training Matrix - Signed by the Safety and Health Manager (SHM) that indicates that each worker performing cleanup operations with potential for contaminate-related occupational exposure meets the training requirements of this contract. The Atlantic Richfield Company Representative shall verify the matrix.
                (c) Work Zones - Drawings including typical initial work zone boundaries for each task covered under this contract: Exclusion Zone (EZ), including restricted and regulated areas; Contamination Reduction Zone (CRZ); and Support Zone (SZ). These shall be submitted as part of the SSHASP.
                (d) Decontamination Facilities - Drawings showing the typical layout of the personnel and equipment decontamination areas and facilities for each task under this contract. These shall be submitted as part of the SSHASP.
    2. SD-05 Test Reports:
        a. Exposure Monitoring Program:
            1) Personnel exposure monitoring results. The CMGC will follow exposure monitoring requirements outlined in 29 CFR 1910.120. Where applicable, CMGC will notify Atlantic Richfield Company as soon as possible following any results that exceed established occupational exposure limits.

1.04 REGULATORY REQUIREMENTS

A. Work performed under this contract shall comply with OSHA requirements in 29 CFR 1910 and 29 CFR 1926, especially OSHA's Standards 29 CFR 1926.65 and 29 CFR 1910.120 and state specific OSHA requirements where applicable. Where the requirements of this specification, applicable laws, criteria, ordinances, regulations, and referenced documents vary, the most stringent requirements shall apply.

1.05 PRECONSTRUCTION SAFETY CONFERENCE

A. A preconstruction safety conference shall be conducted prior to the start of site activities and after submission of the CMGC's SSHASP. The objective of the meeting will be to discuss health and safety concerns related to the impending work, discuss project health and safety organization and expectations, review and answer comments and concerns regarding the SSHASP or other health and safety concerns the CMGC may have. The CMGC shall ensure that those individuals responsible for health and safety at the project level are available and attend this meeting.

1.06 SITE SPECIFIC HEALTH AND SAFETY PLAN (SSHASP)

A. The CMGC shall develop and implement a SSHASP. The SSHASP shall address all occupational safety and health hazards (traditional construction as well as contaminant-related hazards) listed in Section 1.02 and associated with cleanup operations. The SSHASP is a dynamic document, subject to change as project operations/execution change. The SSHASP will require modification to address changing and previously unidentified health and safety conditions. It is the CMGC's responsibility to ensure that the SSHASP is updated accordingly. Amendments to the SSHASP will be submitted to the Atlantic Richfield Company Representative as the SSHASP is updated. For long duration projects the SSHASP shall be resubmitted to the Atlantic Richfield Company Representative annually for review.
   1. Acceptance and Modifications:
      a. The SSHASP shall be submitted for review 7 days prior to the Preconstruction Safety Conference. Deficiencies in the SSHASP will be discussed at the preconstruction safety conference, and the SSHASP shall be revised to correct the deficiencies and resubmitted for acceptance. Onsite work shall not begin until the plan has been accepted. A copy of the written SSHASP shall be maintained onsite. Changes and modifications to the accepted SSHASP shall be made with the knowledge and concurrence of the Site and Health Manger (SHM), the Site Safety and Health Officer (SSHO), the Site Superintendent, and the Atlantic Richfield Company Representative. Should any unforeseen hazard become evident during the performance of the work, the SSHO shall bring such hazard to the attention of the SHM, the Site Superintendent, and the Atlantic Richfield Company Representative for resolution as soon as possible. In the interim, necessary action shall be taken to re-establish and maintain safe working conditions in order to safeguard onsite personnel, visitors, the public, and the environment. Disregard for the provisions of this specification or the accepted SSHASP shall be cause for stopping work until the matter has been rectified.
   2. Availability:
      a. The SSHASP shall be made available in accordance with 29 CFR 1910.120, (b)(1)(v) and 29 CFR 1926.65, (b)(1)(v).

1.07 TASK SPECIFIC HAZARDS, INITIAL PPE, HAZWOPER MEDICAL SURVEILLANCE AND TRAINING APPLICABILITY

A. Site-specific information to assess the task specific occupational hazards, task specific HAZWOPER medical surveillance and training applicability and task specific initial PPE requirements for the project are provided in the Summary of Work contained within the Contract Documents.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

(NOT USED)

END OF SECTION

SECTION 01 35 00
ENVIRONMENTAL PROTECTION

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers the requirements for protection of human health and the natural environment during all construction activities, including but not limited to mobilization, earthwork, and site restoration. This includes furnishing all labor, materials, equipment and incidentals required to provide environmental pollution and damage control. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable Contract Documents.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred within the text by the basic designation only.

B. U.S. Department of Labor – Occupational Safety and Health Administration (OSHA):
   1. 40 CFR 261 - Identification and Listing of Hazardous Waste.
   2. 40 CFR 262 - Standards Applicable to Generators of Hazardous Waste.
   3. 40 CFR 279 - Standards for the Management of Used Oil.
   4. 40 CFR 302 - Designation, Reportable Quantities, and Notification.
   5. 40 CFR 355 - Emergency Planning and Notification.
   6. 40 CFR 68 - Chemical Accident Prevention Provisions.
   7. 49 CFR 171 – 178 - Hazardous Materials Regulations.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-01 Preconstruction Submittals:
      a. The CMGC shall prepare a project-specific Construction Execution Plan (CEP) describing the following construction components for the Site:
         1) Storm Water Pollution Prevention Plan (SWPPP):
            (a) The Montana Department of Environmental Quality (DEQ) administers the Montana Pollutant Discharge Elimination System (MPDES) Permit Program through the Montana Water Quality Act. The goal is to eliminate point source discharges of wastewater, process water, and stormwater so state surface water quality is protected. Construction activities that results in “disturbance” of equal to or greater than one acre of total land area are required to obtain permit coverage under the General Permit for water discharges associated with construction activities. The SWPPP shall be prepared as a standalone attachment to the project-specific CEP.
         2) Waste Management Plan (WMP):
            (a) The purpose of the WMP is to provide a framework for managing wastes in a manner which reduces risk to the environment and human health and ensures compliance. This plan addresses the characterization, handling and disposal of soils and construction wastes for the site.
         3) Dust Control Plan:
            (a) The Dust Control Plan shall be prepared as a standalone attachment to the project-specific CEP. The purpose of the Dust Control Plan is to detail

measures that the CMGC will implement to prevent and control fugitive dust emissions during the execution of the Work.

b. CMGC Environmental Protection Plan (EPP):
   1) The purpose of the CMGC EPP is to present a comprehensive overview of known or potential environmental issues beyond the SWPPP requirements which the CMGC must address during construction. CMGC plans for construction water management, including surface water and groundwater containment and dewatering, shall be included within the EPP or the project-specific CEP.

1.04 DEFINITIONS

A. Environmental Pollution and Damage:
   1. Environmental pollution and damage are defined as: the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to humankind; or degrade the environment aesthetically, culturally and/or historically.

B. Environmental Protection:
   1. Environmental protection is the prevention/control of pollution and habitat disruption that may occur to the environment during construction. The control of environmental pollution and damage requires consideration of: land, water, and air; biological and cultural resources; and includes management of visual aesthetics; noise; solid, chemical, gaseous, and liquid waste; radiant energy and radioactive material as well as other pollutants.

C. CMGC Generated Hazardous Waste:
   1. CMGC generated hazardous waste means materials that, if abandoned or disposed of, may meet the definition of a hazardous waste. These waste streams would typically consist of material brought on site by the CMGC's work but are not fully consumed during the course of construction. Examples include, but are not limited to, excess paint thinners (i.e. methyl ethyl ketone, toluene etc.), waste thinners, excess paints, excess solvents, and waste solvents.

1.05 SUBCONTRACTORS

A. Assurance of compliance with this Section by subcontractors will be the responsibility of the CMGC.

1.06 STORMWATER POLLUTION PREVENTION PLAN (SWPPP)

A. Prior to commencing construction activities or delivery of materials to the site, the CMGC shall submit the SWPPP to Atlantic Richfield Company for approval. The purpose of the SWPPP is to present a comprehensive overview of known or potential environmental issues which the CMGC addresses during construction. Issues of concern shall be defined within the SWPPP as outlined in this section. The CMGC shall address topics at a level of detail commensurate with the environmental issue and required construction task(s). Topics or issues which are not identified in this section, but which the CMGC considers necessary shall be identified and discussed after those items formally identified in this section. Prior to submittal of the SWPPP, the Contractor shall meet with the Atlantic Richfield Company Representative for the purpose of discussing the implementation of the initial SWPPP; possible subsequent additions and revisions to the plan including any reporting requirements; and methods for administration of the CMGC's SWPPP. The SWPPP shall

be current and administered onsite by the CMGC. This plan shall contain a complete description of CMGC-quality monitoring activities to occur during construction. This plan shall govern site activities relating to pollution prevention and minimization, spill control and reporting, stormwater management, and dust control, and compliance with State and Federal water, wastewater, air, and solid waste regulations.

1. Compliance:
    a. No requirement in this Section shall be construed as relieving the CMGC of any applicable Federal, state, and local environmental protection laws and regulations. During Construction, the CMGC is responsible for identifying, implementing, and submitting for approval any additional requirements to be included in the SWPPP.
2. Contents:
    a. The SWPPP shall include, but shall not be limited to, the following:
        1) Name(s) of person(s) within the CMGC's organization who is(are) responsible for ensuring adherence to the SWPPP.
        2) Name(s) and qualifications of person(s) responsible for manifesting hazardous waste to be removed from the site, if applicable.
        3) Name(s) and qualifications of person(s) responsible for training the CMGC's environmental protection personnel.
        4) Description of the CMGC's environmental protection personnel training program.
        5) A list of Federal, state, and local laws, regulations and permits concerning environmental protection, pollution control, and abatement that are applicable to the CMGC's proposed operations and the requirements imposed by those laws, regulations, and permits.
        6) Construction Drawings showing locations of proposed temporary excavations or embankments for haul roads, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials including methods to control runoff and to contain materials on the site.
        7) Stream flow re-routing plan. Plan shall include measures to divert stream water flow around construction areas as indicated on the Construction Drawings, if applicable.

1.07 WASTE MANAGEMENT PLAN (WMP)

A. Prior to commencing construction activities or disposal of materials generated at the site, the CMGC shall submit the WMP to Atlantic Richfield Company for approval. The purpose of this WMP is to provide a framework for managing wastes in a manner which reduces risk to the environment and human health and ensures compliance. This plan addresses the characterization, handling and disposal of soils and construction wastes generated during the remedial action construction. The WMP shall be current and maintained onsite by the CMGC shall be consistent with the latest version of the Remediation Management Waste Management Plan for Montana CERCLA Sites and be in compliance with State and Federal solid waste regulations.

1.08 ENVIRONMENT PROTECTION PLAN (EPP)

A. The CMGC shall submit an EPP including:
    1. Work area plan showing the proposed activity in each portion of the area and identifying the areas of limited use or nonuse. Plan should include measures for marking the limits of use areas including methods for protection of features to be preserved within authorized work areas.
    2. A spill prevention, control, and countermeasure (SPCC) plan shall include the procedures, instructions, and reports to be used in the event of an unforeseen spill of a substance in accordance with Atlantic Richfield Defined Practices as regulated by 40

CFR 68, 40 CFR 302, 40 CFR 355, and/or regulated under state or local laws and regulations.

3. An air pollution control plan detailing provisions to ensure that dust, debris, materials, trash, etc., do not become air borne and travel off the project site. The plan shall describe the CMGC's visual air monitoring program as well as methods to detect dust migrating from the site(s). It shall describe the steps the CMGC takes to modify site activities to further control dust if the results of the visual air monitoring program.
4. Atlantic Richfield Company will provide the CMGC with an Unanticipated Discovery Plan (Second Programmatic Agreement) that will include methods to ensure the protection of known or discovered historic, archeological, or cultural resources and shall identify lines of communication between CMGC and the Atlantic Richfield Company Representative. The EPP shall incorporate the Unanticipated Discovery Plan by reference.
5. Appendix:
    a. Copies of all environmental permits, permit application packages, approvals to construct, notifications, certifications, reports, and termination documents shall be attached, as an appendix, to the EPP.

1.09 PROTECTION FEATURES

A. Prior to start of any onsite construction activities, the CMGC, the Atlantic Richfield Company and Agency Representatives shall make a joint condition survey. Immediately following the survey, the CMGC shall prepare a brief report including a plan describing the features requiring protection, which are not specifically identified on the Construction Drawings as environmental features requiring protection along with the condition of trees, shrubs and grassed areas immediately adjacent to construction areas and adjacent to the CMGC's assigned area and access route(s), as applicable. This survey report shall be signed by both the CMGC and the Atlantic Richfield Company Representative upon mutual agreement as to its accuracy and completeness. The CMGC shall protect those environmental features included in the survey report and any indicated on the Construction Drawings, regardless of interference that their preservation may cause to the CMGC's work under the contract.

1.10 ENVIRONMENTAL ASSESSMENT OF CONTRACT DEVIATIONS

A. Any deviations, requested by the CMGC, from the Construction Drawings, plans and specifications which may have an environmental impact will be subject to approval by the Atlantic Richfield Company Representative and may require an extended review, processing, and approval time. The Atlantic Richfield Company Representative reserves the right to disapprove alternate methods, even if they are more cost effective, if the Atlantic Richfield Company Representative determines that the proposed alternate method will have an adverse environmental impact.

1.11 NOTIFICATION

A. The Atlantic Richfield Company Representative will notify the CMGC in writing of any observed noncompliance with Federal, State, or local environmental laws or regulations, permits, and other elements of the CMGC’s EPP, Contractor shall, after receipt of such notice, inform the Atlantic Richfield Company Representative of the proposed corrective action and take such action when approved by the Atlantic Richfield Company Representative. The Atlantic Richfield Company Representative may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions shall be granted or equitable adjustments allowed to the Contractor for any such suspensions. This is in addition to any other actions the Atlantic Richfield Company

Representative may take under the contract, or in accordance with the Federal Acquisition Regulation or Federal Law.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.01 PROTECTION OF ENVIRONMENTAL RESOURCES

A. The environmental resources within the project boundaries and those affected outside the limits of permanent work under this contract shall be protected during the entire period of this contract. The CMGC shall confine all activities to areas defined by the Construction Drawings and specifications. Certain areas as indicated on the Construction Drawings shall not be disturbed and shall be marked. Foundations and structures shall be left undisturbed and in place, unless indicated on the Construction Drawings or directed by the Atlantic Richfield Company Representative.

3.02 LAND RESOURCES

A. The CMGC shall confine all activities to areas defined by the Construction Drawings and specifications. Prior to the beginning of any construction, the CMGC shall identify any land resources to be preserved within the work area. Except in areas indicated on the Construction Drawings or specified to be cleared, the CMGC shall not remove, cut, deface, injure, or destroy land resources including trees, shrubs, vines, grasses, topsoil, and landforms without approval. No ropes, cables, or guys shall be fastened to or attached to any trees for anchorage unless specifically authorized.
   1. Erosion and Sediment Controls:
      a. The CMGC shall be responsible for providing erosion and sediment control measures in accordance with Federal, State, and local laws and regulations. The erosion and sediment controls selected and maintained by the CMGC such that water quality standards are not violated as a result of the Contractor's construction activities. The area of bare soil exposed at any one time by construction operations should be kept to a minimum. The Contractor shall construct or install temporary and permanent erosion and sediment control best management practices (BMPs) as indicated on the Construction Drawing or as directed by the Atlantic Richfield Company Representative. BMPs may include, but not be limited to, vegetation cover, stream bank stabilization, slope stabilization, silt fences, construction of terraces, interceptor channels, sediment traps, inlet and outfall protection, diversion channels, and sedimentation basins. Any temporary measures shall be removed after the area has been stabilized and approved by the Atlantic Richfield Company Representative. The Contractor shall provide erosion and sediment controls for on-site borrow and spoil areas to prevent sediment from entering nearby waters. Temporary excavation and embankments for plant and/or work areas shall be controlled to protect adjacent areas.
   2. CMGC Facilities and Work Areas:
      a. The CMGC's field offices, staging areas, stockpile storage, and temporary buildings shall be placed in areas designated on the Construction Drawings or as directed by the Atlantic Richfield Company Representative. CMGC shall limit equipment and materials storage to the smallest area practical and shall store only equipment and material used for the Work in the construction area. Temporary movement or relocation of CMGC facilities shall be made only when approved.

3.03 WATER RESOURCES

A. The CMGC will not be required to obtain a National Pollutant Discharge Elimination System (NPDES) permit; however, the CMGC must meet the substantive requirements of the NPDES General Permit for Stormwater Discharges from Construction Activities in accordance with the EPP.

B. The CMGC shall monitor construction activities to prevent pollution of surface and ground waters and shall maintain all existing drainage patterns unless otherwise specified in the Construction Drawings. Conveyance swales, ditches, and other areas at the Site shall be clear of debris, materials, and equipment that may disrupt drainage. All attempts shall be made to utilize BMPs at the work site such that water turbidity does not exceed 25 NTU at the point of compliance. If visible turbidity exists at the point of compliance due to disturbances upstream from construction activities, the CMGC shall verify by measurement. If an exceedance occurs or appears to be imminent, corrective action shall be performed to mitigate the situation. Mitigation may include halting certain construction activities.
   1. Cofferdams, Diversions, and Dewatering Operations:
      a. Construction operations for dewatering and diverting shall be controlled at all times to maintain compliance with existing State water quality standards and designated uses of the surface water body. The CMGC shall comply with the Federal and State of Montana water quality standards and anti-degradation provisions. Construction operations for dewatering, removal of cofferdams, tailrace excavation, and tunnel closure will be controlled at all times to maintain compliance with existing State water quality standards and designated uses of the surface water body. The CMGC shall comply with the requirements of the Clean Water Act Section 404 Nation Wide Permit.
   2. Stream Crossings:
      a. Stream crossings shall allow movement of materials or equipment without violating water pollution control standards of the Federal, State, and local governments.

3.04 AIR RESOURCES

A. Equipment operation, activities, or processes performed by the CMGC shall be in accordance with all Federal and State air emission and performance laws and standards.
   1. Particulates:
      a. The CMGC shall develop and implement a Dust Control Plan. Dust particles, aerosols, and gaseous byproducts from construction activities, processing, and preparation of materials shall be controlled at all times, including weekends, holidays, and hours when work is not in progress. Hydrocarbons and carbon monoxide emissions from equipment shall be controlled to Federal and state allowable limits at all times. The CMGC shall maintain excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and other work areas within or outside the project boundaries free from particulates which would cause the Federal, State, and local air pollution standards to be exceeded or which would cause a hazard or a nuisance. Sprinkling or other methods will be permitted to control particulates in the work area. Sprinkling, to be efficient, must be repeated to keep the disturbed area damp at all times. The CMGC must have sufficient, competent equipment available to accomplish these tasks. Particulate control shall be performed as the work proceeds and whenever a particulate nuisance or hazard occurs. The CMGC shall comply with all State and local visibility regulations.
   2. Odors:
      a. Odors from construction activities shall be controlled at all times and shall be in compliance with State regulations and/or local ordinances.

3. Sound Intrusions:
    a. The CMGC shall keep construction activities under surveillance and control to minimize environment damage by noise. The CMGC shall comply with the provisions of the State of Montana rules and local noise ordinances.

3.05 OTHER RESOURCES

A. Fuel and Lubricants:
    1. Storage, fueling and lubrication of equipment and motor vehicles shall be conducted in a manner that affords the maximum protection against spill and evaporation. Fuel, lubricants and oil shall be managed and stored in accordance with all Federal, State, Regional, and local laws and regulations. Used lubricants and used oil to be discarded shall be stored in marked corrosion-resistant containers and recycled or disposed in accordance with 40 CFR 279, State, and local laws and regulations.

B. Wastewater:
    1. Wastewater from construction activities, such as onsite material processing, etc. shall not be allowed to enter waterways of the State of Montana prior to verification that discharges meet federal, state, and local water pollution control standards, anti-degradation standards, and water quality criteria. The CMGC shall dispose of the construction related wastewater off-property in accordance with all Federal, State, Regional and Local laws and regulations.

3.06 HISTORICAL, ARCHEOLOGICAL, AND CULTURAL RESOURCES

A. Site-specific procedures for protecting historic archeological resources will be specified in the Second Programmatic Agreement to be provided by Atlantic Richfield Company. Project personnel (excepting approved archaeologists) shall not for personal observation or use collect, move or in any other way alter any prehistoric or historic artifacts or features in the project vicinity.

B. If during excavation or other construction activities any previously unidentified or unanticipated potential prehistoric archaeological resources and/or human remains/burial(s) are discovered or found, all activities that may damage or alter such resources shall be suspended. Resources covered by this paragraph include but are not limited to: any human skeletal remains or burials; prehistoric artifacts such as - formed stone tools, for example projectile points (arrowheads of spear points), scrappers, and/or the debitage (flakes or chips) left over from forming tools; fire pits/rings; rock art, such as pictographs (rock paintings) or petroglyphs (pecked rock art and/or any other artifacts and/or features indicating other prehistoric human activities. Upon such discovery or find, the CMGC shall immediately notify the Atlantic Richfield Company Representative so that the appropriate authorities may be notified, and a determination made as to their significance and what, if any, special disposition of the finds should be made. The CMGC shall cease all activities that may result in impact to or the destruction of these resources. The CMGCshall secure the area and prevent employees or other persons from trespassing on, removing, or otherwise disturbing such resources.

3.07 BIOLOGICAL RESOURCES

A. The CMGC shall minimize interference with, disturbance to, and damage to fish, wildlife, and plants including their habitat. The CMGC shall be responsible for the protection of threatened and endangered animal and plant species including their habitat in accordance with Federal, State, and local laws and regulations.

3.08 PREVIOUSLY USED EQUIPMENT

A. The CMGC shall clean all previously used construction equipment prior to bringing it onto the project site. The CMGC shall ensure that the equipment is free from soil residuals, egg deposits from plant pests, noxious weeds, and plant seeds. Previously used construction equipment may be subject to inspection by the Atlantic Richfield Company Representative prior to site access or use.

3.09 MAINTENANCE OF POLLUTION CONTROL FACILITIES

A. The CMGC shall maintain all constructed facilities and portable pollution control devices for the duration of the contract or for that length of time construction activities create the particular pollutant.

3.10 TRAINING OF CMGC PERSONNEL

A. The CMGC's personnel shall be trained in all phases of environmental protection and pollution control. The CMGC shall conduct environmental protection/pollution control meetings for all GMGC personnel prior to commencing construction activities. Additional meetings shall be conducted for new personnel and when site conditions change. The training and meeting agenda shall include: methods of detecting and avoiding pollution; familiarization with statutory and contractual pollution standards; installation and care of devices, vegetative covers, and instruments required for monitoring purposes to ensure adequate and continuous environmental protection/pollution control; anticipated hazardous or toxic chemicals or wastes, and other regulated contaminants; recognition and protection of archaeological sites, artifacts, wetlands, and endangered species and their habitat that are known to be in the area.

3.11 CONTAMINATED MEDIA MANAGEMENT

A. Contaminated environmental media consisting of, but not limited to, soils and sediments shall be managed in accordance with Section 02 11 10 – Excavation and Handling and Section 02 12 00 – Hauling and Off-Site Disposal of Excavated Materials.

3.12 POST CONSTRUCTION CLEANUP

A. The CMGC shall clean up all areas used for construction in accordance with Contract. The CMGC shall, unless otherwise instructed in writing by the Atlantic Richfield Company Representative, obliterate all signs of temporary construction facilities such as haul roads, work area, structures, foundations of temporary structures, stockpiles of excess or waste materials, and other vestiges of construction prior to final acceptance of the work. The disturbed area shall be graded, filled and the entire area seeded unless otherwise indicated.

END OF SECTION

SECTION 01 42 00
SOURCES FOR REFERENCE PUBLICATIONS

PART 1 - GENERAL

1.01 REFERENCES

A. Various publications are referenced in other sections of the specifications to establish requirements for the work. These references are identified in each section by document number, date and title. The document number used in the citation is the number assigned by the standards producing organization, (e.g., ASTM B564 Nickel Alloy Forgings). However, when the standards producing organization has not assigned a number to a document, the date of issue for that document will instead be used for identification.

1.02 ORDERING INFORMATION

A. The addresses of the standards publishing organizations whose documents are referenced in other sections of these specifications are listed below, and if the source of the publications is different from the address of the sponsoring organization, that information is also provided. Documents listed in the specifications with numbers which were not assigned by the standards producing organization should be ordered from the source by title rather than by number.

1. ACI International (ACI)
   38800 Country Club Drive
   Farmington Hills, MI 48331
   Ph: 248-848-3700
   Fax: 248-848-3701
   E-mail: bkstore@concrete.org
   Internet: http://www.concrete.org

2. American Association of State Highway and Transportation Officials (AASHTO)
   444 North Capital Street, NW, Suite 249
   Washington, DC 20001
   Ph: 202-624-5800
   Fax: 202-624-5806
   E-Mail: info@aashto.org
   Internet: http://www.aashto.org

3. American National Standards Institute (ANSI)
   1819 L Street, NW, 6th Floor
   Washington, DC 20036
   Ph: 202-293-8020
   Fax: 202-293-9287
   E-mail: info@ansi.org
   Internet: http://www.ansi.org/

4. American Nursery & Landscape Association (ANLA)
   1000 Vermont Ave NW
   Suite 300
   Washington, DC 20005
   Ph: 202-789-2900
   Fax: 202-789-1893
   E-mail: aflynn@anla.org
   Internet: http://www.anla.org

5. American Welding Society (AWS)
   550 N.W. LeJeune Road
   Miami, FL 33126
   Ph: 800-443-9353 - 305-443-9353
   Fax: 305-443-7559
   E-mail: info@aws.org or customerservice@awspubs.com
   Internet: http://www.aws.org

6. ASTM International (ASTM)
   100 Barr Harbor Drive, P.O. Box C700
   West Conshohocken, PA 19428-2959
   Ph: 610-832-9585
   Fax: 610-832-9555
   E-mail: service@astm.org
   Internet: http://www.astm.org

7. Department of Environmental Quality - State of Montana (DEQ-MT)
   1520 E. 6th Avenue
   Helena, MT 59601Ph: (406) 444-2544
   Fax: (406) 444-4386
   Internet: http://deq.mt.gov/

8. National Fire Protection Association (NFPA)
   1 Batterymarch Park
   Quincy, MA 02169-7471
   Ph: 617-770-3000 or 800-344-3555
   Fax: 617-770-0700
   E-mail: webmaster@nfpa.org
   Internet: http://www.nfpa.org

9. National Institute for Occupational Safety and Health (NIOSH)
   Mail Stop C-34
   4676 Columbia Parkway
   Cincinnati, OH 45226
   Ph: 513-533-8611
   Fax: 513-533-8285
   E-mail: nioshdocket@cdc.gov
   Internet: http://www.cdc.gov/nchs/products.htm

10. National Ready Mixed Concrete Association (NRMCA)
    900 Spring Street
    Silver Spring, MD 20910
    Ph: 240-485-1165
    E-mail: jjenkins@nrmca.org (Jacques Jenkins)
    Internet: http://www.nrmca.org

11. Occupational Safety and Health Administration (OSHA)
    U.S. Department of Labor
    Occupational Safety & Health Administration
    200 Constitution Avenue
    Washington, D.C. 20210
    Ph: 1-800-321-OSHA

12. Montana Code Annotated (MCA)
    Department of Administration
    125 N. Roberts St.
    P.O. Box 200101
    Helena, MT 59620-0101
    Ph: 406-444-2032
    Fax: 406-444-6194
    Internet: https://leg.mt.gov/bills/mca/index.html

13. Administrative Rules of Montana (ARM)
    Administrative Rules Services
    P.O. Box 202801
    Helena, MT 59620-2801
    Ph: 406-444-9000
    E-mail: sosarm@mt.gov
    Internet: http://www.mtrules.org/

14. Truck Mixer Manufacturers Bureau (TMMB)
    Truck Mixer Manufacturers Bureau
    900 Spring Street
    Silver Spring, MD 20910
    Ph: 301-587-1400
    Fax: 301-587-1605
    Internet: http://www.tmmb.org/

15. U.S. Composting Council (USCC)
    5400 Grosvenor Lane
    Bethesda, MD 20814
    Ph: 301-897-2715
    Fax: 301-530-5072
    Internet: http://compostingcouncil.org/

16. U.S. Department of Agriculture (USDA)
    Order AMS Publications from:
    Agricultural Marketing Service (AMS)
    Seed Regulatory and Testing Branch
    801 Summit Crossing Place, Suite C
    Gastonia, NC 28054-2193
    Ph: 704-810-8871
    Fax: 704-852-4189
    E-mail: seed.ams@usda.gov
    Internet: http://www.ams.usda.gov/lsg/seed.htm
    Order Other Publications from:
    U.S. Department of Agriculture, Rural Utilities Service
    14th and Independence Avenue, SW, Room 4028-S
    Washington, DC 20250
    Ph: 202-720-2791
    Fax: 202-720-2166
    Internet: http://www.usda.gov/rus

17. U.S. Environmental Protection Agency (EPA)
    Ariel Rios Building
    1200 Pennsylvania Avenue, N.W.
    Washington, DC 20004
    Ph: 202-272-0167
    for Fax and E-mail see below
    Internet: http://www.epa.gov
    --- Some EPA documents are available only from:
    National Technical Information Service (NTIS)
    5301 Shawnee Road
    Alexandria, VA 22312
    Ph: 703-605-6050 or 1-688-584-8332
    Fax: 703-605-6900
    E-mail: info@ntis.gov
    Internet: http://www.ntis.gov

18. U.S. Federal Highway Administration (FHWA)
    FHWA, Office of Safety
    1200 New Jersey Ave., SE
    Washington, DC 20590
    Ph: 202-366-0411
    Fax: 202-366-2249
    E-mail: contactcenter@gpo.gov
    Internet: http://www.safety.fhwa.dot.gov
    Order from:
    Superintendent of Documents
    U. S. Government Printing Office (GPO)
    732 North Capitol Street, NW
    Washington, DC 20401
    Ph: 202-512-1800
    Fax: 202-512-2104
    E-mail: contactcenter@gpo.gov
    Internet: http://www.gpoaccess.gov

19. U.S. General Services Administration (GSA)
    General Services Administration
    1800 F Street, NW
    Washington, DC 20405
    Ph: 202-501-0800
    Internet: www.GSA.gov
    Obtain documents from:
    Acquisition Streamlining and Standardization Information System (ASSIST)
    Department of Defense Single Stock Point (DODSSP)
    Document Automation and Production Service (DAPS)
    Building 4/D
    700 Robbins Avenue
    Philadelphia, PA 19111-5094
    Ph: 215-697-6396 - for account/password issues
    Internet: http://assist.daps.dla.mil/online/start/ ; account registration required

20. U.S. Geologic Survey (USGS)
    12201 Sunrise Valley Drive
    Reston, VA 20192, USA
    Ph: 703-648-5953
    Internet: http://www.usgs.gov/

21. U.S. National Archives and Records Administration (NARA)
    8601 Adelphi Road
    College Park, MD 20740-6001
    Ph: 866-272-6272
    Fax: 301-837-0483
    E-mail: contactcenter@gpo.gov
    Internet: http://www.archives.gov
    Order documents from:
    Superintendent of Documents
    U.S. Government Printing Office (GPO)
    732 North Capitol Street, NW
    Washington, DC 20401
    Ph: 202-512-1800
    Fax: 202-512-2104
    E-mail: contactcenter@gpo.gov
    Internet: http://www.gpoaccess.gov

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

(NOT USED)

END OF SECTION

SECTION 01 45 10
CONTRACTOR QUALITY CONTROL

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Construction Management General Contractor (CMGC) shall furnish all labor, materials, equipment, and incidentals required to prepare and update a quality control system to produce an end product which complies with the contract requirements.

1.02 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-01 Preconstruction Submittals:
      a. CMCG Quality Control Plan:
         1) The CMGC shall furnish for review by Atlantic Richfield Company, a CMCG Quality Control (CQC) Plan for the overall Contract. The Plan shall identify personnel, procedures, controls, instructions, tests, records, and forms to be used. Atlantic Richfield Company will consider an interim plan for the first 30 days of operation. Construction will be permitted to begin only after acceptance of the CQC Plan or acceptance of an interim plan applicable to the particular feature of work to be started. Work outside of the features of work included in an accepted interim plan will not be permitted to begin until acceptance of a CQC Plan or another interim plan containing the additional features of work to be started.
         2) As part of the CQC Plan, the CMGC shall submit their selected Material Testing Laboratory Qualifications. The materials testing laboratory shall be approved by Atlantic Richfield Company for all tests required by contract.
         3) The CQC Plan shall identify the CMGC's submittal of Contractor Quality Control reports to Atlantic Richfield Company. Submitted QC records shall conform to Article 3.09 – Documentation.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

A. The CMGC is responsible for quality control and shall establish and maintain an effective quality control system. The quality control system shall consist of plans, procedures, and organization necessary to produce an end product which complies with the contract requirements. The system shall cover all construction operations, both onsite and offsite, and shall be keyed to the proposed construction sequence. The site project superintendent will be held responsible for the quality of work on the job. The site project superintendent in this context shall be the highest-level manager responsible for overall construction activities at the site, including quality and production. The site project superintendent shall maintain a physical presence at the site at all times, except as otherwise acceptable to Atlantic Richfield Company and shall be responsible for all construction and construction related activities at the site.

3.02 QUALITY CONTROL PLAN

A. Content of the CQC Plan:
   1. The CQC Plan shall include, at a minimum, the following to cover all construction operations, both onsite and offsite, including work by subcontractors, fabricators, suppliers, and purchasing agents:
      a. A description of the quality control organization, including a chart showing lines of authority and acknowledgment that the CQC staff shall implement the features for all aspects of the work specified. The staff shall include a CQC Manager who shall report to the project superintendent.
      b. The name, qualifications, duties, responsibilities, and authorities of each person assigned a CQC function.
      c. A copy of the letter to the CQC Manager signed by an authorized official of the firm which describes the responsibilities and delegates sufficient authorities to adequately perform the functions of the CQC Manager, including authority to stop work that is not in compliance with the contract. The CQC Manager shall issue letters of direction to all other various quality control representatives outlining duties, authorities, and responsibilities. Copies of these letters shall also be furnished to the Atlantic Richfield.
      d. Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, offsite fabricators, suppliers, and purchasing agents. These procedures shall be in accordance with Section 01 33 00 – Submittal Procedures.
      e. Control, verification, and acceptance testing procedures for each specific test to include the test name, specification paragraph requiring test, feature of work to be tested, test frequency, and person responsible for each test. (Laboratory facilities approved by Atlantic Richfield Company shall be used.)
      f. Procedures for tracking preparatory, initial, and follow-up control, verification, and acceptance tests including documentation.
      g. Procedures for tracking construction deficiencies from identification through acceptable corrective action. These procedures shall establish verification that identified deficiencies have been corrected.
      h. Reporting procedures, including proposed reporting formats and daily CQC reporting.
      i. A list of the definable features of work. A definable feature of work is a task which is separate and distinct from other tasks, has separate control requirements, and may be identified by different trades or disciplines, or it may be work by the same trade in a different environment. Although each section of the specifications may generally be considered as a definable feature of work, there are frequently more than one definable feature under a particular section. This list will be agreed upon during the coordination meeting.

B. Acceptance of Plan:
   1. Acceptance of the CQC Plan is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. Atlantic Richfield Company reserves the right to require the CMGC to make changes in its CQC Plan and operations including removal of personnel, as necessary, to obtain the quality specified.
      a. Notification of Changes:
         1) After acceptance of the CQC Plan, the CMGC shall notify Atlantic Richfield Company in writing of any proposed change. Proposed changes are subject to acceptance by Atlantic Richfield Company.

3.03 COORDINATION MEETING

A. After the Preconstruction Conference, before start of construction, and prior to acceptance by Atlantic Richfield Company of the CQC Plan, the CMGC shall meet with Atlantic Richfield Company and discuss the CQC Plan. During the meeting, a mutual understanding of the system details shall be developed, including the forms for recording the CQC operations, control activities, testing, administration of the system for both on-site and off-site work, and the interrelationship of CMGC's Management and control with Atlantic Richfield's Quality Assurance. Minutes of the meeting will be prepared by Atlantic Richfield Company and signed by both the CMGC and Atlantic Richfield Company. The minutes shall become a part of the contract file. There may be occasions when subsequent conferences will be called by either party to reconfirm mutual understandings and/or address deficiencies in the CQC system or procedures which may require corrective action by the CMGC.

3.04 QUALITY CONTROL ORGANIZATION

A. Personnel Requirements:
   1. The requirements for the CQC organization are a CQC Manager and sufficient number of additional qualified personnel to ensure safety and contract compliance. The Safety and Health manager shall receive direction and authority from the CQC Manager and shall serve as a member of the CQC staff. The CMGC shall provide a CQC organization that shall be at the site at all times during progress of the work and with complete authority to take any action necessary to ensure compliance with the contract. All CQC staff members shall be subject to acceptance by Atlantic Richfield Company. The CMGC shall provide adequate office space, filing systems and other resources as necessary to maintain an effective and fully functional CQC organization. Complete records of all letters, material submittals, shop drawings submittals, schedules and all other project documentation shall be promptly furnished to the CQC organization by the CMGC. The CQC organization shall be responsible to maintain these documents and records at the site at all times, except as otherwise acceptable to Atlantic Richfield Company.

B. CQC Manager:
   1. The CMGC shall identify as CQC Manager an individual within the onsite work organization who shall be responsible for overall management of CQC and have the authority to act in all CQC matters for the CMGC. This CQC Manager shall be available to visit the site at times during construction to verify compliance and will be employed by the CMGC, except as noted in the following. An alternate for the CQC Manager will be identified in the plan to serve in the event of the system manager's absence. Period of absence may not exceed 3 weeks at any one time. The requirements for the alternate will be the same as for the designated CQC manager.
   2. The CQC Manager shall be an experienced construction person with experience in related work such as investigations, studies, design, and remedial actions at cleanup sites. The CQC Manager may be assigned other duties such as project superintendent, project manager, and or safety officer in addition to quality control.

C. Organizational Changes:
   1. The CMGC shall obtain Atlantic Richfield Company's acceptance before replacing any member of the CQC staff. Requests shall include the names, qualifications, duties, and responsibilities of each proposed replacement.

3.05 SUBMITTALS AND DELIVERABLES

A. Submittals shall be as specified in Section 01 33 00 – Submittal Procedures. The CQC organization shall be responsible for certifying that all submittals are in compliance with the contract requirements. The CMGC may use standard report forms for submittal of any required data subject to the approval of Atlantic Richfield Company.

3.06 QUALITY CONTROL

A. CMGC Quality Control is the means by which the CMGC ensures that the work performed, to include that of subcontractors and suppliers, complies with the requirements of the contract. The controls shall be adequate to cover all operations, including analytical chemistry and both on-site and off-site fabrication. Such controls will be keyed to the proposed construction sequence.

3.07 TESTS

A. Testing Procedure:
   1. The CMGC shall perform specified or required tests to verify that control measures are adequate to provide a product which conforms to contract requirements. Individual specification sections may also require additional testing. CMGC shall submit all materials test reports on forms standard to industry standards such as ACI, ASTM and AASHTO. Upon request, the CMGC shall furnish to Atlantic Richfield Company duplicate samples of test specimens for possible testing by the Atlantic Richfield. Testing includes operation and/or acceptance tests when specified. The CMGC shall procure the services of a material testing laboratory in advance of any and all required testing; and in addition, submit the material testing laboratory qualifications for Atlantic Richfield Company approval as part of the Quality Control Plan. The CMGC shall perform the following activities and record and provide the following data:
      a. Verify that testing procedures comply with contract requirements.
      b. Verify that facilities and testing equipment are available and comply with testing standards.
      c. Check test instrument calibration data against certified standards.
      d. Verify that recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.
      e. Results of all tests taken, both passing and failing tests, shall be recorded on the CQC report for the date taken. Specification paragraph reference, location where tests were taken, and the sequential control number identifying the test shall be given. If approved by Atlantic Richfield Company, actual test reports may be submitted later with a reference to the test number and date taken. An information copy of tests performed by an off-site or commercial test facility shall be provided directly to Atlantic Richfield Company. Failure to submit timely test reports as stated may result in nonpayment for related work performed and disapproval of the test facility for this contract.

B. Materials Testing Laboratories:
   1. CMGC shall provide services of an independent materials testing laboratory. Provide qualified personnel to perform specified inspection, sampling and testing of materials and methods of construction; comply with specified standards. Maintain and calibrate testing equipment in accordance with the specified test methods and laboratory quality control procedures; calibration records shall be available for Atlantic Richfield Company inspection upon request. Employment of a testing laboratory shall in no way relieve the CMGC from obligations to perform work in accordance with the Contract. Submit written reports and test results within 7 calendar days of receipt by CMGC.

C. On-Site Laboratory:
   1. Atlantic Richfield Company reserves the right to utilize the CMGC's control testing laboratory and equipment to make assurance tests and to check the CMGC's testing procedures, techniques, and test results at no additional cost to Atlantic Richfield.

D. Furnishing or Transportation of Samples for Testing:
   1. Costs incidental to the transportation of samples or materials shall be the responsibility of the CMGC.

3.08 COMPLETION INSPECTION

A. The following provides a summary of the inspection work required at the completion of the project:
   1. Punch List:
      a. At the completion of all work or any increment thereof, the CQC Manager shall conduct an inspection of the work and develop a "punch list" of items which do not conform to the approved Construction Drawings, plans and Technical Specifications. Such a list of deficiencies shall be included in the CQC documentation, as required by paragraph 3.9 Documentation below, and shall include the estimated date by which the deficiencies will be corrected. The CQC Manager or staff shall make a second inspection to ascertain that all deficiencies have been corrected and notify Atlantic Richfield. These inspections and any deficiency corrections required by this paragraph will be accomplished within the time stated for completion of the entire work or any particular increment thereof if the project is divided into increments by separate completion dates. Once this is accomplished, the CMGC shall notify Atlantic Richfield Company that the facility is ready for the Pre-Final Inspection.
   2. Pre-Final Inspection:
      a. Atlantic Richfield, the CQC Manager, and Atlantic Richfield’s Representative(s) will perform this inspection to verify that the feature is complete and ready to be occupied. The CQC Manager or staff shall ensure that all items on this list have been corrected before notifying Atlantic Richfield Company so that a Final Inspection with Atlantic Richfield Company can be scheduled. Any items noted on the Pre-Final Inspection shall be corrected in a timely manner.
   3. Final Acceptance Inspection:
      a. Atlantic Richfield Company, EPA, DEQ, and CQC Manager shall be in attendance. The Final Acceptance Inspection will be formally scheduled by Atlantic Richfield Company prior to the Final Acceptance Inspection and shall include the CMGC's assurance that all specific items previously identified to the CMGC as being unacceptable, along with all remaining work performed under the contract, will be complete and acceptable by the date scheduled for the Final Acceptance Inspection.

3.09 DOCUMENTATION

A. The CMGC shall maintain current records of quality control operations, activities, and tests performed, including the work of subcontractors and suppliers. These records shall be on an acceptable form and shall be a complete description of inspections, the results of inspections, daily activities, tests, and other items, including but not limited to the following:
   1. CMGC/subcontractor and their area of responsibility.
   2. Operating plant/equipment with hours worked, idle, or down for repair.
   3. Work performed each day, giving location, description, and by whom.

4. Test and/or control activities performed with results and references to specifications/plan requirements. The control phase should be identified (Preparatory, Initial, Follow-up). List deficiencies noted along with corrective action.
5. Material received with statement as to its acceptability and storage.
6. Off-site surveillance activities, including actions taken.
7. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
8. List instructions given/received and conflicts in Construction Drawings and/or Technical Specifications.
9. CMGC's verification statement.
10. Estimated volume of waste material hauled to the designated repository from the Site based on truck counts or other approved estimation method. This estimation should include both daily and cumulative volumes.
11. These records shall indicate a description of trades working on the project; the number of personnel working; weather conditions encountered; and any delays encountered. These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in the work and workmanship comply with the contract. These records in report form shall be furnished to Atlantic Richfield Company by 10 am following the date(s) covered by the report, except that reports need not be submitted for days on which no work is performed.

B. Reports shall be signed and dated by the CQC Manager. The report from the CQC Manager shall include copies of test reports and copies of reports prepared by all subordinate quality control personnel.

3.10 NOTIFICATION OF NONCOMPLIANCE

A. Atlantic Richfield Company will notify the CMGC of any detected noncompliance with the foregoing requirements. The CMGC shall, after receipt of such notice, immediately take corrective action. Such notice, when delivered to the CMGC at the site of the work, shall be deemed sufficient for the purpose of notification. If the CMGC fails or refuses to comply promptly, Atlantic Richfield Company may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the CMGC.

END OF SECTION

SECTION 01 50 00
CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Construction Management General Contractor (CMGC) shall provide all the temporary construction support facilities required to execute this Contract and comply, at minimum, with the requirements specified herein. All structures installed under this section shall be removed at the completion of the project. Facilities shall be located as approved by the Atlantic Richfield Company Representative. Office equipment and furnishings identified in this specification shall become property of the CMGC after completion of the project unless otherwise specified. The CMGC shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
   1. National Fire Protection Association (NFPA):
      a. NFPA 70 - National Electrical Code (NEC).

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-01 Preconstruction Submittals:
      a. The CMGC shall prepare a project-specific Construction Execution Plan (CEP) describing the following construction components for the Site:
         1) Construction Site Access, Staging, and Security Plan:
            (a) Prior to the start of work, CMGC shall submit plans showing the locations and dimensions of temporary facilities (including layouts and details), equipment and material storage areas (onsite and offsite), and access and haul routes (including temporary routes). Identify any areas which may have to be graveled to prevent the tracking of mud. Indicate if the use of a supplemental or other staging area is desired. Show locations of safety and construction fences, site trailers, construction entrances, trash dumpsters, temporary sanitary facilities, and worker parking areas.
         2) Utility and Existing Infrastructure Protection Plan:
            (a) Plans to identify and protect existing utilities and infrastructure shall be detailed by the CMGC as part of the project-specific CEP.
         3) Traffic Control Plan:
            (a) The CMGC shall prepare and submit a Traffic Control Plan prior to the start of work. The Traffic Control Plan shall be a standalone attachment to the project-specific CEP. State and county approval of the plan shall be included as necessary.
         4) Dust Control Plan:
            (a) Prior to the start of work, the CMGC shall prepare a Dust Control Plan as a standalone attachment to the project-specific CEP.

1.04 AVAILABILITY OF UTILITY SERVICES

A. The CMGC shall be responsible for providing its own utilities services for all activities.
   1. Sanitary Provisions:
      a. CMGC shall provide sanitary accommodations for the use by employees, visitors, and Atlantic Richfield Company personnel for the duration of site work as may be necessary and shall maintain accommodations approved by the Atlantic Richfield Company Representative and shall comply with the requirements and regulations of the State Health Department, County Sanitarian, or other authorities having jurisdiction. Facilities shall have hand washing/sanitizing capabilities and supplies.
   2. Potable Water:
      a. CMGC shall provide adequate supplies from off-site potable water sources at their own expense for use by employees, visitors, and Atlantic Richfield Company personnel for the duration of site work. It is the CMGC's responsibility to identify and procure the water.
   3. Telephone/Site Communication:
      a. When the CMGC has elements of work where cellular telephone coverage is poor, the CMGC shall provide additional means for site communication.
      b. Whenever the CMGC has the individual elements of its work located so that operation by normal voice is not satisfactory, the CMGC shall provide satisfactory means of communication, such as two-way radio or other suitable devices.

1.05 TEMPORARY ELECTRIC WIRING

A. Temporary Power and Lighting:
   1. The CMGC shall provide construction power facilities in accordance with the safety requirements of the National Electric Code NFPA 70. The CMGC, or its delegated subcontractor, shall enforce the safety requirements of electrical extensions for the work of subcontractors. Work shall be accomplished by skilled electrical tradesmen.

B. Construction Equipment:
   1. Temporary wiring conductors installed for operation of construction tools and equipment shall be either Type TW or THW contained in metal raceways or shall be hard usage or extra hard usage multiconductor cord. Temporary wiring shall be secured above the ground or floor in a workmanlike manner and shall not present an obstacle to persons or equipment. Open wiring may only be used outside of buildings, and then only in accordance with the provisions of the National Electric Code. `

C. Submittals:
   1. Submit detailed drawings of temporary power connections, if utilized, for the specific tasks requiring the associated work. Drawings shall include, but not be limited to, main disconnect, grounding, service drops, service entrance conductors, feeders, Ground Fault Circuit Interrupter (GFCIs). Also submit CMGC’s site trailer connections for any temporary facilities.

1.06 FIRE PROTECTION

A. During the construction period, the CMGC shall provide fire extinguishers. The CMGC shall remove the fire extinguishers at the completion of construction.

1.07 STAGING/STORAGE AREA

A. Access into all secure areas and establishment of the CMGC's staging and designated work areas shall be coordinated through the Atlantic Richfield Company Representative. The CMGC shall be responsible to secure his own work site area.

1.08 HOUSEKEEPING AND CLEANUP

A. The CMGC shall submit a detailed written plan for implementation of this requirement. The plan will be presented as part of the preconstruction safety plan and will provide for keeping the total construction site, structures, and accessways free of debris and obstructions at all times. Work will not be allowed in those areas that, in the opinion of the Atlantic Richfield Company Representative, have unsatisfactory cleanup and housekeeping at the end of the preceding day's normal work shift. At least once each day all areas shall be checked by the CMGC, and the findings recorded on the Quality Control Daily Report in accordance with Section 01 45 10 – Contractor Quality Control. In addition, the Quality Control person shall take immediate action to ensure compliance with this requirement. Housekeeping and cleanup shall be assigned by the CMGC to specific personnel. The name(s) of the personnel shall be available at the project site.

1.09 UTILITY CLEARANCE

A. Utility clearance procedures shall be documented in the CMGC’s project-specific CEP. Before performing any onsite excavation, the CMGC shall be responsible for locating all utilities on site. Copies of clearance tickets shall be provided to the Atlantic Richfield Company Representative. Utility lines shall be marked in the field prior to excavation. The locations of any utilities obtained from the clearances shall be verified on or added to the as-built drawings.

1.10 TRAFFIC CONTROL

A. The CMGC shall prepare a Traffic Control Plan and provide for movement of traffic through and around each construction zone in a manner that is conducive to the safety of workers. This shall include placement and maintenance of traffic control devices in accordance with the U.S. Department of Transportation, Federal Highway Administration publication, Manual on Uniform Traffic Control Devices. Traffic control on all roads shall be coordinated with the appropriate local government agencies with a copy of all requests and approved plans to the Atlantic Richfield Company Representative prior to the work.

1.11 DUST CONTROL

A. Dust control shall be conducted in accordance with the CMGC’s Dust Control Plan, the CMGC’s Environmental Protection Plan (EPP) described in Section 01 35 00 – Environmental Protection, and in accordance with Section 01 80 00 – Road Maintenance and Dust Control.

1.12 CLEARING AND GRUBBING

A. Clearing and grubbing for access and road improvement shall be in accordance with Section 31 01 10 – Clearing and Grubbing.

1.13 PROJECT AND SAFETY SIGNS

A. The CMGC shall furnish and install project identification sign(s) as indicated on the Construction Drawings or as directed by the Atlantic Richfield Company Representative.

Signs, at a minimum, shall be placed near entrances to the site in a location accessible for viewing by onsite workers, Atlantic Richfield Company personnel, the Atlantic Richfield Company Representative, visitors, and the public.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

(NOT USED)

END OF SECTION

SECTION 01 72 00
FIELD SURVEYING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Construction Management General Contractor (CMGC) shall provide all materials, items, operations, or methods specified, listed, or scheduled on the Construction Drawings or in the Technical Specifications, including all materials, labor, equipment, and incidentals necessary and required to conduct proper surveys required to stake and layout the Work.

B. The Atlantic Richfield Company Representative will perform quantity surveys to verify the quantities of "as-built" construction work. Copies of the survey notes and calculations will be supplied to CMGC upon request. CMGC will note any discrepancies between Atlantic Richfield Company Representative's calculation and CMGC's calculation and notify Atlantic Richfield Company Representative of such discrepancies.

C. Atlantic Richfield Company will provide all primary control and establish control coordinates, as shown on the Construction Drawings, for the Work with necessary benchmarks adjacent to the Work. Atlantic Richfield Company will provide all horizontal and vertical controls on the Construction Drawings. CMGC shall be responsible for setting any supplementary stakes necessary to control its Work and meet the accuracy requirements of the Contract documents. CMGC shall perform its Work by reference and control provided. CMGC shall maintain in place all primary and other control coordinate stakes, and benchmarks. Control stakes carelessly or willfully destroyed or disturbed by CMGC will be reset by the Atlantic Richfield Company Representative at the CMGC's expense. Control points located within areas that must be disturbed can be removed without replacement at Atlantic Richfield Company Representative's discretion. CMGC shall notify the Atlantic Richfield Company Representative of any required survey at least 48 hours before starting Work.

D. CMGC shall verify the location of all section corners, property pins, survey monuments or benchmarks that are shown on the Construction Drawings. Once verified in the field, it is the CMGCs responsibility to protect these section corners, property pins, survey monuments or benchmarks, to the extent possible. Any disturbed section corners, property pins, survey monuments or benchmarks shall be reset by Atlantic Richfield Company Representative's Professional Land Surveyor licensed in the State of Montana at CMGCs expense.

E. Contactor shall provide a qualified individual to perform field grade and alignment setting, checking, and staking for excavation and backfilling activities. The CMGC's designated person's responsibilities are to coordinate with the Atlantic Richfield Company Representative Surveyor and the Atlantic Richfield Company Representative on construction grading, assure that construction grades are met within established tolerances, direct equipment to meet required grades, and communicate to the Atlantic Richfield Company Representative when quality assurance verification measurements are needed. CMGC shall utilize the initial staking provided by the Atlantic Richfield Company Representative. CMGC shall include a thorough description of the designated field grade setter/checker qualifications and duties in the Contractor Quality Control Plan.

F. Progress/quantity surveys will be completed by the Atlantic Richfield Company Representative. Due to the sequencing required to complete construction activities, the CMGC's designated person shall also be responsible for performing interim quantity surveys. CMGC shall complete interim surveys as required to accurately account for the

Work being completed (i.e. excavation of mine wastes, placement of general backfill materials, etc.). All survey data (point files and notes) collected by the CMGC shall be submitted to the Atlantic Richfield Company by 10 a.m. on the day after interim survey work was completed. The Atlantic Richfield Company Representative will verify the adequacy of the interim survey Work. This interim survey data will be used in conjunction with Atlantic Richfield Company Representative's survey data to determine payment volumes and to ensure suitable as-built excavation, site grading, and final surfaces are developed.

G. The CMGC shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
   1. Montana Code Annotated (MCA):
      a. MCA 70-22-104 Title 70 Property, Chapter 22 - Corner Recordation Act Surveys and Coordinates.
   2. Administrative Rules of Montana (ARM):
      a. ARM 24.183.1001 - Form of Corner Records.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-05 Test Reports:
      a. Field notes, computations, and survey information.
      b. Upon completion of the fieldwork, the CMGC shall furnish the Atlantic Richfield Company Representative copies of all field notes, computations, any records relating to the survey information or to the layout of the Work.
   2. SD-06 Certificates:
      a. Survey crew qualifications.
      b. Prior to start of any survey work, the CMGC shall submit name and qualifications of the grade checker/surveyor who are proposed to perform surveys or survey-related duties to the Atlantic Richfield Company Representative for review and acceptance.

1.04 PROJECT RECORD DOCUMENTS

A. The CMGC shall maintain on site a complete, accurate log of control of survey work completed by the CMGC as it progresses.

B. Upon completion of the Work, the CMGC shall submit Field Data to the Atlantic Richfield Company Representative under the provisions of Section 01 78 10 – As-Built Records and Section 01 78 20 – Closeout Submittals.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.01 SURVEY WORK

A. The CMGC shall exercise care during the execution of the Work to minimize any disturbance to existing property and to the landscape in the areas surrounding the work site. Surveys by the CMGC shall include, but not be limited to, the following:
   1. Initial inspection.
   2. Survey to establish new benchmarks, if necessary.
   3. Any surveys indicated or implied by these specifications or necessary to document pre-excavation grades and final grades for the payment of quantities as described in Section 02 11 10 Excavation And Handling, Section 31 00 00 – Earthwork, Section 31 37 00 – Riprap, and Section 31 01 20 – Growth Media (Cover Soil).The CMGC shall comply with all requests by the Atlantic Richfield Company Representative for additional surveys deemed necessary to verify that conditions of the Contract are met. Any surveys necessary to correct defects in the work shall be performed by the CMGC at no additional cost to Atlantic Richfield Company.
   4. CMGC shall complete interim survey, as required, to accurately account for Work being completed. Survey coordinates reported shall use Montana State Plane Coordinate System (NAD 83), Montana 2500, International feet. Survey units reported shall be International Feet. Elevation surveys shall use the North American Vertical Datum of 1988 (NAVD 88), Geoid 03. Interim survey work required shall include, but not limited to, survey of mine waste excavation progress, site grading (general backfill) progress, and survey to document as-built features. CMGC shall check in and out of at least 3 Atlantic Richfield Company established control points prior to and upon completing each interim survey. CMGC shall record control point coordinates in survey notebook for interim survey check in and check out. CMGC shall label point files, and collect survey information according to the following:
   5. CMGC shall develop survey files according to definable Work activities. Activity codes for definable Work activities will be agreed upon between CMGC surveyor and Atlantic Richfield Company Representative.
   6. Point files within each job shall be named as follows:
      1) Date(mmddyy)_Activity Code_Site Name_C (i.e., CMGC interim survey point file for excavation collected on July 20,2023 at the Grove Gulch would be labeled: 072023_EXC_GG_C).
   7. Point numbering ranges for CMGC surveys will be agreed upon between CMGC surveyor and Atlantic Richfield Company Representative.

3.02 SURVEY REFERENCE POINTS AND PROPERTY CORNERS

A. The CMGC shall identify and protect existing survey control points prior to starting site work and preserve permanent control points during construction. The CMGC shall not relocate site control points without prior written approval from the Atlantic Richfield Company Representative.

B. The CMGC shall promptly report to the Atlantic Richfield Company Representative the loss, damage, destruction, or relocation of any other control points or property corners required because of changes in grades or other reasons. Survey accuracy used to relocate disturbed control points shall be equal to or better than that with which the original control was set. At a minimum, control points shall be reset to within the tolerance described in Paragraph Survey Requirements. Permanent reference points shall be constructed to meet the applicable requirements of Montana Code Annotated including but not limited to Title 37, Chapter 67 (Engineers and Land Surveyors) and property corners shall be

reestablished to meet the applicable requirements of MCA 70-22-104; and ARM 24.183.1001.

3.03 INSPECTION AND INITIAL SURVEY

A. The CMGC shall verify existing site conditions, including but not limited to locations and horizontal and vertical coordinates of existing benchmarks, survey control points, utilities, and site features, prior to starting work. The CMGC shall promptly notify the Atlantic Richfield Company Representative of any discrepancies discovered. The CMGC shall also verify layouts periodically during construction. The CMGC shall perform a damage inspection prior to the start of work activities at the Site. The inspection shall include all structures and identified aboveground utilities. The inspection shall include the limits of site work. The damage inspection results shall be compared to the site conditions indicated on the Construction Drawings. Any discrepancies in existing site conditions, damage to existing facilities or missing items shall be noted in writing and provided to the Atlantic Richfield Company Representative prior to the start of site work.

3.04 SURVEY REQUIREMENTS

A. The CMGC shall reference Atlantic Richfield Company -established site reference points and survey control points to the provided permanent benchmarks, with horizontal and vertical data, and As-Built Drawings.

B. All control surveys for elevation shall be ±0.01 foot and, for horizontal, control angles shall be to the nearest twenty (20) seconds ±10 seconds, and measured distances shall be to ±0.01 foot. All measurement surveys for elevation shall be to the nearest 0.01 foot and for horizontal distances shall be to ± 0.01 foot for monuments and 0.1 foot for ground shots.

C. The CMGC shall provide all materials as required to properly perform the interim construction surveys, including, but not limited to, instruments, tapes, rods, measures, mounts and tripods, stakes and hubs, nails, ribbons, other reference markers, and all else as required. All material shall be of good professional quality and condition.

D. All lasers, transits, and other instruments shall be calibrated and maintained in accurate calibration throughout the execution of the Work. Calibration certificates shall be submitted to the Atlantic Richfield Company Representative prior to the use of any instrument.

E. The CMGC shall furnish all materials and accessories (i.e., grade markers, stakes, pins, spikes, etc.) required for the proper location of grade points and line.

F. All marks given shall be carefully preserved and, if destroyed or removed without the Atlantic Richfield Company Representative's approval, shall be reset, if necessary, at the CMGC's expense.

3.05 SURVEY RECORDS

A. By 10 a.m. on the day after interim survey work was completed, the CMGC shall furnish the Atlantic Richfield Company Representative copies of all field notes, computations, and CMGC survey information or layout of the work, and digital files that comply with Atlantic Richfield Company -required computer software formats (AutoCAD or Microsoft Excel [.csv] file) required to interpret finished data. The Atlantic Richfield Company Representative will use them in conjunction with Atlantic Richfield Company Representative survey data as necessary to calculate the amount of progress payments. The CMGC will provide monthly surveys for quantity measurement for payment purposes. The survey records shall be kept updated as construction progresses with a marked-up set of as-built drawings. The CMGC shall retain copies of all such material furnished to the Atlantic Richfield Company

Representative. In addition, the CMGC shall provide copies of all field notes, maps, or other records within 30 calendar days of completion of all fieldwork for each season. The final coordinates reported shall use the Montana State Plane Coordinate System (NAD 83), Montana 2500, International feet. Elevation surveys shall use the North American Vertical Datum of 1988 (NAVD 88), Geoid 03.

END OF SECTION

SECTION 01 78 10
AS-BUILT RECORDS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Construction Management General Contractor (CMGC) shall maintain and submit as-built record documents. All such record documents shall conform to the applicable requirements for this section.

1.02 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-07 Closeout Submittals:
      a. As-Built Drawings:
         1) Two complete sets of the As-Built Drawings shall be submitted to the Atlantic Richfield Company Representative for review and approval within 30 calendar days after substantial completion. If review of the preliminary as-built drawings reveals errors and/or omissions, one of the marked drawings will be returned to the CMGC for the completion of the final as-built drawings. The CMGC shall make all corrections and return the drawings to the Atlantic Richfield Company Representative for review and approval within 10 calendar days of receipt.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.01 AS-BUILT DRAWINGS

A. The CMGC shall keep at the construction site field office two complete sets of the prints of the Construction Drawings, reproduced at CMGC expense, one for the CMGC's use, one for Atlantic Richfield Company. During construction, both sets of prints shall be marked to show the as-built conditions during the duration of the project. Changes from the Construction Drawings, which are made in the work or additional information which might be uncovered in the course of construction, shall be accurately and neatly recorded as they occur by means of details and notes. The color red shall be used to indicate all additions and green to indicate all deletions. Current Construction Drawings shall also be made available electronically through a common web base access at the choice of Atlantic Richfield Company. The drawings shall show the following information but not be limited thereto:
   1. Correct grade, elevations, cross section, or alignment of roads, or earthwork if any changes were made from Construction Drawings.
   2. Correct location of all existing site features, including buildings, trees, and stumps to remain, fence lines, if different from original Construction Drawings.
   3. Locations of any replacement plantings of trees or other landscape features.
   4. The topography and grades of all drainage affected or altered as part of the project construction.
   5. Changes or modifications which result from the final inspection.
   6. Where Construction Drawings or specifications present options, only the option selected for construction shall be shown on the final as-built prints.

7. If borrow material for this project is from sources on Atlantic Richfield Company property, or if Atlantic Richfield Company property is used as a spoil area, the CMGC shall furnish a contour map of the final borrow pit/spoil area elevations.
8. Features designed or enhanced by the CMGC.
9. Miscellaneous changes or modifications from the original design and layout of work.

B. Deviations shall be shown in the same general detail utilized in the Construction Drawings. These working as-built marked drawings shall be kept current on a weekly basis and at least one set shall be available on the jobsite at all times. Additional drawing sheet(s) shall be provided as required to explain all work performed and shall be in the same format and detail utilized in the Construction Drawings. The resulting field-marked prints and data shall be referred to and marked as "As-Built Drawings" and shall be used for no other purpose. They shall be made available for inspection by Atlantic Richfield Company or its Representatives whenever requested during construction and shall be jointly inspected for accuracy and completeness by Atlantic Richfield Company or its Representatives and a responsible representative of the CMGC prior to submittal of the Contract records.

C. Final As-Built Drawings:
1. Within 30 calendar days of substantial completion, the CMGC shall submit final as-built drawings. All drawings from the original Construction Drawings set shall be included, including drawings where no changes were made. The Atlantic Richfield Company Representative will review all final as-built drawings for accuracy. The drawings will be returned to the CMGC if corrections are necessary. Within 10 calendar days the CMGC shall revise the drawings accordingly, at no additional cost, and return the drawings to the Atlantic Richfield Company Representative for approval. Paper prints will become the property of the Atlantic Richfield Company upon final approval.

END OF SECTION

SECTION 01 78 20
CLOSEOUT SUBMITTALS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The CMGC shall furnish all labor, materials, and incidentals required to prepare and update the project records and closeout report to produce an end product which complies with the contract requirements.

B. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures and Guidance.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
   1. U.S. National Archives And Records Administration (NARA):
      a. 29 CFR 1910 - Occupational Safety and Health (OSHA) Standards.
      b. 29 CFR 1926 - Safety and Health Regulations for Construction.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-07 Closeout Submittals:
      a. Project Records:
         1) The CMGC shall maintain all construction documents as required and submit, upon request or upon completion of field operations, project documents to the Atlantic Richfield Company Representative including analytical and chemical quality control results in final report format, as-built drawings, final SSHASP with all project safety documentation attached, records, and correspondence.
      b. Closure Report:
         1) The CMGC shall submit a draft of the Closure Report to the Atlantic Richfield Company Representative for approval within 30 calendar days of substantial completion. The draft report shall contain a complete set of As-Built Drawings in accordance with Section 01 78 10 – As-Built Records.
         2) The CMGC shall submit the final Closure Report within 15 calendar days of receipt of review comments. The final report shall contain a complete set of As-Built Drawings in accordance with Section 01 78 10 – As-Built Records.

1.04 PROJECT RECORDS

A. The CMGC shall maintain at the CMGC's field office all contract documents or a web-based access of Atlantic Richfield Company’s choice; modifications to the contract and technical requirements of the work; Atlantic Richfield Company Representative's or Atlantic Richfield Company’s directives; and written reports of any significant quality control problems.

B. The CMGC shall maintain an activity summary file for each property that shall include: Photographs; Reports on emergency response actions/spill incidents; Records of all site work; Chain-of-custody documents; All laboratory analytical results; All safety and accident

reports; Air monitoring reports and data; Construction quality control daily reports; Chemical quality control reports; Cost information.

1. Maintenance of Documents:
    a. All project record and backup documents shall be stored and managed by the CMGC. The CMGC shall store the documents in the CMGC's field office or a web-based access of Atlantic Richfield Company's choice apart from current working documents. The CMGC shall maintain documents in a clean, dry legible condition and in good order, and not use record documents for work purposes. The CMGC shall maintain all current records; and make those documents available at all times for inspection by the Atlantic Richfield Company Representative.

1.05 CLOSEOUT SUBMITTALS

A. As-Built Drawing Documentation:
    1. The CMGC shall prepare and submit as-built drawings in accordance with Section 01 78 10 – As-Built Records.

B. Closure Report:
    1. A Closure Report shall be prepared by the CMGC covering all remediation actions. The Closure Report shall provide adequate detail to describe and document all activities conducted on each specific project including boundaries of excavation, excavation and backfill volumes, materials placement, documentation of health and safety, sample results for materials brought onto site, problems encountered, material disposal, air monitoring results, and progress photographs.

1.06 RECORD KEEPING

A. A copy of the SSHASP with all safety documentation listed in the contract must be kept up-to-date and on site as well as an up-to-date electronic copy on a web-based access of Atlantic Richfield Company's choice.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

(NOT USED)

END OF SECTION

SECTION 01 78 30
WARRANTY OF CONSTRUCTION

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Construction Management General Contractor (CMGC) shall warranty construction.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.01 WARRANTY OF CONSTRUCTION

A. In addition to any other warranties in this contract, the CMGC warrants that work performed under this contract conforms to the contract requirements and is free of any defect in equipment, material, or design furnished, or workmanship performed by the CMGC or any subcontractor or supplier at any tier.

B. This warranty shall continue for a period of 1 year from the date of final acceptance of the Work. If Atlantic Richfield Company takes possession of any part of the Work before final acceptance, this warranty shall continue for a period of 1 year from the date Atlantic Richfield Company takes possession.

C. The CMGC shall remedy at the CMGC's expense, any failure to conform, or any defect. In addition, the CMGC shall remedy, at the CMGC's expense, any damage to Atlantic Richfield Company owned or controlled real or personal property, when that damage is the result of the CMGC's failure to conform to contract requirements or any defect of equipment, material, workmanship, or design furnished.
    a. The CMGC shall restore any work damaged in fulfilling the warranty. The CMGC's warranty with respect to work repaired or replaced will run for 1 year from the date of repair or replacement.
    b. Atlantic Richfield Company or its representatives will notify the CMGC, in writing or by telephone, after the discovery of any failure, defect, or damage.
    c. If the CMGC fails to remedy any failure, defect, or damage after receipt of notice, Atlantic Richfield Company will have the right to replace, repair, or otherwise remedy the failure, defect, or damage at the CMGC's expense.
    d. With respect to all warranties, express or implied, from subcontractors, manufacturers, or suppliers for work performed and materials furnished under this contract, the CMGC shall:
        1) Obtain all warranties that would be given in normal commercial practice.
        2) Require all warranties to be executed, in writing, for the benefit of Atlantic Richfield Company, if directed by the Atlantic Richfield Company Representative.
        3) Enforce all warranties for the benefit of Atlantic Richfield Company, if directed by the Atlantic Richfield Company Representative.
            (a) In the event the CMGC's warranty has expired, Atlantic Richfield Company may bring suit at its expense to enforce a subcontractor's, manufacturer's, or supplier's warranty.

(b) Unless a defect is caused by the negligence of the CMGC or subcontractor or supplier at any tier, the CMGC shall not be liable for the repair of any defects of material or design furnished by Atlantic Richfield Company nor for the repair of any damage that results from any defect in Atlantic Richfield Company -furnished material or design.
(c) This warranty shall not limit the Atlantic Richfield Company's rights under the contract with respect to latent defects, gross mistakes, or fraud.

END OF SECTION

SECTION 01 80 00
ROAD MAINTENANCE AND DUST CONTROL

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Grade and maintain access roads and drainage ditches on all roads designated by the Atlantic Richfield Company Representative within the project areas as described in the Technical Specifications and Construction Drawings.

B. Apply water and liquid magnesium chloride as needed to control dust from construction traffic within the project areas as shown on the Construction Drawings.

C. Apply water or other Atlantic Richfield Company approved dust suppression methods on stockpiles, cover areas, etc., to prevent fugitive dust from leaving the Site.

D. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-01 Preconstruction Submittals:
      a. Dust Control Plan:
         1) The CMGC shall prepare and submit a Dust Control Plan as a standalone attachment to the project-specific Construction Execution Plan (CEP). The purpose of the Dust Control Plan is to detail measures that the CMGC will implement to prevent and control fugitive dust emissions during the execution of the Work.
   2. SD-03 Product Data:
      a. Liquid Magnesium Chloride:
         1) The CMGC shall submit physical and analytical characteristics of liquid magnesium chloride to be utilized and certificates showing guaranteed analysis. The CMGC shall also provide equipment to be utilized for application of Liquid Magnesium Chloride.

PART 2 - PRODUCTS

2.01 WATER

A. Water used for dust suppression will be the responsibility of the CMGC. Water sources must be approved by Atlantic Richfield Company.

2.02 LIQUID MAGNESIUM CHLORIDE

A. Liquid magnesium chloride used for dust suppression may be used as approved or as directed by the Atlantic Richfield Company Representative.

B. Liquid magnesium chloride shall have the following physical properties:

Physical Property	Value
Specific Gravity	1.31 (+/- 0.02)
pH (5% Solution)	7.0 to 9.0
Weight	10.7 to 11.1 lbs./gallon
Density	Approx. 185 gallons/ton

C. Liquid magnesium chloride shall have the following analysis:

Typical Analysis	Range (%)
Magnesium Chloride (MgCl2)	30 to 33
Sulfate (SO4)	1.0 to 4.0
Potassium (K)	0.1 to 0.5
Water (H2O)	62 to 70

PART 3 - EXECUTION

3.01 GENERAL

A. Dust control shall be performed throughout the work in accordance with the CMGC's Dust Control Plan and as directed by the Atlantic Richfield Company Representative.

3.02 WATER APPLICATION

A. Water shall be applied to roads or other site areas requiring dust control at a rate and frequency that controls all visible dust and does not produce sheet flow and/or erode existing features. Water applications and costs incurred to produce such shall be provided by the CMGC during the course of work on an as-needed basis or as directed by Atlantic Richfield Company Representative with no additional cost to Atlantic Richfield Company.

3.03 LIQUID MAGNESIUM CHLORIDE APPLICATION

A. Liquid magnesium chloride shall be applied to pre-watered and regraded roads requiring dust control by water truck or other Atlantic Richfield Company -approved application equipment. Prior to application of liquid magnesium chloride, CMGC shall complete road maintenance and regrading to an acceptable road surface, as directed by Atlantic Richfield Company Representative. CMGC shall apply liquid magnesium chloride at an application rate of 0.5 gallons per square yard (split in two 0.25 gallons per square yard applications) and frequency that controls all visible dust and does not produce sheet flow and/or erode existing features. Liquid magnesium chloride applications shall be provided by the CMGC during the course of work on an as-needed basis or as directed by Atlantic Richfield Company Representative.

3.04 ROAD MAINTENANCE

A. Regrade, repair and or resurface all roads which receive project related traffic within the project areas as described in the Technical Specifications and Construction Drawings, or as directed by the Atlantic Richfield Company Representative.

B. Provide and apply water to the road as required for regrading and fugitive dust control purposes and as directed by Atlantic Richfield Company Representative.

END OF SECTION

SECTION 02 11 10
EXCAVATION AND HANDLING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Work includes excavation, handling, and shaping of excavated areas to the lines and grades indicated on Construction Drawings. Tailings, waste, and contaminated soils are materials that exceed the Waste Identification Criteria (Table 1) presented in Article 1.04 and shall be handled as described within this Section. On-site material suitable for use as backfill are materials that meet the Backfill Material Suitability Criteria, conforming to the definition presented in Article 1.04. Only areas indicated on the Construction Drawings are suitable for additional handling to meet the Backfill Material Suitability Criteria. Blending of tailings, waste, and contaminated soils with suitable general backfill is not allowed.

B. The sequencing of the Work shall generally consist of creating access and haul roads, installing erosion control features, installing decontamination pads, clearing and grubbing excavation areas, excavating tailings, waste, and contaminated materials. Tailings, waste, and contaminated materials will be directly loaded and hauled offsite to an approved disposal site and/or consolidated into previously approved stockpile locations and later hauled off-site.

C. In addition, the Work shall consist of the excavation, loading, and off-site disposal of miscellaneous debris materials that are located within the removal action areas. Materials disposal plans shall be done in accordance with Construction Management General Contractor's (CMGC) approved Waste Management Plan (WMP) and all local, state, and federal regulations.

D. Additional handling of material suitable for on-site work shall consist of excavation, loading, crushing, screening and stockpiling of suitable materials. Materials will be consolidated into approved stockpile locations and later utilized as on-site as appropriate.

E. The CMGC shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 REFERENCES

A. The publication listed below is a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
   1. U.S. National Archives and Records Administration (NARA):
      a. 40 CFR 302 - Designation, Reportable Quantities, and Notification.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-01 Preconstruction Submittals:
      a. The CMGC shall prepare a project-specific Construction Execution Plan (CEP) describing the following construction components for the Site:
         1) Excavation Work Plan:
            (a) Submit Excavation Work Plan at least 14 calendar days prior to start of excavation as part of the project-specific Construction Execution Plan (CEP). No excavation shall be completed at the Site, without formal

written approval from Atlantic Richfield Company and/or the Atlantic Richfield Company Representative of the Excavation Work Plan. Atlantic Richfield Company and/or its representative will approve, modify, or reject the Excavation Work Plan. No adjustment for time or money will be made if re-submittals of the Excavation Work Plan are required due to deficiencies in the plan.

(b) At a minimum, the Excavation Work Plan shall include:
   (i) Schedule of activities and general sequence of excavation activities anticipated for the Work.
   (ii) Means and methods of excavation and equipment, including crushing/screening, to be utilized.
   (iii) Plans for construction dewatering and surface water diversion.
   (iv) A Waste Management Plan (WMP).
   (v) A Dust Control Plan (prepared as a standalone attachment to the CEP).
   (vi) Anticipated haul routes including locations of decontamination devices.
   (vii) Shoring and/or sidewall proposed slopes.
   (viii) Decontamination procedures.
   (ix) Storage means and methods and locations for fuels, equipment, and other supplies.
   (x) Proposed schedule and work hours.

1.04 DEFINITIONS

A. Tailings, Waste, and Contaminated Materials:
   1. Tailings, waste, and contaminated materials shall be defined as materials that meet the Waste Identification Criteria outlined in Appendix 1, Table 1, of the Further Remedial Elements Scope of Work (FRESOW) included as Attachment C to Appendix D of the Consent Decree for the Butte Priority Soils Operable Unit. Table 1 is also provided below. If three of the six contaminant criteria listed are exceeded or any one contaminant is above 5,000 mg/kg, then the material is considered tailings, waste, or contaminated soil.

Table 1: Waste Identification Criteria

Arsenic	200 mg/kg
Cadmium	20 mg/kg
Copper	1,000 mg/kg
Lead	1,000 mg/kg
Mercury	10 mg/kg
Zinc	1,000 mg/kg
Any single analyte above 5,000 mg/kg	

   2. These materials shall also be defined as any material identified on the Construction Drawings for removal as well as any material identified by Atlantic Richfield Company Representative.

B. On-Site Suitable Backfill Material:
   1. On-site suitable backfill materials shall be defined as material meeting the Backfill Material Suitability Criteria outlined in Appendix 1, Table 2, of the FRESOW included as Attachment C to Appendix D of the Consent Decree for the Butte Priority Soils Operable Unit.

2. These materials shall also be defined as material identified on the Construction Drawings for excavation, crushing, screening, and on-site reuse.

1.05 ENVIRONMENTAL PROTECTION

A. Air Emissions Monitoring:
   1. Air emissions shall be monitored and controlled in accordance with Section 01 35 00 – Environmental Protection and the CMGC's Environmental Protection Plan (EPP).

B. Spill Prevention and Control:
   1. Spill prevention and control shall be executed in accordance with Section 01 35 00 – Environmental Protection and the CMGC's EPP.

1.06 SCHEDULING

A. The CMGCs approved Excavation Work Plan shall notify Atlantic Richfield Company of CMGCs intent to begin excavation. The CMGC shall be responsible for contacting the Atlantic Richfield Company Representative.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.01 CULTURAL RESOURCES

A. Mitigation, avoidance, and/or removal of cultural resources within or near excavation areas shall be conducted in accordance with Section 01 35 00 – Environmental Protection.

3.02 CLEARING

A. Clearing shall be performed to the limits shown on the Construction Drawings and in accordance with Section 31 01 10 – Clearing and Grubbing.

3.03 TAILINGS, WASTE, AND CONTAMINATED MATERIAL REMOVAL

A. Safety and Health:
   1. Excavation of tailings, waste, and contaminated materials shall be conducted in accordance with the standards and regulations specified in Section 01 34 00 – Safety, Health, and Emergency Response.

B. Pre-Determined Tailings, Waste, and Contaminated Material Remedial Action Areas:
   1. The CMGC shall perform an initial excavation of all tailings, waste, and contaminated material within the limits of excavation to the lines and grades as shown on the Construction Drawings or bedrock is reached. Additional excavation of tailings, waste, and contaminated materials beyond the extent indicated on the Construction Drawings may be required based on the structural stability of the remaining materials as determined by the Atlantic Richfield Company Representative.
      a. The Atlantic Richfield Company Representative shall be notified immediately if suspect tailings, waste, and/or contaminated material is discovered (visual, olfactory, etc.) that has not been previously identified or if other discrepancies between data provided and actual field conditions are encountered. The CMGC shall notify the Atlantic Richfield Company Representative when the initial excavation has been completed.

C. Field-Identified Tailings, Wastes, and Contaminated Material Remedial Action Areas:
   1. The CMGC shall perform excavation of field-identified tailings, waste, and/or contaminated materials as directed by Atlantic Richfield Company or their representative. Additional excavation of these materials beyond the extent identified may be required based on the structural stability of the remaining materials as determined by the Atlantic Richfield Company Representative.

D. Regraded Fill:
   1. The CMGC shall regrade and realign the excavation areas as shown on the Construction Drawings. Fill materials shall meet the general fill criteria as defined in Article 1.04.

3.04 DEBRIS MATERIAL

A. The CMGC shall remove and dispose of debris material in accordance with the approved Waste Management Plan (WMP), Section 02 12 00 – Hauling and Off-Site Disposal of Excavated Materials, and as indicated on the Construction Drawings. Debris material shall not be disposed with tailings, waste, and contaminated materials in the approved repository unless approved in writing by Atlantic Richfield Company and must be separated prior to offsite disposal in an approved facility. Debris material meeting the Backfill Material Suitability Criteria defined in Article 1.04 may be used as general backfill.

3.05 HAULING AND DISPOSAL OF EXCAVATED MATERIALS

A. Reference Section 02 12 00 – Hauling and Off-Site Disposal of Excavated Materials for disposal requirements.

3.06 SURFACE WATER DIVERSION AND DEWATERING

A. Surface water shall be diverted as identified in the Contract Documents, or as directed by Atlantic Richfield Company. The CMGC shall use best management practices (BMPs) identified on the Construction Drawings, the CMGC's approved project-specific CEP and associated Excavation Work Plan, the CMGC's approved EPP, and as directed by the Atlantic Richfield Company Representative to control erosion and mobilization of sediment along creek, stream, or wetland excavation areas. BMPs shall be installed and maintained in accordance with Section 02 37 00 – Erosion Control. Dewatering shall be limited to that necessary to assure adequate access, a safe excavation, prevent the spread of contamination, and to ensure that compaction requirements can be met. CMGC shall perform dewatering as identified in the Contract Documents and/or as directed by the Atlantic Richfield Company Representative. No dewatering shall be performed without prior approval of the Atlantic Richfield Company Representative.

3.07 TEMPORARY TAILINGS, WASTE, AND CONTAMINATED MATERIAL STORAGE

A. Stockpiling of tailings, waste, and contaminated material is only allowed within designated areas shown on the Construction Drawings or direction and approval of the Atlantic Richfield Company Representative. CMGC shall implement BMPs or other control measures as outlined in CMGC's approved Excavation Plan or as directed by the Atlantic Richfield Company Representative.

END OF SECTION

SECTION 02 12 00
HAULING AND OFF-SITE DISPOSAL OF EXCAVATED MATERIALS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This work item shall consist of hauling tailings, waste, and contaminated materials (mine waste) as defined in Section 02 11 10 – Excavation and Handling to the designated repository location(s) as shown on the Construction Drawings. This work also includes hauling and disposal of debris material to off-site disposal site(s). No on-site disposal will be allowed.

B. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-01 Preconstruction Submittals:
      a. The CMGC shall prepare a project-specific Construction Execution Plan (CEP) describing the following construction components for the Site:
         1) Traffic Control Plan:
            (a) The CMGC shall prepare a Traffic Control Plan to detail the measures that will be implemented to address traffic safety and to coordinate and control the movement of workers, construction vehicles, and equipment within the work zone and surrounding area. The Traffic Control Plan shall be a standalone attachment to the project-specific CEP. The plan shall include State and County approvals, as necessary.
         2) Waste Management Plan:
            (a) The CMGC shall prepare a Waste Management Plan (WMP) as part of the project-specific CEP. The purpose of the WMP is to provide a framework for managing wastes in a manner which reduces risk to the environment and human health and ensures compliance. This plan addresses the characterization, handling and disposal of soils and construction wastes for the site.
   2. SD-07 Certificates:
      a. Shipping Documents:
         1) The CMGC shall provide shipping documents that indicate debris materials were shipped to the approved off-site disposal site(s).
      b. Disposal Facility:
         1) Licensed, Atlantic Richfield Company approved offsite disposal site(s).

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.01 OFF-SITE TRANSPORTATION AND DISPOSAL:

A. All excavated tailings, waste, and contaminated materials, excluding construction debris and solid waste material, shall be consolidated at the designated repository location(s) as shown on the Construction Drawings or as approved by the Atlantic Richfield Company Representative. The CMGC shall include, in his Construction Daily Reports, the estimated daily and cumulative volume of waste material hauled to the designated repository from the Site as outlined in Section 01 45 10 – Contractor Quality Control. This information shall also be relayed to Atlantic Richfield Company during the weekly coordination meetings. Contaminated materials are defined in Section 02 11 10 – Excavation and Handling. Debris material Backfill Material Suitability Criteria defined in Section 02 11 10 – Excavation and Handling may be used as general backfill.

B. Transportation:
   1. The CMGC shall ensure that materials are not blown or spilled along the haul route by use of an appropriate load covering system in accordance with Section 01 35 00 – Environmental Protection. Any major spillage or accumulation of minor spillage shall be cleaned up as described in this Section. The CMGC shall ensure that roadways and other public access areas are kept clean and not tracked with soil or contaminated material from the excavation areas.
      a. Use of Public Roadways:
         1) All contract operations requiring use of public roadways shall conform to local and state rules and regulations.

C. Disposal Areas:
   1. Contaminated materials located within the Remedial Action boundaries, as shown on the Construction Drawings, shall be hauled to the designated repository. Debris material shall not be disposed with tailings, waste, and contaminated materials in the designated repository unless approved in writing by Atlantic Richfield Company and must be separated prior to offsite disposal in an approved facility.

3.02 DISPOSAL

A. Landfill Waste:
   1. The CMGC shall dispose of landfill waste in accordance with the CMGCs approved WMP (Section 01 35 00 – Environmental Protection) and in compliance with Federal, State, and local requirements.

B. Tailings, Waste, and Contaminated Material:
   1. The CMGC shall dispose of tailings, waste, and contaminated materials accordance with the CMGCs approved WMP and in compliance with Federal, State, and local requirements. All waste materials shall be disposed of in an approved AR-RM facility and approved by the Agencies prior to disposal. The CMGC shall provide shipping documents that indicate materials were shipped to the approved disposal site. Segregation measures shall be employed to minimize the disposal quantities. The CMGC shall verify that the selected transporters and disposal facilities have the necessary permits and licenses to operate.

END OF SECTION

SECTION 02 31 00
GATES, BARRIERS, AND SIGNAGE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Work includes installation of access prevention steel gates and signage indicated on the Construction Drawings.

B. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures and Guidance.

1.02 REFERENCES

A. American Welding Society (AWS):
   1. AWS D1.1/D1.1M - Structural Welding Code – Steel.

B. ASTM International (ASTM):
   1. ASTM A 36 - Standard Specification for Carbon Structural Steel
   2. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   3. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   4. ASTM A 924/A 924M - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

C. U.S. Federal Highway Administration (FHWA):
   1. MUTCD - Manual of Uniform Traffic Control Devices for Streets and Highways.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-02 Shop Drawings:
      a. Approved Detail Drawings:
         1) Drawings showing elevations of each type of sign; dimensions, details, and methods of mounting or anchoring; shape and thickness of materials; and details of construction.
         2) A schedule showing the location, each sign type, and message shall be included as part of the submittal of Approved Detail Drawings.
   2. SD-03 Product Data:
      a. Steel Gate:
         1) The CMGC shall submit applicable manufacturer's specifications on the type of gate that will be used.
      b. Signage Installation:
         1) Material specifications, installation/cleaning instructions, and manufacturers’ recommendations for all products and materials. CMGC shall submit signage schedule in electronic media with spreadsheet format. Spreadsheet shall include sign location, sign type, and message. Shall meet requirements as stated in Section 2.02 of Specification.

1.04 GENERAL

A. Steel Gate:
   1. The steel gate shall be of the design, detail, sizes, and types as shown on the Construction Drawings, shall conform to the requirements specified, and shall be provided at the locations indicated and approved by the Atlantic Richfield Company Representative.

B. Signage:
   1. All exterior signage shall be provided by a single manufacturer. Exterior signage shall meet the MUTCD or as approved by the Atlantic Richfield Company Representative. Signs shall be complete with lettering, framing as detailed, and related components for a complete installation.

1.05 SIGNAGE CHARACTER PROPORTIONS AND HEIGHTS

A. Characters and numbers on indicated signs shall be sized according to the viewing distance from which they are to be read. The minimum height is measured using an upper-case letter "X". Lower case characters are permitted.

1.06 SIGNAGE QUALIFICATIONS

A. Signs, plaques, and dimensional letters shall be the standard product of a manufacturer regularly engaged in the manufacture of the products.

1.07 DELIVERY AND STORAGE

A. Materials shall be wrapped for shipment and storage, delivered to the jobsite in manufacturer's original packaging, and stored in a clean, dry area in accordance with manufacturer's installation instructions.

1.08 WARRANTY

A. Manufacturer's standard performance guarantees or warranties that extend beyond a one-year period shall be provided to the Atlantic Richfield Company Representative prior to installation at the specified location.

PART 2 - PRODUCTS

2.01 STEEL GATE

A. The steel gates shall conform to the following:
   1. Structural tubing shall be ASTM A 36 structural steel.
   2. Tube sizes and wall thickness are as shown on the Construction Drawings.

2.02 EXTERIOR SIGNAGE

A. The exterior signage shall conform to the following:
   1. Sign Construction Material:
      a. One-piece aluminum or galvanized steel or other Atlantic Richfield Company approved posts shall be provided with minimum 0.125-inch wall thickness. Posts shall be designed to accept panel framing system described. The post shall be designed to permit attachment of panel framing system without exposed fasteners. Caps shall be provided for each post.

2. Graphics for Exterior Signage Systems:
    a. Signage graphics shall conform to the following and provided to and approved by the Atlantic Richfield Company Representative:
        1) Pressure sensitive precision cut vinyl letters shall be provided.
        2) Message shall be constructed of durable and waterproof materials with a minimum life expectancy of 10 years. Sheets shall be processed in one piece, in one process, to prevent delamination.
3. Anchors and Fasteners:
    a. Exposed anchor and fastener materials shall be compatible with metal to which applied and shall match in color and finish and shall be non-rusting, non-corroding, and non-staining. Exposed fasteners shall be tamper-proof.
4. Shop Fabrication and Manufacture:
    a. Factory Workmanship:
        1) Work shall be assembled in the shop, as far as practical, ready for installation at the site. Work that cannot be shop assembled shall be given a trial fit in the shop to ensure proper field assembly. Holes for bolts and screws shall be drilled or punched. Drilling and punching shall produce clean, true lines and surfaces. Welding to or on structural steel shall be in accordance with AWS D1.1/D1.1M. Welding shall be continuous along the entire area of contact. Exposed welds shall be ground smooth. Exposed surfaces of work shall have a smooth finish and exposed riveting shall be flush. Fastenings shall be concealed where practical. Items specified to be galvanized shall be by hot-dip process after fabrication if practical. Galvanization shall be in accordance with ASTM A 123/A 123M and ASTM A 653/A 653M, as applicable. Other metallic coatings of steel sheet shall be in accordance with ASTM A 924/A 924M. Joints exposed to the weather shall be formed to exclude water. Drainage and weep holes shall be included as required to prevent condensation buildup.
    b. Dissimilar Materials:
        1) Where dissimilar metals are in contact, or where aluminum is in contact with concrete, mortar, masonry, wet or pressure-treated wood, or absorptive materials subject to wetting, the surfaces shall be potected with a coat of asphalt varnish or a coat of zinc-molybdate primer to prevent galvanic or corrosive action.
    c. Color, Finish, and Contrast:
        1) Color shall be selected from manufacturers standard colors. Characters and symbols shall contrast with their background - either light characters on a dark background or dark characters on a light background.

PART 3 - EXECUTION

3.01 STEEL GATE INSTALLATION

A. The steel gate shall be installed as shown on the Construction Drawings.

B. The post holes shall be filled with a minimum 6-inches of concrete around the exterior of the gate post and lock closed post with concrete so that no voids exist. The remainder of the subsurface structure shall be backfilled as described below. CMGC shall use Quikrete fast setting concrete mix product No. 1004-50 or equivalent shall be installed per manufacturer's installation instructions.

C. Subsurface structure backfill material shall be placed in 6-inch maximum lifts. Each lift shall be compacted or tamped by hand prior to placing the next lift. Backfill material shall be obtained at or near the site and shall contain adequate moisture to obtain good compaction.

D. Access travel management sign shall be centered on the gate as shown on the Construction Drawings.

E. Gate post shall be marked with reflectorized yellow object markers, on both sides of the locked closed post, on one side of the lock open post, and three sides of the hinge post as shown on the Construction Drawings.

3.02 SIGNAGE INSTALLATION

A. No excavation shall be performed until site utilities have been field located. The CMGC shall take the necessary precautions to ensure no damage occurs to existing structures and utilities. Damage to existing structures and utilities resulting from the CMGC's operations shall be repaired at no additional cost to Atlantic Richfield Company. Utilities encountered that were not previously shown or otherwise located shall not be disturbed without approval from the Atlantic Richfield Company Representative.

B. Signs shall be installed in accordance with approved manufacturer's instructions. Signs shall be installed plumb, true, and level at mounting heights indicated, and by method shown or specified.
   1. Protection and Cleaning:
      a. The work shall be protected against damage during construction. Signs shall be cleaned, as required, at time of installation and during time of work completion.

3.03 REMOVAL

A. Permanent gates, barriers, and signs are determined on the Construction Drawings and/or at the direction of the Atlantic Richfield Company Representative.

END OF SECTION

SECTION 02 37 00
EROSION CONTROL

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The work shall consist of furnishing and installing soil surface erosion control materials, including fine grading, mulching, and miscellaneous related work, within project limits and in areas outside the project limits where the soil surface is disturbed from work under this contract at the designated locations. This work shall include all necessary materials, labor, supervision and equipment for installation of a complete system. This section shall be coordinated with the requirements of Section 31 00 00 – Earthwork and Section 01 35 00 – Environmental Protection.

B. Additionally, the work shall consist of furnishing and installing temporary surface erosion control materials (e.g., establishment of temporary vegetation, spray on erosion control (i.e., bonded fiber matrix), covered with chipped vegetation/mulch, etc.) to prepare exposed soil and disturbed soil surfaces (e.g., soil salvage stockpiles, cleared and grubbed areas not stabilized with rock, construction disturbance areas, consolidated mine waste, etc.) for winter.

C. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-01 Preconstruction Submittals:
      a. Winterization Plan:
         1) The purpose of the Winterization Plan is to identify specific surface erosion control products and installation locations to protect exposed soil areas prior to demobilization for the winter season. The Winterization Plan shall be included in the CMGC's project-specific Construction Execution Plan (CEP).
   2. SD-03 Product Data:
      a. Products:
         1) Manufacturer's catalog cuts and material specifications.
         2) Manufacturer's literature including physical characteristics, application, and installation instructions.
         3) A listing of equipment to be used for the application of erosion control materials.
         4) Installation manuals.
   3. SD-04 Samples:
      a. Samples:
         1) Hydraulic Mulch: 2 pounds.
         2) Geotextile Fabrics Square: 6 inches.
   4. SD-06 Certificates:
      a. Certificates:
         1) Certificate that indicates that mulch is certified weed-free.

1.03 DELIVERY, INSPECTION, STORAGE, AND HANDLING

A. Materials shall be stored in designated areas as recommended by the manufacturer protected from the elements, direct exposure, and damage. Containers shall not be dropped from trucks. Material shall be free of defects that would void required performance or warranty.

1.04 SUBSTITUTIONS

A. Substitutions will not be allowed without written request and approval from the Atlantic Richfield Company Representative.

PART 2 - PRODUCTS

2.01 MULCH

A. Straw:
   1. Straw shall be stalks from oats, wheat, rye, barley, or rice, furnished in air-dry condition and with a consistency for placing with commercial mulch-blowing equipment. All straw shall be certified weed-free.

B. Hydraulic Mulch:
   1. The hydraulic mulch shall be composed of heat and mechanically treated straw fibers, with long natural fibers for maximum fiber matrix entanglement, and cross linked high-strength polymer binders. The hydraulic mulch shall be manufactured by HydroStraw, LLC or approved equivalent.
   2. Use HydroStraw® Bonded Fiber Matrix hydraulic mulch or approved equal for all locations requiring application of hydraulic mulch materials. Bonded Fiber Matrix hydraulic mulch components shall meet the requirements shown in Table 1 and shall be applied in accordance with the manufacturer's recommendations.

Property	**Minimum Requirement**
Physical	
Organic Matter	100%
Toxicity	Non-Toxic
Applied Color	Dye shall be water activated, green color
pH	6.8 +/- 0.5
Average Fiber Length	" +/- "
Composition	
Heat and Mechanically Treated Straw	68% +/- 1%
Natural Fibers	12% +/- 1%
Moisture	10% +/- 1%
Tackifier	10% +/- 1%
Mixture Rates	
Mulch Fiber Weight (lbs)	Gallons of Water
60	100 (Hose Work)
75	100 (Tower Work)
Application Rates	
Slope Gradient	Pounds per Acre
S - 3:1 (H:V) or flatter	3,000
S - 3:1 (H:V) or steeper	4,500

3. The hydraulic mulch shall contain the following:
    a. a. Refer to Section 32 01 89 – Fertilizing and Seeding for fertilizer and seed application rates and specifications.
    b. Tackifier shall be a biodegradable organic formulation processed specifically for the adhesive binding of mulch. The tackifier shall uniformly disperse when mixed with water and not be detrimental to the homogeneous properties of the mulch slurry. Any tackifier which has been moisture damaged or damaged by other means will not be acceptable. Tackifier may be added either during the manufacturing of the mulch or incorporated during mulch application.
    c. Organic soil and mulch tackifier for use in hydraulically planting of grass seeds, flowers, or woody tree seeds, or stolon, either alone or in combination with fertilizer, wood fiber mulch and other approved additives, shall consist of specifically blended compatible hydrocolloids. Starch-based tackifiers are unacceptable.
    d. The organic soil and mulch tackifier shall have the additional characteristics of hydrating and dispersing in circulating water to form a homogeneous slurry and remain in such a state in the hydraulic mulching unit, or adequate equal, with the specified, or other approved materials.
    e. Soil and mulch tackifier shall be applied at the manufacturer's recommended rate and as approved by the Atlantic Richfield Company Representative.
    f. When applied, the organic soil and mulch tackifier shall form a loose chain like protective film, but not a plant inhibiting membrane, which will allow moisture to percolate into the underlying soil, while helping "stick" seeds, fertilizer and other specified materials to the soil surface during germination and initial seedling growth, after which the organic soil and mulch tackifier shall breakdown by microbial action.

C. Dye:
    1. Dye shall be a water-activated, green color. Dye shall be pre-packaged in water dissolvable packets in the hydraulic mulch.

2.02 RIPRAP

A. Reference Section 31 37 00 – Riprap.

2.03 STRAW WATTLES

A. Straw wattles shall be 9 to 12-inch diameter tubes of 100% weed seed free agricultural straw wrapped in UV-stabilized synthetic net. Secure wattle ends with wire enclosures. Straw wattles shall be equal to American Excelsior Premier. Stakes shall be wood and measure no less than 1.5 inch by 1.5 inch by 18 inches.

2.04 ROCK WATTLE AND CURB SOCK

A. Rock used in wattles and curb socks shall be 1.5-inch crushed rock fill. Recycled asphalt and concrete are not acceptable. Rock shall be placed in either high-flow, high strength, UV resistant multi-filament knit textile or high strength steel wire mesh.

2.05 SILT FENCE

A. Silt fence shall be a woven (directional) fabric designed for retention of silt in runoff, backed by an industrial netting stitched to the fabric. Fabric shall be furnished in 100 feet continuous rolls of at least 3-foot width. Net backing may be 6 inches less than fabric

width. Silt fence shall be suitable for attachment to driven wood or steel posts. Silt fence shall be equal to Mirafi Enviro-Fence 100X.

2.06 EROSION CONTROL MAT

A. Erosion control mat (or erosion control blanket) shall be straw, straw/coconut or coconut with photodegradable extruded plastic mesh or woven jute fabric. Turf reinforcement mat shall be ultraviolet (UV)-stabilized woven permanent products. CMGC will install fabric equal to coir 700.

B. Provide erosion control mat of the type and grade specified in the Contract Documents or as requested by the Atlantic Richfield Company Representative.

C. Provide erosion control mats in continuous rolls of 30-feet or greater with a minimum width of 4 feet.

D. Anchoring of coir fabric will be accomplished using eighteen (18) inch wooden stakes driven into the underlying vegetative backfill on three (3)-foot centers (a horizontal and vertical grid of stakes over the embankment area) as approved by the Atlantic Richfield Company Representative.

E. Coir fabric shall meet the minimum requirements:

Property	**Test Method**	**Criteria**
Thickness	ASTM D5199	0.35 in.
Weight	ASTM D5261	20.6 oz./yd^2. (700 g/m^2)
Wide Width Tensile Strength MD x TD (Dry)	ASTM D4595	126 x 86 lbs./in.
Maximum Elongation MD x TD (Dry)	ASTM D4595	40% x 33%
Wide Width Tensile Strength MD x TD (Wet)	ASTM D4595	77 x 57 lbs./in.
Maximum Elongation MD x TD (Wet)	ASTM D4595	69% x 34%
Flexural Rigidity	ASTM D1388	12,896 x 8,132 mg/cm
Water Absorption	ASTM D1117	146%
Open Area	Measured	50%
Roll Width	Measured	7 ft or 13 ft

2.07 SURFACE EROSION CONTROL PRODUCTS FOR STOCKPILES

A. Only surface erosion control products, such as temporary vegetation, spray on erosion control (i.e., bonded fiber matrix), chipped vegetation/mulch, etc. shall be utilized to prepare exposed and soil and construction disturbed surfaces for winter as shown on the Construction Drawings and in accordance with this Specification Section.

PART 3 - EXECUTION

3.01 CONDITIONS

A. Erosion control operations shall be performed under favorable weather conditions; when excessive moisture, frozen ground or other unsatisfactory conditions prevail, the work shall

be stopped as directed by the Atlantic Richfield Company Representative. When special conditions warrant a variance to earthwork operations, a revised construction schedule shall be submitted for approval. Erosion control materials shall not be applied in adverse weather conditions which could affect their performance.

B. Winterization Plan:
   1. The CMGC shall submit a Winterization Plan that describes products, methods, and procedures to be used to install surface erosion controls prior to demobilization for the season. Install erosion control features in accordance with the approved Winterization Plan.

3.02 SITE PREPARATION

A. Finished Grade:
   1. The CMGC shall verify that finished grades are as indicated on the Construction Drawings or as directed by the Atlantic Richfield Company Representative; finish grading, compaction, and surface preparation shall be completed in accordance with Sections 31 00 00 – Earthwork and Section 31 01 20 – Growth Media (Cover Soil) prior to seeding or installation of erosion control features.
   2. Remove unsuitable material from the subgrade and replace it with suitable material if necessary. Before placing the erosion control materials, ensure the subgrade has been graded smooth; has no depressed, void areas; is free from obstructions, such as tree roots, projecting stones or other foreign matter.

B. Protecting Existing Vegetation
   1. Reference Section 01 35 00 – Environmental Protection.

3.03 INSTALLATION

A. Mulch:
   1. Mulch, when required, must be applied to seeded areas not more than 24 hours after seeding regardless of the type used. If the CMGC does not mulch within 24 hours after seeding, the CMGC may be required to re seed the project at no additional cost to Atlantic Richfield Company. Mulch shall not be applied in the presence of free surface water but may be applied upon damp ground. Mulch shall not be applied to snow-covered ground surfaces.
   2. Mulch shall not be applied to areas having a substantial vegetative growth, such as grasses, weeds and grains. Areas not to be mulched shall be determined by the Atlantic Richfield Company Representative. Mulching shall not be done during adverse weather conditions or when wind prevents uniform distribution. Application, if after seeding, shall be in a manner to not seriously disturb the seedbed surface. All roadway structures and facilities shall be protected and kept undamaged from application of bituminous material and other operations. Any such material deposited on such structures or facilities shall be removed, at the expense of the CMGC, to the satisfaction of the Atlantic Richfield Company Representative.
   3. The CMGC shall remove any equipment tracks on the seedbed prior to final mulching. The CMGC shall use a rake, small harrow or other acceptable means to remove the tracks.
      a. Application of Straw Mulch:
         1) Vegetative mulch shall be applied after seeding and fertilizing is completed unless otherwise specified by Atlantic Richfield Company. The mulch shall be applied in a uniform manner by a mulch spreader, at the rate of 2,000 pounds per acre or as shown on the Construction Drawings. The mulch spreader

shall be designed specifically for this type of work. The vegetative material shall be fed into the mechanical mulch spreader at an even, uniform rate.

2) When asphalt or a tackifying agent is used as a binder for vegetative mulch, it shall be applied at the rate specified or as outlined on the Construction Drawings. It shall be evenly distributed over the vegetative material as it emerges from the blower discharge or it may be hydraulically applied directly following mulch application. Uneven distribution, caused by inadequately powered or improperly adjusted equipment, poor workmanship, erratic material feed or discharge, or similar causes within the CMGC's control, shall be corrected. The quantity of asphalt or tackifying agent specified is subject to increase or decrease as determined in the field by the Atlantic Richfield Company Representative.

3) Straw or native hay shall be uniformly spread at the rate specified or as outlined on the Construction Drawings. Unless otherwise specified by the Atlantic Richfield Company Representative, straw or hay shall be anchored into the seedbed by using a mulch crimper. Straw or hay shall have a minimum length of 10 inches shall be pliable. If straw breaks during crimping, it shall be sprinkled with water, not soaked, to facilitate placement.

4) The mulch crimper, specifically designed for this type of work, shall have round, flat (not angled), notched blades of these approximate dimensions: 1/4-inch thick by 18 inches in diameter and spaced 8 inches apart. The crimper shall have sufficient weight to force the vegetative mulch a minimum of 3 inches into the soil and shall be equipped with disc scrapers. Mulch crimping shall be done on all slopes capable of being safely traversed by a tracked vehicle. All mulch crimping shall be done perpendicular to the flow line of the slope.

b. Application of Hydraulic Mulch:

1) Organic mulch shall be applied by means of hydraulic equipment which utilizes water as the carrying agent. A continuous agitator action, that keeps the mulching material and approved additives in uniform suspension, must be maintained throughout the distribution cycle. The pump pressure shall be capable of maintaining a continuous non fluctuating stream of slurry. The slurry distribution lines shall be large enough to prevent stoppage.

2) The discharge line shall be equipped with a set of hydraulic spray nozzles which will provide an even distribution of the mulch slurry to the seedbed. Mulching shall not be done in the presence of free surface water resulting from rains, melting snow, or other causes.

3) The CMGC shall start at the top of the slope and work downward. If necessary, he may be required to use extension hoses to reach the extremities of slopes.

c. Finishing:

1) Prior to final acceptance of the project, the CMGC shall immediately re-mulch any area from which the original mulch may have been washed or blown. If the original seedbed and seeding is damaged due to the displacement of the mulching material, the seedbed shall be repaired and reseeded before re-mulching. The operations described in this paragraph shall be at the CMGC's expense if the damage is due to his negligence.

B. Riprap:

1. Reference Section 31 37 00 – Riprap.

C. Silt Fence:
   1. Silt fence shall be erected by attachment to driven wood or metal posts or other suitable anchors at a maximum spacing of 10 feet. Fence shall be erected to prevent sags that runoff water may overtop. To prevent sagging, silt fence shall be backed with metal mesh. Joints in silt fence shall be lapped a minimum of 5 feet and secured against breaching. The bottom edge of the silt fence shall be buried a minimum of 6 inches deep in a manner to prevent surface water from flowing under the fence.

D. Straw Wattles:
   1. The area to be covered with the straw wattles shall be as shown on the Construction Drawings and areas designated by the Atlantic Richfield Company Representative. The straw waddle shall be installed according to the Manufacturer's Specifications. Install wattles along contours in accordance with manufacturer's recommendations and as shown on the Drawings. Stake wattles at 4-foot centers unless otherwise specified.

E. Rock Wattles and Curb Socks:
   1. Install as shown on the Drawings, according to the Contract Documents, or Atlantic Richfield Company Representative designation.

F. Erosion Control Mat:
   1. Provide and place coir fabric over vegetative backfill as requested by the Atlantic Richfield Company Representative in locations where the embankment work area requires direct placement of backfill on potentially erosive embankment slopes. CMGC will place and grade the vegetative backfill to the lines shown on the Drawings.
   2. Seed the vegetative backfill as requested by the Atlantic Richfield Company Representative.

3.04 MAINTENANCE, PROVISIONAL AND FINAL ACCEPTANCE

A. Maintenance:
   1. On slopes, provide against washouts by an approved method. Any washout that occurs shall be regraded at the CMGC's expense until a good stand of grass is established.
   2. The Atlantic Richfield Company Representative will inspect all erosion control work at the completion of the construction for provisional acceptance. CMGC shall maintain all erosion control work during the construction and warranty period for the project.
   3. Furnish full and complete written instructions and schedule for maintenance of the erosion control measures to the Atlantic Richfield Company Representative prior to and at the completion of construction.
   4. Inspections by the Atlantic Richfield Company Representative will determine whether maintenance is required more or less frequent than the CMGC's provided maintenance schedule.
   5. After all necessary corrective work and clean up has been completed and maintenance instructions and schedules have been received by the Atlantic Richfield Company Representative, the Atlantic Richfield Company Representative will certify in writing the provisional acceptance of the environmental measures.

B. Final Acceptance:
   1. All erosion control measures shall be maintained and guaranteed for not less than 1 full year from the time of provisional acceptance.
   2. At the end of the guarantee period, inspection will be made by the Atlantic Richfield Company Representative upon written request submitted at least 10 days before the anticipated date. Areas not demonstrating satisfactory effectiveness, as determined by

the Atlantic Richfield Company Representative, shall be renovated and maintained meeting all requirements as specified herein.

3. After all necessary corrective work has been completed, the Atlantic Richfield Company Representative shall certify in writing the final acceptance.

END OF SECTION

SECTION 02 41 00
DEMOLITION AND DECONSTRUCTION

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
   1. Occupation Safety and Health Organization (OSHA):
      a. 29 CFR 1910.120 - Hazardous waste and emergency response standard (HAZWOPER).
      b. 29 CFR 1926 - Construction Regulations.
   2. U.S. National Archives and Records Administration (NARA):
      a. 40 CFR 61 - National Emission Standards for Hazardous Air Pollutants.

1.03 PROJECT DESCRIPTION

A. Definitions:
   1. Demolition:
      a. Demolition is the process of wrecking or taking out any load-supporting structural member of a facility together with any related handling and disposal operations.
   2. Deconstruction:
      a. Deconstruction is the process of taking apart a facility with the primary goal of preserving the value of all useful building materials.
   3. Demolition Plan:
      a. Demolition Plan is the planned steps and processes for managing demolition activities and identifying the required sequencing activities and disposal mechanisms.
   4. Deconstruction Plan:
      a. Deconstruction Plan is the planned steps and processes for dismantling all or portions of a structure or assembly, to include managing sequencing activities, storage, re-installation activities, salvage and disposal mechanisms.

B. Demolition/Deconstruction Plan:
   1. Prepare a Demolition Plan and Deconstruction Plan and submit proposed salvage, demolition, deconstruction, and removal procedures for approval before work is started. Include in the plan procedures for careful removal and disposition of materials specified to be salvaged, coordination with other work in progress, a disconnection schedule of utility services, and a detailed description of methods and equipment to be used for each operation and of the sequence of operations. Identify components and materials to be salvaged for reuse or recycling with reference to paragraph Existing Facilities to be Removed. Append tracking forms for all removed materials indicating type, quantities, condition, destination, and end use. Coordinate with Waste Management Plan (WMP) in accordance with Section 01 35 00 – Environmental Protection. Include statements affirming CMGC inspection of the existing conditions

and its suitability to perform as a safe working platform or if inspection reveals a safety hazard to workers, state provisions for securing the safety of the workers throughout the performance of the work. Provide procedures for safe conduct of the work in accordance with EM 385-1-1. Plan shall be approved by Structural PE or Contracting Officer prior to work beginning.

C. General Requirements:
   1. Do not begin demolition or deconstruction until written authorization is received from the Atlantic Richfield Company Representative. Remove rubbish and debris from project site and do not allow accumulations. The work includes demolition, deconstruction, salvage of identified items and materials, and removal of resulting rubbish and debris. Remove rubbish and debris from Atlantic Richfield Company Property daily, unless otherwise directed. Store materials that cannot be removed daily in areas specified by the Atlantic Richfield Company Representative. In the interest of occupational safety and health, perform the work in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance's.

1.04 ITEMS TO REMAIN IN PLACE:

A. The CMGC shall prepare a Utility and Existing Infrastructure Protection Plan prior to the start of the Work. Take necessary precautions to avoid damage to existing items to remain in place, to be reused, or to remain the property of Atlantic Richfield Company. Repair or replace damaged items as approved by the Atlantic Richfield Company Representative. Coordinate the work of this section with all other work indicated. Construct and maintain shoring, bracing, and supports as required. Ensure that structural elements are not overloaded. Increase structural supports or add new supports as may be required as a result of any cutting, removal, deconstruction, or demolition work performed under this contract. Do not overload structural elements or pavements to remain. Provide new supports and reinforcement for existing construction weakened by demolition, deconstruction, or removal work. Repairs, reinforcement, or structural replacement require approval by the Contracting Officer prior to performing such work.

B. Existing Construction Limits and Protection:
   1. Do not disturb existing construction beyond the extent indicated or necessary for installation of new construction. Provide temporary shoring and bracing for support of building components to prevent settlement or other movement. Provide protective measures to control accumulation and migration of dust and dirt in all work areas. Remove snow, dust, dirt, and debris from work areas daily.

C. Trees:
   1. Protect trees within the project site which might be damaged during demolition or deconstruction, and which are indicated to be left in place, by the Atlantic Richfield Company Representative. Erect and secure fence a minimum of 5 feet from the trunk of individual trees or follow the outer perimeter of branches or clumps of trees. Replace any tree designated to remain that is damaged during the work under this contract with like-kind or as approved by the Atlantic Richfield Company Representative.

D. Utility Service:
   1. Maintain existing utilities indicated to stay in service and protect against damage during demolition and deconstruction operations.

E. Facilities:
   1. Protect electrical and mechanical services and utilities. Where removal of existing utilities and pavement is specified or indicated, provide approved barricades, temporary covering of exposed areas, and temporary services or connections for electrical and mechanical utilities. Floors, roofs, walls, columns, pilasters, and other structural components that are designed and constructed to stand without lateral support or shoring, and are determined to be in stable condition, must remain standing without additional bracing, shoring, or lateral support until demolished or deconstructed, unless directed otherwise by the Atlantic Richfield Company Representative. Ensure that no elements determined to be unstable are left unsupported and place and secure bracing, shoring, or lateral supports as may be required as a result of any cutting, removal, deconstruction, or demolition work performed under this contract.

1.05 BURNING

A. The use of burning for the disposal of refuse and debris will not be permitted unless approved by the Atlantic Richfield Company Representative and proper permits have been filed. It is the CMGC's responsibility to acquire all permits.

1.06 SUBMITTALS

A. Atlantic Richfield Company approval in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-01 Preconstruction Submittals:
      a. The CMGC shall prepare and submit a project-specific Construction Execution Plan (CEP) that includes the following components:
         1) Demolition, Deconstruction and Disposal Plan.
         2) Existing Conditions.
         3) Utility and Existing Infrastructure Protection Plan.
         4) Dust Control Plan (as a standalone attachment).
         5) Traffic Control Plan (as a standalone attachment, including any necessary State and County approvals).
   2. SD-11 Closeout Submittals:
      a. Receipts.

1.07 QUALITY CONTROL

A. CMGC shall adhere to the requirements established in the CMGC's WMP, CMGCs Demolition and/or Deconstruction Plan and Section 01 35 00 – Environmental Protection. Use of explosives will not be permitted.
   1. Dust and Debris Control:
      a. Prevent the spread of dust and debris and avoid the creation of a nuisance or hazard in the surrounding area in accordance with the Dust Control Plan. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution. Additional dust control requirements are provided in Section 01 35 00 – Environmental Protection.

1.08 PROTECTION

A. Traffic Control Signs:
   1. Where pedestrian and driver safety is endangered in the area of removal work, use traffic barricades with flashing lights per the approved Traffic Control Plan. Anchor

barricades in a manner to prevent displacement by wind. Notify the Atlantic Richfield Company Representative prior to beginning such work.

B. Protection of Personnel:
   a. Before, during and after the demolition and deconstruction work continuously evaluate the condition of the structure being demolished or deconstructed and take immediate action to protect all personnel working in and around the project site. No area, section, or component of floors, roofs, walls, columns, pilasters, or other structural element will be allowed to be left standing without sufficient bracing, shoring, or lateral support to prevent collapse or failure while workmen remove debris or perform other work in the immediate area.

1.09 RELOCATIONS

A. Perform the removal and reinstallation of relocated items as indicated with workmen skilled in the trades involved. Repair or replace items to be relocated which are damaged by the CMGC with new undamaged items as approved by the Atlantic Richfield Company Representative.

1.10 EXISTING CONDITIONS

A. Before beginning any demolition or deconstruction work, survey the site and examine the drawings and specifications to determine the extent of the work. Record existing conditions in the presence of the Atlantic Richfield Company Representative showing the condition of structures and other facilities adjacent to areas of alteration or removal. It is the CMGC's responsibility to verify and document all required outages which will be required during the course of work, and to note these outages on the record document. Submit survey results.

PART 2 - PRODUCTS

2.01 FILL MATERIAL

A. Refer to the Backfill Material Suitability Criteria defined in Section 02 11 10 – Excavation and Handling, and to Section 31 00 00 – Earthwork and Section 31 38 00 – Granular Fill Material.

PART 3 - EXECUTION

3.01 EXISTING FACILITIES TO BE REMOVED

A. Inspect and evaluate existing structures onsite for reuse. Existing construction scheduled to be removed for reuse shall be disassembled. Dismantled and removed materials are to be separated, set aside, and prepared as specified, and stored or delivered to a collection point for reuse, remanufacture, recycling, or other disposal, as specified. Materials shall be designated for reuse onsite whenever possible.

B. Structures:
   1. Remove existing structures indicated to be removed as specified in the Construction Drawings. Break up slabs to a spherical foot or less prior to loading and transport from site. Remove sidewalks, curbs, gutters and street light bases as indicated.
   2. Demolish or Deconstruct structures in a systematic manner from the top of the structure to the ground. Demolish or Deconstruct concrete and masonry walls in small sections. Remove structural framing members and lower to ground by means of derricks, platforms hoists, or other suitable methods as approved by the Atlantic Richfield Company Representative.

3. Locate demolition and deconstruction equipment throughout the structure and remove materials so as to not impose excessive loads to supporting walls, floors, or framing.

C. Utilities and Related Equipment:
   1. General Requirements:
      a. Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by the Atlantic Richfield Company Representative. Do not interrupt existing utilities serving facilities occupied and used by Atlantic Richfield Company except when approved in writing and then only after temporary utility services have been approved and procured. Do not begin demolition or deconstruction work until all utility disconnections have been made. Shut off and cap utilities for future use, as indicated.
   2. Disconnecting Existing Utilities:
      a. Remove existing utilities as indicated and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by the Atlantic Richfield Company Representative. When utility lines are encountered but are not indicated on the drawings, notify the Atlantic Richfield Company Representative prior to further work in that area. Remove meters and related equipment and deliver to a location in accordance with instructions of the Atlantic Richfield Company Representative.

D. Chain Link Fencing:
   1. Remove chain link fencing, gates and other related salvaged items scheduled for removal and transport to Atlantic Richfield Company approved areas. Remove gates as whole units. Cut chain link fabric to 25-foot lengths and store in tied rolls off the ground.

E. Paving and Slabs:
   1. Remove concrete and asphaltic concrete paving and slabs including aggregate base as indicated to a depth of 18 inches below existing adjacent. Provide neat sawcuts at limits of pavement removal as indicated. Pavement and slabs designated to be recycled and utilized in this project shall be moved, ground, and stored as directed by the Atlantic Richfield Company Representative. Pavement and slabs not to be used in this project shall be removed from the Installation at CMGC's expense.

F. Roofing:
   1. Remove existing roof system and associated components in their entirety down to existing roof deck. Remove roofing to effect the connections with new flashing or roofing. Remove gravel surfacing from existing roofing felts for a minimum distance of 18 inches back from the cut. Remove gravel without damaging felts. Salvage asphalt roofing materials. Cut existing felts, membrane, and insulation along straight lines. Remove roofing system and insulation without damaging the roof deck. Sequence work to minimize building exposure between demolition or deconstruction and new roof materials installation.
      a. Reroofing:
         1) When removing the existing roofing system from the roof deck, remove only as much roofing as can be recovered by the end of the work day, unless approved otherwise by the Atlantic Richfield Company Representative. Do not attempt to open the roof covering system in threatening weather. Reseal all openings prior to suspension of work the same day with materials approved by the Atlantic Richfield Company Representative.

G. Masonry:
   1. Sawcut and remove masonry as to prevent damage to surfaces to remain, to removed materials being salvaged, and to facilitate the installation of new work. Where new masonry adjoins existing, the new work shall abut or tie into the existing construction as indicated specified for the new work. Provide square, straight edges and corners where existing masonry adjoins new work and other locations. Masonry will be disposed at the CMGC's expense.

H. Concrete:
   1. Saw concrete along straight lines to a depth of a minimum 1 inch less than the thickness of the concrete. Make each cut in walls perpendicular to the face and in alignment with the cut in the opposite face. Break out the remainder of the concrete provided that the broken area is concealed in the finished work, and the remaining concrete is sound. At locations where the broken face cannot be concealed, grind smooth or saw cut entirely through the concrete.

I. Structural Steel:
   1. Dismantle structural steel at field connections and in a manner that will prevent bending or damage. Salvage for reuse structural steel, steel joists, girders, angles, plates, columns and shapes as directed by the Atlantic Richfield Company Representative. Flame-cutting torches are only permitted when other methods of dismantling are not practical and only after Approval from the Atlantic Richfield Company Representative. Transport structural steel shapes to a designated area as directed by the Atlantic Richfield Company Representative, stacked according to size, type of member and length, and stored off the ground, protected from the weather.

J. Miscellaneous Metal:
   1. Salvage shop-fabricated items such as access doors and frames, steel gratings, metal ladders, wire mesh partitions, metal railings, metal windows and similar items as whole units as Directed by the Atlantic Richfield Company Representative. Salvage light-gage and cold-formed metal framing, such as steel studs, steel trusses, metal gutters, roofing and siding, metal toilet partitions, toilet accessories and similar items. Recycle scrap metal as part of demolition and deconstruction operations. Provide separate containers to collect scrap metal and transport to a scrap metal collection or recycling facility.

K. Carpentry:
   1. Salvage for reuse lumber, millwork items, and finished boards, and sort by type and size. Chip or shred and recycle salvaged wood unfit for reuse, except stained, painted, or treated wood. Remove windows, doors, frames, and cabinets, and similar items as whole units, complete with trim and accessories. Do not remove hardware attached to units, except for door closers. Salvage hardware attached to units for reuse. Brace the open end of door frames to prevent damage.

L. Patching:
   1. Where removals leave holes and damaged surfaces exposed in the finished work, patch and repair these holes and damaged surfaces to match adjacent finished surfaces, using on-site materials when available and approved by the Atlantic Richfield Company Representative. Where new work is to be applied to existing surfaces, perform removals and patching in a manner to produce surfaces suitable for receiving new work. Finished surfaces of patched area shall be flush with the adjacent existing surface and shall match the existing adjacent surface as closely as possible as to texture and finish. Patching shall be as specified and indicated, and shall include:

a. Concrete and Masonry: Completely fill holes and depressions, caused by previous physical damage or left as a result of removals in existing masonry walls to remain, with an approved masonry patching material, applied in accordance with the manufacturer's printed instructions.

M. Mechanical Equipment and Fixtures:
1. Disconnect mechanical hardware at the nearest connection to existing services to remain, unless otherwise noted. Disconnect mechanical equipment and fixtures at fittings. Remove service valves attached to the unit. Salvage each item of equipment and fixtures as a whole unit; listed, indexed, tagged, and stored. Salvage each unit with its normal operating auxiliary equipment. Transport salvaged equipment and fixtures, including motors and machines, to a designated storage area as directed by the Atlantic Richfield Company Representative. Do not remove equipment until approved. Do not offer low-efficiency equipment for reuse.
   a. Preparation for Storage:
      1) Remove water, dirt, dust, and foreign matter from units; tanks, piping and fixtures shall be drained; interiors, if previously used to store flammable, explosive, or other dangerous liquids, shall be steam cleaned. Seal openings with caps, plates, or plugs. Secure motors attached by flexible connections to the unit. Change lubricating systems with the proper oil or grease.
   b. Piping:
      1) Disconnect piping at unions, flanges and valves, and fittings as required to reduce the pipe into straight lengths for practical storage. Store salvaged piping according to size and type or dispose with the approval of the Atlantic Richfield Company Representative. If the piping that remains can become pressurized due to upstream valve failure, end caps, blind flanges, or other types of plugs or fittings with a pressure gage and bleed valve shall be attached to the open end of the pipe to ensure positive leak control. Carefully dismantle piping that previously contained gas, gasoline, oil, or other dangerous fluids, with precautions taken to prevent injury to persons and property. Store piping outdoors until all fumes and residues are removed. Box prefabricated supports, hangers, plates, valves, and specialty items according to size and type. Classify piping not designated for salvage, or not reusable, as scrap metal.
   c. Fixtures, Motors and Machines:
      1) Remove fixtures, motors and machines associated with plumbing, heating, and other mechanical system installations. Salvage materials as directed by the Atlantic Richfield Company Representative. Salvage, box and store auxiliary units and accessories with the main motor and machines. Tag salvaged items for identification, storage, and protection from damage. Classify broken, damaged, or otherwise unserviceable units and not caused to be broken, damaged, or otherwise unserviceable as debris to be disposed of by the CMGC.

N. Electrical Equipment and Fixtures:
1. Salvage motors, motor controllers, and operating and control equipment that are attached to the driven equipment, wiring systems and components with direction from the Atlantic Richfield Company Representative. Box loose items and tag for identification. Disconnect primary, secondary, control, communication, and signal circuits at the point of attachment to their distribution system.
   a. Fixtures:
      1) Remove all electrical fixtures, unprotected glassware from the fixture and incandescent, mercury-vapor, and fluorescent lamps and fluorescent ballasts

manufactured prior to 1978, boxed and tagged for identification, and protected from breakage. Salvage with approval from the Atlantic Richfield Company Representative.

b. Electrical Devices:
   1) Remove switches, switchgear, transformers, conductors including wire and nonmetallic sheathed and flexible armored cable, regulators, meters, instruments, plates, circuit breakers, panelboards, outlet boxes, and similar items. Box and tag these items for identification according to type and size. Salvage with approval from the Atlantic Richfield Company Representative.

c. Wiring Ducts or Troughs:
   1) Remove wiring ducts or troughs. Dismantle plug-in ducts and wiring troughs into unit lengths. Remove plug-in or disconnecting devices from the busway and store separately. Salvage with approval from the Atlantic Richfield Company Representative.

d. Conduit and Miscellaneous Items:
   1) Classify supports, knobs, tubes, cleats, and straps as debris to be removed and disposed. Salvage with approval from the Atlantic Richfield Company Representative.

O. Hoists:
   1. Remove hoists, and similar conveying equipment and salvage as whole units, to the most practical extent. Remove and prepare items for salvage without damage to any of the various parts. Salvage and store rails for structural steel with the equipment as an integral part of the unit.

P. Items With Unique/Regulated Disposal Requirements:
   1. Remove and dispose of items with unique or regulated disposal requirements in the manner dictated by CMGC's WMP.

3.02 CONCURRENT EARTH-MOVING OPERATIONS

A. Do not begin excavation, filling, and other earth-moving operations that are sequential to demolition or deconstruction work in areas occupied by structures to be demolished or deconstructed until all demolition and deconstruction in the area has been completed and debris removed. Fill holes, open basements and other hazardous openings.

3.03 DISPOSITION OF MATERIAL

A. Title to Materials:
   1. All salvaged items remain property of Atlantic Richfield Company unless specified otherwise. It is the CMGC responsibility to handle, store, or remove salvaged material as specified by the Atlantic Richfield Company Representative. If Atlantic Richfield Company relinquishes property to the CMGC, the CMGC shall remove the property from the construction site at no additional cost to Atlantic Richfield Company.
   2. Title to materials resulting from demolition and deconstruction, and materials and equipment to be removed, is vested in the CMGC upon approval by the Atlantic Richfield Company Representative of the CMGC's demolition, deconstruction, and removal procedures, and authorization by the Atlantic Richfield Company Representative to begin demolition and deconstruction. Atlantic Richfield Company will not be responsible for the condition or loss of, or damage to, such property after contract award. Showing for sale or selling materials and equipment on site is prohibited.

B. Reuse of Materials and Equipment:
   1. Remove and store materials and equipment listed in the Demolition and Deconstruction Plan or as indicated on the construction drawings to be reused or relocated to prevent damage and reinstall as the work progresses. Coordinate the re-use of materials and equipment with the re-use requirements in accordance with Section 02 11 10 – Excavation and Handling. Capture re-use of materials in the diversion calculations for the project.

C. Salvaged Materials and Equipment:
   1. Remove materials and equipment that are listed in the Demolition and Deconstruction Plan or as indicated on the construction drawings to be removed by the CMGC. Salvaged materials and equipment are to remain the property of Atlantic Richfield Company. This work shall be considered incidental to the contract and no additional payment will be made.
      a. Salvage items and material to the maximum extent possible.
      b. Store all materials salvaged for the CMGC as approved by the Atlantic Richfield Company Representative and remove from Atlantic Richfield Company property before completion of the contract. Coordinate the salvaged materials with tracking requirements in accordance with Section 02 11 10 – Excavation and Handling. Capture salvaged materials in the diversion calculations for the project.
      c. Remove salvaged items to remain the property of Atlantic Richfield Company in a manner to prevent damage and packed or crated to protect the items from damage while in storage or during shipment. Items damaged during removal or storage must be repaired or replaced to match existing items. Properly identify the contents of containers. Deliver the following items reserved as property of Atlantic Richfield Company to the areas designated: on the construction drawings or by the Atlantic Richfield Company Representative.
      d. Remove the following items reserved as property of the using service prior to commencement of work under this contract.
      e. Remove historical items in a manner to prevent damage. Deliver the following historical items to the Atlantic Richfield Company Representative for disposition: Corner stones, contents of corner stones, and document boxes wherever located on the site.

D. Unsalvageable and Non-Recyclable Material:
   1. Dispose of unsalvageable and non-recyclable noncombustible material in accordance with Atlantic Richfield Company approved WMP and local, state, and federal laws.

3.04 CLEANUP

A. Remove debris and rubbish from basement and similar excavations. Remove and transport the debris in a manner that prevents spillage on streets or adjacent areas. Apply local regulations regarding hauling and disposal.

3.05 DISPOSAL OF REMOVED MATERIALS

A. Regulation of Removed Materials:
   1. Dispose of debris, rubbish, scrap, and other non-salvageable materials resulting from removal operations with all applicable federal, state and local regulations as contractually specified.

B. Removal from Atlantic Richfield Company Property:
   1. Transport waste materials removed from demolished and deconstructed structures from Atlantic Richfield Company property for legal disposal. Dispose of waste soil in the specified waste repository.

3.06 REUSE OF SALVAGED ITEMS

A. Recondition salvaged materials and equipment designated for reuse before installation. Replace items damaged during removal and salvage operations or restore them as necessary to usable condition.

END OF SECTION

SECTION 03 01 06
CEMENTITIOUS CRYSTALLINE LEAK REPAIR

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide all labor, materials, services and equipment necessary for the supply and installation of cementitious crystalline leak repairs to concrete substrates, above-grade or below-grade, on either dry side or wet side of substrates, as indicated on drawings and as specified herein.

B. Work performed by General Contractor:
   1. Concrete tank tightness testing in accordance to ACI 350.1 will be performed by the Construction Management General Contractor (CMGC) where required in Drawings.

C. Related Requirements:
   1. Section 03 16 00 – Concrete Specialties.
   2. Section 03 30 00 – Cast-In-Place Concrete.
   3. Section 03 30 20 – Concrete Placing, Curing, and Finishing.

1.02 REFERENCES

A. Reference Standards:
   1. American Concrete Institute (ACI):
      a. ACI 350.1 - Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures.
   2. ASTM International (ASTM):
      a. ASTM C267 - Chemical Resistance of Mortars, Grouts, and Monolithic Surfacings and Polymer Concretes.
      b. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   3. German Institute for Standardization (DIN):
      a. DIN 1048 Part-5 - Testing of Hardened Concrete (Water Penetration).
   4. U.S. Army Corps of Engineers (USACE):
      a. CRD C48-73 - Permeability of Concrete.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit the following in accordance with Division 01 General Requirements and Section 01 33 00 – Submittal Procedures:
   1. SD-03 Product Data:
      a. Manufacturer Instructions.
      b. Manufacturer Reports.
      c. Manufacturer Warranty.

2. SD-05 Test Reports:
    a. Sample Test Reports and Evaluations.
3. SD-06 Certificates:
    a. Qualification Statements.
    b. Applicator Warranty.
4. SD-07 Closeout Submittals:
    a. Per Division 01 General Requirements.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Qualifications: Per Division 01 General Requirements and as follows for installation contractor:
1. Manufacturer Qualifications:
    a. Manufacturer shall be ISO 9001 registered and shall have no less than 10 years of experience in manufacturing the cementitious crystalline leak repair materials for the required work.
2. Installation Applicator:
    a. Five years minimum experience installing cementitious crystalline leak repairs to concrete structures including water, and wastewater storage tanks.

C. Independent Testing:
1. Crystalline Penetration:
    a. Crystallizing capability of waterproofing material shall be evidenced by independent SEM (Scanning Electron Microscope) photographs documenting penetration of crystal-forming waterproofing material to a depth of 2 inches.
2. Permeability:
    a. Independent testing shall be performed according to USACE CRD C48-73 "Permeability of Concrete" or DIN 1048 Part-5.
        1) No admixtures permitted in test sample.
        2) Coatings to have maximum thickness of 0.05 inches per coat with up to two coats permitted.
        3) Samples to be pressure tested to 70 psi.
        4) Treated samples, after crystalline growth has occurred, shall exhibit no measurable leakage.

D. Pre-Installation Conference:
1. Prior to installation of cementitious crystalline leak repairs, conduct meeting or conference call with applicator, installers of work adjacent to or which penetrates repairs, Engineer, Atlantic Richfield Company’s Representative, and Manufacturer’s Representative to verify and review the following:
    a. Project requirements per contract documents
    b. Manufacturer’s product data including application instruction, curing, and protection.
    c. Substrate conditions, anticipated air and surface temperatures, and preparation requirements on cementitious crystalline leak repairs application

E. Technical Consultation:
1. The manufacturer of the cementitious crystalline leak repair products shall provide technical consultation on application of product.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Packing, Shipping, Handling, and Unloading.

C. Storage and Protection.

D. Waste Management and Disposal.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.
   1. Product will be used to seal actively leaking cracks as indicated in Drawings. Where applicable, application of cementitious crystalline leak repairs will occur during concrete tank tightness testing in accordance with ACI 350.1.
   2. Comply with manufacturer's product data regarding condition of substrate to receive cementitious crystalline leak repairs, weather conditions before and during installation, and protection of the installed system.

1.08 WARRANTY

A. Manufacturer Warranty:
   1. Standard 10-year limited warranty.

B. Applicator Warranty:
   1. Applicator shall warrant the installation against defects caused by faulty workmanship or materials for a period of 5 years from date of substantial completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers:
   1. Xypex Chemical Corporation.
   2. Kryton International Inc.
   3. Penetron.
   4. Or equal.

2.02 PRODUCTS

A. General:
   1. Products listed below are grouped by Manufacturer. CMGC shall submit product data from one manufacturer.
   2. Materials shall not contain chlorides.
   3. Materials shall not provide waterproofing by way of hydrophobic ingredients such as oils, stearates, silanes, silicate salts or other hydrophobic treatments.

B. Xypex Chemical Corporation:
   1. WaterStop Plug: Xypex Patch'n Plug.
   2. Repair Grout: Xypex Concentrate.
   3. Crystalline Concentrate Powder: Xypex Concentrate.
   4. Curing: Spray method (water) or Gamma Cure.

C. Kryton International Inc:
   1. WaterStop Plug: Krystol Plug.
   2. Repair Grout: Krystol Repair Grout.
   3. Crystalline Concentrate Powder: Krystol T1.
   4. Curing: Spray method (water).

D. Penetron:
   1. WaterStop Plug: PenePlug.
   2. Repair Grout: Penecrete Mortar.
   3. Crystalline Concentrate Powder: Penetron.
   4. Curing: Spray method (water).

E. Mixes:
   1. Mixes shall be in accordance with manufacturer's product data and written instructions. For any discrepancies in manufacturer's instructions and information listed herein, mixes shall be per manufacturer's instructions.
   2. General: Mix waterproofing material by volume with clean water which is free from salt and deleterious materials. Mix waterproofing material in quantities that can be applied within 20 to 30 minutes from time of mixing. As mixture thickens, stir frequently, but do not add additional water. Do not mix bonding agents or admixtures with crystalline waterproofing materials.
   3. Brush or Trowel Application: Measure dry powder and place in mixing container. Measure water and mix into the dry powder with a paddle on a slow speed electric drill (250 RPM) or other type mixer which is acceptable to manufacturer. Mixing proportions shall be as recommended by the manufacturer.
   4. Spray Application: Mixing shall be same as specified for brush application except that mixture shall be thinner. Use following proportions as a guide only. Adjust proportions to match type of spray equipment and pressures used.
   5. Dry-Pack Mix: Using a trowel, mix clean water for 10 to 15 seconds. It is acceptable that lumps may be present in mixture. Mix only as much as can be applied in 15 minutes.

F. Curing Compounds (Preferred Method):
   1. Provide manufacturer's recommended curing compound to protect product after installation and during curing period.
   2. If curing compounds are not available from cementitious crystalline leak repair manufacturer, CMGC shall water cure (fog spray) or shall provide a curing compound that is compatible with and approved by the cementitious crystalline leak repair manufacturer.

G. Accessories:
   1. Tools.
   2. Extra supplies.

H. Source Quality Control:
   1. Obtain cementitious crystalline leak repairs from a single manufacturer.
      a. Provide in accordance with Division 01 General Requirements.
      b. Manufacturer field services.
      c. Coordination of other tests and inspections.

PART 3 - EXECUTION

3.01 INSTALLERS

A. Qualified per Division 01 General Requirements.

3.02 EXAMINATION

A. Site Visit: Prior to installation, visit the site with a manufacturer's representative to inspect and certify that concrete surfaces are in acceptable condition to receive treatment.

B. Verification of Substrates: Verify concrete surfaces are sound and clean, and that form release agents and materials to cure and seal the concrete are compatible with the treatment.

C. Defects: Examine surfaces to be treated for form tie holes and defects such as honeycombing, rock pockets, faulty construction joints, and cracks.

D. Tightness Testing (where applicable): Leaks shall be examined during concrete tank tightness testing in accordance with ACI 350.1, while the concrete tank is filled with water. All leaks shall be sealed in accordance with ACI 350.1 and to the satisfaction of the Engineer and Atlantic Richfield Company's representative.

3.03 PREPARATION

A. General:
   1. Preparation shall be in accordance with manufacturer's product data and written instructions. For any discrepancies in manufacturer's instructions and information listed herein, preparation shall be per manufacturer's instructions.

B. Concrete Finish:
   1. Concrete surfaces to receive cementitious crystalline leak repair treatment shall have an open capillary system to provide tooth and suction, and shall be free from scale, excess form oil, laitance, curing compounds and foreign matter. Horizontal surfaces shall have a rough wood float or broom finish.

C. Surface Preparation:
   1. Smooth surfaces (e.g. where steel forms are used) or surfaces covered with excess form oil or other contaminants shall be:
      a. Washed, lightly sand-blasted, water-blasted, or acid etched with muriatic acid as necessary to provide a clean absorbent surface. Surfaces to be acid-etched shall be saturated with water prior to application of acid.
      b. Surface areas that are mechanically removed as part of repair are not required to be acid etched, sand-blasted, or water-blasted.

D. Demolition/Removal:
   1. Cracks, Construction Joints, and Tie Holes:
      a. Chip out or saw cut defective areas in a "U" shaped slot one 1-inch wide and a minimum of 1-1/2 inch deep extending at least 4 inches past termination of existing defect. A V-shaped slot or joint is not acceptable. Clean slot of debris and dust.
   2. Rock Pockets, Honeycombing or Other Defective Concrete:
      a. Rout out defective areas to sound concrete. Remove loose materials and clean area of debris and dust.

3.04 INSTALLATION

A. General:
   1. Installation shall be in accordance with manufacturer's product data and written installation instructions. For any discrepancies in manufacturer's instructions and information listed herein, installation shall be per manufacturer's instructions.

B. Where possible, all wall crack repairs shall be made from a side of the wall which will be either below grade or not exposed to public view.

C. Cracks, Construction Joints and Tie Holes:
   1. Chip out or saw cut defective area in a U-shaped slot per Article 3.03 Preparation.
   2. Saturate any dry areas with water and allow water to soak in. Remove all excess surface water.
   3. To stop water flow, apply waterstop plug to half the depth of slot immediately after removing surface water. Mix waterstop plug dry powder with water to form a dry-pack mix per manufacturer's instructions Waterstop plug should be applied to full length of crack/joint area. Repair full length of cracks or construction joints, even if only a portion of the crack is visibly leaking. Do not proceed until water flow has stopped. This step may be omitted only if crack or construction joint is not actively leaking.
   4. Mix crystalline concentrate powder with water per manufacturer's instructions to form slurry. Apply slurry coat over the installed waterstop plug and on a 6-inch-wide strip of concrete surface both sides of the slot. Application may be by brush or gloved hand at manufacturer's recommended thickness. Allow application to set per manufacturer's instructions. For Kryton repair products, skip this step and directly apply repair grout per step 5.
   5. Mix repair grout with water per manufacturer's instructions to form dry-pack mix. While prior coat is still tacky, fill remaining slot depth flush with adjacent surface. Apply dry-pack by gloved hand, then compress it tightly by using a pneumatic packing toll or a hammer and block.
   6. Wet the dry-pack surface lightly with water, then apply a final slurry coat of crystalline concentrate powder over the repaired area and to 6-inches on both sides of the slot at manufacturer's recommend thickness.
   7. Cure with manufacturer's curing compound (preferred) or fog spray with water three times a day for 3 days.

D. Rock Pockets, Honeycombing or Other Defective Concrete which are Actively Leaking:
   1. Rout out defective area per Article 3.03 Preparation.
   2. Saturate any dry areas and allow time for concrete to absorb water, then remove any free-standing water.
   3. To stop the flow of water, fill the cavity to surface with waterstop plug mixed with water to form dry-pack mix. For large cavities, first handrub a layer of waterstop plug into the cavity to help "key" the patch. Large patches may require the addition of aggregate to the waterstop plug. For the size and amount of aggregate, refer to manufacturer's product data sheet. Do not proceed until water flow has stopped. This step may be omitted only if crack or construction joint is not actively leaking.
   4. After the patch has set, apply slurry coat of crystalline concentrate powder over the repair area at manufacturer's recommended dosage. Allow repair to set per manufacturer's instructions. For Kryton repair products, skip this step and directly apply repair grout per step 5.
   5. While the prior coat is still tacky, fill the cavity with repair grout.

6. Allow the patch to set, then apply a final slurry coat of crystalline concentrate powder over the repaired area at manufacturer's recommended application thickness.
7. Cure with manufacturer's curing compound (preferred) or fog spray with water three times a day for 3 days.

E. Where cementitious crystalline leak repairs are applied to interior surfaces, prior to tightness testing in accordance with ACI 350.1, the applied products shall be cured for 3-days and then allowed to set (air cure) for an additional 12 days. Unless otherwise noted, concrete tanks cannot be tightness tested until concrete obtains its 28-day design compressive strength.

F. Backfilling:
1. Do not backfill against cementitious crystalline leak repair materials prior to 7 days after application.

3.05 WORKMANSHIP AND FINAL APPEARANCE:

A. All repairs to surfaces that are exposed to view including all concrete basement walls, retaining walls and other wall surfaces above grade:
1. Surface preparation shall include additional care and workmanship to allow final slurry coat of crystalline of concentrate powder to be applied flush with adjacent surfaces.
2. Final application of repairs that are not flush with adjacent surfaces or do not match finish of adjacent surfaces shall be repaired or re-installed at no additional cost to Atlantic Richfield Company.
3. CMGC shall prepare a crack repair mock-up for exposed to view areas for approval by Atlantic Richfield Company's Representative prior to proceeding with additional repairs.

B. Cementitious crystalline leak repair materials applied to surfaces not exposed to view shall be applied per manufacturer's instructions and per CMGC's means and methods to provide a repair that seals all leaks to the satisfaction of the engineer and Atlantic Richfield Company's representative.

3.06 RE-INSTALLATION AND REPAIRS

A. Any leaks that develop during any period of construction are required to be sealed to the satisfaction of the Engineer and Atlantic Richfield Company's representative.

B. Cementitious crystalline leak repair materials not installed according to the workmanship and final appearance requirements of Article 3.05, shall be re-installed or repaired to the satisfaction of the engineer and Atlantic Richfield Company's representative.

3.07 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Manufacturer Field Services.

END OF SECTION

SECTION 03 11 00
CONCRETE FORMING

PART 1 - GENERAL

1.01 SUMMARY

A. The Work of this section comprises all materials, tools, equipment and labor required for the design, preparation and cleaning, construction, and removal of all concrete formwork, and the installation of all concrete embedment's furnished under other sections, necessary for the proper completion of the Work in accordance with this Section and applicable reference standards listed in Article 1.02.

B. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

C. Related Requirements:
   1. Section 03 30 20 – Concrete Placing, Curing, and Finishing.

1.02 REFERENCES

A. Reference Standards:
   1. American Concrete Institute International (ACI):
      a. ACI 117 - Specifications for Tolerances for Concrete Construction and Materials and Commentary.
      b. ACI 301 - Specifications for Structural Concrete.
      c. ACI 347 - Guide to Formwork for Concrete.
   2. ASTM International (ASTM):
      a. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
      b. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   3. U.S. Army Corps of Engineers (USACE):
      a. COE CRD-C 572 - Corps of Engineers Specifications for Polyvinylchloride Waterstops.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements and Section 01 33 00 – Submittal Procedures:
   1. SD-03 Product Data:
      a. Form Liners.
      b. Form Ties.
      c. Form Release Agent.
      d. Flashing Reglets.
      e. Waterstops, including details at all corners and intersections, which shall be factory formed.

f. Manufacturer's Instructions:
    1) Form Liners.
    2) Form Ties.
    3) Form Release Agent.
    4) PVC Reglets.
    5) Waterstops.
2. SD-04 Samples:
    a. Form Liners.
3. SD-07 Closeout Submittals:
    a. Per Division 01 General Requirements.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General:
    1. Formwork shall conform dimensionally to the concrete Work as shown on the Drawings. To minimize the number of panel joints, formwork panels shall be of the largest practicable sizes. Radiused walls shall be formed with radiused formwork, not straight-segmented forms except as noted on drawings. Formwork shall be sufficiently tight to prevent leakage.
    2. Undamaged smooth form facing materials such as plywood, hardboard, metal, and plastic, that will produce a smooth form finish, shall be used. Formwork shall not result in fins or offsets exceeding 1/8 inch. If used, aluminum forms with un-oxidized surfaces shall be pretreated with a paste made of calcium hydroxide and water, followed by water rinsing, repeated until hydrogen bubbles do not form.

B. Form Release Agent:
    1. Form release agent shall be non-grain raising, non-staining, and shall not leave a residue on the concrete nor adversely affect bonding of materials to be applied.
    2. CMGC shall verify compatibility of form release agent with integral color product manufacturer, where applicable.

C. Form Ties:
    1. General Requirements:
        a. Form ties shall be adjustable length, sized to withstand construction loads, and upon removal shall prevent concrete spalling. Ties shall have break back indentation.
        b. Plastic Cones: Form tie assembly with cone-shaped depressions at the concrete surfaces with break back ties. The protion of the tie remaining embedded in the concrete upon removal shall be equal to the depth of the cone specified.

c. Neoprene Washers: Flat washer sized to fit tightly on tie wire and positioned at the center of the tie wire.
d. Tie Systems that include plug style waterstops inserted into tie holes after removal of forms are not permitted.

2. Watertight Structures:
a. Concrete structures which include PVC waterstops in concrete walls shall be considered watertight and are subject to the requirements of this section.
b. Plastic Cones: 1” diameter x 1-1/2 inches deep (Special Order).
c. Neoprene Washers: Required on all form ties.

3. All Other Work:
a. Plastic Cones: 1” diameter x 1” deep (Standard).
b. Neoprene Washers: Not required, unless noted otherwise on drawings.

D. PVC Waterstops:
1. PVC waterstops, where noted on the Drawings, shall meet COE CRD-C 572 except: the tensile strength shall exceed 2,000 psi; the minimum ultimate elongation shall be 300 percent; and they shall be manufactured from virgin polyvinyl chloride with no scrap, reclaimed material, or pigment.
2. Waterstops for expansion joints shall be 9-inch wide, heavy duty, with center and end bulbs: Sika Greenstreak 725 or approved equal.
3. Waterstops for construction joints shall be 6 inch wide, ribbed, and flat: Sika Greenstreak 679, Vinylex R638, Wirestop FR-6380, or approved equal.
4. Retrofit waterstop shall be 3/16 inch thick, L-shaped with a 3-inch-long ribbed vertical leg, and 3-inch-long non-ribbed horizontal leg: Sika Greenstreak 655 or approved equal. Stainless steel batten bars with pre-drilled holes 6 inch on center and approved stainless steel fasteners shall be provided. A bedding epoxy recommended by the waterstop manufacturer shall also be provided, Greenstreak 7300 Epoxy, or approved equal.
5. Corners and intersections shall be factory formed and tested.
6. A system of hog rings or grommets spaced 12 inches apart along both edges of waterstop shall be provided for proper positioning and securing of waterstop to adjacent reinforcement by wiring.

E. Hydrophilic Waterstops:
1. Hydrophilic waterstops, where noted on the Drawings, shall be non-bentonite, expansive rubber strip: CJ-1020-2K by Sika Hydrotite, Swellseal Joint as manufactured by DeNeef Construction Chemicals, Inc., ConSeal CS-231 by Concrete Sealants, Inc., or approved equal.

F. Flashing Reglets:
1. Heckmann Building Products, Inc flashing reglets, or approved equal.
2. Strip-Out reglets: 26-gage mill galvanized steel, standard 10-ft lengths.
3. Stay-Put reglets: 26-gage stainless steel, standard 10-ft.

G. Form Liners:
1. Form liners shall be as manufactured by Greenstreak, Doran, Scofield, or approved equal, type as shown on the Drawings.

2.02 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 - EXECUTION

3.01 TECHNICAL REQUIREMENTS

A. The CMGC shall design, erect, shore, brace, and maintain formwork in accordance with ACI 301 to support all loads, including construction loads, until the concrete structure can support such loads.

3.02 CONSTRUCTION

A. Tolerances:
   1. Tolerances shall be in accordance with ACI 117.

B. Form Alignment:
   1. At locations where continuous surfaces are formed in successive units, forms shall be tightly fitted over the hardened concrete surface to obtain accurate surface alignment and to prevent leakage of mortar and the formation of fins, ridges, and other defects.

C. Chamfered Edges:
   1. All exposed concrete corners shall be formed with beveled strips to provide 3/4-inch chamfers, unless otherwise shown, specified, or directed by the Engineer.
   2. Where concrete walls, columns, and beams abut masonry walls, the chamfer shall be omitted.
   3. Chamfering by grinding is prohibited.

D. Openings:
   1. Form openings in concrete where required for other Work. Upon failing to form such openings, provide them in a manner approved by the Engineer at no additional cost to the Atlantic Richfield Company.

E. Cleanouts and Access Panels:
   1. Temporary openings shall be provided to facilitate cleaning and inspection prior to concrete placement, including at the bottom of wall forms. Cleanout openings are not permitted in exposed concrete, concrete exposed to view upon completion of the Work, whether or not it is painted, without the approval of the Engineer.
   2. All refuse, sawdust, shavings, etc. shall be removed, and the forms broom cleaned before concrete placement.

F. Form Release Agent:
   1. Forms shall be coated with the approved form release agent before placement of reinforcing steel. Do not apply form release agent at locations of monolithic construction joints, which are construction joints with all the reinforcement continuous through the joint. Excess agent applied to the forms, and on the reinforcing steel and other surfaces requiring a concrete bond, shall be removed.
   2. Forms for unexposed surfaces may be thoroughly wetted in lieu of the approved form release agent immediately before concrete is placed. However, form release agent shall be used in freezing weather.

G. PVC Waterstops:
   1. Waterstops shall be stored under tarpaulins, protected from sunlight, precipitation, soiling, etc.
   2. Center waterstop in joint and secure in correct position with hog rings or grommets spaced 12 inches apart along both edges of waterstop and wired to adjacent reinforcement prior to concrete placement.

3. Install retrofit waterstops in accordance with the manufacturer's instructions. Grind or shot blast concrete surface to receive waterstop. Apply approximately an epoxy bed 1/8 inch thick, and slightly wider than the waterstop. Place waterstop in epoxy bed prior to epoxy cure and secure waterstop to substrate with stainless steel batten bars and approved stainless steel anchors 6 inches on center. Fasten vertical leg of waterstop to reinforcement with wire ties every 12 inches prior to concrete placement.
4. Waterstops shall be continuous throughout.
5. Only straight butt splices shall be made in the field. All field splices shall be heat fused welded using a Teflon coated thermostatically controlled waterstop splicing iron at 380 degrees F and following manufacturer's recommendations. Unacceptable field splices include, but are not limited to, the following:
    a. Tensile strength less than 80 percent of parent section.
    b. Misalignment of center bulbs and ribs more than 1/16 inch or that reduces cross section by more than 15 percent.
    c. Visible porosity, bubbles, or inadequate bonding. If while prodding the joint with a penknife, the knife breaks through the outer portion of the weld into a bubble.
    d. Visible signs of splice separation when cooled splice is bent by hand at a sharp angle, including bond failure greater than 1/16-inch depth.
    e. Combined misalignment and bond failure with net cross-sectional reduction of more than 15 percent.
    f. Charred or burnt material.
    g. Edge welded tee intersections.

H. Hydrophilic Waterstop:
1. Hydrophilic waterstop shall be continuous, and installed in strict accordance with the manufacturer's instructions, in double rows with a space between, at each joint. Any extended contact with standing water, such as puddles, is not permitted.

3.03 INSTALLATION OF EMBEDDED ITEMS

A. General:
1. Coordinate the setting of anchor bolts, thimbles, inserts, wall pipe, sleeves, and other embedded items. Before placing concrete, ensure that all items are accurately located and firmly secured against displacement.
2. All items shall be thoroughly cleaned and free of loose rust, mill scale, dirt, grease, etc. Wood used for removable keys shall be thoroughly dampened before concrete is placed against it.
3. CMGC shall notify Engineer of any embedded conduits not installed according to the conditions specified herein a minimum of 24 hours prior to concrete placement. Noncompliant conduit placements shall be repositioned or removed to the satisfaction of the engineer and Atlantic Richfield Company’s representative.

B. Electrical Conduit:
1. Electrical conduit may be embedded in concrete provided the following conditions are met:
    a. Outside diameter of conduit shall not exceed 1/3 of concrete thickness.
    b. Conduit shall not be placed closer than 3 diameters on center.
    c. Conduit shall not significantly impair the strength of the construction.
    d. Conduit shall not be embedded in structural concrete slabs less than 4 inches thick.
    e. Only 2 conduits may cross at any point. The sum of the outside diameter of the crossing conduits shall not exceed 1/3 of the concrete thickness.

f. A 1-1/2-inch minimum concrete cover shall be provided for conduits in structural slabs.
g. Conduit shall not be located between bottom of reinforcing steel and bottom of slab.
h. Conduit is not permitted in beams, girders, and columns without the approval of the Engineer.
i. Aluminum conduit shall not be embedded in concrete.
j. Conduit shall be installed so that cutting, bending, or displacement of reinforcement from its proper location is not necessary.

C. Maintainable Weep Devices: Locate and embed cast-in sleeves for per device manufacturer instructions. Elevation shall be according to Drawings. Space equally along wall at maximum spacing indicated on Drawings and with first device from end of wall at approximately half of typical spacing.

3.04 REMOVAL

A. Form Removal:
1. Form removal per ACI 347, as modified herein.
2. Forms shall be removed while ensuring the complete safety and serviceability of the structure. Forms or shoring for slabs, beams, and other suspended members shall not be removed until members are of sufficient strength to safely support their own weight and the weight thereon.
3. Newly unsupported portions of the structure shall not be subjected to heavy construction or material loading. Additional shores or re-shores shall be provided as required to adequately support the members during the construction period.
4. The CMGC shall be responsible for the proper removal of forms, shores, and bracing.
5. Spalling of concrete surfaces shall be prevented.
6. When forms are removed before the specified curing period (as specified in Section 03 30 20 – Concrete Placing, Curing, and Finishing) is complete, measures shall be taken to continue curing and to continue providing thermal protection for the concrete.
7. Forms may be removed when the cumulative time during which the temperature of the air surrounding the concrete is above 50 degrees F are as follows:
   a. Walls, columns, sides of beams and girders, and similar parts of the Work not supporting the weight of the concrete: 24 hours.
   b. When design superimposed load is less than the self-weight:
      1) Beam and Girder Soffits:
         (a) Clear span less than 10 feet: 7 days.
         (b) Clear span 10 feet to 20 feet: 14 days.
         (c) Clear span more than 20 feet: 21 days.
      2) Slabs:
         (a) Clear span less than 10 feet: 4 days.
         (b) Clear span 10 feet to 20 feet: 7 days.
         (c) Clear span more than 20 feet: 10 days.
   c. When design superimposed load is more than the self-weight:
      1) Beam and Girder Soffits:
         (a) Clear span less than 10 feet: 4 days.
         (b) Clear span 10 feet to 20 feet: 7 days.
         (c) Clear span more than 20 feet: 14 days.
      2) Slabs:
         (a) Clear span less than 10 feet: 3 days.
         (b) Clear span 10 feet to 20 feet: 4 days.
         (c) Clear span more than 20 feet: 7 days.

d. Alternatively, to the stripping times specified, additional concrete cylinders shall be made using representative concrete, witnessed, and approved by the Engineer, and tested at no additional cost to the Atlantic Richfield Company. Such specimens shall be field cured in accordance with ASTM C31 under conditions that are not more favorable than the most unfavorable conditions for the portions of the concrete that the test specimens represent. The supporting forms and shores may be removed when the concrete strength as tested per ASTM C39 is a minimum of 70 percent of the specified design strength, as determined by the field-cured cylinders according to ACI 301.

B. Tie Holes:
   1. Filling of form tie holes and concrete finishing are specified in Section 03 30 20 – Concrete Placing, Curing, and Finishing.

3.05 CLEANING AND REPAIR OF FORMS

A. Parts of forms reserved for reuse shall be inspected, cleaned, and repaired. Any parts dented, deformed, or otherwise rendered unfit for reuse shall be discarded.

3.06 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.07 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 03 16 00
CONCRETE SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide all materials, tools, equipment, and labor necessary for the construction of concrete specialties as specified, as shown on the Drawings, and as necessary for the proper completion of the Work in accordance with this section and applicable reference standards listed in Article 1.02.
   2. Epoxy adhesive for installing drilled and epoxy rebar is specified herein.
   3. Post-installed expansion anchors and adhesive anchoring systems are specified in Section 05 50 00 – Metal Fabrications.

B. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

C. Related Requirements:
   1. Section 03 30 00 – Cast-In-Place Concrete.
   2. Section 03 30 20 – Concrete Placing, Curing, and Finishing.
   3. Section 05 50 00 – Metal Fabrications.
   4. Section 26 05 43 – Underground Ducts and Raceways for Electrical Systems.

1.02 REFERENCES

A. Reference Standards:
   1. American Society for Testing and Materials (ASTM):
      a. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
      b. ASTM A1064 - Standard Specification Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
      c. ASTM C1107 - Standard Specification for Packed Dry, Hydraulic-Cement Grout (Non-shrink).
      d. ASTM D4832 - Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
   2. ICC Evaluation Service (ICC-ES):
      a. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
   3. American Concrete Institute (ACI):
      a. ACI 355.2 - Qualification of Post-Installed Mechanical Anchors in Concrete.
      b. ACI 355.4 - Qualification of Post-Installed Adhesive Anchors in Concrete.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-01 Preconstruction Submittals:
      a. Design Data
         1) Concrete For Concrete Fill and Duct Banks:
            (a) Submittals as required in Section 03 30 00 – Cast-In-Place Concrete.
         2) Controlled Low Strength Material:
            (a) Submittals as required in Section 03 30 00 – Cast-In-Place Concrete.
   2. SD-02 Shop Drawings:
      a. Reinforcement.
   3. SD-03 Product Data:
      a. Non-Shrink Grout.
      b. Epoxy Adhesive (for drill and epoxy rebar):
         1) ICC-ES report for manufacturer's specific product.
         2) Epoxy ultimate bond strength.
         3) Manufacture's chart for embedment to develop yield strength and tensile strength of ASTM A615, grade 60, rebar sizes #3 thru #11.
         4) Storage requirements.
         5) Gel and cure times as a function of temperature.
         6) Installation temperature requirements for cartridges and base material.
         7) Drilling method (diamond drill bit shall be prohibited).
         8) Drill bit diameter and depth of hole for rebar sizes.
         9) Hole cleaning procedure and required condition of hole.
         10) Requirements for discarding initial discharge to ensure proper mixing.
         11) Hole filling procedure.
         12) Time period when anchor cannot be contacted or otherwise disturbed.
   4. SD-05 Test Reports:
      a. Both 28-day and 90-day compressive strength test results.
   5. SD-07 Closeout Submittals:
      a. Per Division 01 General Requirements.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Qualifications: Per Division 01 General Requirements for anchor installation and as follows:
   1. Anchors shall be installed by qualified personnel trained to install adhesive anchors.
   2. Adhesive anchors shall be installed in strict accordance with the Manufacturer's Printed Installation Instructions (MPII).
   3. Each installer shall have the MPII in their possession at all times.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.07 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

PART 2 - PRODUCTS

2.01 GROUT

A. Grout shall be non-metallic, cementitious non-shrink grout meeting ASTM C1107, grade C. Grout shall be Five Star Grout by U.S. Grout Company, Crystex or Premier by L&M Construction Chemicals, Inc., Sure-Grip High Performance Grout, by Dayton Superior, or approved equal.

2.02 CONCRETE FILLS

A. Concrete shall be as specified in Section 03 30 00 – Cast-in-Place Concrete, except it shall have a 28-day design compressive strength of 4,000 pounds per square inch and a maximum water-to-cementitious ratio of 0.45.

B. Concrete fills shall be reinforced with fibermesh as specified in Section 03 30 00 – Cast-in-Place Concrete where indicated on drawings.

C. Concrete fills shall include integral color as specified in Section 03 30 00 – Cast-in-Place Concrete where indicated on drawings.

D. Concrete fills shall have a 1/2-inch maximum size aggregate.

2.03 DUCTBANKS

A. All underground electrical duct banks shall be concrete encased. Concrete shall be as specified in Section 03 30 00 – Cast-in-Place Concrete, except it shall have a 3/8 inch maximum aggregate size and a minimum 28-day compressive strength of 3,000 pounds per square inch.

B. Duct banks shall be reinforced as detailed where crossing under roads, driveways, parking areas, all areas subject to vehicular traffic, and whereas shown or specified in the Contract Documents. Reinforcement shall extend a minimum of 4 feet beyond the specified areas.

C. Coordinate red shake-on red pigmented dye, acid stains, or integral coloring as required in Section 26 05 43 – Underground Ducts and Raceways for Electrical Systems.

2.04 CONTROLLED LOW STRENGTH MATERIAL

A. A rigid-setting mixture of portland cement, sand, and water shall not require vibration during placement, flow without noticeable segregation, self-consolidate, and be excavatable with hand tools.

B. Sand Gradation (U.S. Standard Sieve/Percent Passing):
   1. 3/8-inch/100.
   2. No. 4/95-100.
   3. No. 16/45-80.
   4. No. 50/10-30.
   5. No. 100/2-10.
   6. No. 200/0-3.

C. Cement, water, and chemical admixtures shall meet the requirements of Section 03 30 00 – Cast-In-Place Concrete.

D. The 28-day and 90-day compressive strengths, measured in accordance with ASTM D4832, shall be between 30-80 psi and less than 100 psi, respectively.

2.05 EPOXY ADHESIVE

A. Epoxy adhesive for installation of post-installed reinforcing bars denoted as “Drill and Epoxy” or “Drill & Epoxy” on drawings.

B. Evaluation Requirements: ICC-ES evaluation report stating product is compliant with 2018 International Building Code and approved for use to resist static, wind and earthquake (Seismic Design Categories A through F) tension and shear loads in cracked and uncracked normal-weight concrete having a compressive strength of 2,500 psi to 8,500 psi. Evaluation reports with a listed renewal date month/year which is prior to the month/year the product is submitted for engineer’s review will be rejected.

C. Epoxy adhesive for anchoring reinforcement to concrete shall be a 2component solid epoxy-based system supplied in manufacturer's standard side-by-side cartridge and dispensed through manufacturer's standard static-mixing nozzle. Epoxy adhesive shall be:
   1. Simpson Strong Tie SET-XP or ET-HP:
      a. SET-XP Compliance Report (ESR-2508).
      b. ET-HP Compliance Report (ESR-3372).
   2. Hilti HIT-RE 500 V3:
      a. Compliance Report (ESR-3814)
   3. Approved equal based.
      a. Compliance Report to be submitted

D. Epoxy adhesive shall pass the creep test requirements of ICC-ES AC58.

E. The embedment depth shall be per the manufacturer's requirements and the ultimate strength exceeds the tensile strength of the bar, and the ultimate strength divided by a minimum factor of safety of 3.75 is at least 40 percent of the yield strength of the bar.

2.06 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 - EXECUTION

3.01 EQUIPMENT PADS

A. New concrete surfaces upon which equipment pads are to be built shall receive a scratched finish in accordance with Section 03 30 20 – Concrete Placing, Curing, and Finishing.

B. All laitance shall be removed, and the surface shall be saturated with water for a minimum of 6 hours. Excess water shall then be removed and the epoxy bonding compound applied as specified in Section 03 30 20 – Concrete Placing, Curing, and Finishing.

C. All equipment pads shall be sized to suit the approved equipment, and reinforcement shall be as shown on the Drawings.

D. The top surface shall be level within 1/8-inch. All exposed faces shall be formed with smooth forms and shall be smooth and free of sands streaks, bug holes, and honeycomb. All exposed surfaces shall have a smooth, even surface with all exterior corners chamfered. Exposed faces of pads shall receive a sack-rubbed finish as specified in Section 03 30 20 – Concrete Placing, Curing, and Finishing.

E. All anchor bolts, dowels, sleeves, and other fittings required for the equipment shall be built in.

3.02 GROUTING

A. Grouting is required for structural, mechanical, and electrical items, and shall be in accordance with the manufacturer's recommendations.

B. Concrete surfaces to receive grout shall be cleaned of all contamination and debris. Surface roughening shall be required if laitance or poor concrete is evident.

C. Grout placement shall be rapid and continuous such that grout completely fills the space to be grouted, absent of air pockets.

D. Grout may be placed by gravity or pumped. When practical, grout shall be placed from one side and made to flow to the open side to prevent the formation of air pockets.

3.03 CONCRETE FILLS

A. New unformed concrete surfaces upon which concrete fills are to be placed shall receive a rough broom scratched, rough screed, or rough wood float finish in accordance with Section 03 30 20 – Concrete Placing, Curing, and Finishing.

B. All laitance shall be removed, and the surface shall be saturated with water for a minimum of 6 hours. Excess water shall then be removed and the epoxy-bonding compound applied as specified in Section 03 30 20 – Concrete Placing, Curing, and Finishing.

C. Concrete fills and/or toppings shall be hammer sounded after placement. Any hollow areas shall be saw cut out and replaced as directed by the Engineer at no additional cost to the Atlantic Richfield Company.

3.04 DUCTBANKS

A. There shall be a minimum of 4 inches of concrete between the outside of a duct and surrounding soil. There shall be not less than 3 inches of concrete between adjacent ducts.

B. All duct bank concrete placements shall be continuous between manholes and handholes, and between manholes, handholes, and structures.

C. Where ducts pass through a foundation wall, the concrete encasement shall extend through the wall and be flush with inside face per the details on the Drawings. Watertight construction joints shall be provided.

3.05 EPOXY ADHESIVE

A. Installation: Per manufacturer’s installation instructions and as listed in the product ICC-ES Evaluation Report

B. Drilled and epoxied rebar shall be installed in concrete having a minimum age of 21 days at time of installation.

C. All cartridges shall have the expiration date clearly visible. Material past its expiration date shall not be used and shall be immediately removed from the Site.

D. Diamond drill bits are not permitted. Hammer drills shall be used. Hole diameter size per manufacturer’s installation instructions.

E. The initial material extruded from each cartridge shall be discarded in accordance with the manufacturer's instructions to ensure that all material is properly mixed.

F. Depth stop shall be used to ensure correct drilling depth. Drilled holes shall be blown out with air, thoroughly wire brushed with a repeated back and forth movement, blown out, thoroughly wire brushed, and blown out again. Adhesive shall be injected, starting from the bottom of the hole and slowly withdrawn as filling progresses to prevent air pockets.

G. Rebar shall remain completely undisturbed between the manufacturer's specified gel time and the full cure time. Zero load shall be applied during this time.

3.06 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Manufacturer's Field Services:
   1. Epoxy Adhesive:
      a. Except where specified to be performed by personnel certified by an applicable program such as the ACI/CRSI Adhesive Anchor Installer Certification program or equivalent, as approved by the Engineer, the CMGC shall furnish the services of a competent manufacturer's field representative who shall be present at the Work Site prior to beginning installation in order to instruct the CMGC and the Engineer on proper installation and inspection procedures. Such instruction shall include a full and complete demonstration.
      b. Installation of anchors horizontally or upwardly inclined to resist sustained tension loads shall be continuously inspected by the Engineer's special inspector approved for that purpose. The special inspector shall furnish a report to the Engineer that the Work covered by the report has been performed and that the materials and installation procedures conform to the Contract Documents and the Manufacturer's Printed Installation Instructions (MPII).
      c. Proof Loading: Performed where required per ACI 355.4.

3.07 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 03 20 00
CONCRETE REINFORCING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide all materials, tools, equipment, and labor necessary for the fabrication and installation of all concrete reinforcement as shown on the Drawings, as specified, and as necessary for the proper completion of the Work in accordance with this Section and applicable reference standards listed in Article 1.02.

B. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

C. Related Requirements:
   1. Section 03 30 00 – Cast-In-Place Concrete.

1.02 REFERENCES

A. Reference Standards:
   1. American Concrete Institute (ACI):
      a. ACI 117 - Specifications for Tolerances for Concrete Construction and Materials and Commentary.
      b. ACI SP-66 - ACI Detailing Manual.
   2. American Society for Testing and Materials (ASTM):
      a. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
      b. ASTM A1064 - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
   3. American Welding Society (AWS):
      a. AWS D1.4 - Structural Welding Code – Reinforcing Steel.
   4. Concrete Reinforcing Steel Institute (CRSI):
      a. CRSI 10MSP - Manual of Standard Practice.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance Section 01 33 00 – Submittal Procedures:
   1. SD-02 Shop Drawings:
      a. Reinforcement Drawings:
         1) Comply with ACI SP-66, and include the following information:
            (a) Sizes, dimensions, and locations for reinforcement and supports.
            (b) Bending diagrams and schedules.
            (c) Splices.
            (d) Cover and clearances.
            (e) Class designation and details of bar supports.

(f) Pertinent reinforced concrete details with dimensions and elevations.
(g) Items furnished by other trades or under other sections of the Specification that are to be cast in concrete where interference with reinforcement may occur.
(h) Reinforcement shall be shown on wall elevations with required sections, on beam elevations with required sections, on plan views of slabs with required sections. Provide plan details where walls intersect.

2. SD-03 Product Data:
   a. Certified mill reports, including chemical and physical analyses.
   b. Dowel bar splicers and dowel inserts.
3. SD-07 Closeout Submittals:
   a. Per Division 01 General Requirements.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Fabricate reinforcement in accordance with ACI 117.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Deliver reinforcement in bundles with tags indicating size, length, and identification mark.

C. Store materials off the ground to prevent soiling and to facilitate subsequent inspection and handling.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

PART 2 - PRODUCTS

2.01 STEEL REINFORCEMENT

A. General: Steel reinforcement shall include all bars, anchorages, stirrups, dowels, ties, tie-wire, chairs and other steel supports, and spacers as noted on the Drawings, specified, and as required for the proper completion of the Work.

B. Materials:
   1. Reinforcement bars shall be formed from new billet steel conforming to ASTM A615, Grade 60 except as otherwise specified.
   2. Plain wire fabric shall conform to ASTM 1064. Flat sheets shall be used, rolls are not permitted.

C. Tie Wire:
   1. 16-gauge minimum.
   2. FS QQ-W-461 annealed black, except for architectural concrete.
   3. ASTM A1064 galvanized steel, for architectural concrete.

D. Bar Supports:
   1. Chairs, bolsters, spacers and other supports to properly position reinforcement shall conform to the bar support recommendations of CRSI 10MSP and shall be of adequate

strength and design to prevent displacement of reinforcement and discoloration of concrete.
2. Supports shall be Class 1 - plastic protected.
3. Supports for bottom reinforcement of slabs on soil shall be chairs with integral plates, or precast concrete blocks not less than 4-inches square with a compressive strength equal to that of the surrounding concrete. Precast blocks may only be used to support reinforcement not more than 3-inches from the bottom of the slab.

E. Fabrication:
1. Steel reinforcement shall be fabricated to the sizes, shapes and dimensions shown on the Drawings, details, and schedules. All bending shall be in accordance with CRSI 10MSP. All steel shall be bent cold and shall not be bent or straightened in a manner that will injure the metal. Bars with kinks or bends not so detailed shall not be used.
2. Bends for stirrups and ties shall be made around a pin having a diameter not less than 4 times the diameter of the bar. Bends for other bars shall be made around a pin having a diameter not less than 6 times the diameter of the bar, except for bars larger than 1-inch, the pin shall be not less than 8 times the diameter of the bar.

F. Dowel Bar Splicers and Dowel Inserts (DBS/DI):
1. Dowel bar splicers shall be a 2-component threaded rebar splice system. The internally threaded component shall be forged from Grade 60 deformed rebar material free of external machining or welding. It shall contain an integral flange with nailing holes and be threaded with Unified National Coarse (UNC) or UN (unified) threads to a depth equal to the nominal diameter of the threads plus 1/4 inch. The externally threaded splice component shall be fabricated from Grade 60 deformed rebar material and supplied with rolled threads corresponding with the internally threaded component. The root diameter of the threads shall provide a minimum cross-sectional area equal to the cross-sectional area of the nominal bar size. Manufacturer testing shall indicate ultimate tension failure occurring in the nominal bar diameter, not at the mechanical splice.
2. Mechanical splices shall be Type 2 unless noted otherwise on drawings.

2.02 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Reinforcement:
1. Tolerances shall conform to ACI 117.
2. Placement:
   a. Reinforcement shall be accurately positioned both horizontally and vertically and shall be properly secured and sufficiently rigid to prevent displacement during concrete placement.
   b. Reinforcement shall be securely tied at intersections with tie wire or clips in a manner that will keep all metal away from exposed concrete surfaces.
3. Splices:
   a. Reinforcement splices shall be as shown on the Drawings. Where not shown, splices shall be located away from areas of maximum stress and shall be approved by the Engineer.
   b. Welding shall only be permitted by written approval of the Engineer and shall be in accordance with AWS D1.4.

4. All reinforcement within an area of a continuous concrete placement shall be installed, supported, and secured before beginning the concrete placement.
5. Reinforcement Adjustment:
    a. Adjust to within allowable tolerances to avoid interference with other reinforcement, conduits, or embedded items.
    b. Reinforcement shall not be moved beyond allowable tolerances without the Engineer's approval.
    c. Reinforcement shall not be heated, bent or cut without approval Engineer's approval.

B. Wire Fabric:
1. Wire fabric shall be installed in the longest practicable sheet.
2. Adjoining sheets shall be lapped a minimum of 1-1/2 wire spacing’s and securely wired together.
3. End laps in adjacent sheets shall be offset.

C. All reinforcement shall be entirely free from flaking rust, loose mill scale, grease, dirt, etc. that might reduce its bond with the concrete.

D. Concrete cover for reinforcement shall conform to the dimensions shown on the Drawings.

E. Notify the Engineer at least 24 hours before placing concrete. All reinforcement within the area of 1 day's concrete placement shall be tied in place and observed by the Engineer or Atlantic Richfield Company’s representative, prior to commencing concrete placement.

3.02 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.03 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 SUMMARY

A. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 SECTION INCLUDES

A. Provide cast-in-place concrete in accordance with this Section and applicable reference standards listed in Article 1.04.

1.03 RELATED REQUIREMENTS

A. Section 03 16 00 – Concrete Specialties

B. Section 03 20 00 – Concrete Reinforcing

C. Section 03 30 20 – Concrete Placing, Curing and Finishing

1.04 REFERENCES

A. Reference Standards:
   1. American Concrete Institute International (ACI):
      a. ACI 117 - Specifications for Tolerances for Concrete Construction and Materials and Commentary.
      b. ACI 301 - Specifications for Structural Concrete.
   2. ASTM International (ASTM):
      a. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
      b. ASTM C33 - Standard Specification for Concrete Aggregates.
      c. ASTM C40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
      d. ASTM C88 - Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
      e. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
      f. ASTM C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
      g. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete.
      h. ASTM C150 - Standard Specification for Portland Cement.
      i. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
      j. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
      k. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
      l. ASTM C295 - Standard Guide for Petrographic Examination of Aggregates for Concrete.
      m. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.

n. ASTM C535 - Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
o. ASTM C586 - Standard Test Method for Potential Alkali Reactivity of Carbonate Rocks as Concrete Aggregates (Rock-Cylinder Method).
p. ASTM C595 - Standard Specification for Blended Hydraulic Cements.
q. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
r. ASTM C989 - Standard Specification for Slag Cement for Use in Concrete and Mortars.
s. ASTM C1105 - Standard Test Method for Length Change of Concrete Due to Alkali-Carbonate Rock Reaction.
t. ASTM C1116 - Standard Specification for Fiber-Reinforced Concrete.
u. ASTM C1157 - Standard Specification for Hydraulic Cement.
v. ASTM C1260 - Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
w. ASTM C1293 - Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
x. ASTM C1567 - Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).
y. ASTM C1602 - Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete.
z. ASTM E329 - Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination, sequencing, and scheduling per Division 01 General Requirements.

1.06 SUBMITTALS

A. Submit in accordance Section 01 33 00 – Submittal Procedures:
   1. SD-01 Preconstruction Submittals:
      a. Design Data:
         1) Submit for mix designs for each concrete mixture specified in the Concrete Mix Design Schedule, located at the end of this Section using the same, or similar, names as indicated in the Concrete Mix Design.
         2) Submit minimum 14 days before initial placement of concrete.
         3) Proportions for ingredients, 28-day design compressive strength, water to cementitious materials ratio, admixture dosages, slump, and air content.
         4) Test data supporting proportions based upon laboratory trial batches or field test records according to ACI 301.
            (a) Field test data used to determine the standard deviation used for establishing the required average design strength shall be from within the previous 12 months, according to ACI 301.
            (b) Field test data documenting proposed concrete proportions will produce an average compressive strength equal to or greater than the required average compressive strength from within the previous 12 months.
   2. SD-03 Product Data:
      a. Admixtures.
      b. Fibermesh.
      c. Sample Batch Ticket from concrete batch plant.

3. SD-05 Test Reports:
    a. Provide reports by testing agencies according to ASTM E329.
    b. Cement:
        1) Certified mill reports, not older than 90 days.
    c. Supplementary Cementitious Materials:
        1) Source and test reports for actual material to be used in the Work, not older than 90 days.
            (a) Fly ash.
            (b) Ground granulated blast-furnace slag.
    d. Aggregate:
        1) Data not older than 90 days, except test data for soundness, abrasion, and alkali reactivity - not older than 1 year.
        2) Fine and coarse aggregate data, except as specified.
            (a) Sources.
            (b) Specific gravity.
            (c) Sieve analyses according to ASTM C33 (including fineness modulus of fine aggregate).
            (d) Organic impurities for fine aggregate according to ASTM C40.
            (e) Potential alkali reactivity (not required if a cement containing less than 0.60 percent alkalis is used, according to ASTM C33) according to ASTM C1260, ASTM C1293, or ASTM C1567.
            (f) Soundness according to ASTM C88.
        3) Abrasion for coarse aggregate according to ASTM C131 and ASTM C535.
4. SD-07 Closeout Submittals:
    a. Per Division 01 General Requirements.

1.07 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Storage and Protection for Material for On-Site Batching:
1. Carefully store cement immediately upon receipt in a weatherproof structure, as airtight as practical to prevent moisture absorption, stacked closely to reduce air circulation, but not against exterior walls. Allow easy access for inspection and shipment identification.
2. Transfer bulk cement to elevated airtight weatherproof bins. Test quality of cement that has been stored for suitability if quality is questionable and do not use without approval.
3. Store aggregates to prevent contamination by foreign materials and in separate piles by size. Build coarse aggregate stockpiles in horizontal layers not exceeding 4-feet in depth to avoid segregation.

1.09 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

PART 2 - PRODUCTS

2.01 SOURCE

A. Provide concrete supplied from a single commercial ready-mix plant, mixed and delivered according to ASTM C94, except if plant does not exist within a reasonable distance from Site, furnish material for on-site batching and store as specified.

2.02 CONCRETE MATERIALS

A. Concrete Mixture Design:
   1. Comply with ACI 301, Section 4, Concrete Mixtures.
   2. 28-day design compressive strength: 4,500 pounds per square inch, except as otherwise specified.
   3. Water to Cementitious Materials Ratio: Not to exceed 0.42 except as otherwise specified. Additionally, water to cement ratio shall conform to integral color manufacturer's requirements to achieve uniform color where applicable.
   4. Minimum total cementitious material shall be as follows:

Nominal max aggregate size, in	Minimum cementitious materials, lbs/CY
1-1/2	515
1	535
3/4	560
1/2	580
3/8	600

   5. Provide designs of required strength, water to cementitious materials ratio, slump, and workability for placing conditions and specified finishes without segregation.
   6. Slump: ASTM C143.
      a. Specified Slump Range: 3 inches to 5 inches.
      b. Specified Slump Range (mixes with mid-range water reducer): 2 inches to 4 inches, before admixture is added; maximum 6 inches, after admixture is added.
      c. Specified Slump Range (mixes with high-range water reducer): 2 inches to 4 inches, before admixture is added; maximum 8 inches, after admixture is added.

B. Cement: Shall be sulfate resistant for ACI exposure class S2 including ASTM C150, Type V or ASTM C595 Types IP, IS or IT(HS) or ASTM C1157 Type HS. Do not use ASTM C595 cements that contain ASTM C1157 cement. Alternate cementitious materials may be submitted for approval provided test data verifies adequacy of the material for exposure class S2 in accordance with ACI. If equivalent alkali content is greater than 0.60 percent, submit aggregate reactivity testing as specified.

C. Supplementary Cementitious Materials:
   1. Fly Ash (optional): ASTM C618, Class F.
      a. Maximum Loss of Ignition: 3.0 percent.
      b. Not less than 15 percent or more than 25 percent of weight of cement plus fly ash.
      c. Maximum Available Alkalis: 5 percent.
   2. Ground-Granulated Blast Furnace (GGBF) Slag (optional): ASTM C989.
      a. Activity Classification: Grade 100 or 120.

b. Percentage: Minimum 25 percent or more than 50 percent of weight of cementitious material.
3. Fly Ash plus GGBF Slag: Maximum 50 percent of total cementitious materials.
4. Fly Ash Portion: Maximum 25 percent of total cementitious materials.
5. Minimum Portland Cement: 337 pounds per cubic yard of concrete.

D. Aggregate: ASTM C33, as amended.
1. Evidence of a satisfactory service record in lieu of testing for alkali reactivity is not permitted.
2. Do not use crushed hydraulic cement concrete for aggregate.
3. Aggregate Reactivity Testing: According to ASTM C1260. Do not use aggregate having a 14-day expansion greater than 0.10 percent (considered potentially reactive), except if tested according to ASTM C1567, the 14 day expansion is not greater than 0.10 percent, or if tested according to ASTM C1293, the 2-year expansion is not greater than 0.04 percent, or if cement containing less than 0.60 percent alkalis is used according to ASTM C33. In lieu of the above, Alkali-Silica Reactivity (ASR) mitigation may be by substitution of a minimum 25 percent fly ash or 50 percent GGBF slag for cement by weight.
4. Fine Aggregates: sand or screenings of gravel or crushed stone, well graded from fine to coarse; clean and free from soft particles, clay, loam and organic matter, with the volume removed by sedimentation not more than 3 percent.
a. Organic Impurities Testing: According to ASTM C40. Color of the supernatant liquid above the test sample not darker than organic plate No. 3.
b. Grading:

U.S. Standard Sieve	Percent Passing
Size 3/8 inch	100
No. 4	95 - 100
No. 8	80 - 100
No. 16	50 - 85
No. 30	25 - 60
No. 50	5 -30
No. 100	0-10

c. Maximum 45 percent retained between any 2 consecutive sieves listed above. Fineness modulus: minimum 2.3 nor more than 3.1.
5. Coarse Aggregates: Crushed stone or washed gravel of clean, hard, durable, uncoated particles, free from dust, dirt, or other deleterious substances, and free from thin, flat, or elongated particles.
a. Nominal maximum aggregate size for slabs poured on ground, at least 15 inches thick, except where clear spacing between reinforcing bars is less than 2 inches: 1-1/2".
b. Nominal maximum aggregate size at all other locations: 3/4 inch.
c. Nominal maximum aggregate sizes per grading in Table 2 of ASTM C33: No. 467 (1-1/2 inches), No. 57 (1-inch), No. 67 (3/4 inch), No. 7 (1/2-inch), and No. 8 (3/8-inch).

E. Admixtures:
   1. Air-entraining Admixture: ASTM C260 and chloride free.
      a. Provide air entrainment, except as noted below, according to manufacturer's directions and this Specification to produce the following total entrained air content determined according to ASTM C173 or ASTM C231.

Nominal Maximum Size Coarse Aggregate (inches)	Air Content by Volume (percent plus or minus 1.5)
3/8	7.5
1/2	7.0
3/4	6.0
1	6.0
1-1/2	5.5

      b. Maximum air content for interior concrete slabs to be hard-troweled: 3.0 percent.
   2. Mid-Range Water Reducing Agents: According to ASTM C494, Type A, with consideration of air entraining effect of water reducing agent.
   3. Use water reducing-retarding agents when ambient temperature is above 70 degrees . Replace water reducing agent in whole or part with water reducing-retarding agent according to ASTM C494, Type D. Use amounts to produce concrete with set time equal to that at 70 degrees F without the retarder.
   4. Set Accelerator: Non-chloride type conforming to ASTM C494, Type C or E where allowed under Section 03 30 20.
   5. High-Range Water Reducing Agent: ASTM C494, Type F or G (added in plant or field).

F. Water: Per ASTM C1602.
   1. Use fresh water, free from oil, acid, salt, alkali, sewage, organic matter, and other deleterious substances.
   2. The amount of water carried on the aggregate and the effect of admixtures is included in the water content. Provide that water carried on the aggregate is determined periodically by test and the amount of free water on the aggregate subtracted from water added to the mixture.
   3. Residual, wash, or other water in drums: completely discharged prior to concrete batching (drums backed out).
   4. Use maximum amount of water required to produce a plastic mixture of the strength and water-to-cementitious materials ratio specified, and to produce a mixture of the required density, uniformity and workability. Consistency of mixture: as required for the specific placing conditions and methods.
   5. Do not make slump adjustment at wash down, slump rack, or by any other means prior to arrival at point of delivery at the Site.
   6. Water added after arrival at Site: accurately metered and recorded on the batch ticket.
   7. Integral Color: Changes in water content and water-to-cement ratio in the mix and on the concrete surface during finishing can influence final color. Mix designs that develop excessive bleed water can cause uneven or weak coloring. Once mix designs are established for concrete with integral color, do not add water to alter concrete plastic properties.

G. Fibermesh: Designed to control plastic shrinkage and provide long-term reinforcement.

1. Micro- and Macro- Reinforcement System: polypropylene fibers for cast-in-place concrete manufactured from 100 percent virgin copolymer fibers that conforms to ASTM C1116.
    a. Product: Novamesh 950 by Sika, or approved equal.
    b. Dosage Rate: 5 pounds per cubic yard.

H. Integral Dye Coloring:
1. Refer to drawings for any concrete placements requiring integral color.
2. Type: Integral dye coloring conforming to ASTM C979. Scofield Integral Color SG by Sika Corp or approved equal.
3. Integral dye shall be added to the concrete mix at the batch plant unless addition at the site is approved by the Engineer.

2.03 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Provide testing laboratory and field observers with a minimum 24 hours' notice in advance of placing concrete to allow for scheduling observation and testing.

C. Assist testing laboratory and Engineer in obtaining and handling samples at the Site and other sources of material.

D. Provide space and electrical power at the Site for facilities to be provided by CMGC's testing agency for proper initial curing and storage of concrete test cylinders to be lab-cured as required by ASTM C31 for 48 hours after casting. For cylinders to be field-cured: per Section 03 30 20 – Concrete Placing, Curing and Finishing.

3.02 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

3.03 ATTACHMENTS

A. Concrete Mix Design Schedule.

END OF SECTION

ATTACHMENT A – CONCRETE MIX DESIGN SCHEDULE

The following table provides a list of concrete mixtures required for the Project. Obtain a concrete mix design for each of the concrete mixtures listed from Supplier and submit per Article 1.05.

Submit mix designs under separate mix number designations for with and without integral color where applicable.

Concrete Mixture	Min Comp Strength (psi)	Max W/C Ratio	Air Entrained	Description of Use
Main Mix Design w/ air	4,500 at 28 days	0.42	Yes	Use for all concrete, unless noted otherwise, including for concrete retaining walls; exterior slabs-on-grade; exterior stairs; equipment pads; and concrete surface water conveyance and control structures.
Interior Floor Slabs	4,500 at 28 days	0.45	No	Interior floor slabs to receive hard trowel finish.
Concrete Fills	4,000 at 28 days	0.45	Yes	Section 03 16 00 – Concrete Specialties. Provide fiber-mesh reinforcement per this specification unless noted otherwise in Drawings.
Duct Banks & Mud Mats	3,000 at 28 days	0.55	Yes	Section 03 16 00 – Concrete Specialties.
Controlled Low-Strength Material	See Division 31	N/A	See Division 31	As noted in Drawings.

END OF ATTACHMENT A

SECTION 03 30 20
CONCRETE PLACING, CURING, AND FINISHING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide placing, curing, and finishing of cast-in-place concrete accordance with this Section and applicable reference standards listed in Article 1.02.
   2. Concrete sampling and field testing by an independent technician certified in accordance with the requirements of ACI Concrete Field-Testing Technician – Grade 1 certification program, or the requirements of ASTM C1077. Paid for by CMGC.
   3. Laboratory testing of concrete cylinders by an independent, accredited, and certified testing laboratory. Paid for by CMGC.
   4. Tightness testing in accordance with ACI 350.1 and concrete leak repairs are required for watertight structures where indicated in Drawings. CMGC is responsible for all costs associated with testing and completing all repairs to successfully pass the testing requirements of ACI 350.1. CMGC's construction schedule shall account for sufficient time to perform testing and leak repairs prior to backfilling walls.

B. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

C. Related Requirements:
   1. Section 03 01 06 – Cementitious Crystalline Leak Repair.
   2. Section 03 11 00 – Concrete Forming.
   3. Section 03 16 00 – Concrete Specialties.
   4. Section 03 30 00 – Cast-In-Place Concrete.

1.02 REFERENCES

A. Reference Standards:
   1. American Concrete Institute International (ACI):
      a. ACI 117 - Specifications for Tolerances for Concrete Construction and Materials and Commentary.
      b. ACI 301 - Specifications for Structural Concrete.
      c. ACI 306.1 - Standard Specification for Cold Weather Concreting.
      d. ACI 308.1 - Standard Specification for Curing Concrete.
      e. ACI 350.1 - Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures.
      f. ACI 306R - Cold Weather Concreting.
   2. ASTM International (ASTM):
      a. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
      b. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
      c. ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
      d. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete.

e. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.
f. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete.
g. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete.
h. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
i. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
j. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
k. ASTM C404 - Standard Specification for Aggregates for Masonry Grout.
l. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
m. ASTM C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
n. ASTM C1064 - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
o. ASTM C1077 - Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation.
p. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
q. ASTM D2486 - Standard Test Methods for Scrub Resistance of Wall Paints.
r. ASTM D4541 - Standard Test Methods for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
s. ASTM D4810 - Standard Specification for Flexible Cellular Materials made from Polyolefin Plastics.
t. ASTM E1155 - Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers.
u. ASTM E1745 - Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.

B. Definitions:
1. Construction joint refers to a monolithic construction joint in which the surface between successive placements is prepared to enhance bond and shear transfer and reinforcement is continuous.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
1. SD-01 Preconstruction Submittals:
a. Source and Field Quality Control Submittals:
1) Methods to be used to protect concrete placed during cold weather. The Engineer's review shall not constitute approval as the CMGC shall be responsible for the protection of concrete placed during cold weather.
2) Methods to be used to protect concrete placed during hot weather. The Engineer's review shall not constitute approval as the CMGC shall be responsible for the protection of concrete placed during hot weather.
b. Integral Color Concrete Finish and Acceptance (where applicable):

1) Color of the dyed concrete shall be selected by the Atlantic Richfield Company.
2) CMGC shall have completed integral dyed concrete work of similar square footage on a minimum of 5 projects. Photo examples shall be submitted for Engineer and Atlantic Richfield Company approval prior to concrete placement.
3) When accepted, examples will demonstrate minimum standard of quality required for this work.

2. SD-03 Product Data:
   a. Delivery Tickets:
      1) Provide duplicate delivery tickets at time of delivery for each truckload of concrete delivered.
      2) Serial number of ticket.
      3) Date and Project location.
      4) Name and location of ready mixed concrete plant.
      5) Truck number, time loaded, cubic yardage delivered.
      6) Dispatcher's name.
      7) Mixture design, cement type, and admixtures with brand names.
      8) Types and quantities of cement, fly ash and/or slag (if included in approved mix design) and admixtures. Quantities of water and fine and coarse aggregate including moisture content, and nominal maximum aggregate size.
      9) Water added subsequent to plant batching, if any. (Only applicable if total water per mixture design is not added at plant. Addition of water such that the water content of the approved mixture design is exceeded will be strictly prohibited.)
      10) Concrete temperature upon delivery.
      11) Unloading time and location.
   b. Curing paper.
   c. Epoxy bonding compound.
   d. Evaporation retardant.
   e. Floor hardener.
   f. Cure and seal compound.
   g. Curing compound.
   h. Preformed joint filler.
   i. Expansion joint filler.
3. SD-05 Test Reports:
   a. Concrete Testing.
   b. Tightness Testing.
4. SD-07 Closeout Submittals:
   a. Per Division 01 General Requirements.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Integral Color Mock-up (where applicable):
   1. Construct at least one month prior to start of other concrete work to allow concrete to cure before observation.
   2. At location acceptable to Atlantic Richfield Company, demonstrate methods used for construction, including forming and finishing conditions required for Project using materials, workmanship, form ties, patching techniques and curing methods to be used throughout the project.

3. Minimum size: 100 square feet.
4. Accepted mock-up provides visual standard for work of Section.
5. Remove mock-up when no longer required for comparison with finished work.

C. Concrete sampling and testing per Article 3.10.

D. Tightness test concrete tanks per Article 3.11.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Protection:
1. Provisions shall be made for maintaining new concrete in a continuously moist condition for at least seven days after placement.
2. Fresh concrete shall be protected from freezing, premature drying, flowing water, and mechanical injury.
3. Concrete shall not be placed while rain, sleet, or snow is falling unless acceptable protection is provided. Precipitation shall not be allowed to enter into the concrete mix or damage concrete surfaces.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

PART 2 - PRODUCTS

A. Preformed Joint Filler:
1. Conform to ASTM D4819, closed cell polyethylene foam isolation joint material, 1/2” thick unless noted otherwise on drawings. Joint filler shall be Deck-O-Foam by W.R. Meadows, or approved equal.

B. Expansion Joint Filler:
1. Conform to ASTM D1752, Type III, self-expanding cork expansion joint material. Filler shall permit expansion to 140% of original thickness. WR Meadows Self-expanding cork or approved equal.

C. Cure and Seal Compound:
1. Cure and Seal Compound used for placements with integral color shall be compatible with integral dye coloring. CMGC shall confirm compatibility of the with integral color product manufacturer.
2. Water Based Cure and Seal Compound: Conform to ASTM C309, Type 1, and ASTM C1315, Type 1 with minimum 25 percent solids, non-yellowing, non-staining, and UV light resistant.
   a. MasterKure CC 1315WB, by Master Builders; Vocomp-25, by W.R. Meadows; Dress & Seal WB 25, by L&M Construction Chemicals, Inc.; or approved equal shall be provided.
   b. Approved Use: Water based products are preferred and approved for application to surfaces with a surface temperature above 50F for interior or exterior surfaces.
   c. Limitations: Not permitted for Cold weather application to surfaces temperatures less than 50F. Not permitted for surfaces to receive additional concrete fills, chemical hardeners, sealers, waterproofing, and architectural finishes such as

concrete stain, paints and coatings, tile, carpet, and floor covering adhesives. Not permitted for surfaces to receive a sack-rubbed finish.

D. Solvent Based Cure and Seal Compound: Conform to ASTM C309, Type 1, and ASTM C1315, Type 1 with minimum 25 percent solids, non-yellowing and non-staining, and UV light resistant.
   1. MasterKure CC 250 SB, by Master Builders; CS-309-25, by W.R. Meadows; Dress & Seal 30, by L&M Construction Chemicals, Inc..
   2. Approved Use: Exterior surfaces with surface temperature above 40F.
   3. Limitations: Not permitted for surfaces with a surface temperature less than 40F. Not permitted for surfaces to receive additional concrete fills, chemical hardeners, sealers, waterproofing, and architectural finishes such as concrete stain, paints and coatings, tile, carpet, and floor covering adhesives. Not permitted for surfaces to receive a sack-rubbed finish.

E. Curing Paper:
   1. Shall consist of two layers of kraft paper cemented together and reinforced with fiber and conform to ASTM C171, for regular or white waterproof paper. Regular shall be used if ambient temperatures are below 60 degrees F.

F. Epoxy Bonding Compound:
   1. Conform to ASTM C881, contain 100 percent solids, and be moisture tolerant. Sikadur 32 Hi-Mod or Sikadur 32 Hi-Mod LPL, by Sika Corporation; Sure-Bond (J-58, or J-58 LPL), by Dayton Superior; or approved equal shall be provided.
   2. Where larger placements require open times greater than 2 hours: Sika Armatec 110 EpoCem or approved equal for larger placements.

G. Evaporation Retardant:
   1. Water-based polymer liquid placed on fresh concrete to control the rate of evaporation and extend workability. E-CON as manufactured by L&M Construction Chemicals, Inc.; SikaFilm by Sika Corporation; MasterKure ER 50 by Master Builders; or approved equal.
   2. Compatibility: Product shall be compatible with integral color product where applicable. CMGC shall confirm compatibility with integral color product manufacturer.

H. Floor Hardener:
   1. Clear potassium silicate solution that rapidly penetrates concrete surface without scrubbing and rinsing. Once absorbed, product shall react with the free lime and calcium hydroxide, producing a permanent chemical reaction that hardens, densifies and tightens the concrete surface. StarSeal PS Clear, by Vexon Chemicals, Inc or approved equal.
   2. Performance Requirements:
      a. VOC: 0 grams/liter.
      b. Abrasive Scrub: ASTM D2486, minimum 1200 cycles.
      c. Bond Strength: ASTM D4541, greater than 50 psi.
      d. Percent Solids: Min 18%.

I. Manufacturer’s Warranty: 20 years.

2.02 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 - EXECUTION

3.01 CONCRETE PLACEMENT AND JOINTING

A. Tolerances:
   1. Tolerances shall conform to all requirements of ACI 117 except as modified.

B. Cold Weather Requirements:
   1. Cold weather concreting provisions shall be followed during cold weather: any and all periods when for more than three consecutive days the average daily outdoor temperature drops below 40 degrees F. (The average daily temperature is the average of the highest and lowest temperature during the period from midnight to midnight.) When temperatures higher than 50 degrees F occur during more than half of any 24-hour duration, the period shall not be regarded as cold weather.
   2. When freezing temperatures may occur during periods not defined as cold weather, concrete surfaces shall be protected against freezing for at least the first 24 hours after placing.
   3. Concrete shall not be placed on frozen subgrade. Insulate or heat subgrade to ensure temperature above 32 degrees F when concrete is placed.
   4. All embedment's having a cross sectional area of 1.0 square inch or greater, and including #9 reinforcing bars, shall be at a temperature not less than 10 degrees F at time of concrete placement.
   5. Thermal protection must be provided immediately after concrete placement. Procedures for covering, insulating, housing, and/or heating concrete shall be prearranged. Except when supplemental heat is provided, the R-value of the insulation shall be per the recommendations of chapter 9 of ACI 306R.
   6. Accelerating admixtures shall be approved at the Engineer's discretion, however those containing calcium chloride shall not be permitted.
   7. When combustion heaters are used, flue gases shall be vented to the exterior of enclosures.
   8. Concrete shall be placed and maintained at the following minimum concrete placement temperatures (measured at concrete surface).
   9. Sections of less than 12-inch minimum dimension: 55 degrees F.
   10. Sections of 12 to 36 inches minimum dimension: 50 degrees F.
   11. The concrete placement temperature shall not be higher than the minimum concrete placement temperature by more than 20 degrees F.
   12. The minimum concrete temperature as mixed shall be: 5 degrees F higher than the minimum concrete placement temperature when the air temperature is above 30 degrees F; 10 degrees F higher when the air temperature is between 0- and 30-degrees F; and 15 degrees F higher when the air temperature is less than 0 degrees F.
   13. The temperature shall be monitored at the surface of the concrete, including at corners and edges, which are more vulnerable to freezing. The concrete surface temperature and the corresponding outside air temperature shall be recorded a minimum of twice per each 24-hour period.
   14. Concrete shall be maintained at the minimum specified temperatures for a protection period of 6 days. When an approved accelerating admixture is used the protection period may be reduced to 4 days.
   15. Slabs, regardless of air content, shall not be exposed to freezing temperatures when exposed to rain, snow or other water sources, prior to reaching a compressive strength of 3,500 psi.
   16. Concrete shall be cooled gradually at the end of the protection period. The maximum allowable temperature drop at the concrete surface during the first 24 hours after the

protection period shall be: 50 degrees F for concrete sections of less than 12 inch minimum dimension; and 40 degrees F for concrete sections of 12 to 36 inch minimum dimension.

C. Hot Weather Requirements:
   1. The temperature of the concrete when placed shall not exceed 90 degrees F. When the air temperature is 90 degrees F and above, procedures to cool mixture ingredients may be warranted. These include: providing shaded storage for aggregate, frequent sprinkling or fog spraying of coarse aggregate, and using chilled batch water and/or ice. Forms and reinforcement shall be sprinkled with cold water just prior to concrete placement. When possible, placement of slabs should be scheduled after walls and roof structure are in place in order to minimize problems associated with direct sunlight and/or drying winds. Newly placed concrete shall be protected from the direct sunlight.
   2. Records shall be maintained of: time and location of concrete placement, air temperature, weather conditions (i.e. calm, windy, clear, and/or cloudy), relative humidity, and concrete temperature as delivered and after placement.
   3. When the air temperature is 90 degrees F and above: the time between the addition of water to cement or cement to aggregate (whichever occurs first) and the time of concrete placement shall not exceed 60 minutes, except upon approval of the Engineer when all tests for air content, slump and temperature are acceptable.

D. Placing:
   1. Concrete shall be handled from the truck to the place of final deposit as rapidly as practicable by methods preventing segregation and/or loss of ingredients.
   2. The time between the addition of water to cement, or cement to aggregates (whichever occurs first), and the placement of concrete shall not exceed 90 minutes. When air temperature is 90 degrees F and above, this time shall be reduced to 60 minutes. These times may be exceeded only upon approval of the Engineer, and only if all tests for air content, slump, and temperature are also acceptable.
   3. Water shall be removed from all forms and excavations and the Work shall be kept dry during placement. No water shall be thrown on, allowed to flow over, or rise upon the concrete until it is thoroughly set.
   4. Prior to placement of slabs on soil, the subgrade shall be moist with no free water and no muddy or soft spots.
   5. The concrete shall be directly deposited as close as possible to its final location, and shall be deposited in such manner so as to maintain a homogeneous, plastic, approximately horizontal surface.
   6. Where concrete may contact soil while being placed, free fall shall be limited to a maximum of 3 feet. Concrete that has been contaminated by soil and/or other foreign matter shall be rejected. The accumulation of concrete on the forms and/or on reinforcement above the level of placement shall be avoided. The splashing of concrete upon formwork that is set for a subsequent concrete placement shall be prevented due to the resulting marks on the finished concrete.
   7. Re-tempering of concrete and concrete placement against partially hardened concrete shall not be permitted. A concrete placement, once started, shall be carried out as a continuous operation until the placement of the entire section between construction joints is complete.

E. Runways:
   1. Runways shall be provided for wheeled concrete handling equipment which shall not be wheeled over reinforcement. Runways shall not be supported upon reinforcement that is part of the Work.

F. Chuting:
   1. Minimum slope shall be 3 horizontals to 1 vertical and maximum slope shall be 2 horizontal to 1 vertical. Between these limits, the slope shall be that which will prevent segregation and ensure continuous flow.
   2. A baffle shall be provided at the end of the chute to prevent segregation. If the end of the chute is more than 3 feet above the surface of deposit, a spout shall be used. The spout shall be kept full of concrete with the end kept as near as practical to the surface of deposit.
   3. The chute shall be steel or steel lined, and sections shall have the same slope throughout. Aluminum chutes are not permitted.
   4. The chute shall be thoroughly flushed with water before and after each use, the water discharged outside the forms.

G. Pumping:
   1. The inside diameter of pipes and hoses used to convey the concrete shall be a minimum of three times the maximum size aggregate of the mixture. In order to minimize altering the concrete properties, long vertical sections at the end of the pump line shall be avoided. A horizontal hose run, a hose loop, or a slide gate at the end of the hose may be used to reduce loss of entrained air.

H. Compaction:
   1. Provide at least one standby vibrator, and at least one for each three in use.
   2. Concrete may be deposited in one or multiple layers. Each layer shall be compacted by mechanical internal vibrating equipment supplemented by hand spading, rodding, and tamping as required. The depth of each layer shall not exceed the smaller of 36 inches and the depth that can be properly vibrated with the equipment used. When deposited in multiple layers, the vibrator shall penetrate the previous layer approximately 6 inches. Ensure initial setting of the previous layer does not occur prior to placement of subsequent layer.
   3. Vibrators shall be relocated frequently, and over-vibration resulting in segregation shall be prevented. Vibrators shall not be used to move concrete within the forms. Concrete shall be thoroughly consolidated around reinforcement, embedments, and into the corners of the forms.
   4. Ensure that vibrator is kept several inches clear of waterstops.
   5. Where internal vibration is impractical, the use of form vibrators will be considered, and will be allowed only with the Engineer's written approval. When allowed, the vibrator shall be placed so that motion is horizontal

I. Construction Joints:
   1. Construction joints shall be located where shown on the Drawings, or, if not shown, locations shall be approved by the Engineer. Where required to be watertight, waterstops as specified in Section 03 11 00 – Concrete Forming shall be used.
   2. Horizontal construction joints: laitance shall be removed immediately after initial set and the surface shall roughened in an acceptable manner that exposes the aggregate uniformly and doesn't leave laitance or loose aggregate. After the concrete has set to a degree that precludes laitance removal by shovels or scrapers, the CMGC shall remove it, and create a roughened surface, by water jetting or other effective method. The use of pneumatic hammers is not permitted.
   3. Vertical construction joints: the surface shall be thoroughly cleaned of laitance by water jetting, or by wire brushing followed by air blasting.
   4. Before concrete is placed against set concrete, the surface shall be thoroughly wetted with standing water removed. Horizontal construction joints shall be in a saturated

surface dry condition: saturated for a minimum of 6 hours, with standing water removed.

5. Where noted on the Drawings, and as approved by the Engineer where an unplanned interruption within a concrete placement has occurred, epoxy-bonding compound shall be used in accordance with the manufacturer's instructions.
6. Reinforcement shall be continuous at construction joints unless otherwise shown on the Drawings. Waterstops shall be provided where called for in the Contract Documents. All necessary precautions to ensure that the waterstop is properly located and aligned and remains so during concrete placement shall be taken. In the event that the waterstop is improperly located, allowing a tolerance of plus or minus 1/2-inch, the Engineer may order the waterstop extended, or replaced, or such other action as deemed necessary, and at no additional cost to the Atlantic Richfield Company.

J. Concrete Fills:
   1. New unformed concrete surfaces upon which concrete is placed shall receive a rough (broom, scratched, rough screed, or rough wood float) finish.

K. Existing Concrete:
   1. Where concrete is placed against existing concrete, the following surface preparation shall be required.
   2. The existing concrete surface shall be cleaned of all contamination and debris, and roughened by steel shot blasting, abrasive (sand) blasting, or water jetting (hydrodemolition). Use of scabblers, scarifiers, bush hammers, or pneumatic hammers is not permitted.
   3. The existing concrete surface shall be water-saturated for a minimum of six hours, after which the excess water shall be removed immediately prior to placement of new concrete.
   4. Apply epoxy-bonding compound to prepared concrete surface prior to concrete placement.

3.02 CURING AND PROTECTION

A. Temperature:
   1. When the ambient temperature falls below 40 degrees F or rises above 95 degrees F, a record shall be kept of concrete temperatures and of protection given to concrete during placement and curing.
   2. The temperature of in-place concrete shall be the surface temperature of the concrete. The surface temperature may be determined by placing temperature sensors in contact with concrete surfaces or between concrete surfaces and covers used for curing, such as insulation blankets or plastic sheeting.

B. Curing:
   1. Provide curing per ACI 308.1 except as modified.
   2. During cold weather, as previously defined, the application of water shall not be required. Curing shall be accomplished by the use of curing paper, curing compounds, cure and seal compounds, or other approved methods. Thermal blankets are not an approved curing method and shall be used in conjunction with curing provisions previously stated.
   3. Provisions shall be made for maintaining new concrete in a continuously moist condition for a minimum of 7 days. Curing shall commence as soon as possible after final finishing when it will not mar, erode, or stain the concrete surface.

4. Curing shall be accomplished by the use of curing paper, curing compounds (except as noted below), wet methods (ponding, fog spray, damp sand or burlap, sprinkling, soaker hoses) or other methods.
5. Curing methods shall not result in inconsistent concrete color. Verify methods with integral color product manufacturer where applicable. Methods such as sprinklers will likely result in inconsistent concrete color.
6. Water used for curing shall be no more than 20 degrees F cooler than the concrete surface temperature.
7. Concrete slabs to receive a coating or bonded finish, including chemical hardeners, that aren't wet cured, shall be covered with curing paper as specified, laid with side joints lapped 4 inches and end joints lapped 6 inches. Paper shall be applied no earlier than 24 hours and no later than 30 hours after finishing the slab and shall be left in place at least seven days. (Wet methods shall be used for the first 24-30 hours.) The slab surface shall be maintained in a wet condition beneath the paper at all times. Joints shall be taped and paper shall be weighted to prevent displacement. Tears during the first 7 days after a slab is completed shall be immediately repaired.
8. Curing paper shall also be used to protect newly poured concrete floors from damage. Where heavy tools and/or equipment may be used, provide additional protection as required. Only light traffic will be permitted until 7 days after concrete placement. Slabs shall be protected from damage for the Contract duration, with any and all damage repaired by the CMGC at no additional cost to the Atlantic Richfield Company.
9. The use of a curing compound or cure and seal compound on surfaces to receive applied toppings, chemical hardeners, water repellents, coatings, or a rubbed or bonded finish will not be allowed. Where used, curing compound shall be applied immediately following the disappearance of the surface water sheen after the final finishing pass for slabs, and immediately upon removal of forms for formed concrete. Apply two coats per manufacturer’s installation instructions. Apply each coat uniformly with no gaps in coverage. If applied by spray, provide additional spray tank and spray nozzles as required to provide uninterrupted application of product. Cure and seal compounds have high solid content and shall be applied by trays and rollers, if application by spray tanks is not completed in a timely manner and to the satisfaction of the engineer.
10. Soaker hoses shall be used at tops of walls and columns before forms are removed. Wood forms shall be kept continuously wet in hot weather.

3.03 DEFECTIVE CONCRETE

A. The Engineer may direct the CMGC to remove and replace, at no additional cost to the Atlantic Richfield Company, concrete Work that is not formed as shown and/or specified in the Contract Documents, or that contains a defective surface.

B. Upon the Engineer's approval, minor imperfections may be patched as specified herein.

3.04 REPAIR OF SURFACE DEFECTS AND PATCHING

A. After form removal, all form ties shall be cut off, all fins and irregularities removed, and all defective areas, holes, honeycombs, cavities and irregularities shall be repaired where surface finish defects exceed the finish tolerances of Section 3.05

B. Exposed patchwork shall match adjacent finish to blend repair into adjacent surfaces and cured and protected as specified for concrete. Make patches with stiff mortar made with materials from same sources as concrete including integral color where applicable. Adjust

mortar mix proportions so dry patch matches dry adjacent concrete. Add white cement to mortar mix if necessary to lighten it.

C. Filling Form Tie Holes: Tie holes shall be filled solid in the same manner as specified under patching above.

3.05 FINISH OF FORMED SURFACES

A. General:
   1. Concrete surfaces "exposed to view" shall be defined as those exposed to view upon completion of the Work, whether or not a painted or stained finish is specified. Surfaces which will be covered by fill, such as exterior faces of walls, shall not be considered exposed to view.
   2. Surface tolerance classes indicated herein are specified in ACI 117 and include abrupt surface irregularities that are measured within 1-inch of the irregularity, and gradual surface irregularities measured as the maximum gap between the concrete and the near surface of a 5-foot straight-edge, measured between contact points.

B. Surface Finish – 2.0 (SF-2.0):
   1. SF-2.0 shall be provided for formed surfaces not exposed to view.
   2. Patch voids larger than 3/4-inch wide or 1/2-inch deep.
   3. Remove projections larger than 1-inch.
   4. Fill tie holes.
   5. Surface tolerance Class D, with formed surface irregularities not more than 1-inch.

C. Surface Finish – 3.0 (SF-3.0):
   1. SF-3.0 shall be provided for formed surfaces exposed to view.
   2. Patch voids larger than 1/2-inch wide or 1/4-inch deep.
   3. Remove projections larger than 1/8-inch.
   4. Fill tie holes.
   5. Surface tolerance Class C, with formed surface irregularities not more than 1/2-inch.

3.06 FINISHING OF RELATED UNFORMED SURFACES

A. Tops of exposed walls and similar unformed surfaces shall be struck off smooth and hand steel troweled to produce a smooth hard level surface. Line and elevation shall be pre-established by means of preset wood screeds, which shall be removed during the troweling operation.

B. After troweling is completed and after the curing period, the surface shall be dry honed to a smooth non-directional surface texture satisfactory to the Engineer.

3.07 FINISH OF SLABS

A. General:
   1. The evaporation retardant specified may be used in accordance with manufacturer recommendations to control plastic shrinkage cracking and as an aid in slab finishing operations. Conditions that may warrant its use include: high temperature, low humidity, high winds, and direct sunlight.
   2. Loss of bleed water and surface drying shall be allowed to proceed naturally. Means to accelerate drying such as applying dry cement, sand, or other materials shall be prohibited.

3. CMGC shall use finish methods which will result in consistent color where integral color is specified. Use of wet brooms and tools will likely result in inconsistent color. Verify methods with integral color product manufacturer.

B. Floor Flatness and Floor Levelness:
   1. Concrete base slabs shall be true to the gradient and elevation shown on the Drawings. Flat Slabs shall be level with a tolerance of 1/8 inch in 10 feet. Sloped slabs shall be true to the gradient shown, within a tolerance of 1/8 inch in 10 feet. Slabs shall be pitched to drains as indicated on the Drawings.

C. Floated Finish:
   1. Slabs shall receive a floated finish. Floating shall also precede a troweling, where a troweled finish is required as specified below. After consolidating, screeding, and leveling, the slab shall not be worked further until it is ready for floating.
   2. Floating shall begin when the water sheen has disappeared, and when the slab has stiffened sufficiently to allow proper operation of a power-driven float. Hand floating with wood, aluminum or magnesium floats shall be used at locations inaccessible to the power-driven float.
   3. Surface trueness shall be verified at this stage with a 10-foot straightedge applied in multiple angles. High spots shall be cut down and low spots filled so that the finished surface is true. The slab shall then be immediately refloated to a uniform, smooth, granular texture.

D. Troweled Finish:
   1. All interior slabs left exposed shall receive a troweled finish.
   2. The surface shall be finished with power floats as specified above for floated finish, followed by power trowels, and finally hand trowels. The first power troweling shall produce a smooth surface relatively free of defects but which may contain trowel marks. Subsequent trowel shall be by hand after the surface has sufficiently hardened. The surface shall be thoroughly consolidated by the hand troweling, and final troweling shall be done when a ringing sound is produced as the trowel is moved over the surface. The finished surface shall be free of trowel marks and uniform in texture and appearance.
   3. Interior concrete slabs to be hard-troweled shall have a maximum air content of 3.0 percent. After the curing period, they shall be protected from freezing temperatures for a minimum of 8 weeks. Thereafter, and for the duration of the Contract, if such slabs might be subject to freezing temperatures, they shall be fully sheltered from rain, snow and all other water sources.
   4. Subsequent trowels shall be by hand after the surface has sufficiently hardened. The surface shall be thoroughly consolidated by the hand troweling, and final troweling shall be done when a ringing sound is produced as the trowel is moved over the surface. The finished surface shall be free of trowel marks and uniform in texture and appearance.

E. A broom finish shall be provided for all exterior slabs, sidewalks, platforms, ramps, exterior stairs and as specified herein or shown on the Drawings. After floating, and between initial and final set, the surface shall be given a coarse transverse scored texture by drawing a broom across the surface.

F. Do not dampen brooms used to finish flatwork with integral color specified.

G. Raked Finish: After consolidating, screeding, and leveling, the surface shall be roughened with stiff brushes or raked before final set. At sloped surfaces scratches shall be made parallel to the direction of slope, to facilitate subsequent cleaning.

H. A wood float finish, a broom finish with open pores, or a finish as otherwise required by the waterproofing manufacturer shall be provided for concrete slabs that will receive a wet slurry application of cementitious waterproofing.

3.08 FLOOR HARDENER

A. Floor hardener shall be applied at exposed interior concrete building floor slabs. It shall be applied at a coverage rate recommended by the manufacturer. It shall be applied per the manufacturer's instructions after curing. Slabs to receive hardener shall be wet cured or cured using curing paper.

3.09 CLEANING CONCRETE

A. Cleaning during progress of the Work shall not be permitted. Cleaning shall not commence until the structure is entirely completed.

B. Rust and other stains and discolorations shall be removed with a non-etching cleaning agent used in accordance with the manufacturer's instructions. Cleaning of all surfaces to receive additional finish is also required.

C. Rust stains may be removed by applying a bleaching agent such as oxalic acid. Acid etching, sandblasting, or cleaning by other methods may be used as approved by the Engineer.

3.10 FIELD QUALITY CONTROL

A. General:
   1. Provide in accordance with Division 01 General Requirements.
   2. During the progress of the Work, an independent, accredited, and certified testing laboratory shall conduct concrete testing as specified herein, including the preparation and testing of concrete cylinders. All testing shall be paid for by the CMGC.
   3. Field technicians in charge of sampling concrete; testing for slump, unit weight, air content, and temperature; and making and curing test specimens shall be certified in accordance with the requirements of ACI Concrete Field-Testing Technician – Grade 1 certification program, or the requirements of ASTM C1077.
   4. Scheduling: CMGC to advise testing laboratory and field technician(s) a minimum 24 hours in advance of placing concrete to allow for scheduling observation and testing.
   5. Test Cylinder Storage: Provide space and electrical power at the Site for temperature-controlled storage of concrete laboratory test cylinders to be standard cured per Specification 03 30 00 – Cast-In-Place Concete. Temperature controlled storage containers to be provided by testing agency.

B. Field Testing and Sampling Procedures:
   1. Concrete samples shall be taken in accordance with ASTM C172 for slump, entrained air, unit weight, and strength tests.
   2. Entrained air content and slump requirements are listed in Specification 03 30 00 – Cast-In-Place Concrete.
   3. Air Content: Test in accordance with ASTM C173 or ASTM C231. Prior to pumping initial delivery of concrete each day, air content and slump shall be verify at point of delivery. Thereafter, pumped concrete shall be sampled and tested for air content at

the point of placement, as opposed to at the point of delivery. Upon the Engineer's approval: once the slump loss and the loss of entrained air due to pumping is established, correlated acceptance limits at the point of delivery, where sampling and testing may then be performed, shall be made applicable. When the pump line configuration is changed significantly, sampling and testing shall again be performed at the point of placement until new acceptance limits at the point of delivery may be determined.

4. Slump: Measured in accordance with ASTM C143 at the point of delivery.
5. Temperature shall be measured in accordance with ASTM C1064 at the point of delivery.
6. Test Cylinders: Concrete cylinders shall be prepared in accordance with ASTM C31 and be 4 inches diameter by 8 inches tall. Refer to Article 3.10, part D for number of cylinders required.
    a. Lab-Cured (Standard Cured) Cylinders: Filed cured in temperature-controlled storage per Specification 03 30 00 – Cast-In-Place Concrete. Cylinders shall be transported to the testing lab within 48 hours of forming, but not sooner than 8 hours after final set.
    b. Field Cured Cylinders: Cured in the field under conditions that are not more favorable than the most unfavorable conditions for the portions of the concrete that the cylinders represent.

C. Laboratory Testing of Test Cylinders:
    1. Cylinders shall be tested for compressive strength in accordance with ASTM C39
    2. Test concrete cylinders per Article 3.10, Paragraph D.
    3. The compressive strength shall be the average strength of three-cylinder breaks per ASTM C39 and tested at 28-days.
    4. Test Results: Submit test results to Engineer and concrete supplier within 24 hours of laboratory testing.

D. Field and Laboratory Testing Frequency:
    1. Minimum field-testing frequency for each day concrete is delivered and placed at the project site shall be as follows:
        a. Take concrete test cylinders at frequency stated herein from truckload determined by technician, CMGC, or engineer.
        b. 1st truck load: Test air content, slump, and temperature.
        c. 2nd and 3rd truck load: No testing unless noted otherwise.
        d. 4th truck load: Test air content, slump, and temperature
        e. 5th and 6th truck load: No testing unless noted otherwise.
        f. 7th truck load: Test air content, slump, and temperature.
        g. Repeat test frequency for additional truckloads of concrete delivered during each day of concrete placement.
        h. Concrete temperature shall be tested for each truckload of concrete during cold weather or hot weather as defined within this specification.
        i. CMGC, Atlantic Richfield Company’s representative, or Engineer shall increase testing frequency as required to verify mix designs, address workability concerns, and to ensure all concrete placed complies with specifications.
    2. Lab-Cured (Standard Cure) Cylinders:
        a. Lab-cured cylinders are required for all concrete on the project and shall be in addition to field-cured cylinders, where provided.
        b. One set of 5 cylinders shall be prepared for each 100 cubic yards, or fraction thereof, of each different mix placed in each single day; or for each 5,000 square feet of slab or wall surface area placed each day.

c. Test one cylinder at 7 days, three at 28 days, and reserve one cylinder for 56-days.
d. Test 56-day cylinder as needed or requested by CMGC or Engineer.

3. Field-Cured Cylinders:
   a. CMGC is responsible for taking additional field-cured test cylinders to verify concrete compressive strength prior to tightness testing concrete tanks, backfilling concrete basement walls, or early removal of formwork.
   b. One set of 3 field-cured cylinders shall be prepared for each 100 cubic yards, or fraction thereof, of the concrete placed in each single day.
   c. Test field cured cylinders at 14 days or as requested by CMGC or Engineer.

E. Acceptance Criteria and Additional Testing Requirements:
1. Concrete strength shall be evaluated in accordance with ACI 301 Section 1.6.5, "Evaluation of concrete strength tests", and Section 1.6.6, "Acceptance of concrete strength."
2. Construction will be considered potentially deficient if concrete fails to meet any requirements that affect the strength and durability of the structure, including but not necessarily limited to:
   a. Low strength concrete per ACI 301, Section 1.6.5, "Evaluation of concrete strength tests", and Section 1.6.6, "Acceptance of concrete strength".
   b. Water-to-cementitious materials ratio higher than that of the specified mix.
   c. Reinforcing steel size, quantity, strength, position, or arrangement that does not meet the requirements of the Contract Documents.
   d. Reinforced concrete that differs from the dimensions or locations shown on the Drawings.
   e. Curing that does not meet the requirements of the Contract Documents, including premature formwork removal.
   f. Hot or cold weather concreting that doesn't meet the requirements of the Contract Documents.
   g. Mechanical damage from accidents or fire.
   h. Poor construction practices.
3. Appearance: Accepted mock-up is visual standard for integrally colored concrete work. Minor variations in appearance of integrally colored concrete that are similar to natural variations in color and appearance of uncolored concrete are acceptable.

F. The Engineer may order load and/or core tests in accordance with ASTM C42. Such testing shall be paid for by the Atlantic Richfield Company if the concrete is proven to meet the requirements specified.

3.11 TIGHTNESS TESTING OF WATERTIGHT CONCRETE STRUCTURES

A. General:
1. The CMGC shall individually test the following concrete basins for water tightness before backfilling operations, except where backfilling is necessary in order to construct tank:
   a. Lexington: None.
   b. Grove Gulch: None.
   c. Buffalo Gulch: None.
2. Testing shall be in accordance with ACI 350.1, Section 2- “Hydrostatic tightness test for open or covered containment structures”.
   a. Testing Criteria: Volume loss shall not exceed 0.0125 percent net liquid loss per day.

B. Testing Sequence and Schedule:
   1. CMGC shall submit tank basin testing sequence and testing schedule for Engineer's review.
   2. Prior to submitting testing sequence and testing schedule, CMGC shall request and obtain test documentation forms prepared by Engineer. Forms will be provided to CMGC within 14-calender days of request.

C. Documentation:
   1. CMGC shall document test results for each tank test basin using Engineer's documentation forms.

D. Failed Test:
   1. If any basin fails Part 1: Qualitative Criteria or Part 2: Quantitative Criteria per ACI 350.1, the CMGC shall correct the problem and retest at CMGC's expense.

E. Tank Leak Repairs:
   1. CMGC shall repair leaks per Section 03 01 06 – Cementitious Crystalline Leak Repair.

3.12 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

B. Submit signed and completed concrete tightness testing forms for each tank basin required to be tested.

END OF SECTION

SECTION 03 42 13
PLANT-PRECAST CONCRETE FOR BELOW GRADE CONSTRUCTION

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Section Includes: Precast, concrete products used for below grade construction (Sewage Systems, Subdrainage Systems, Storm Drainage Systems, Utility and Communications Structures, etc.).

B. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
   1. American Concrete Institute (ACI):
      a. ACI 211.1 (1991; R 2009) - Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.
      b. ACI 211.2 (1998; R 2004) - Standard Practice for Selecting Proportions for Structural Lightweight Concrete.
      c. ACI 305R (2010) - Guide to Hot Weather Concreting.
      d. ACI 306.1 (1990; R 2002) - Standard Specification for Cold Weather Concreting.
      e. ACI 318 (2014; Errata 1-2 2014; Errata 3-5 2015; Errata 6 2016; Errata 7-9 2017) - Building Code Requirements for Structural Concrete (ACI 318-14) and Commentary (ACI 318R-14).
   2. American Concrete Pipe Association (ACPA):
      a. ACPA 01-102 (2000) - Concrete Pipe Handbook.
      b. ACPA 01-110 (1984) - Design Manual for Sulfide and Corrosion Prediction and Control.
      c. ACPA QPC (2016) - QCast Plant Certification Manual.
   3. American Welding Society (AWS)
      a. AWS D1.1/D1.1M (2015; Errata 1 2015; Errata 2 2016) - Structural Welding Code – Steel.
      b. AWS D1.4/D1.4M (2011) - Structural Welding Code - Reinforcing Steel.
   4. ASTM International (ASTM)
      a. ASTM A1064/A1064M (2017) - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
      b. ASTM A153/A153M (2016) - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      c. ASTM A36/A36M (2014) - Standard Specification for Carbon Structural Steel.
      d. ASTM A615/A615M (2016) - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
      e. ASTM A706/A706M (2016) - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
      f. ASTM A767/A767M (2016) - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.

g. ASTM A775/A775M (2017) - Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
h. ASTM A884/A884M (2014) - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement.
i. ASTM C1064/C1064M (2017) - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
j. ASTM C1107/C1107M (2017) - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
k. ASTM C1116/C1116M (2010a; R 2015) - Standard Specification for Fiber-Reinforced Concrete.
l. ASTM C1244 (2011; R 2017) - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.
m. ASTM C138/C138M (2017a) - Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
n. ASTM C143/C143M (2015) - Standard Test Method for Slump of Hydraulic-Cement Concrete.
o. ASTM C1478 (2008; R 2013) - Standard Specification for Storm Drain Resilient Connectors Between Reinforced Concrete Storm Sewer Structures, Pipes and Laterals.
p. ASTM C171 (2016) - Standard Specification for Sheet Materials for Curing Concrete.
q. ASTM C173/C173M (2016) - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
r. ASTM C192/C192M (2016a) - Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
s. ASTM C231/C231M (2017a) - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
t. ASTM C309 (2011) - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
u. ASTM C31/C31M (2018b) - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
v. ASTM C39/C39M (2018) - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
w. ASTM C443 (2012; R 2017) - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
x. ASTM C857 (2016) - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
y. ASTM C858 (2010; E 2012) - Standard Specification for Underground Precast Concrete Utility Structures.
z. ASTM C877 (2008) - External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections.
aa. ASTM C891 (2011) - Installation of Underground Precast Concrete Utility Structures.
bb. ASTM C920 (2018) - Standard Specification for Elastomeric Joint Sealants.
cc. ASTM C923 (2008; R 2013; E 2016) - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.
dd. ASTM C990 (2009; R 2014) - Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants.

5. CSA Group (CSA):
   a. CSA A23.4 (2016; Errata 2016) - Precast Concrete - Materials and Construction.

6. National Precast Concrete Association (NPCA):
    a. NPCA QC Manual (2017) - Quality Control Manual for Precast and Prestressed Concrete Plants.

1.03 SUBMITTALS

A. All submittals are the responsibility of the precast concrete producer. CMGC is responsible for submitting product details to the Atlantic Richfield Company Representative. Atlantic Richfield Company approval is required for submittals in accordance with Section 01 33 00 – Submittal Procedures:
    1. SD-01 Preconstruction Submittals:
        a. Quality control procedures.
        b. Design Data:
            1) Design calculations.
            2) Concrete mix proportions.
    2. SD-02 Shop Drawings:
        a. Standard precast units.
        b. Custom-made precast units.
        c. Special finishes.
    3. SD-03 Product Data:
        a. Standard precast units.
        b. Proprietary precast units.
        c. Embedded items.
        d. Accessories.
    4. SD-05 Test Reports:
        a. As indicated in this Section.
    5. SD-06 Certificates:
        a. Quality control procedures.
    6. SD-07 Closeout Submittals:
        a. Recycled content for fly ash and pozzolan.
        b. Recycled content for Ground Iron Blast-Furnace Slag.
        c. Recycled content for Silica Fume.
        d. Recycled content for Synthetic Fiber Reinforcement.
        e. Recycled content for steel.

1.04 QUALITY CONTROL

A. Demonstrate adherence to the standards set forth in NPCA QC Manual or ACPA QPC. Meet requirements written in the subparagraphs below.
    1. NPCA and ACPA Plant Certification: The precast concrete producer must be certified by the National Precast Concrete Association's or the American Concrete Pipe Association's Plant Certification Program prior to and during production of the products for this project.
    2. Qualifications, Quality Control and Inspection:
        a. Qualifications: Select a precast concrete producer that has been in the business of producing precast concrete units similar to those specified for a minimum of 3 years. The precast concrete producer must maintain a permanent quality control department or retain an independent testing agency on a continuing basis.
        b. Quality Control Procedures: Submit quality control procedures established by the precast manufacturer in accordance with NPCA QC Manual and ACPA QPC. Show that the following QC tests are performed as required and in accordance with the ASTM standards indicated:

1) Slump: Perform a slump test for each 150 cu yd of concrete produced, or once a day, whichever comes first. Perform slump tests in accordance with ASTM C143/C143M.
2) Temperature: Measure the temperature of fresh concrete when slump or air content tests are made and when compressive test specimens are made in accordance with ASTM C1064/C1064M.
3) Compressive Strength: Make at least four compressive strength specimens for each 150 cubic yards of concrete of each mix in accordance with the following Standards: ASTM C31/C31M, ASTM C192/C192M, ASTM C39/C39M.
4) Air Content: Perform tests for air content on air-entrained, wet-cast concrete for each 150 cu yd of concrete, but not less often than once each day when air-entrained concrete is used. Determine the air content in accordance with either ASTM C231/C231M or ASTM C173/C173M for normal weight aggregates and ASTM C173/C173M for lightweight aggregates.
5) Unit Weight: Perform tests for unit weight a minimum of once per week to verify the yield of batch mixes. Perform unit weight tests for each 100 cu yd of lightweight concrete in accordance with ASTM C138/C138M.

c. Inspection: The Atlantic Richfield Company Representative may place an inspector in the plant when the units covered by this specification are being manufactured. The burden of payment for plant inspection will be the responsibility of the CMGC. The precast concrete producer must give notice 14 days prior to the time the units will be available for plant inspection. Neither the exercise nor waiver of inspection at the plant will affect Atlantic Richfield Company's right to enforce contractual provisions after units are transported or erected.

d. Test Reports: Submit the following:
1) Material Certifications or Laboratory Test Reports: Include mill tests and all other test data, for portland cement, blended cement, pozzolans, ground granulated blast furnace slag, silica fume, aggregate, admixtures, and curing compound proposed for use on this project.
2) Mix Test: Submit reports showing that the mix has been successfully tested to produce concrete with the properties specified and will be suitable for the job conditions. Such tests may include compressive strength, flexural strength, plastic or hardened air content, freeze thaw durability, abrasion and absorption. Clearly detail in the specifications' special tests for precast concrete or cast-in items.
3) Self-Consolidating Concrete: Submit sufficient documentation, when the use of self-consolidating concrete (SCC) is proposed, showing a minimum of 30-days production track records demonstrating that SCC is appropriate for casting of the product.
4) In-Plant QA/QC Inspection Reports: Submit inspection reports upon the request of the Atlantic Richfield Company Representative.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver precast units to the site in accordance with the delivery schedule to avoid excessive build-up of units in storage at the site. Upon delivery to the jobsite, all precast concrete units will be inspected by the Atlantic Richfield Company Representative for quality and final acceptance.

B. Storage: Store units off the ground or in a manner that minimizes potential damage.

C. Handling: Handle, transport, and store products in a manner to minimize damage. Lifting devices or holes must be consistent with industry standards. Perform lifting with methods in

accordance with the AR-RM HSSE Management System Practices, Procedures, and Guidance.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Furnish precast concrete units designed and fabricated by an experienced and acceptable precast concrete manufacturer who has been, for at least three years, regularly and continuously engaged in the manufacture of precast concrete work similar to that indicated on the drawings. Coordinate precast work with the work of other trades. Below grade structures must comply with ASTM C858.

B. Standard Precast Units: Design standard precast concrete units to withstand indicated design load conditions in accordance with applicable industry design standards ACI 318, ASTM C857, ACPA 01-102, Chapter 7-Design for Sulfide Control. Design must also consider stresses induced during handling, shipping and installation as to avoid product cracking or other handling damage. Indicate design loads for precast concrete units on the shop drawings. Submit drawings for standard precast concrete units furnished by the precast concrete producer for approval by the Atlantic Richfield Company Representative. These drawings must demonstrate that the applicable industry design standards have been met. Include installation and construction information on shop drawings. Include details of steel reinforcement size and placement as well as supporting design calculations, if appropriate. Produce precast concrete units in accordance with the approved drawings. Submit cut sheets, for standard precast concrete units, showing conformance to project drawings and requirements, and to applicable industry design standards listed in this specification.

C. Custom-Made Precast Units: Submit design calculations for custom-made precast units, prepared and sealed by a registered professional engineer, for approval prior to fabrication. Include in the calculations the analysis of units for lifting stresses and the sizing of lifting devices. Submit drawings furnished by the precast concrete producer for approval by the Atlantic Richfield Company Representative. Show on these drawings complete design, installation, and construction information in such detail as to enable the Atlantic Richfield Company Representative to determine the adequacy of the proposed units for the intended purpose. Include details of steel reinforcement size and placement as well as supporting design calculations, if appropriate. Produce precast concrete units in accordance with the approved drawings.

D. Proprietary Precast Units: Products manufactured under franchise arrangements must conform to all the requirements specified by the franchiser. Items not included in the franchise specification, but included in this specification, must conform to the requirements in the Contract Documents. Submit standard plans or informative literature, for proprietary precast concrete units. Make available supporting calculations and design details upon request. Provide sufficient information as to demonstrate that such products will perform the intended task.

E. Joints and Sealants: Provide joints and sealants between adjacent units of the type and configuration indicated on shop drawings meeting specified design and performance requirements.

F. Concrete Mix Design: Concrete mix designs and aggregate gradations shall adhere to the construction documents and in accordance with Section 03 30 00 – Cast-In-Place Concrete and Section 31 38 00 – Granular Fill Material. Deviation from specified mixes require an Atlantic Richfield Company Representative approval.

1. Concrete Mix Proportions: Base selection of proportions for concrete on the methodology presented in ACI 211.1 for normal weight concrete and ACI 211.2 for lightweight concrete. Develop the concrete proportions using the same type and brand of cement, the same type and brand of pozzolan, the same type and gradation of aggregates, and the same type and brand of admixture that will be used in the manufacture of precast concrete units for the project. Do not use calcium chloride in precast concrete containing reinforcing steel or other embedded metal items. At a minimum of thirty days prior to precast concrete unit manufacturing, the precast concrete producer will submit a mix design and proportions for each strength and type of concrete that will be used. Furnish a complete list of materials, including quantity, type, brand and applicable data sheets for all mix design constituents as well as applicable reference specifications. The use of self-consolidating concrete is permitted, provided that mix design proportions and constituents meet the requirements of this specification.
2. Concrete Strength: Provide precast concrete units with a 28-day compressive strength (f'c) of 4,000 psi.
3. Water-to-Cement Ratio: Where exposed to freezing and thawing, furnish concrete containing entrained air and with a water-cementitious ratio of 0.45 or less. Where not exposed to freezing, but required to have a low permeability, furnish concrete with a water-cementitious ratio of 0.48 or less. Where exposed to deicer salts, brackish water, or seawater, furnish concrete with a water-cementitious ratio of 0.40 or less, for corrosion protection.
4. Air Content: The air content of concrete that will be exposed to freezing conditions must be within the limits given below.

	AIR CONTENT PERCENT	
NOMINAL MAXIMUM AGGREGATE SIZE	**EXPOSURE CLASS F1**	**EXPOSURE CLASSES F2 and F3**
3/8 inch	6.0	7.5
1/2 inch	5.5	7.0
3/4 inch	5.0	6.0
1.0 inch	4.5	6.0
1.5 inch	4.5	5.5
Note: For specified compressive strengths greater than 5000 psi, air content may be reduced 1 percent		

5. Corrosion Control for Sanitary Sewer Systems: Follow design recommendations outlined in Chapter 7 of ACPA 01-102 or the ACPA 01-110 when hydrogen sulfide is indicated as a potential problem.

2.02 MATERIALS

A. Except as otherwise specified in the following paragraphs, conform material to Section 03 30 00 – Cast-In-Place Concrete.
   1. Material Sustainability Criteria: For products in this section, where applicable and to extent allowed by performance criteria, provide and document the following:

a. Recycled content for fly ash and pozzolan.
b. Recycled content for ground iron blast-furnace slag.
c. Recycled content for silica fume.
d. Recycled content for synthetic fiber reinforcement.
e. Recycled content for steel, 75 percent minimum.

2. Pigments: Non-fading and lime-resistant.
3. Reinforcement: Concrete reinforcement shall conform with the construction documents and Section 03 20 00 – Concrete Reinforcing.
   a. Reinforcing Bars:
      1) Deformed Billet-steel: ASTM A615/A615M.
      2) Deformed Low-alloy Steel: ASTM A706/A706M.
   b. Reinforcing Wire:
      1) Plain Wire: ASTM A1064/A1064M.
      2) Deformed Wire: ASTM A1064/A1064M.
   c. Welded Wire Reinforcement:
      1) Plain Wire: ASTM A1064/A1064M.
      2) Deformed Wire: ASTM A1064/A1064M.
   d. Epoxy Coated Reinforcement:
      1) Reinforcing Bars: ASTM A775/A775M.
      2) Wires and Welded Wire: ASTM A884/A884M.
   e. Galvanized Reinforcement: Provide galvanized reinforcement conforming to ASTM A767/A767M.
4. Synthetic Fiber Reinforcement: Provide fiber reinforced concrete in accordance with ASTM C1116/C1116M Type III, synthetic fiber reinforced concrete, and as follows. Synthetic reinforcing fibers must be [100 percent virgin] monofilament polypropylene fibers, with a minimum of [5] [10] percent post-consumer recycled content, or a minimum of [20] [40] percent post-industrial recycled content. Provide fibers that have a specific gravity of 0.9, a minimum tensile strength of 70 ksi, graded per manufacturer, and specifically manufactured to an optimum gradation for use as concrete secondary reinforcement. [Toughness indices must meet requirements for performance level I.]
5. Inserts and Embedded Metal: All items embedded in concrete must be of the type required for the intended task and meet the following standards:
   a. Structural Steel Plates, Angles, etc.: ASTM A36/A36M.
   b. Hot-dipped Galvanized: ASTM A153/A153M.
   c. Proprietary Items: In accordance with manufacturers published literature.
6. Accessories: Submit proper installation instructions and relevant product data for items including, but not limited to, sealants, gaskets, connectors, steps, cable racks and other items installed before or after delivery.
   a. Rubber Gaskets for Circular Concrete Sewer Pipe and Culvert Pipe: ASTM C443.
   b. External Sealing Bands for Noncircular Sewer, Storm Drain and Culvert Pipe: ASTM C877.
   c. Preformed Flexible Joint Sealants for Concrete Pipe, Manholes, and Manufactured Box Sections: ASTM C990.
   d. Elastomeric Joint Sealants: ASTM C920.
7. Pipe Entry Connectors: Pipe entry connectors must conform to ASTM C923 or ASTM C1478.
8. Grout: Non-shrink Grout must conform to ASTM C1107/C1107M. Cementitious grout must be a mixture of portland cement, sand, and water. Proportion one part cement to approximately 2.5 parts sand, with the amount of water based on placement method. Provide air entrainment for grout exposed to the weather.
9. Bituminous Coating: A bituminous coating shall be placed on the outside of all below-grade pre-cast concrete structures as specified in the construction documents.

PART 3 - EXECUTION

3.01 FABRICATION AND PLACEMENT

A. Perform fabrication in accordance with NPCA QC Manual or ACPA QPC unless specified otherwise.

B. Forms: Use forms, for manufacturing precast concrete products, of the type and design consistent with industry standards and practices. They should be capable of consistently providing uniform products and dimensions. Construct forms so that the forces and vibrations to which the forms will be subjected can cause no product damage. Clean forms of concrete build-up after each use. Apply form release agents according to the manufacturers recommendations and do not allow to build up on the form casting surfaces.

C. Reinforcement: Follow applicable ASTM Standard or ACI 318 for placement and splicing. Fabricate cages of reinforcement either by tying the bars, wires or welded wire reinforcement into rigid assemblies or by welding, where permissible, in accordance with AWS D1.4/D1.4M. Position reinforcing as specified by the design and so that the concrete cover conforms to requirements listen in Section 03 20 00 REINFORCING STEEL. Take positive means to assure that the reinforcement does not move significantly during the casting operations.

D. Embedded Items: Position embedded items at locations specified in the design documents. Perform welding in accordance with AWS D1.1/D1.1M when necessary. Hold rigidly in place inserts, plates, weldments, lifting devices and other items to be imbedded in precast concrete products so that they do not move significantly during casting operations. Submit product data sheets and proper installation instruction for anchors, lifting inserts and other devices. Clearly indicate the products dimensions and safe working load.

E. Synthetic Fiber Reinforced Concrete: Add fiber reinforcement to the concrete mix at the batch plant in accordance with the applicable sections of ASTM C1116/C1116M and the recommendations of the manufacturer. Use a minimum of 1.5 pounds of fibers per cubic yard of concrete.

3.02 CONCRETE

A. Concrete Mixing: Mixing operations must produce batch-to-batch uniformity of strength, consistency, and appearance.

B. Concrete Placing: Deposit concrete into forms as near to its final location as practical. Keep the free fall of the concrete to a minimum. Consolidate concrete in such a manner that segregation of the concrete is minimized, and honeycombed areas are kept to a minimum. Use vibrators to consolidate concrete with frequencies and amplitudes sufficient to produce well consolidated concrete.
   1. Cold Weather Concreting: Perform cold weather concreting in accordance with ACI 306.1.
      a. Provide adequate equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather.
      b. All concrete materials, reinforcement, forms, fillers, and ground with which concrete is to come in contact must be free from frost.
      c. Do not use frozen materials or materials containing ice.
      d. In cold weather the temperature of concrete at the time of placing must not be below 45 degrees F. Discard concrete that freezes before its compressive strength reaches 500 psi.

2. Hot Weather Concreting: Follow recommendations for hot weather concreting in ACI 305R. During hot weather, give proper attention to constituents, production methods, handling, placing, protection, and curing to prevent excessive concrete temperatures or water evaporation that could impair required strength or serviceability of the member or structure. The temperature of concrete at the time of placing must not exceed 90 degrees F.

C. Concrete Curing: Commence curing immediately following the initial set and completion of surface finishing.
   1. Curing by Moisture Retention: Prevent moisture evaporation from exposed surfaces until adequate strength for stripping is reached by one of the following methods:
      a. Cover with polyethylene sheets a minimum of 6 mils thick in accordance with ASTM C171.
      b. Cover with burlap or other absorptive material and keep continually moist.
      c. Use a membrane-curing compound, conforming to ASTM C309 and applied at a rate not less than 200 square ft/gallon, or in accordance with manufacturers' recommendations.
   2. Curing with Heat and Moisture: Do not subject concrete to steam or hot air until after the concrete has attained its initial set. Apply steam, if used, within a suitable enclosure, which permits free circulation of the steam in accordance with CSA A23.4. If hot air is used for curing, take precautions to prevent moisture loss from the concrete. The temperature of the concrete must not be permitted to exceed 150 degrees F. These requirements do not apply to products cured with steam under pressure in an autoclave.

D. Surface Finish: Finish unformed surfaces of wet-cast precast concrete products as specified. If no finishing procedure is specified, finish such surfaces using a strike-off to level the concrete with the top of the form.
   1. Formed Non-Architectural Surfaces: Cast surfaces against approved forms following industry practices in cleaning forms, designing concrete mixes, placing and curing concrete. Normal color variations, form joint marks, small surface holes caused by air bubbles, and minor chips and spalls will be accepted but no major imperfections, honeycombs or other major defects will be permitted.
   2. Unformed Surfaces: Finish unformed surfaces with a vibrating screed, or by hand with a float. Normal color variations, minor indentations, minor chips and spalls will be accepted. Major imperfections, honeycombs, or other major defects are not permitted.
   3. Special Finishes: Troweled, broom or other finishes must be according to the requirements of Contract Documents and performed in accordance with industry standards or supplier specifications. Submit finishes for approval when required by the Contract Documents. The sample finishes must be approved prior to the start of production.

E. Stripping Products from Forms: Do not remove products from the forms until the concrete reaches the compressive strength for stripping required by the design. If no such requirement exists, products may be removed from the forms after the final set of concrete provided that stripping damage is minimal.

F. Patching and Repair: No repair is required to formed surfaces that are relatively free of air voids and honeycombed areas, unless the surfaces are required by the design to be finished.
   1. Repairing Minor Defects: Defects that will not impair the functional use or expected life of a precast concrete product may be repaired by any method that does not impair the product.

2. Repairing Honeycombed Areas: When honeycombed areas are to be repaired, remove all loose material and cut back the areas into essentially horizontal or vertical planes to a depth at which coarse aggregate particles break under chipping rather than being dislodged. Use proprietary repair materials in accordance with the manufacturer's instructions. If a proprietary repair material is not used, saturate the area with water. Immediately prior to repair, the area should be damp, but free of excess water. Apply a cement-sand grout or an approved bonding agent to the chipped surfaces, followed immediately by consolidating an appropriate repair material into the cavity.
3. Repairing Major Defects: Evaluate, by qualified personnel, defects in precast concrete products which impair the functional use or the expected life of products to determine if repairs are feasible and, if so, to establish the repair procedure.

G. Shipping Products: Do not ship products until they are at least five days old, unless it can be shown that the concrete strength has reached at least 75 percent of the specified 28-day strength, or that damage will not result, impairing the performance of the product.

H. Acceptance: Atlantic Richfield Company and or the Atlantic Richfield Company Representative reserves the right to reject precast structures if defects are observed.

3.03 INSTALLATION

A. Site Access: It is the CMGC's responsibility to provide adequate access to the site to facilitate hauling, storage and proper handling of the precast concrete products.

B. General Requirements:
1. Install precast concrete products to the lines and grades shown in the contract documents or otherwise specified.
2. Lift products in accordance with the AR-RM HSSE Management System Practices, Procedures, and Guidance by suitable lifting devices at points provided by the precast concrete producer.
3. Install products in accordance with the precast concrete producer's instructions. In the absence of such instructions, install underground utility structures in accordance with ASTM C891. Install pipe and manhole sections in accordance with the procedures outlined by the American Concrete Pipe Association.
4. Field modifications to the product will relieve the precast producer of liability even if such modifications result in the failure of the product.

C. Water Tightness: Where water tightness is a necessary performance characteristic of the precast concrete product's end use, watertight joints, connectors and inserts should be used to ensure the integrity of the entire system.

3.04 FIELD QUALITY CONTROL

A. Site Tests: When water tightness testing is required for an underground product, use one of the following methods:
1. Vacuum Testing: Prior to backfill vacuum test system according to ASTM C1244.
2. Water Testing: Perform water testing according to the Contract Documents and precast concrete producer's recommendations.

END OF SECTION

SECTION 05 12 00
STRUCTURAL STEEL

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide steel structure in accordance with this Section and applicable reference standards listed in Article 1.02.
   2. The Work of this section comprises all materials, tools, equipment and labor required to furnish, fabricate and erect structural steel shown on the Drawings, specified herein, and evidently required to complete the Work. Structural steel comprises steel elements as defined in Section 2.1 of AISC 303.
   3. Other steel items, as defined in Section 2.2 of AISC 303, shall be furnished and installed under other sections of the Project Manual.
   4. Items to be embedded in concrete or masonry shall be furnished under this section but installed under Division 3 Concrete or Division 4 Masonry, as applicable.

B. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures and Guidance.

1.02 REFERENCES

A. Reference Standards:
   1. American Institute of Steel Construction (AISC):
      a. AISC 303 - Code of Standard Practice for Steel Buildings and Bridges.
      b. AISC 360 - Specification for Structural Steel Buildings.
   2. American Welding Society (AWS):
      a. AWS D1.1 - Structural Welding Code – Steel.
   3. ASTM International (ASTM):
      a. ASTM A6 - Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
      b. ASTM A36 - Standard Specification for Carbon Structural Steel.
      c. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      d. ASTM A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
      e. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      f. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      g. ASTM A239 - Standard Practice for Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles.
      h. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
      i. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
      j. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts.
      k. ASTM A572 - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.

l. ASTM A588 - Standard Specification for High-Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point, with Atmospheric Corrosion Resistance.
m. ASTM A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
n. ASTM A992 - Standard Specification for Structural Steel Shapes.
o. ASTM D6386 - Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.
p. ASTM F436 - Hardened Steel Washers.
q. ASTM F959 - Compressible Washer Type Direct Tension Indicators for use with Structural Fasteners.
r. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
s. ASTM F1852 - Standard Specification for "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
t. Specification for Structural Joints Using ASTM A325 and A490 Bolts.

4. The Society for Protective Coatings (SSPC):
   a. SSPC SP 3 - Power Tool Cleaning.
   b. SSPC SP 6 - Commercial Blast Cleaning.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures.
   1. SD-02 Shop Drawings:
      a. Details of connections, copes, splices, camber, holes, hardware, finish, and other pertinent information.
      b. Indicate welds by standard AWS symbols.
      c. Indicate bolts and identify pre-tensioned and slip-critical connections as applicable.
      d. Identify areas of slip-critical connections to be masked from shop painting.
      e. Indicate connection design loads for all connection details.
   2. SD-03 Product Data:
      a. Tension control (twist off) bolt assemblies and direct tension indicators.
      b. Manufacturer's technical information for primer.
   3. SD-06 Certificates:
      a. Material Certificates:
         1) Mill test reports for structural steel shapes, bolts, nuts, washers, and studs.
         2) Anchor bolt embedment Drawings.
      b. Welding Certificates:
         1) For welding procedures and personnel.
      c. AISC Certification:
         1) For fabricator.
         2) For erector.
   4. SD-07 Closeout Submittals:
      a. Per Division 01 General Requirements.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. The erector shall participate in the AISC Quality Certification Program and shall be certified as an AISC-Certified Steel Erector.

C. The fabricator shall participate in the AISC Quality Certification Program and shall be certified as an AISC-Certified Plant, Standard for Steel Building Structures.

D. Comply with AISC 303.

E. Comply with AISC 360.

F. Comply with AWS D1.1/D1.1M.

G. Comply with RCSC, "Specification for Structural Joints Using ASTM A325 or A490 Bolts".

H. Mill materials shall meet the tolerances specified in ASTM A6/A6M.

I. The fabricator shall provide anchor bolt templates.

1.06 DELIVERY, STORAGE AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. The material shall be unloaded as soon as it is delivered and carefully handled and stacked to prevent deformation and damage. All structural steel shapes shall be carefully stored on substantial pallets, dunnage, or other supports and spacers, free from the earth and properly drained, preventing splattering with dirt and other foreign matter.

C. Store materials to permit easy access for inspection and identification. Protect steel shapes and packaged materials from deterioration. Maintain markings.

D. ASTM F1852 and galvanized ASTM A325 bolt assemblies must be assembled and shipped in the same container.

E. Provide protective storage for all fastener components. Fastener components removed from protective storage shall be protected from dirt and moisture in closed containers at the Site of installation. Fastener components shall not be cleaned or modified from as-delivered condition, and if they accumulate rust or dirt shall not be incorporated into the Work and shall be removed from the Site. ASTM F1852 tension-control bolt assemblies shall not be re-lubricated,

1.07 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Steel W-shapes shall conform to ASTM A992/A992M (50 ksi yield strength). Steel channels and angles shall conform to ASTM A36/A36M, ASTM A572/A572M grade 50, or ASTM A992/A992M. Other steel shapes, plates and bars shall conform to ASTM A36/A36M.

B. Steel pipe shall conform to ASTM A53/A53M, Grade B.

C. Hollow structural shapes shall conform to ASTM A500/A500M, Grade C.

D. Weathering steel shall be ASTM A588/A588M, grade 50.

E. Welding electrodes shall comply with AWS requirements, with a tensile strength level of 70 ksi.

F. Anchor bolts shall be of the sizes indicated, threaded, headed and made of ASTM F1554 Grade 36 steel.

G. Except for weathering steel: bolts shall be ASTM A325 Type I, heavy hex; nuts shall be ASTM A563, heavy hex; and washers shall be ASTM F436, hardened steel.

H. For weathering steel: bolts shall be ASTM A325 Type 3, heavy hex; nuts shall be ASTM A563 grade DH3, heavy hex; and washers shall be ASTM F436, Type 3.

I. Plate washers shall be ASTM A36/A36M.

J. Tension-control bolt assemblies shall meet ASTM F1852 Type I, heavy hex.

K. Direct tension indicators shall be ASTM F959, Type 325, compressible washer type.

L. Shear studs shall be ASTM A108, Grades 1015 through 1020, headed-stud type, cold-finished steel, AWS D1.1/D1.1M, Type B.

M. Threaded rods shall be ASTM A36/A36M.

2.02 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 - EXECUTION

3.01 FABRICATION

A. Materials and workmanship shall be subject to the approval of the Engineer. Members shall be marked and match marked for field assembly.

B. Field measurements shall be made prior to fabrication to ensure proper fit. Discrepancies in existing conditions that require detail changes shall be reported to the Engineer prior to fabrication.

C. Provide templates for setting of anchor bolts.

D. All bolt holes in structural steel, including those for attaching wood blocking and other components, shall be provided by the fabricator. Holes shall not be made or modified by burning.

3.02 CONNECTIONS

A. Where connections are not detailed on the Drawings, they shall be provided by the fabricator to withstand the service loads indicated on the Drawings. Where connection loads are not provided on the Drawings, the fabricator shall calculate them according to the full specified floor and roof loads. The fabricator shall use allowable stress design (ASD) in the selection of connection details.

B. Bolted connections shall be designed as N-type bearing connections installed snug tight, except where indicated as pre-tensioned or slip critical.

C. Slip critical joints are required where shown, and at connections that include oversized holes or slotted holes (including braces) except where the direction of the load is normal to the slot.

D. Pre-tensioned joints are required where shown, and in structures carrying cranes of over 5-ton capacity at column splices, column bracing, knee braces, and crane supports.

E. Where bolts are specified to be installed loose or finger tight, the connection must first be snugged-up to ensure that all plies are in contact. The nuts shall then be backed off between 1/2 and 1 turn to permit the intended movement of the connection. The bolts shall be provided with double nuts to prevent loosening.

F. Shear connections shall consist of standard 2-angle beam web connections except where shown otherwise.

G. The minimum bolt size shall be 3/4 inch. The minimum number of bolts per connection shall be two.

H. Where 3 or more members are joined, their lines of action shall meet at a common point and there shall be no eccentricity, except as shown otherwise on the Drawings.

3.03 WELDING

A. Welding shall be in accordance with AWS D1.1/D1.1M. Exposed welds shall be ground smooth.

B. Prepare surfaces to receive shear studs as recommended by the stud manufacturer. Use automatic end welding of shear studs in accordance with AWS D1.1/D1.1M and stud manufacturer requirements.

3.04 SHOP COATINGS

A. All items shall be prepared to be painted in accordance with Specification 09 90 00 – Painting and Coating, with the exception of the following surfaces which shall not be shop primed: weathering steel, surfaces embedded in concrete or masonry (priming of partially embedded components shall extend 2 inches into the embedment), faying surfaces at bolted connections designated as slip-critical, and surfaces to receive sprayed on fire-resistive materials.

B. Prepare surfaces to be shop primed in accordance with SSPC SP 3 and apply standard shop prime coat.

C. Weathering steel shall be shop cleaned in accordance with SSPC SP 6 prior to erection.

D. Galvanizing: All items specified as galvanized shall be coated by the hot-dip process in accordance with ASTM A123/A123M or ASTM A153/A153M, in molten zinc, producing a continuous coating of uniform thickness of weight required by the referenced Specifications.
   1. Coating shall be of best commercial quality, free from injurious defects, flux and uncoated spots, and of such quality as will endure, without penetration of the coating, not less than 4 immersions in copper sulfate in conformance with ASTM A239.
   2. A stamp showing the name of the galvanizer, the weight of the coating, and applicable ASTM compliance shall identify all galvanized items.
   3. Where it is to be painted, galvanized steel shall not be quenched. It shall be phosphatized and prepared for painting per ASTM D6386. It shall be prime painted,

compatible with the finish paints specified in Specification 09 90 00 – Painting and Coating.

4. At locations where galvanized steel is field cut, and at other locations where galvanized coating is removed, the steel surface shall be touched up with a zinc rich paint meeting ASTM A780/A780M and containing a minimum of 65 percent zinc.

3.05 ERECTION

A. Verify elevations of concrete and masonry bearing surfaces and locations of anchor rods, bearing plates, and other embedments. Use anchor bolt templates provided by the fabricator. Clean concrete and masonry bearing surfaces of bond reducing materials and roughen surfaces prior to setting plates. Set bearing plates using leveling nuts or galvanized leveling plates, and grout with non-shrink grout as specified in Specification 03 16 00 – Concrete Specialties. Leveling plates shall be promptly grouted after they are set and checked for line and grade. When leveling nuts are used, bearing plates shall be grouted after the structural steel frame, or portion thereof, is plumbed.

B. Bolts shall be installed snug-tight except where indicated as pre-tensioned or slip critical. Bolts shall be of the proper length. The end of the bolt shall be at least flush with the outer face of the nut, however bolts projecting more than 5/8 inch beyond the nut in exposed Work shall be cut off close to the nut as directed by the Engineer. Where twist-off bolts are used in exposed Work in other than pre-tensioned and slip-critical connections, the bolt extensions shall be removed.

C. All cutting, fitting, drilling, and tapping required shall be included. Thermal cutting shall not be used during erection except as approved, in writing, by the Engineer. Bolt holes shall not be made or modified by burning.

3.06 CLEANING

A. Immediately after erection, round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects. Remove weld splatter.

3.07 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.08 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 05 50 00
METAL FABRICATIONS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide the following metal fabrications in accordance with this Section and applicable reference standards listed in Article 1.02.
      a. Railings and components including mounting brackets.
      b. Swing gates.
      c. Grating and grating supports.
      d. Ladders.
      e. Miscellaneous steel items.
      f. Cast-in anchors.
      g. Expansion anchors.
      h. Adhesive anchors.
      i. Steel stairs.
      j. Weirs.
      k. Manhole-type rungs.
      l. Maintainable weep devices.
      m. Embedded metal items not receiving structural steel (excluding items embedded in precast concrete).
   2. Epoxy adhesive for installing drilled and epoxy rebar is specified in Section 03 16 00 – Concrete Specialties.

B. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

C. Related Requirements:
   1. Section 03 11 00 – Concrete Forming.
   2. Section 03 16 00 – Concrete Specialties.
   3. Section 09 90 00 – Painting and Coating.

1.02 REFERENCES

A. Reference Standards:
   1. American Concrete Institute (ACI):
      a. ACI 355.2 - Qualification of Post-Installed Mechanical Anchors in Concrete.
      b. ACI 355.4 - Qualification of Post-Installed Adhesive Anchors in Concrete Elements.
   2. American Institute of Steel Construction (AISC):
      a. AISC 303 - Code of Standard Practice for Steel Buildings and Bridges.
   3. American National Standards Institute (ANSI):
      a. A14.3 - American National Standard for Ladders-Fixed-Safety Requirements.
   4. American Welding Society (AWS):
      a. AWS D1.1 - Structural Welding Code – Steel.
      b. AWS D1.2 - Structural Welding Code – Aluminum.
      c. AWS D1.6 - Structural Welding Code – Stainless Steel.

5. ASTM International (ASTM):
    a. ASTM A6 - Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
    b. ASTM A36 - Standard Specification for Carbon Structural Steel.
    c. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
    d. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
    e. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
    f. ASTM A239 - Standard Practice for Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles.
    g. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
    h. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts.
    i. ASTM A572 - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
    j. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
    k. ASTM A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
    l. ASTM A992 - Standard Specification for Structural Steel Shapes.
    m. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
    n. ASTM B211 - Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire.
    o. ASTM B308 - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
    p. ASTM D6386 - Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.
    q. ASTM F436 - Hardened Steel Washers.
    r. ASTM F959 - Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
    s. ASTM F1136 - Standard Specification for Zinc/Aluminum Corrosion Protective Coatings for Fasteners.
    t. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
    u. ASTM F1852 - Standard Specification for "Twist Off" Type Tension Control. Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
    v. ASTM F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.
    w. ASTM F2833 - Standard Specification for Corrosion Protective Fastener Coatings with Zinc Rich Base Coat and Aluminum Organic/Inorganic Type.
    x. ASTM F3125 - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength, Inch and Metric Dimensions.
6. ICC Evaluation Services (ICC-ES):
    a. ICC-ES AC58 - Acceptance Criteria for Adhesive Anchors in Masonry Elements.
    b. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.

7. National Association of Architectural Metal Manufacturers (NAAMM):
    a. AMP 500 - Metal Finishes Manual.
    b. MBG 531 - Metal Bar Grating Manual.
    c. MBG 533 - Welding Specification for Fabrication of Steel, Aluminum, & Stainless Steel Bar Grating.
8. Research Council on Structural Connections (RCSC):
    a. Specification for Structural Joints Using High-Strength Bolts.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures.
1. SD-02 Shop Drawings:
    a. Details of connections, copes, splices, holes, hardware, finish, and other pertinent information
    b. Anchor bolt embedment drawings.
    c. Indicate welds by standard AWS symbol.
    d. Indicate bolts and identify slip-critical connections as applicable.
    e. Identify areas of slip-critical connections to be masked from shop painting.
2. SD-03 Product Data:
    a. Manufacturer Installation Instructions.
    b. Maintainable Weep Devices:
        1) Installation Instructions.
        2) Maintenance Instructions.
        3) Dimensions and performance specifications.
        4) Furnish manufacturer’s limited warranty against faulty parts and materials for repair or replacement: 10-year steel housings, 5-year filter cartridge, 3-year check valve minimum.
    c. Expansion Bolts:
        1) ICC-ES Compliance Report.
        2) Allowable and ultimate load tables per embedment depths.
        3) Capacity reduction factors for bolt spacing and edge distances.
        4) Installation Instructions including bolt torque.
    d. Adhesive Anchors:
        1) ICC-ES Compliance Report.
        2) Allowable and ultimate load tables per embedment depths.
        3) Storage requirements.
        4) Gel and cure times as a function of temperature.
        5) Installation temperature requirements.
        6) Drilling method (diamond drill bit shall be prohibited).
        7) Drill bit diameter and depth of hole for each size anchor.
        8) Hole cleaning procedure and required condition of hole.
        9) Dual-nozzle instructions to ensure proper mixing.
        10) Hole Filling procedure.
        11) Time period anchor cannot be contacted or disturbed.
3. SD-04 Samples:
    a. Samples and Mockups: As specified in Article 1.05.
4. SD-05 Test Reports:
    a. Source and Field Quality Control Submittals.

5. SD-06 Certificates:
    a. Mill test reports for structural shapes, bolts, nuts, and washers.
    b. Welding certifications for welding procedures and personnel.
6. SD-07 Closeout Submittals:
    a. Per Division 01 General Requirements.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Samples:
    1. Railings indicating weld, splicing, and finish.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Assemble and ship ASTM F1852 and galvanized ASTM F3125 bolt assemblies in the same container. Do not re-lubricate ASTM F1852 tension-control bolt assemblies.

C. Carefully unload material and equipment and stack to prevent deformation and damage. Store items on substantial pallets, dunnage, or other supports and spacers, free from the earth and properly drained, preventing splattering with dirt and other foreign matter.

D. Store material and equipment to permit easy access for inspection and identification. Protect from deterioration and maintain markings.

E. Provide protective storage for fastener components. Protect fastener components removed from protective storage from dirt and moisture in closed containers at the location of installation. Do not clean or modify fastener components from as-delivered condition. Do not use fastener components accumulating rust or dirt, and remove from the Site.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

PART 2 - PRODUCTS

2.01 GENERAL

A. Make field measurements prior to fabrication to ensure proper fit. Report discrepancies in existing conditions that require detail changes to Engineer prior to fabrication.

B. Assemble built-up Work in sections in the shop as much as practicable and match mark components for field assembly.

C. Bolt holes (including those for attaching wood blocking and other components): by fabricator and not made or modified by burning.

D. Gauges:
    1. For iron sheets and steel: U.S. Standard.
    2. For non-ferrous products: Brown & Sharpe.
    3. For wire: United States Steel Wire.

E. Weld carbon steel per ANSI/AWS D1.1, with electrodes with a tensile strength of 70 ksi.

F. Fusion weld aluminum by the inert gas-shielded arc method per ANSI/AWS D1.2. Use alloy rods similar to alloy being welded where appearance match is required. Alloy 4043 rods may be used where appearance is not a factor and anodizing is not required.

G. Weld stainless steel per AWS D1.6

H. Steel:
   1. Comply with AISC 303.
   2. Steel Mill Material Tolerances: per ASTM A6.
   3. Steel W-shapes: ASTM A992 (50 ksi yield strength).
   4. Steel Channels And Angles: ASTM A992 (50 ksi yield strength) ASTM A572 grade 50, or ASTM A36.
   5. Other Steel Shapes, Plates and Bars: ASTM A36.
   6. Steel Pipe: ASTM A53, Grade B.
   7. Hollow Structural Shapes: ASTM A500, Grade C.

I. Bolts: ASTM F3125 Grade A325 Type I, heavy-hex, hot-dipped galvanized per ASTM F2329 at exterior applications and/or where indicated on Drawings.

J. Nuts: ASTM A563, heavy-hex.

K. Washers: ASTM F436 hardened steel.

L. Tension-Control Bolt Assemblies: ASTM F1852 Type I, heavy-hex.

M. Direct Tension Indicators: ASTM F959, Type 325, compressible washer type.

N. Threaded Rods: ASTM A36.

O. Aluminum Items: Fabricated from bars, plates, pipes, rolled and extruded shapes conforming to the following alloy designation unless otherwise specified.
   1. Standard structural shapes: Rolled 6061-T6 per ASTM B308.
   2. Rolled rod and bar: 6061-T6 per ASTM B211.
   3. Sheets, Plates, Checkered Plates: 6061-T6 per ASTM B209.
   4. Bolts: 2024-T4.
   5. Nuts: 6061-T6.
   6. Washers: Alclad 2024-T4.

P. Stainless Steel Items: Type 304 (Type 304L if welded).

2.02 STEEL RAILING

A. Steel Railing: 1-1/2 inch round steel pipe in all welded construction.

B. Furnish railing in the largest practical sections with the locations and details of field connections indicated on Shop Drawings. Close exposed ends of railing members.

C. Welds: Continuous at intersections and ground smooth on all exposed areas. Use radius corners only, do not use mitered corners. Where intersections occur, shape and cut pieces to fit with no distortion of the circular shape.

D. Posts:
   1. Schedule 40, single, un-spliced pipe length.
   2. Spacing: Maximum 5-feet on center measured along the rail.

E. Rails:
   1. Schedule 40.
   2. Top Rails:
      a. Continuous wherever possible with single un-spliced length attached to minimum of 3 posts.
      b. At platforms and other level runs: 42 inches from the top of rail to floor, tank wall or other horizontal surface unless otherwise specified.
      c. On stair flights: 42 vertical inches from the top of rail to a line connecting the toes of the treads.
   3. Lower Rails:
      a. Single un-spliced length between posts.
      b. At level runs and at stairs: approximately half the height of the top rail.

F. Toeboard: 4-inches high, 1/4 inch thick, connected to posts except where specifically shown to be omitted on the Drawings.

G. Provide expansion joints at each railing and toe plate, allowing 1/2 inch of joint movement at each location and space at intervals of maximum 24 feet. Provide internal slip sleeve fastened securely to one side and extend a minimum of 2 inches beyond each side of the joint. Locate within 6 inches of posts.

H. Stairs: Provide additional (third) rail forming a handrail, bracketed off the vertical posts at a height of 36 inches from the upper surface to a line connecting the toes of the treads. Provide 2 1/4-inch minimum clearance from posts and obstructions.

I. Completed railing structure and anchorage: Capable of withstanding the loads prescribed by the building code of Project location.

J. Support wall mounted railing with cast brackets and fasten with stainless steel expansion or toggle bolts.

K. Furnish removable railings where indicated on the Drawings, mounted so that when the railing is removed, it is separated from the mounting bracket.

L. Hot-dip galvanized steel railing per ASTM A123 after fabrication.

2.03 STEEL SAFETY GATE

A. OSHA Compliant, self-closing swing gate Gates shall ship fully assembled.

B. Size: 22-1/4-inch minimum distance from top of gate arm to bottom of gate arm.

C. Width: As required to accommodate vertical railing post spacing.

D. Mounting bracket: Galvanized steel, sized to fit diameter of railing posts that support gate.

E. Hinge: Full-height plate to provide gate width adjustment. Torsion springs with a minimum of two springs per gate, housed within hinge pivot. Hinged to open full 180 degrees.

F. Finish: Galvanized steel

2.04 GRATINGS AND FRAMES

A. Manufacturers:
   1. IKG Industries,.

2. Klemp Corporation.
3. Ohio Gratings, Inc.
4. Or equal.

B. Gratings: Material, type, size, and bar dimensions as indicated on Drawings per NAAMM MBG 531, and NAAMM MBG 533.

C. Band grating with 1/4-inch-thick band of width equal to the full depth of grating, welded on at the ends of all sections and at openings.

D. Provide hinged panels as indicated on drawings. Hinged panels shall be provided with recessed lifting handle and locking device.

E. Steel Grating: Galvanize after fabrication.

F. Aluminum Grating: Alloy 6063-T6 bearing bars and alloy 6063-T5 cross bars with mill finish.

G. Where not shown, provide suitable supporting members as required when span of grating changes direction.

H. Fasteners: Manufacturer's standard clips. Provide one fastener at each section corner, and a minimum of one additional fastener for each intermediate support. Provide micarta between aluminum and dissimilar materials.

I. Aluminum Frames: coat portions of aluminum to be embedded in, or in contact with concrete with heavy-bodied bitumastic paint.

2.05 EXPANSION BOLTS (INTO CONCRETE)

A. General: Torque controlled expansion anchor suitable for seismic loads and cracked concrete applications.

B. Material: AISI 304 stainless steel anchor body, nut, washer, and expansion sleeve, unless noted otherwise.

C. Evaluation Requirements: ICC-ES evaluation report stating product is compliant with 2018 International Building Code and approved for use to resist static, wind and earthquake (Seismic Design Categories A through F) tension and shear loads in cracked and uncracked normal-weight concrete having a compressive strength of 2,500 psi to 8,500 psi. Evaluation reports with a listed renewal date month/year which is prior to the month/year the product is submitted for engineer's review will be rejected.

D. Approved Expansions Bolts:
1. Simpson Strong-Tie Strong-Bolt 2:
   a. Compliance Report (ESR-3037).
2. Hilti Kwik Bolt TZ-2:
   a. Compliance Report (ESR-1917).
3. Powers Power-Stud + SD6:
   a. Compliance Report (ESR-2502).

2.06 ADHESIVE ANCHORS (INTO CONCRETE)

A. General: Epoxy adhesive for installing post-installed bolts into concrete denoted as "Adhesive Anchors" on drawings.

B. Evaluation Requirements: ICC-ES evaluation report stating product is compliant with 2018 International Building Code and approved for use to resist static, wind and earthquake (Seismic Design Categories A through F) tension and shear loads in cracked and uncracked normal-weight concrete having a compressive strength of 2,500 psi to 8,500 psi. Evaluation reports with a listed renewal date month/year which is prior to the month/year the product is submitted for engineer's review will be rejected.

C. Epoxy adhesive for anchoring reinforcement to concrete shall be a 2-component solid epoxy-based system supplied in manufacturer's standard side-by-side cartridge and dispensed through manufacturer's standard static-mixing nozzle. Epoxy adhesive shall be:
   1. Simpson Strong Tie SET-XP or ET-HP:
      a. SET-XP Compliance Report (ESR-2508).
      b. ET-HP Compliance Report (ESR-3372).
   2. Hilti HIT-RE 500 V3:
      a. Compliance Report (ESR-3814).
   3. Powers PE1000+:
      a. Compliance Report (ESR-2583).

D. Epoxy adhesive shall pass the creep test requirements of ICC-ES AC308.

E. Hardware: From same manufacturer as epoxy adhesive for a complete anchoring system.
   1. Threaded Steel Rods: Continuously threads (all-thread).
   2. Material: AISI 304 stainless steel threaded steel rods, nut and washers, unless noted otherwise.

2.07 LADDERS

A. Steel Ladders:
   1. Material: ASTM A36 steel with 2-1/2 inches by 3/8-inch flat bar side rails and 1 inch square, or other approved rungs.
   2. Cover each rung with 1-inch-wide anti-slip high traction course safety tape with silicon carbide black grit. Acceptable level of quality: equivalent to #NS5301B by No Skidding Product, Inc.
   3. Rails: Bracketed for wall areas at no greater than 4 feet centers.
   4. Center of the rungs 7 inches from the face of walls.
   5. Ladders and safety cages: Per ANSI A14.3 and OSHA Regulations.

2.08 MISCELLANEOUS STEEL ITEMS

A. Fabricate and furnish miscellaneous steel items, galvanized angles, relieving angles, plates, channels, and all required fastenings per Drawing details. Miscellaneous steel items shall be galvanized as specified.

2.09 CAST-IN ANCHORS

A. ASTM F1554 Grade 36 steel, galvanized except where stainless steel specified, headed and threaded.

B. Type 304 stainless steel: to attach aluminum and in all submerged locations – including washers and nuts.

C. Sizes: Per Drawings

2.10 STEEL STAIRS

A. Per Drawing details and furnished with bolts, nuts and washers.

B. Construction: Rigid and substantial throughout with welded joints closely fitted, designed for 100 psf pounds per square foot. Grind welds.

C. Bolt Holes: Punched, drilled and tapped as required.

D. Stringers: Fabricate of channel sections, with minimum size indicated in Drawings.

E. Stair Treads: Open grating with serrated surface, swaged.
   1. Furnish treads with carrier plates welded to the ends of tread, punched for bolting to stringers.
   2. Bar size: as recommended by the manufacturer for the length of the tread, and approved by Engineer.

F. Nosing: Spray-on traction surface or aluminum abrasive

G. Railings: Per Article 2.2

H. Finish: See Drawings and Section 09 90 00 – Painting and Coating for finish requirements. Galvanize per ASTM A123 where hot-dip galvanizing is required.

2.11 WEIRS

A. Per Drawing details and furnished with bolts, nuts and washers.

2.12 MAINTAINABLE WEEP DEVICES

A. Jet Filter System, LLC (Casey, IL) or approved equal of type and size indicated on Drawings.

B. Furnish with stainless steel louvered vent cap, stainless steel hardware and Manufacturer's standard filter fabric cartridge.

C. Open-End Type: No check valve required.

D. Closed-End Type (Backflow Prevention): Provide with check valve to prevent backflow leakage from 0 psf to a minimum of 312 psf (5-ft head) net pressure.

2.13 MANHOLE-TYPE STEPS

A. Steps: Injection molded polypropylene (black) encapsulating 1/2" ASTM A615 Grade 60 reinforcing bar with integral slip resistance.

B. Steps shall comply with OSHA standards for manhole steps.

2.14 SHOP COATING

A. Prepare ferrous items and paint per Section 09 90 00 – Painting and Coating, except where otherwise specified.

B. Do not prime paint galvanized steel not specified to be painted, stainless steel surfaces embedded in concrete or masonry (except for partially embedded components, extend

priming 2 inches into the embedment), surfaces to be field welded, and faying surfaces at bolted connections designated as slip-critical.

C. Coat items specified as galvanized by the hot-dip process per ASTM A123, ASTM A153, or ASTM A653, as applicable, in molten zinc, to produce a continuous coating of uniform thickness of weight required by the referenced standards.
   1. Coating: Commercial quality, free from injurious defects, flux and uncoated spots, and per ASTM A239: capable of enduring not less than 4 immersions in copper sulfate without penetration of the coating.
   2. Identify galvanized items with a stamp showing the name of the galvanizer, the weight of the coating, and applicable ASTM compliance.

D. Galvanized steel specified to be painted:
   1. Do not quench.
   2. Phosphatize and prepare to be painted per ASTM D6386.
   3. Prime with paint compatible with the finish paints specified in Section 09 90 00 – Painting and Coating.

2.15 SOURCE OF QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 - EXECUTION

3.01 DISSIMILAR MATERIAL

A. Keep aluminum surfaces from direct contact with metals other than stainless steel by painting the dissimilar metal with a coating of zinc chromate paint or provide non-absorptive tape between dissimilar metals.

B. Paint aluminum with a coat of bituminous paint where aluminum is embedded in, or comes in contact with, concrete, masonry or by-products of these materials.

C. Use ASTM F3125 A325 Type III or 304 SS hardware for connections to weathering steel as approved by engineer. Do not use galvanized hardware for connections to weathering steel.

3.02 STEEL CONNECTIONS

A. Comply with RCSC Specifications for Structural Joints Using ASTM F3125 Grade A325 or A490 Bolts.

B. Design bolted connections as N-type bearing connections, installed snug-tight, except where shown as slip critical on Drawings.

C. Minimum Size: 3/4 inch, unless noted otherwise in Drawings.

D. Minimum Number of Bolts per Connection: 2.

E. Slip critical joints are required per Drawings and at connections that include oversized holes or slotted holes, including braces, except where the direction of the load is normal to the slot.

F. Where bolts are specified to be installed loose or finger tight, snug up the connection to ensure that plies are in contact. Then back off the nut between 1/2 and 1 turn to permit intended movement of the connection. Provide double nuts on bolts to prevent loosening.

G. Weld steel per AWS D1.1. Grind exposed welds smooth.

3.03 INSTALLATION

A. Verify elevations of concrete bearing surfaces and locations of anchor rods, bearing plates, and other embedments. Clean concrete bearing surfaces of bond reducing materials and roughen surfaces prior to setting plates.

B. Set bearing plates using leveling nuts or galvanized leveling plates, and grout with non-shrink grout as specified in Section 03 16 00 – Concrete Specialties. Promptly grout leveling plates after set and checked for line, levelness and elevation.

C. Grout bearing plates after framing is plumb when leveling nuts are used.

D. Concrete embedment's: Installed under Section 03 11 00 – Concrete Forming.

E. Use stainless steel hardware when anchoring aluminum and in submerged locations.

3.04 BOLTS

A. Install bolts snug tight except where indicated as slip critical. Install bolt at least flush with the outer face of the nut. Cut off bolts projecting more than 5/8 inch beyond the nut in exposed Work as close to nut as possible and as directed.

B. All joint surfaces shall be free of loose mill scale, burrs, and foreign material. Enough bolts shall be brought to a snug tight condition to ensure that the parts of the joint are properly compacted, i.e., brought into full contact with each other. Snug tight shall be defined as the tightness attained by a few impacts of an impact wrench or the full effort of a worker using an ordinary spud wrench. Following the initial tightening, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall be tightened an additional 1/3 turn if bolt length is up to and including four bolt diameters, or a 1/2 if longer.

C. Provide required cutting, fitting, drilling, and tapping. Do not use thermal cutting during installation and erection. Do not make or modify bolt holes by burning.

3.05 ADHESIVE ANCHORS

A. Installation: Per manufacturer's installation instructions and as listed in the product ICC-ES Evaluation Report.

B. Drilled and epoxied bolts shall be installed in concrete having a minimum age of 21 days at time of installation.

C. All cartridges shall have the expiration date clearly visible. Material past its expiration date shall not be used and shall be immediately removed from the Site.

D. Diamond drill bits are not permitted. Hammer drills shall be used.

E. Drill Holes:
   1. Diameter: Per manufacturer's instructions.
   2. Embedment: Manufacturer's standard embedment for anchor size, unless noted otherwise on drawings. Depth stop shall be used to ensure correct drilling depth.
   3. Installation Torque: Per manufacturer's instructions.

F. The initial material extruded from each cartridge shall be discarded in accordance with the manufacturer's instructions to ensure that all material is properly mixed.

G. Drilled holes shall be blown out with air, thoroughly wire brushed with a repeated back and forth movement, blown out, thoroughly wire brushed, and blown out again. Adhesive shall be injected, starting from the bottom of the hole and slowly withdrawn as filling progresses to prevent air pockets.

H. Installed bolt shall remain completely undisturbed between the manufacturer's specified gel time and the full cure time. Zero load shall be applied during this time.

3.06 EXPANSION ANCHORS

A. Installation: Per manufacturer's installation instructions and as listed in the product ICC-ES Evaluation Report.

B. Drill Holes:
   1. Diameter: Per manufacturer's instructions.
   2. Embedment: Manufacturer's standard embedment for anchor size, unless noted otherwise on drawings. Depth stop shall be used to ensure correct drilling depth.

C. Installation Torque: Per manufacturer's instructions.

3.07 FIELD TOUCH UP

A. Where galvanized steel is field cut and locations where galvanized coating is removed: Touch up steel surface with zinc rich paint meeting ASTM A780 and containing a minimum of 65 percent zinc at locations.

3.08 CLEANING

A. Immediately after installation, round or chamfer sharp edges and grind burrs, jagged edges and surface defects smooth. Remove weld splatter.

3.09 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.10 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 06 10 53
MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes, window bucks, roof curbs, wall coping sub-supports, cants, and perimeter nailers; blocking in wall and roof openings; wood furring and grounds; concealed wood blocking for support of toilet and bath accessories, wall cabinets, wood trim, telephone, and electrical panel back boards, sheathing, and preservative treatment of wood.

1.02 REFERENCES

A. American Wood-Preservers' Association (AWPA):
   1. AWPA U1 - All Timber Products - Preservative Treatment by Pressure Process.
   2. AWPA C20 - Structural Lumber - Fire-Retardant Treatment by Pressure Processes.

B. National Institute of Standards and Technology (NIST):
   1. NIST PS 20 - American Softwood Lumber Standard.

C. Western Wood Products Association (WWPA):
   1. WWPA G-5 - Western Lumber Grading Rules.

D. American Galvanizers Association:
   1. Hot-Dip Galvanizing for Corrosion Protection.

E. ASTM Standards
   1. ASTM E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials.

F. Underwriters Laboratory (UL):
   1. UL 723 Standard for Test for Surface Burning Characteristics of Building Materials.

G. 2021 International Building Code (IBC).

1.03 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-03 Product Data:
      a. Complete materials list of all materials proposed to be furnished and installed under this Section.
      b. Specifications and other data required to demonstrate compliance with the specified requirements.

1.04 QUALITY CONTROL

A. Perform Work in accordance with the following:
   1. Lumber Grading Agency: Certified by NIST PS 20.
   2. Plywood Grading Agency: Certified by APA/EWA.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Lumber Grading Rules.

B. Miscellaneous Framing:
   1. Stress Group D species, grade 19 percent maximum moisture content, pressure preservative treat.

C. Plywood:
   1. APA/EWA Rated Sheathing.

2.02 ACCESSORIES

A. Fasteners and Anchors:
   1. Fasteners:
      a. Hot dipped galvanized steel for high humidity and treated wood locations, unfinished steel elsewhere.
   2. Anchors:
      a. Toggle bolt type for anchorage to hollow masonry. Expansion shield and lag bolt type for anchorage to solid masonry or concrete. Bolt or PAF fastener for anchorages to steel.
   3. Fasteners and Anchors in ACQ (Alkaline Copper Quarternary) Treated Lumber:
      a. All fasteners, anchors clips etc, in direct contract with ACQ treated products must be one of the following:
         1) Hot Dip Galvanized Fasteners ASTM A123, sheet metal parts Class G-185 .
         2) Ceramic Coated.
         3) 304 Stainless Steel.
   4. Fasteners in Exposed Wood Walls in Wood Shop:
      a. Self-tapping type screws, 1-inch length.
      b. Pan-head configuration.
      c. Hot-dipped galvanized with a bright silver finish.

B. Exposed-to-View Wood Finishing:
   1. As specified in Section 09 90 00 – Painting and Coating.

2.03 FACTORY WOOD TREATMENT

A. Preservative Treatment:
   1. All materials required to be preservative treated shall be treated with waterborne preservatives in accordance with AWPA Standard U1 to the requirements of Use Category 2 (UC2).

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 01 30 00 – Administrative Requirements: Verification of existing conditions before starting work.

B. Verify substrate conditions are ready to receive blocking, curbing and framing.

3.02 PREPARATION

A. Coordinate placement of blocking, curbing and framing items.

B. Provide solid pressure treated wood blocking continuous around all openings where indicated on drawings, and at similar conditions such as penetrations.

C. Alternate to Wood Backing:
   1. Where accessory items are to be fastened to walls with metal stud wall framing, 22 gage break metal strips, spanning at least 1 stud beyond accessory item, to each side, may be fastened to the metal studs in lieu of solid wood blocking. Metal strips to be 6-inches tall minimum x continuous and shall be centered on accessory fastener rows. Fasten metal strips to studs with 2 screws per each stud, minimum.

3.03 INSTALLATION

A. Set members level and plumb, in correct position.

B. Place horizontal members crown side up.

C. Construct curb members of solid wood sections.

D. Any wood components in direct contact with the ground, masonry, concrete, or grout shall be preservative treated.

E. Curb roof openings, except where prefabricated curbs are provided by mechanical (see mechanical drawings and Division 23 specifications for more.) Form corners by alternating lapping side members.

F. Coordinate curb installation with installation of decking and support of deck openings, roofing vapor retardant, and parapet construction.

G. Space framing and furring 16 inches on center unless specified otherwise.

H. Secure sheathing to framing members with ends over firm bearing and staggered or as otherwise indicated by structural drawings.

I. Install telephone and electrical panel back boards with plywood sheathing material where required. Size back boards 12 inches beyond size of electrical and telephone panel.

J. All rough carpentry exposed in plenum spaces must be covered with a minimum of ½" gypsum board or 0.032-inch aluminum or corrosion resistant steel.

3.04 SITE APPLIED WOOD TREATMENT

A. Apply preservative treatment.

B. Brush apply one coat of preservative treatment on wood in contact with cementitious materials, roofing and related metal flashings. Treat site-sawn cuts.

C. Allow preservative to dry prior to erecting members.

3.05 SCHEDULES

A. Roof Blocking:
   1. S/P/F species, 19 percent maximum moisture content, pressure preservative treatment.

B. Window Bucks:
   1. S/P/F species, 19 percent maximum moisture content, pressure preservative treatment.

C. Parapet Caps, Wall Copings, Sub-Fascias:
   1. Sloped blocking, S/P/F species, 19 percent maximum moisture content, pressure preservative treated; plywood thickness as indicated on drawings, pressure preservative treated.

D. Interior Blocking within Walls:
   1. S/P/F species, 19 percent maximum moisture content. 2-inch nominal thickness, and 6 inch nominal width.

E. Telephone and Electrical Panel Boards:
   1. Provide whether or not indicated on drawings, 3/4-inch-thick plywood panels, extending at minimum of 1-foot beyond installed items in each direction, square edges, and site brush applied preservative treated.

END OF SECTION

SECTION 06 12 00
STRUCTURAL INSULATED PANELS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Structural Insulated Panels (SIPs) and related work.

B. SIPs Roof Panels Related Work:
   1. Specifications:
      a. Section 06 10 53 – Miscellaneous Rough Carpentry.
   2. Structural Drawings:
      a. Wood blocking, and plates interfacing with work of this section.
      b. Where any conflicts exist between structural drawings, architectural drawings, and these specifications, refer such conditions to architect for direction.

1.02 SYSTEM DESCRIPTION

A. Structural Insulated Panels (SIPs) consist of oriented strand board (OSB) laminated with structural adhesives to a termite resistant EPS insulation core, an EPA registered treatment for mold, mildew, and termites, and SIP Manufacturer supplied connecting splines, sealants, and SIP screws.

1.03 REFERENCES

A. ACSE 7 - Minimum Loads for Buildings and other Structures.

B. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.

C. DOC PS2 - Performance Standard for Wood-based Structural-Use Panels.

D. ICC ES AC04 - Acceptance Criteria for Sandwich Panels.

E. ICC ES AC05 - Acceptance Criteria for Sandwich Panel Adhesives.

F. ICC ES AC12 - Acceptance Criteria for Foam Plastic Insulation.

G. ICC ES AC239 - Acceptance Criteria for Termite-Resistant Foam Plastics.

H. AWPA E1 - Standard Method for Laboratory Evaluation to Determine Resistance to Subterranean Termites.

I. AWPA E12 - Standard Method of Determining Corrosion of Metal in Contact with Treated Wood.

J. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.

K. EPA - Registered products listing.

1.04 DESIGN REQUIREMENTS

A. Provide SIPs which have been manufactured, fabricated, and installed to withstand gravity, lateral and out-of-plane loads required by 2021 International Building Code (IBC) or greater as required by structural drawings and to maintain performance criteria stated by SIP manufacturer without defects, damage or failure.

B. Refer to structural drawings for specific loading requirements and deflection limits.

1.05 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-01 Preconstruction Submittals:
      a. Calculations:
         1) Provide structural calculations by a registered architect or professional engineer in the state of Montana qualified to perform such work.
   2. SD-02 Shop Drawings:
      a. Submit shop drawings for SIPs showing the following:
         1) Roof panel layout in plan view.
         2) Manufacturer's standard details where applicable, including the following:
            (a) Sill fastening conditions.
            (b) Fastening splines (OSB, Block, I-beam or otherwise).
            (c) Supplemental internal panel reinforcing provisions where required for spans indicated, or where required to strengthen or otherwise facilitate connections.
            (d) Framing, blocking, and headers required around openings including but not limited to door openings, window openings, and mechanical penetrations.
            (e) Panel end details indicating nailer inlays at end of panels to support subsequent fascia or parapet work.
         3) Identify any custom engineered details required to suit unique project conditions.
         4) Product components and accessories, including fastener requirements.
   3. SD-03 Product Data:
      a. Submit product data for specified products.
      b. SIP Code Compliance:
         1) Provide ICC ES code report for SIP with evidence of compliance with code requirements as an alternate method of construction. Submit current compliance report number from ICC ES showing conformance to the International Building Code (IBC) and International Residential Code (IRC). Code report shall include compliance with ICC ES AC04 (Sandwich Panels).
      c. EPS Code Compliance:
         1) Provide ICC ES code report for EPS foam with evidence of compliance with code. Submit current compliance report numbers from ICC ES with conformance to the International Building Code (IBC) and International Residential Code (IRC). Code report shall include compliance with ICC ES AC12 (Foam Plastic).
      d. Manufacturer's Instructions:
         1) SIP Manufacturer's Construction Manual and load design charts.
      e. Warranty documents specified herein.
   4. SD-06 Certificates:
      a. Quality Control Submittals:
         1) Certificate: Product certificate showing compliance to Third Party Quality Control program.

1.06 QUALITY CONTROL

A. Installer Qualifications:
   1. Installer shall have documented experience in having successfully installed Work of this section and should have specialized in installation of work similar to that required for this project. Where manufacturer is not specifically pre-approved by name in this specification, written preapproval of Architect is required to bid both supply and installation of work of this section. Provide architect with owner and general contractor references from previous project experience for review. Determination of acceptability to bid shall be at the sole discretion of the Architect.

B. Source Limitations:
   1. Obtain all SIPs, standard SIPs fasteners, and SIPs adhesives through one source. All accessories to be as furnished or recommended by the SIPs manufacturer.

1.07 REGULATORY REQUIREMENTS:

A. SIPs shall be recognized for compliance with International Building Code and in a current ICC ES evaluation report.

B. Pre-installation Meeting:
   1. Conduct pre-installation meeting to verify project requirements, foundation/structural system/substrate conditions, SIPs manufacturer installation instructions and SIP manufacturer warranty requirements. Comply with Division 1 Project Management and Coordination (Project Meetings) Section.

1.08 DELIVERY, STORAGE & HANDLING

A. Ordering:
   1. Comply with SIP manufacturer ordering instructions and lead time requirements to avoid construction delays.

B. Delivery:
   1. Deliver materials from SIP manufacturer with identification labels or markings intact.

C. Handling and Storage:
   1. Off-load SIPs from truck and handle using forklift or other means to prevent damage to SIPs.
   2. SIPs shall be fully supported in storage and prevented from contact with the ground. Stack SIPs on pallets or a minimum of three stickers for every 8 feet of SIP length.
   3. SIPs shall be fully protected from weather. Protect against exposure to rain, water, dirt, mud, and other residue that may affect SIP performance. Cover stored SIPs with breathable protective wraps. SIPs shall be stored in a protected area.

1.09 WARRANTY

A. Project Warranty:
   1. Refer to Conditions of the Contract for project warranty provisions.

B. Manufacturer’s Warranty:
   1. Submit SIP manufacturer’s standard warranty document. SIP Manufacturer warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents.

a. Warranty Period:
   1) Full product warranty of 20 years commencing on Date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PRE-APPOVED MANUFACTURERS/SUPPLIERS

A. Big Sky Insulations, Inc.
15 Arden Drive
Belgrade, MT 59714
Phone: (800) 766-3626
Phone: (406) 388-4146
www.bigskyrcontrol.com

B. Premier SIPS
270 Floss Flats Road Suite A
Belgrade, MT 59714
Phone: (406) 388-5553

2.02 MATERIALS

A. SIPs consisting of the following:
   1. UL certified EPS core with Perform Guard treatment, minimum of 0.95 pcf (15.2 kg/m3) complying with ASTM C578 Type I and having ICC ES recognition of termite resistance. Insulation manufacturer shall provide Third Party UL certificate. ICC ES report shall be provided for recognition of termite resistance in compliance with ICC AC239.
   2. OSB identified with APA or TECO performance mark with Exposure I durability rating and performance in accordance with DOC PS-2 span rating 24/16 or greater.
   3. Adhesives shall be in conformance with ICC ES AC05 – Acceptance Criteria for Sandwich Panel Adhesives.

2.03 ACCESSORIES

A. Splines:
   1. OSB, block splines, or I-beam for use in joining SIPs shall be supplied by SIPs manufacturer.

B. Fasteners:
   1. Corrosion resistant SIP screws compatible with SIP system shall be provided by the SIPs manufacturer.
      a. Wood Screws for attachment to wood members.
      b. Heavy Duty Metal Screws for attachment to metal members (16 gauge to 3/16-inch).
      c. Light Duty Metal Screws for attachment to metal decks (18 gauge or thinner).

C. SIP Sealant:
   1. Shall be specifically designed for use with SIPs. Sealant must be compatible with all components of the SIP. Sealant shall be provided by the SIP manufacturer.

D. Dimensional Lumber:
   1. SPF, #2 or better, or engineered equivalent unless otherwise required by structural drawings.

E. Vapor Barrier SIP Tape:
   1. Woven and coated polyolefin membrane with synthetic adhesive suitable for indoor use, min. 6 inch wide for use on SIP joints as specified by designer. SIP Tape shall be supplied by the SIP manufacturer.

F. Opening Headers:
   1. Openings in SIPs panels to be provided with headers designed by SIPs manufacturer, and inlaid into panel construction, unless noted otherwise on drawings. Header design to be included in engineered shop drawings and shall be in response to loading criteria provided by structural engineer. Note that limited headers at select large curtain wall openings are achieved differently, via connections to structural steel, and in such cases, details are indicated on drawings.

G. Polyurethane Spray Foam Insulation:
   1. Foam-in-place in the field, any and all voids created in SIP's panels and additionally as recommended by SIPs manufacturer to maintain continuous thermal envelope.

2.04 FABRICATION

A. Sizes:
   1. SIPs shall be fabricated in accordance with approved Shop Drawings.

B. Thermal Resistance:
   1. 8 ¼-inch thick SIP, R-value of 30 and a U-value of 0.034 at 75 degrees F.

2.05 PRODUCT SUBSTITUTIONS

A. Substitutions:
   1. No substitutions permitted without prior written approval of architect.

B. See Division 1 Product Substitution Procedures and Requirements.

2.06 RELATED MATERIALS

A. Related Materials: Refer to other sections for related materials as follows:
   1. Dimensional Lumber:
      a. SPF #2 or better or pre-engineered equivalent. Refer to Division 6 Carpentry Sections.

2.07 SOURCE QUALITY

A. Source Quality Assurance:
   1. Each SIP component required shall be supplied by SIP manufacturer and shall be obtained from selected SIP manufacturer or its approved supplier.
      a. Each SIP shall be labeled indicating PFS Third Party certification.
      b. Provide evidence of UL Third Party inspection and labeling of all insulation used in manufacture of SIPs.
      c. SIP manufacturer shall provide Lamination, R-Value, and mold/mildew/termite resistance warranty documents for building owner acceptance. Manufacturer standard forms will be submitted.
      d. Provide SIPs with Foam-Control EPS with Perform Guard for termite resistance. Treatment shall be EPA registered with treatment efficacy substantiated by ICC ES report.

e. Provide SIPs with treatment for mold, mildew, and termite resistance. Treatment shall be EPA registered with treatment efficacy substantiated by independent research.
f. Dimensional Tolerance - shall comply with values listed in the manufacturer's Quality Control Manual.

B. Source Quality:
1. Obtain all SIPs and SIPs accessories from a single manufacturer.

PART 3 - EXECUTION

3.01 MANUFACTURER'S INSTRUCTIONS

A. Compliance:
1. Comply with manufacturer's ICC ES report, Load Design Charts, Construction Manual, Shop Drawings, and product data, including product technical bulletins, for installation.

B. Plans shall be reviewed by a qualified architect/engineer and shall be signed and/or sealed. Deviations from standard detail and load design values shall be calculated and signed and/or sealed by a qualified architect/engineer.

3.02 EXAMINATION

A. Site Verification of Conditions:
1. Verify substrate conditions (which have been previously installed under other sections) are acceptable for product installation in accordance with manufacturer's instructions.
a. Verify conditions of foundation/structural system/substrate and other conditions which affect installation of SIPs. Any adverse conditions shall be reported in writing. Do not proceed with installation until adverse conditions are corrected.

3.03 INSTALLATION

A. SIP Installation:
1. SIPs Erection:
a. Complete installation recommendations are available from the manufacturer. Contractor is responsible for being informed on such recommendations and including such efforts and requirements in the bid. SIP weight and contractor preference will dictate the erection method used. The use of a crane or lift truck may be required for placement of some SIP panels. Consult with SIP manufacturer for recommended handling methods. Supplementary lifting clamps and attachments to be provided by the contractor.
2. SIP Supports:
a. Provide level and square foundation/structural system/substrate that support roof SIPs. Provide 1 ½-inch (38 mm) diameter access holes in plating to align with electrical wire chases in SIPs. Provide adequate bracing of SIPs during erection. Remove debris from plate area prior to SIP placement.
3. SIP Fastening:
a. Unless noted otherwise on structural drawings, or otherwise required by manufacturer, connect SIPs panels to top plates with staples at 6-inches on center, unless noted otherwise on drawings. Screws of equal strength may be substituted for nails and staples as specified by engineer. SIP sealant must be used together with each fastening techniques. Where SIP Screw Fasteners are used, provide a minimum of 1-inch (25.4 mm) penetration into support. Join SIPs

using plates and splines. Secure attachment with nails, staples, or screws, and SIP sealant. Apply SIP sealant following SIP manufacturer recommendations.

4. Manufacturer's Standard Details:
    a. Representative manufacturers standard details are included in the drawings for reference, but do not necessarily address all conditions that will be required for work of this section. Installing contractor is responsible to be informed about SIPs installation requirements and to coordinate and perform all work required by SIPs manufacturer's project specific shop drawings/
5. SIP Tape:
    a. Provide continuous sips tape at underside of all roof panel joints.
6. Restrictions:
    a. Do not install SIPs directly on concrete. Do not overcut OSB skins for field-cut openings and do not cut OSB skins for electrical chases. SIPs shall be protected from exposure to solvents and their vapors that damage the EPS foam core.
7. Remove and replace insulated roof SIPs which have become excessively wet or damaged before proceeding with installation of additional SIPs or other work.

3.04 FIELD QUALITY REQUIREMENTS

A. Manufacturer's Field Services:
    1. Provide manufacturer's field service consisting of observing initial install and providing recommendations, as well as inspecting completed work as follows:
        a. General contractor shall provide SIP's supplier and architect with 2 weeks advance notice for such field service, to occur at the following intervals:
            1) Panel delivery, staging, and commencement of all panel installation.
            2) Manufacturer shall additionally inspect completed SIPs panel installation prior to covering of the Work.

3.05 PROTECTION

A. Protection:
    1. Protect installed product and finish surfaces from damage during construction.
        a. Roof SIPs:
            1) Protect roof SIPs from weather with roofing materials to provide temporary protection at the end of the day or when rain or snow is imminent.
        b. After installation, cover SIPs to prevent contact with water on each exposed SIP edges and faces.

END OF SECTION

SECTION 07 20 00
THERMAL INSULATION AND PROTECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes rigid board insulation at perimeter foundation walls, behind metal siding, and batt insulation in stud walls.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. ASTM C240 - Standard Test Methods of Testing Cellular Glass Insulation Block.
   2. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation.
   3. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
   4. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
   5. ASTM C1289 - Standard Specification for Faced Rigid Cellular Thermal Insulation Board.
   6. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics.
   7. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
   8. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.

B. National Fire Protection Association (NFPA):
   1. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

C. Underwriters Laboratories Inc. (UL):
   1. UL 723 - Tests for Surface Burning Characteristics of Building Materials.

1.03 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-03 Product Data:
      a. Submit data on product characteristics, performance criteria and limitations.
      b. Manufacturer's Installation Instructions:
         1) Submit special environmental conditions required for installation and installation techniques.
   2. SD-06 Certificates:
      a. Manufacturer's Certificate:
         1) Certify products meet or exceed specified requirements.

1.04 ENVIRONMENTAL REQUIREMENTS

A. Section 01600 – Common Product Requirements.

B. Do not install adhesives when temperature or weather conditions are detrimental to successful installation.

1.05 SEQUENCING

A. Section 01011 – Summary of Work: Work sequence.

1.06 COORDINATION

A. Section 01039 – Coordination and Meetings: Coordination and project conditions.

PART 2 - PRODUCTS

2.01 BOARD INSULATION

A. Manufacturers:
   1. Owens Corning – Extruded Polystyrene Insulation, Foamular 250.
   2. Dow Chemical.
   3. Rmax.
   4. Substitutions: Section 01600 – Common Product Requirements.

2.02 COMPONENTS

A. Extruded Polystyrene Insulation (Type A): ASTM C578 Type VI, conforming to the following:
   1. Board Size: 48 x 96 inch.
   2. Board Thickness: 2 inches.
   3. Thermal Resistance: R of 5.0 per inch.
   4. Water Absorption: In accordance with ASTM D2842 0.1 percent by volume maximum.
   5. Compressive Strength: Minimum 25 psi.
   6. Board Edges: Square edges.
   7. Flame/Smoke Properties: 75/450 in accordance with ASTM E84.

2.03 ACCESSORIES

A. Adhesive Type 1: Compatible with extruded polystyrene insulation board, polyethylene film and adjacent materials as recommended by insulation manufacturer for application.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 01039 – Coordination and Meetings: Coordination and project conditions.

B. Verify substrate, adjacent materials, and insulation boards are dry and ready to receive insulation.

C. Verify substrate surface is flat, free of irregularities, materials or substances affecting installation of insulation.

3.02 INSTALLATION - FOUNDATION PERIMETER

A. Adhere 6-inch-wide strip of polyethylene sheet over construction joints with beads of Type 1 adhesive each side of joint.
   1. Tape seal joints.
   2. Extend sheet full length of joint.

B. Apply Type 1 adhesive in three continuous beads per board length to full bed 1/8 inch thick.

C. Install Type A boards on foundation wall or grade beam perimeter, horizontally.
   1. Place boards in method to maximize contact bedding.
   2. Butt edges and ends tight to adjacent board and to protrusions.

D. Extend boards over control joints, unbonded to foundation 6 inches on one side of joint.

E. Cut and fit insulation tight to protrusions or interruptions to insulation plane.

3.03 INSTALLATION - ROOF

A. Specified in Section 07 50 00.

3.04 PROTECTION OF INSTALLED CONSTRUCTION

A. Do not permit damage to insulation prior to covering.

END OF SECTION

SECTION 07 46 19
STEEL SIDING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Steel siding for walls and soffits.
   2. Related trim, flashings, accessories, and fastenings.

B. Related Requirements:
   1. Section 06 10 53 – Miscellaneous Rough Carpentry: Blocking for openings and penetrations.
   2. Section 07 21 13 – Board Insulation & Envelope Accessories: Continuous insulation and associated metal framing components.
   3. Section 07 26 00 – Vapor Retarders.
   4. Section 07 62 00 – Sheet Metal Flashing & Trim.
   5. Section 07 90 00 – Joint Protection.
   6. Section 09 22 16 – Non-Structural Metal Framing.
   7. Section 09 90 00 – Painting and Coating: Field painting at pre-primed siding

1.02 REFERENCE STANDARDS

A. American Architectural Manufacturers Association (AAMA):
   1. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.
   2. AAMA 2604 - Voluntary specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.
   3. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.

B. American Iron and Steel Institute (AISI):
   1. AISI General - Standard for Cold-Formed Steel Framing - General Provisions.
   2. AISI Header - Standard for Cold-Formed Steel Framing - Header Design.
   3. AISI NASPEC - North American Specification for Design of Cold-Formed Steel Structural Members.

C. ASTM International (ASTM):
   1. ASTM A606 Standard Specification for Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot- Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance.
   2. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc- Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   3. ASTM A755/A755M - Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products.
   4. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   5. ASTM C1371-2004a - Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers.

6. ASTM C1549-2004 - Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer.
7. ASTM D226 - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
8. ASTM D523 - Standard Test Method for Specular Gloss.
9. ASTM D2244 - Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
10. ASTM D4214 - Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films.
11. ASTM D1970 - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.
12. ASTM D2178 - Standard Specification for Asphalt Glass Felt Used in Roofing and Waterproofing.
13. ASTM D4397 - Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.
14. ASTM D4586 - Standard Specification for Asphalt Roof Cement, Asbestos-Free.
15. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
16. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
17. ASTM E408-1971(1996)e1 - Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.
18. ASTM E903-1996 - Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres.
19. ASTM E1918-1997 - Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field.
20. ASTM E1980-2001 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.

1.03 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-03 Product Data:
      a. Submit data indicating materials, component profiles, fastening methods, jointing details, sizes, surface texture, finish, color, and accessories.
   2. SD-04 Samples:
      a. Submit two samples, 12 by 12 inch in size, illustrating surface texture, finish, and color for each stile and color indicated on Drawings.

1.04 QUALITY CONTROL

A. Perform Work according to SMACNA Architectural Sheet Metal Manual.

B. Provide in accordance with Division 01 Requirements.

1.05 QUALIFICATIONS

A. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 – Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Deliver materials in manufacturer's packaging; include installation instructions.

C. Inspection: Accept siding materials on-Site. Inspect for damage.

D. Store siding materials according to manufacturer's instructions.

1.07 EXISTING CONDITIONS

A. Field Measurements: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

1.08 WARRANTY

A. Section 01 70 00 – Execution and Closeout Requirements: Requirements for warranties.

B. Furnish five-year manufacturer's warranty for steel siding, including deterioration of finish.

C. Finish Warranty:
   1. Kynar 500®: Twenty (20) years.
   2. Kynar 500® Metallic: Twenty (20) years.
   3. Anodized: Twenty (20) years.
   4. Ceramic Impregnated Silicon Modified Polyester (CSMP) paint system: thirty (30) years.

PART 2 - PRODUCTS

2.01 STEEL SIDING

A. Manufacturer List:
   1. Metal Sales Inc
   2. Pac-Clad Petersen
   3. Pro-Tech Steel, Great Falls, MT
   4. Forma Steel
   5. Substitutions: Section 01 60 00 – Product Requirements.

2.02 COMPONENTS

A. Wall Siding: Flush face concealed fastener.
   1. Basis of Specification: EM15-126 Wall Panel (Metal Sales) or approved equal.
   2. Minimum 24 ga thickness.
   3. Material: ASTM A606 sheet and strip steel components.
   4. Panel Width: 12-inch panel coverage.
   5. Panel Height: 1-inch height.
   6. Fastening System: Concealed fastener.
   7. Finish: Factory applied PVDF to be selected by Architect.

B. Soffit Material and Fascia Material: Flush face panel.
   1. Basis of Specification: Soffit Panel (Metal Sales) or approved equal.
   2. Minimum 24 ga thick sheet stock.
   3. Material: Steel.

4. Width: 12-inch coverage.
5. Height: 1-inch height.
6. Finish: Factory applied PVDF to be selected by Architect.
7. Fastening System: Direct fasten, concealed fastener.
8. Perforations: Non-lanced.

2.03 FINISHES

A. Corrosion Protection:
   1. Aluminum-zinc alloy-coated steel sheet, ASTM A 792, Class AZ50 coating designation, Grade 50, 0.0236-inch (0.60-mm) minimum thickness.

B. PVDF Coating:
   1. Non-reactive thermoplastic fluoropolymer coating (Kynar 500, Hylar 5000).
      a. Comply with ASTM D3222.
      b. Primer: As required by manufacturer.
      c. Color: As selected by Architect.

C. Factory pre-primed coated steel substrate with field paint custom color.

2.04 ACCESSORIES

A. Nails or Screws:
   1. Corrosion-resistant type; non-staining, of size and strength to securely and rigidly retain Work.
   2. Prefinished to match siding finish.

B. Flashings:
   1. 26-gage metal, to match siding (prefinished wall coping included).
   2. Finish and steel type to match adjacent siding/soffit.
   3. Provide the following profiles as described:
      a. Outside Corners: 4-inch x 4-inch, ½-inch hem at each edge.
      b. Inside Corners: 4-inch x 4-inch, ½-inch hem at each edge.
      c. Base Trim: 4-inch high inside leg x siding thickness, hem exposed end.
      d. F-trim: 3-inch x soffit thickness, provide at inside edge between soffit and wall.
      e. J-Trim: 2-inch x siding thickness: provide at all openings 7/8” face depth.
      f. Z-trim: 2-inch x siding thickness, provide at breaks and on back side of J-trim. 1” face depth
   4. Pop-rivets: Use to fasten adjacent pieces of flashing together. Color matched trim where exposed.

C. Metal Furring, Zees, and Grid Strapping Components for Attachment:
   1. See Section 07 21 13.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that framing, substrate surfaces, and wall openings are ready to receive Work.

3.02 INSTALLATION

A. Install metal flashings at internal and external corners sills head of wall openings and joints of dis- similar sheet materials.

B. Install corner strips, closures, and trim.

C. Install sealant to prevent weather penetration.

D. Touch up damaged prefinished surfaces.

E. Metal soffit system: Install system spanning perpendicular to framing. Begin coursings on fascia side and work towards wall, breaking partial width piece against wall.

3.03 TOLERANCES

A. Section 01 40 00 – Quality Requirements: Requirements for tolerances.

B. Maximum Variation from Plumb/Level: 1/4 inch per 10 feet.

C. Maximum Offset from Joint Alignment: 1/16 inch.

3.04 ATTACHMENTS

A. Schedule: See exterior elevations and reflected ceiling plans for locations.

END OF SECTION

SECTION 07 46 23
THERMALLY MODIFIED WOOD CLADDING

PART 1 - GENERAL

1.01 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-03 Product Data:
      a. Manufacturer's descriptive data and product attributes for wood materials.
   2. SD-04 Samples:
      a. Verification samples.

1.02 QUALITY CONTROL

A. Installer Qualifications: Firm specializing in work of this Section, with minimum 2 years' experience.

B. Mockup: Minimum 4 x 4 feet. Approved mockup may remain as part of the Work.

C. Provide in Accordance with Division 01.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Contract Documents are based on products by ThermoryUSA, www.thermoryusa.com.

B. Substitutions: [Refer to Division 01.] [Not permitted.]

2.02 MATERIALS

A. Thermally Modified Wood Wall Cladding:
   1. Species: White Ash.
   2. Nominal Size: 1 x 6 inches.
   3. Actual Size: 0.79 x 5.9 inches.
   4. Coverage: 5.6 inches.
   5. Profile: Shiplap, joint end matched (JEM), back side grooved for PaCS press-and-click system.
   6. Color: Exotic Brown.
   7. Surface Texture: Smooth.
   8. Finish: Pre-oiled with Cutek Extreme.
   9. Fire Hazard Classification: Class B flame spread/smoke developed rating, tested to ASTM E84.
   10. Installation Type: Hidden.
   11. Installation Method: PaCS press-and-click system.

2.03 ACCESSORIES

A. Metal Flashings: See Section 07 62 00 – Sheet Metal Flashing and Trim.

B. PaCS Press and Click System: Cladding manufacturer's standard.

C. Fasteners: Type 305 stainless steel screws.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Installation Method: PaCS press-and-clip system.

C. Install metal flashings at sills and heads of wall openings per architectural details. Provide air space to allow for air movement.

END OF SECTION

SECTION 07 61 03
MANUFACTURED SHEET METAL ROOFING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Architectural standing seam metal roofing.
2. Underlayment.
3. Metal flashing and accessories.
4. Snow guards.

B. Related Sections:
1. Section 06 10 53 – Miscellaneous Rough Carpentry: Plywood roof deck substrate.
2. Section 07 62 00 – Sheet Metal Flashing and Trim.
3. Section 07 90 00 – Joint Protection.

1.02 REFERENCES

A. American Architectural Manufacturers Association (AAMA):
1. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.
2. AAMA 2604 - Voluntary specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.
3. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.

B. American Iron and Steel Institute (AISI):
1. AISI General - Standard for Cold-Formed Steel Framing - General Provisions.
2. AISI Header - Standard for Cold-Formed Steel Framing - Header Design.
3. AISI NASPEC - North American Specification for Design of Cold-Formed Steel Structural Members.

C. American Society of Civil Engineers (ASCE):
1. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.

D. ASTM International (ASTM):
1. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
2. ASTM A755/A755M - Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products.

E. National Roofing Contractors Association (NRCA):
1. NRCA - The NRCA Roofing and Waterproofing Manual.

F. Sheet Metal and Air Conditioning Contractors (SMACNA):
1. SMACNA - Architectural Sheet Metal Manual.

G. Underwriters Laboratories Inc. (UL):
   1. UL 580 - Tests for Uplift Resistance of Roof Assemblies.

1.03 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-02 Shop Drawings:
      a. Indicate metal roofing panel profiles, jointing patterns, jointing details, fastening methods, flashings, terminations, and installation details.
   2. SD-03 Product Data:
      a. Submit data on metal types, finishes, and characteristics.
      b. Submit color charts for finish selection.
   3. SD-04 Samples:
      a. Submit two samples illustrating metal roofing mounted on plywood backing illustrating typical seam, external corner, internal corner, valley, and ridge, junction to vertical dissimilar surface, material, and finish.
      b. Submit two samples illustrating metal finish color.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 – Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.

C. Prevent contact with materials causing discoloration or staining.

1.05 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.06 COORDINATION

A. Section 01 30 00 – Administrative Requirements: Coordination and project conditions.

1.07 WARRANTY

A. Section 01 70 00 – Execution and Closeout Requirements: Requirements for warranties.

B. Furnish 20-year manufacturer warranty for sheet metal roofing against corrosion, and water penetration.

C. Furnish 20-year manufacturer warranty for metal finish against fading, chipping, chalking, and blistering.

D. Special Exposed Panel Finish Warranty: Manufacturer's standard form PVDF (Fluorocarbon) System Warranty for film integrity, chalk rating and fade rating in which manufacturer agrees to repair or replace panels that show evidence of deterioration within specified warranty period.

PART 2 - PRODUCTS

2.01 MANUFACTURED SHEET METAL ROOFING

A. Manufacturers:
   1. Metal Sales.
   2. Substitutions: Section 01 60 00 – Product Requirements.

B. Standing Seam Metal Roofing:
   1. Factory formed metal roofing panel system with concealed fasteners.
      a. Basis of Design: Metal Sales, 16-Inch Vertical Seam.
      b. Thickness: 24 gauge.
      c. Panel Width: 16 inches.
      d. Snap-seam rib design.
      e. Surface Finish: PVDF (Kynar 500 or Hylar 5000).
      f. Color: Selected by Architect from Manufacturer standard colors.

2.02 ACCESSORIES

A. Fasteners:
   1. Same material and finish as roofing metal and type recommended by roofing manufacturer.

B. Underlayment:
   1. Ice & Water Shield:
      a. ASTM D 1970; self adhering, polymer-modified, bituminious sheet underlayment, 40 mils thick.
      b. Provide primer when recommended by underlayment manufacturer.

C. Plastic Cement:
   1. ASTM D4586, Type I.

D. Snow Guards:
   1. Standing Seam Two Pipe Snow Guard.
      a. Clamps: 6061-76 Aluminum extrusions conforming to ASTM B 221
      b. Bracket: 600 Series aluminum, clamp to seam.
      c. Base Plate: Stainless steel.
      d. Coupling, End Caps, End Collars: Stainless steel 304.
      e. Cross Members: 6000 Series alloy and temper aluminum extrusions.
      f. Snow and Ice Clips: Aluminum, with rubber foot, minimum 3 inches wide.
      g. Bracket spacing to be recommended by guard manufacturer.
      h. Spacing will vary by manufacturer.
      i. Color: Match finish to roof panels.
      j. See Drawings for locations.

E. Sheet Metal Materials:
   1. Aluminum-zinc alloy coated steel sheet: ASTM A 792/A 792M, Class AZ50 (AZ150) coating designation; minimum Grade 37 (Grade 255)

2.03 FABRICATION

A. Form sections shape as indicated on Drawings, accurate in size, square, and free from distortion or defects.

B. Fabricate, trim, flashing, and other metal components from same material as metal roof panels. Provide exposed metal surfaces with same finish as exposed face of metal roof panels.

C. Fabricate starter strips of same material as sheet, continuous, to interlock with sheet.

D. Form pieces in longest practical lengths.

E. Hem exposed edges on underside 1/2 inch (13 mm); miter and seam corners.

F. At moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.

G. Fabricate corners from one piece with minimum 18 inch (450 mm) long legs; seam for rigidity, seal with sealant.

H. Fabricate vertical faces with bottom edge formed outward 1/4 inch (6 mm) and hemmed to form drip.

I. Fabricate flashings to allow toe to extend 2 inches (50 mm) over roofing. Return and brake edges.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

3.02 PREPARATION

A. Wood and Metal Deck Substrate:
   1. Fill knot holes and surface cracks with latex filler at areas of bonded eave protection.
   2. Broom clean deck surfaces under eave protection and underlayment.

B. Back paint concealed metal surfaces and surfaces in contact with dissimilar metals with protective backing paint to minimum dry film thickness of 15 mil (0.4 mm).

3.03 INSTALLATION - STANDING SEAM METAL ROOFING

A. Conform to NRCA details.

B. Install sheathing over entire roof surface using recommended fasteners. Install furring, eave angles, sub-purlins and other miscellaneous roof panel support members and anchor according to metal roof panel manufacturer’s recommendations.

C. Install roofing panels in whole segments with no joints in panels.

D. Align transverse lapped joints of roofing sheets.

E. Install clips to secure roof panels without deforming roof panels.

F. Terminate roofing panels with sheet metal trim and flashing for watertight installation. Close and conceal openings between roofing panels, panel seams, and roof substrate.

G. Seal metal joints watertight.

3.04 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 01 70 00 - Execution and Closeout Requirements: Protecting installed construction.

B. Do not permit traffic over unprotected roof surface.

END OF SECTION

SECTION 07 62 00
SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes flashings and counterflashings, gutters and downspouts, roof vents, soffit panels, and fabricated sheet metal items.
   1. Provide reglets and accessories, precast concrete splash pads, roof equipment rails, and soffit.

B. Related Sections:
   1. Section 07 90 00 – Joint Protection.
   2. Section 09 90 00 – Painting and Coating: Field painting.

1.02 REFERENCES

A. American Architectural Manufacturers Association (AAMA):
   1. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.
   2. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.
   3. AAMA 2604 - Voluntary specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.
   4. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.

B. ASTM International (ASTM):
   1. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   2. ASTM A755/A755M - Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products.
   3. ASTM B32 - Standard Specification for Solder Metal.
   4. ASTM B101 - Standard Specification for Lead-Coated Copper Sheet and Strip for Building Construction.
   5. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   6. ASTM B370 - Standard Specification for Copper Sheet and Strip for Building Construction.
   7. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
   8. ASTM D226 - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
   9. ASTM D4397 - Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.
   10. ASTM D4586 - Standard Specification for Asphalt Roof Cement, Asbestos-Free.

C. Copper Development Association Inc. (CDA):
   1. CDA - Copper in Architecture - Handbook.

D. Federal Specification Unit:
   1. FS TT-C-494 - Coating Compound, Bituminous, Solvent Type, Acid Resistant.

E. Sheet Metal and Air Conditioning Contractors (SMACNA):
   1. SMACNA - Architectural Sheet Metal Manual.

1.03 DESIGN REQUIREMENTS

A. Sheet Metal Flashings: Conform to the following criteria of SMACNA "Architectural Sheet Metal Manual."

B. Gutter and Downspout Components: Conform to applicable code for size and method of rain water discharge.

C. Maintain one copy of each document on site.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-02 Shop Drawings:
      a. Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.
   2. SD-03 Product Data:
      a. Submit data on manufactured components metal types, finishes, and characteristics.

1.05 QUALITY CONTROL

A. Fabricate accessories in profile and size to suit gutters and downspouts.
   1. Anchorage Devices: In accordance with SMACNA requirements.
   2. Gutter Supports: Brackets.
   3. Downspout Supports: Brackets.

B. Seal metal joints.

PART 2 - PRODUCTS

2.01 SHEET METAL FLASHING AND TRIM

A. Type 1 - Galvanized Steel: ASTM A653/A653M; G90 zinc coating; 0.024-inch-thick steel.

B. Type 2 - Pre-Finished Galvanized Steel Sheet: ASTM A755/A755M; G90 zinc coating; 0.024-inch-thick core steel, shop pre-coated with fluoropolymer top coat; color as selected from manufacturer's standard color.

2.02 ACCESSORIES

A. Fasteners: Same material and finish as flashing metal, with soft neoprene washers.

B. Underlayment: 10 mil polyethylene.

C. Slip Sheet: Rosin sized building paper.

D. Primer: Galvanized iron type.

E. Protective Backing Paint: Zinc molybdate alkyd.

F. Sealant: Sealant specified in Section 07 90 00 – Joint Protection.

G. Plastic Cement: ASTM D4586, Type I.

H. Reglets: Surface mounted galvanized steel; face and ends covered with plastic tape.

I. Solder: ASTM B32; type suitable for application and material being soldered.

2.03 FABRICATION

A. Form sections shape indicated on Drawings, accurate in size, square, and free from distortion or defects.

B. Fabricate cleats of same material as sheet metal, interlocking with sheet.

C. Form pieces in longest possible lengths.

D. Hem exposed edges on underside 1/2 inch; miter and seam corners.

E. Form material with flat lock seams, except where otherwise indicated. At moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.

F. Fabricate corners from one piece with minimum 18-inch-long legs; seam for rigidity, seal with sealant.

G. Fabricate vertical faces with bottom edge formed outward 1/4 inch and hemmed to form drip.

H. Fabricate flashings to allow toe to extend 2 inches over roofing. Return and brake edges.

I. Fabricate downspouts to rectangular profile; size 4 inches x 5 inches.

J. Fabricate accessories in profile and size to suit gutters and downspouts.
   1. Downspout Supports: Brackets.

K. Seal metal joints.

2.04 FACTORY FINISHING

A. Fluoropolymer Coating: Multiple coats as specified for sheet metal system, thermally cured, conforming to AAMA 2604.

B. Washcoat: Finish concealed side of metal sheets with washcoat compatible with finish system, as recommended by finish system manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.

B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.02 PREPARATION

A. Install surface mounted reglets to lines and levels indicated on Drawings. Seal top of reglets with sealant.

B. Paint concealed metal surfaces with protective backing paint to minimum dry film thickness of 15 mil.

3.03 INSTALLATION

A. Secure flashings in place using concealed fasteners. Use exposed fasteners only where permitted.

B. Apply plastic cement compound between metal flashings and felt flashings.

C. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.

D. Seal metal joints watertight.

E. Slope gutters minimum 1/4 inch per foot.

F. Set splash pads under downspouts.

G. Seal metal joints watertight.

3.04 FIELD QUALITY CONTROL

A. Inspection will involve surveillance of Work during installation to ascertain compliance with specified requirements.

3.05 SCHEDULE

A. Fascia: Type 2.

B. Flashings Associated with Roof System: Type 1.

C. Sheet Metal Roof Expansion Joint Covers, and Roof-to-Wall Joint Covers: Type 1.

D. Counterflashings at Roofing Terminations (over roofing base flashings): Type 1.

E. Counterflashings at Curb-Mounted Roof Items, including Skylights and Roof Hatches: Type 2.

F. Roofing Penetration Flashings, for Pipes, Structural Steel, and Equipment Supports: Type 3.

END OF SECTION

SECTION 07 90 00
JOINT PROTECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Sealants and joint backing, pre-compressed foam sealers, hollow gaskets, and accessories.
   2. Acoustic sealants.

B. Related Sections:
   1. Section 08 80 00 – Glazing: Glazing sealants and accessories

1.02 REFERENCES

A. ASTM International (ASTM):
   1. ASTM C834 - Standard Specification for Latex Sealants.
   2. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications.
   3. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
   4. ASTM C1193 - Standard Guide for Use of Joint Sealants.
   5. ASTM D1056 - Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
   6. ASTM D1667 - Standard Specification for Flexible Cellular Materials-Vinyl Chloride Polymers and Copolymers (Closed-Cell Foam).
   7. ASTM D2628 - Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements.

B. California Department of Health Services:
   1. CA/DHS/EHLB/R-174 - Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda.

1.03 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-03 Product Data:
      a. Submit manufacturer’s specifications and installation instructions for each product proposed for use as part of the Work.
   2. SD-06 Certificates:
      a. Submit manufacturer's certificate of compliance indicating that each product to be furnished complies with these Specifications, is recommended for the application indicated, and is compatible with the other materials in the joint system.

1.04 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience and approved by manufacturer.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Maintain temperature and humidity recommended by sealant manufacturer during and after installation.

1.06 COORDINATION

A. Coordinate Work with sections referencing this section.

PART 2 - PRODUCTS

2.01 JOINT SEALERS

A. Manufacturers:
   1. Sika Corp (basis of specification).
   2. Dow Corning Corp.
   3. GE Silicones.
   4. Pecora Corp.
   5. Tremco Sealants & Waterproofing.
   6. Substitutions: Section 01 60 00 – Product Requirements.

B. Products Description:
   1. High Performance General Purpose Exterior (non-traffic) Sealant (Type 1):
      a. ASTM C-920, Grade NS, Class 100/50, Uses T, NT, G, A O, M; single or multi-component.
      b. Color: Colors as selected by Architect.
      c. Composition: Polyurethane.
      d. Basis: Sikaflex-15 LM.
   2. Single Component, Low to No-Bleed, Non-Sag Elastomeric Sealant (Type 2):
      a. ASTM C-920, Grade NS, Class 100/50, Use NT, M, G, A, O.
      b. Color: As Selected by Architect, Field Pigmentable.
      c. Composition: Silicone.
      d. Movement Capability: Plus and minus 100 percent ASTM C-719.
      e. Basis: Sikasil WS-290 FPS.
   3. Single Component, Self-Leveling (Traffic Rated) Polyurethane Sealant (Type 3):
      a. ASTM C-920, Type S, Grade P, Class 25, Use T.
      b. Color: As Selected by Architect.
      c. Composition: Polyurethane.
      d. Movement Capability: Plus and Minus 25 percent.
      e. Basis: Sikaflex 1c.
   4. High Performance, Low-Modulus Elastomeric Polyurethane Sealant (Type 4):
      a. Federal Specification TT-S-00230C, Type II, Class A, ASTM C-920, Type S, Class 100/50, Grade NS, AAMA 808.3 verified.
      b. Movement Accommodation Factor (ASTM C 719): +100/-50%.
   5. Shower/Tile Sealant (Type 5):
      a. White silicone; ASTM C920, Uses M and A; single component, mildew resistant.
      b. Suitable for intermittent wetting.
      c. Applications: Use for joints between plumbing fixtures and floor and wall surfaces, and joints between kitchen and bathroom toilet room counter tops and wall surfaces.
   6. Acoustical Sealant (Type 6):
      a. Butyl or acrylic sealant; ASTM C920, Grade NS, Class 12-1/2, Uses M and A; single component, solvent release curing, non- skinning.
      b. Type: Manufactured by.

c. Applications: Use for concealed locations only at acoustically rated construction.
   1) Provide sealant bead between top stud runner and structure and between bottom stud track and floor.
7. Silicone Sealant (Type 7):
   a. ASTM C920, Grade NS, Class 25, Uses NT, A; single component, non-sagging, non-staining, fungus resistant (in wet locations), non- bleeding.
   b. Color: Colors as selected by Architect.
   c. Movement Capability: Plus and minus 25 percent.
8. Two-Part Polysulfide Sealant and Primer (Type 8):
   a. Basis: Deck-O-Seal Gun Grade.
   b. Non-staining sealant cures to a firm, flexible, tear-resistant rubber.
   c. Resistant to most chemicals, all weather conditions, aging, and shrinkage.

2.02 ACCESSORIES

A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.

B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.

C. Joint Backing: Round foam rod compatible with sealant; ASTM D1056, sponge or expanded rubber D1667, closed cell PVC; oversized 30 to 50 percent larger than joint width.

D. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 01 30 00 – Administrative Requirements: Coordination and project conditions.

B. Verify substrate surfaces and joint openings are ready to receive work.

C. Verify joint backing and release tapes are compatible with sealant.

3.02 PREPARATION

A. Remove loose materials and foreign matter impairing adhesion of sealant.

B. Clean and prime joints.

C. Perform preparation in accordance with ASTM C1193.

D. Protect elements surrounding Work of this section from damage or disfiguration.

3.03 INSTALLATION

A. Perform installation in accordance with ASTM C1193.

B. Perform acoustical sealant application work in accordance with ASTM C919.

C. Measure joint dimensions and size joint backers to achieve width-to-depth ratio, neck dimension, and surface bond area as recommended by manufacturer.

D. Install bond breaker where joint backing is not used.

E. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.

F. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

G. Tool joints concave.

H. Pre-compressed Foam Sealant: Do not stretch; avoid joints except at corners, ends, and intersections; install with face 1/8 to 1/4 inch below adjoining surface.

I. Compression Gaskets: Avoid joints except at ends, corners, and intersections; seal joints with adhesive; install with face 1/8 to 1/4 inch below adjoining surface.

3.04 CLEANING

A. Section 01 70 00 – Execution and Closeout Requirements: Final cleaning.

B. Clean adjacent soiled surfaces.

3.05 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 01 70 00 – Execution and Closeout Requirements: Protecting installed construction.

3.06 SCHEDULE

A. Exterior joints for which no other sealant type is indicated: Type 1.

B. Control, expansion, and soft joints in masonry, and between masonry and adjacent work: Type 2.

C. Joints between precast concrete panels: Type 2.

D. Control and expansion joints in concrete sidewalks and patios: Type 3.

E. Expansion joints between concrete sidewalks, patios and adjacent building: Type 3.

F. Lap joints in exterior sheet metal work: Type 1.

G. Butt joints in exterior metal work and siding: Type 1.

H. Joints between exterior, windows, doors, and metal frames and adjacent work: Type 1.

I. Under exterior door thresholds: Type 1.

J. Interior joints for which no other sealant is indicated: Type 1.

K. Control and expansion joints in interior concrete slabs and floors: Type 3.

L. Interior joints for which no other sealant is indicated: Type 4.

M. Control and expansion joints in interior concrete slabs and floors: Type 1.

N. Joints between plumbing fixtures and walls and floors, and between counter tops and walls: Type 5.

O. Joints between pre-formed shower inserts, around plumbing fixtures, all within “wet” areas such as restrooms, bathrooms, locker rooms, showers and eye wash stations: Type 7.

END OF SECTION

SECTION 08 12 14
STANDARD STEEL FRAMES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Non-rated and thermally insulated steel frames for exterior use.

B. Exterior glazed light frames.

1.02 RELATED SECTIONS

A. Section 08 13 14 – Standard Steel Doors.

B. Section 08 71 00 – Door Hardware.

1.03 REFERENCES

A. ASTM A525 - Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.

B. DHI - Door Hardware Institute: The Installation of Commercial Steel Doors and Steel Frames, Insulated Steel Doors in Wood Frames and Builder's Hardware.

C. SDI-100 - Standard Steel Doors and Frames.

1.04 SUBMITTALS FOR REVIEW

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-02 Shop Drawings:
      a. Indicate frame elevations, reinforcement, anchor types and spacings, location of cut-outs for hardware and finish.
   2. SD-03 Product Data:
      a. Indicate frame configuration and finishes.

1.05 QUALITY CONTROL

A. Conform to requirements of SDI-100.

B. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years experience in production of door and window assemblies.

C. Provide in accordance with Division 01.

PART 2 - PRODUCTS

2.01 FRAME MANUFACTURERS

A. Manufacturers:
   1. Curries/Essex.
   2. Ceco Corporation.
   3. Steelcraft Manufacturing Company.
   4. Substitutions: Per Section 01600 – Common Product Requirements.

2.02 FRAMES

A. Exterior Frames: Grade III, fully flush design; 16-gauge thick metal. Fabricate from cold rolled sheets per ASTM A366 and ASTM A568. Frames shall be fully welded type at exterior locations.

2.03 ACCESSORIES

A. Removable Stops:
   1. Rolled steel channel shape, butted corners; prepared for countersink style screws.

B. Supports and Anchors:
   1. Fabricate of not less than 14-gauge sheet steel.
      a. Provide manufacturer standard metal stud anchor.
      b. Provide manufacturer standard foot clips at all frames.

C. Primer:
   1. Manufacturer standard lead and chromate free primer.

D. Silencers:
   1. Except on weather stripped frames, drill stops to receive three silencers on strike jambs of single door frames.

2.04 FABRICATION

A. Fabricate frames as welded unit for gypsum board slip on type.

B. Transom Bars for Glazed Lights: Fixed type, of same profiles as jamb and head.

C. Fabricate frames with hardware reinforcement plates welded in place. Provide mortar guard boxes.

D. Terminate door stops so bottom of frame is at concrete slab or at top of finish floor.

E. Prepare frames for silencers. Provide three single silencers for single doors on strike side.

F. Configure exterior frames with special profile to receive recessed weather- stripping.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that opening sizes and tolerances are acceptable.

3.02 INSTALLATION

A. Install frames in accordance with SDI-100.

B. Coordinate gypsum board wall construction for anchor placement.
   1. Provide three anchors per jamb in each wall type.
   2. Provide standard foot clip anchor.

C. Coordinate installation of glass and glazing.

D. Install roll formed steel reinforcement channels between two abutting frames. Anchor to structure and floor.

3.03 ERECTION TOLERANCES

A. Maximum Diagonal Distortion: 1/16 inch measured with straight edges, crossed corner to corner.

END OF SECTION

SECTION 08 13 14
STANDARD STEEL DOORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Non-rated thermally insulated steel doors.

1.02 RELATED SECTIONS

A. Section 08 12 14 – Standard Steel Frames.

B. Section 08710 – Finish Door Hardware.

1.03 REFERENCES

A. ASTM A525 - Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.

B. ASTM C236 - Test Method for Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot-Box.

C. DHI (Door Hardware Institute) - The Installation of Commercial Steel Doors and Steel Frames, Insulated Steel Doors in Wood Frames and Builder's Hardware.

D. SDI-100 - Standard Steel Doors and Frames.

1.04 SUBMITTALS FOR REVIEW

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-02 Shop Drawings:
      a. Indicate door elevations, internal reinforcement, closure method, cut- outs for glazing, and all associated details.
   2. SD-03 Product Data:
      a. Indicate door configurations, location of cut-outs for hardware reinforcement.

1.05 QUALITY CONTROL

A. Conform to requirements of SDI-100.

B. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years' experience.

C. Provide in accordance with Division 01.

1.06 WARRANTY

A. Manufacturer five year written against failure of door construction, steel separation and core separation from panel.

1.07 PROJECT CONDITIONS

A. Coordinate the work with door opening construction, door frame, and door hardware installation.

B. Sequence installation to ensure wire connections are achieved in an orderly and expeditious manner.

PART 2 - PRODUCTS

2.01 DOOR MANUFACTURERS

A. Manufacturers:
   1. Curries Essex.
   2. Ceco Corporation.
   3. Steelcraft.
   4. Substitutions: Per Section 01600 – Common Product Requirements.

2.02 DOORS

A. Exterior Doors (Thermally Isolated): ANSI A250.8, 1-3/4 inch thick.
   1. Level 2 – Heavy Duty, Model 1, 1 3/4 inch thick, full flush design.

B. Interior Doors (Non-rated): ANSI A250.8, 1-3/4 inch thick.
   1. Level 2 – Heavy Duty, Model 1, full flush design.

2.03 DOOR CONSTRUCTION

A. Face: Steel sheet in accordance with SDI-100, 16 gauge cold rolled stretcher steel for Grade II, 16 gauge for Grade III.

B. End Closure: Channel, top and bottom, 16 gauge minimum with closing channel flush.

C. Exterior Grade Polyisocyanurate Foam Core: Door shall be reinforced per manufacturer standard method.

2.04 ACCESSORIES

A. Glass: In accordance with Section 08 80 00.

B. Removable Stops: Rolled steel, channel shape, mitered corners; prepared for countersink style tamper proof screws.

C. Primer: Manufacturer standard lead and chromate free type.

2.05 FABRICATION

A. Fabricate doors with hardware reinforcement welded in place.
   1. Lock Rails: 14 gauge.
   2. Top and Bottom Closure Channels: 16 gauge.
   3. Closer and Holder Reinforcing: 12 gauge.
   4. Rim Panics: 14 gauge.

B. Configure exterior doors with special profile to receive recessed weather-stripping.

2.06 FINISH

A. Steel Sheet: Galvanized to ASTM A526 G60.

B. Primer: Manufacturer standard shop priming.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that opening sizes and tolerances are acceptable.

3.02 INSTALLATION

A. Install doors in accordance with SDI-100.

B. Coordinate installation of glass and glazing.

C. Coordinate installation of doors with installation of frames specified in Section 08 12 14 – Standard Steel Frames and hardware specified in Section 08 71 00 – Door Hardware.

D. Touch-up factory prime finished doors.

3.03 ERECTION TOLERANCES

A. Maximum Diagonal Distortion: 1/16 inch measured with straight edge, corner to corner.

3.04 ADJUSTING

A. Adjust door for smooth and balanced door movement.

END OF SECTION

SECTION 08 41 13
ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Aluminum-framed storefronts including aluminum and glass doors and frames including hardware, glass, and infill panels.
   2. Operable window segments stopped into aluminum storefront frame open panes.

B. Related Sections:
   1. Section 07 90 00 – Joint Protection: System perimeter sealant and back-up materials.
   2. Section 08 41 13 – Glazed Aluminum Curtain Walls.
   3. Section 08 80 00 – Glazing.

1.02 REFERENCES

A. Aluminum Association (AA):
   1. AA ADM 1 - Aluminum Design Manual.

B. American Architectural Manufacturers Association/Window & Door Manufacturers Association (AAMA/WDMA):
   1. AAMA/WDMA 101/I.S.2 - Specification for Windows, Doors and Unit Skylights.
   2. AAMA 502 - Voluntary Specification for Field Testing of Windows and Sliding Glass Doors.
   3. AAMA 503 - Voluntary Specification for Field Testing of Metal Storefronts. Curtain Wall and Sloped Glazing Systems.
   4. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.
   5. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.
   6. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.
   7. AAMA 2604 - Voluntary specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.
   8. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
   9. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site.
   10. AAMA MCWM-1 - Metal Curtain Wall Manual.
   11. AAMA SFM-1 - Aluminum Store Front and Entrance Manual.

C. American Society of Civil Engineers (ASCE):
   1. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.

D. ASTM International (ASTM):
   1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
   2. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

3. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
4. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
5. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
6. ASTM E330 - Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
7. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
8. ASTM E547 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Cyclic Static Air Pressure Differential.
9. ASTM E1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Curtain Walls, and Doors by Uniform or Cyclic Static Air Pressure Difference.
10. ASTM E1886 - Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials.
11. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes.

E. National Fenestration Rating Council Incorporated (NFRC):
1. NFRC 100 - Procedures for Determining Fenestration Product U-Factors.

F. The Society for Protective Coatings (SSPC):
1. SSPC Paint 20 - Zinc-Rich Primers (Type I - Inorganic and Type II - Organic).
2. SSPC Paint 25 - Red Iron Oxide, Zinc Oxide, Raw Linseed Oil, and Alkyd Primer.

1.03 SYSTEM DESCRIPTION

A. Aluminum-framed storefront system includes tubular aluminum sections with supplementary internal support framing, aluminum and glass entrances, shop fabricated, factory finished, glass and glazing, insulated metal panel infill, related flashings, anchorage and attachment devices.

B. System Assembly: Site assembled. Shop unitized assembly.

1.04 PERFORMANCE REQUIREMENTS

A. Deflection: Limit mullion deflection to 1/175 for spans under 13’-6” and 1/240 plus 1/4 inch for spans over 13’-6”; with full recovery of glazing materials.

B. System Assembly: Accommodate without damage to components or deterioration of seals, movement within system, movement between system and peripheral construction, dynamic loading and release of loads, deflection of structural support framing.

C. Expansion / Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over 12-hour period without causing detrimental effect to system components and anchorage.

D. System Internal Drainage: Drain water entering joints, condensation occurring in glazing channels, or migrating moisture occurring within system, to exterior by weep drainage network.

1.05 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-02 Shop Drawings:
      a. Indicate system dimensions, framed opening requirements and tolerances, affected related Work and expansion and contraction joint location and details.
   2. SD-03 Product Data:
      a. Submit component dimensions; describe components within assembly, anchorage and fasteners, glass and infill, door hardware, and internal drainage details.
   3. SD-04 Samples:
      a. Submit color sample swatches for final selection of finish and color.

1.06 QUALITY CONTROL

A. Perform Work in accordance with AAMA SFM-1 and AAMA MCWM-1 - Metal Curtain Wall, Window, Store Front and Entrance - Guide Specifications Manual.

B. Surface Burning Characteristics:
   1. Foam Insulation: Maximum 75/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

C. Manufacturer to engineer system to resist site induced loading conditions:
   1. See structural drawings for design requirements.

D. Provide in accordance with Division 01.

1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing aluminum glazing systems with minimum three years' experience.

B. Installer: Company specializing in installing aluminum glazing systems with minimum three years' experience.

C. Design structural support framing components under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of Montana.

1.08 DELIVERY, STORAGE, AND PROTECTION

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Handle Products of this section in accordance with AAMA MCWM-1 - Curtain Wall Manual #10.

C. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings which bond when exposed to sunlight or weather.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements.

B. Do not install sealants or glazing materials when ambient temperature is less than 40 degrees F during and 48 hours after installation.

1.10 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Coordinate the Work with installation of air barrier, vapor retarder, and Atlantic Richfield Company supplied security system and any other related components or materials.

C. Coordinate door hardware, electrical power, raceways, and alarms with the products of this section.

1.11 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 - PRODUCTS

2.01 ALUMINUM-FRAMED STOREFRONTS

A. Manufacturers:
   1. Oldcastle Building Envelope: Series 1000 single glazing, center-set non thermally broken frame.
   2. Kawneer North America.
   3. Substitutions: Section 01 60 00 - Product Requirements.

B. Interior Application Product Description:
   1. Center Glazed: Glass resides to the center of the profile.
   2. Section designed to accept 1/4” glazing, location dependent, glazing as specified in Section 08 80 00.
   3. 1 ¾ inch x 4-inch section dimension.
   4. Glass installs from one side.
   5. Aluminum Frame: Flush applied glazing stops.
   6. Mullions: Profile of extruded aluminum

2.02 COMPONENTS

A. Extruded Aluminum: ASTM B221; 6063 alloy, T5 temper typical, 6061 alloy, T6 temper for extruded structural members.

B. Sheet Aluminum: ASTM B209, 5005 alloy, H15 or H34 temper.

C. Glazing Materials: As specified in Section 08 80 00.

D. Flashings: Minimum 0.032 inch thick aluminum to match mullion sections where exposed.

E. Sealant and Backing Materials:
   1. Perimeter Sealant: Specified in Section 07 90 00 – Joint Protection.

F. Shims: Type and size recommended by storefront manufacture to provide gap between rough opening and outside edge of storefront.

2.03 FABRICATION

A. Fabricate components with minimum clearances and shim spacing around perimeter of assembly yet enabling installation and dynamic movement of perimeter seal.

B. Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.

C. Prepare components to receive anchor devices. Fabricate anchors.

D. Arrange fasteners and attachments to conceal from view.

E. Reinforce framing members for imposed loads.

2.04 FINISHES

A. Clear Anodized:
   1. Conforming to AA-M12C22A31 and AAMA 607.1.
   2. Architectural Class II, etched, medium matte, clear anodic coating, .4 mil minimum thickness.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify dimensions, tolerances, and method of attachment with other Work.

C. Verify wall openings and adjoining air and vapor seal materials are ready to receive Work of this Section.

3.02 INSTALLATION

A. Install wall system in accordance with AAMA MCWM-1 - Metal Curtain Wall, Window, Storefront and Entrance - Guide Specifications Manual.

B. Provide aligning and leveling shims between storefront and rough opening. Shims to provide a minimum clearance of ¼ inch.

C. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.

D. Provide alignment attachments and shims to permanently fasten system to building structure.

E. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent Work.

F. Provide thermal isolation where components penetrate or disrupt building insulation.

G. Install sill flashings. Turn up ends and edges; seal to adjacent Work to form watertight dam.

H. Coordinate attachment and seal of perimeter air and vapor retarder materials.

I. Provide low expansion foam insulation in shim spaces at perimeter of assembly to maintain continuity of thermal and air barrier.

J. Install integral flashings and integral joint sealers.

K. Set thresholds in bed of mastic and secure.

L. Coordinate installation of glass with Section 08 80 00; separate glass from metal surfaces.

M. Coordinate installation of perimeter sealants with Section 07 90 00 – Joint Protection.

3.03 ERECTION TOLERANCES

A. Section 01 40 00 - Quality Requirements: Tolerances.

B. Maximum Variation from Plumb: 0.06 inches every 3 ft non-cumulative or 1/16 inches per 10 ft, whichever is less.

C. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

3.04 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements and Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspection to monitor quality of installation and glazing.

C. Test to AAMA 502 or 503, ASTM E1105, or AAMA 501.

3.05 ADJUSTING

A. Section 01 70 00 – Execution and Closeout Requirements: Testing, adjusting and balancing.

B. Adjust operating hardware and sash for smooth operation.

3.06 CLEANING

A. Section 01 70 00 – Execution and Closeout Requirements: Final cleaning.

B. Remove protective material from pre-finished aluminum surfaces.

C. Wash down surfaces with solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.

D. Remove excess sealant by method acceptable to sealant manufacturer.

3.07 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 01 70 00 – Execution and Closeout Requirements: Protecting installed construction.

B. Protect finished Work from damage.

3.08 SCHEDULES

A. All interior storefront indicted as “ISF” on drawings to be storefront complying with requirements listed above.

END OF SECTION

SECTION 08 71 00
DOOR HARDWARE

JOB: PUMP HOUSE
BUFFALO GULCH REMEDIAL ACTION BUTTE,
MONTANA

MANUFACTURERS:

HINGES	(IV) IVES MFG.
DEADLOCKS	(SC) SCHLAGE LOCK
CLOSERS	(LC) LCN CLOSERS
PUSHES, PULLS	(IV) IVES MFG. THRESHOLD,
WEATHERSTRIP, SWEEPS	(PE) PEMKO MFG.

KEYING:
1. ALL LOCKS KEYED ALIKE.
2. PROVIDE (4) EACH KEYS.

HARDWARE GROUP #1

3 EACH	(IV) HINGES 5BB1 4 ½" X 4 ½" NRP	652
1 EACH	(SC) DEADLOCK B660P 12-631 10-094	626
1 EACH	(IV) PUSH 8200 – 4" X 16"	630
1 EACH	(IV) PULL 8302-6 – 4" X 16"	630
1 EACH	(LC) CLOSER 4040XP-H-CUSH-TB (PUSH SIDE MOUNT)	ALUM
1 EACH	(PE) THRESHOLD 2748A-36"-FHSL14	
1 SET	(PE) WEATHERSTRIP 303AS (2-84" 1-36")	
1 EACH	(PE) SWEEP 18100CNB-36"	

END OF SECTION

SECTION 09 90 00
PAINTING AND COATING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide surface preparation and painting in accordance with this Section and applicable reference standards listed in Article 1.02.
   2. Provide the following types of painting work per the Paint Schedules attached and on Drawings:
      a. Painting of new steel doors and frames.
      b. Painting of new and existing interior masonry, concrete, miscellaneous metal, and gypsum wallboard surfaces as indicated.
      c. Painting and labeling of ductile iron pipes, copper pipes, Polyvinyl Chloride (PVC) / Chlorinated Polyvinyl Chloride (CPVC) pipes, and fittings where indicated.
      d. Painting of equipment where indicated, and labeling of all equipment.
      e. Touch-up painting of factory-coated equipment.
      f. Painting of HVAC equipment and ducts where indicated.

B. Related Requirements:
   1. Section 05 50 00 – Metal Fabrications.
   2. Section 08 10 00 – Metal Doors and Frames.
   3. Section 40 05 13 – Process Pipe and Fittings.

1.02 REFERENCES

A. Reference Standards:
   1. ASTM International (ASTM):
      a. ASTM A780 - Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
      b. ASTM D4258 - Standard Practice for Surface Cleaning Concrete for Coating.
      c. ASTM D4259 - Standard Practice for Abrading Concrete.
      d. ASTM D4260 - Standard Practice for Liquid and Gelled Acid Etching of Concrete.
      e. ASTM 4261 - Standard Practice for Surface Cleaning Concrete Unit Masonry for Coating.
      f. ASTM D4263 - Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
      g. ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness by Notch Gages.
      h. ASTM D4417 - Standard Test Method for Field Measurement of Surface Profile of Blast Cleaned Steel.
      i. ASTM D6386 - Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Products and Hardware Surfaces for Painting.
      j. ASTM D6944 - Standard Test Method for Measuring Humidity with a Physchrometer.
      k. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
   2. International Concrete Repair Institute (ICRI):
      a. ICRI Technical Guideline No 310.1 - Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion.

b. ICRI Technical Guideline No 310.2 - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair with CSP Chips.

3. NACE International (NACE):
   a. NACE Publication 6D-173 - A Manual for Painter Safety.
   b. NACE SP0178 - Surface Finishing of Welds Prior to Coating.
   c. NACE No. 6/SSPC-SP13 - Surface Preparation of Concrete.
4. NSF International (NSF):
   a. NSF/ANSI 61 - Drinking Water System Components – Health Effects.
5. Steel Structures Painting Council (SSPC):
   a. SSPC-Paint 16 - Coal Tar Epoxy-Polyamide.
   b. SSPC-Paint 20 - Zinc-Rich Coating Inorganic and Organic.
   c. SSPC-SP12/NACE 5 - Surface Preparation and Cleaning of Steel and Other Hard Materials by High and Ultra High-Pressure Jetting Prior to Recoating.
   d. SSPC-SP13/NACE No. 6 - Surface Preparation of Concrete.
   e. SSPC-Guide 12 - Guide for Illumination of Industrial Painting Projects.
   f. SSPC-VIS-1 - Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning.

B. Definitions:
1. Concrete Surface Profiles (CSP) per ICRI Technical Guideline No 310-2. Concrete surface preparation definitions listed below shall be field verified with Concrete Surface Profile Chips.
   a. CSP 1: Acid Etched.
   b. CSP 2: Grinding.
   c. CSP 3: Light Shotblast.
   d. CSP 4: Light Scarification.
   e. CSP 5: Medium Shotblast.
   f. CSP 6: Medium Scarification.
   g. CSP 7: Heavy Abrasive Blast.
   h. CSP 8: Scabbed.
   i. CSP 9: Heavy Scarification.
   j. CSP 10: Course Planing.
2. Surface Preparation of Carbon Steel per SSPC Surface preparation Standards. Definitions below summarize surface preparation requirements for each level of cleaning. Refer to SSPC standards for complete requirement for each level of surface preparation and cleaning.
   a. Adherent: Mill scale, rust and coating are considered tightly adherent if they cannot be lifting with a dull putty knife.
   b. SSPC-SP1: Solvent Cleaning – The removal of all visible oil, grease, soil, drawing and cutting compounds and other soluble contaminants from surfaces with solvents or commercial cleaners using various methods of cleaning such as wiping, dipping, steam cleaning or vapor degreasing.
   c. SSPC-SP2: Hand Tool Cleaning – The removal of all loose mill scale, loose rust, loose paint and other loose detrimental foreign matter by the use of non-power hand tools.
   d. SSPC-SP3: Power Tool Cleaning – The removal of all loose mill scale, loose rust, loose paint and other loose detrimental foreign matter by the use of power-assisted hand tools.
   e. SSPC-SP5/NACE 1: White Metal Blast Cleaning – The complete removal of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products and other foreign matter by compressed air nozzle blasting, centrifugal wheels or other specified methods.

f. SSPC-SP6/ NACE 3: Commercial Blast Cleaning – The complete removal of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products and other foreign matter by compressed air nozzle blasting, centrifugal wheels or other specified methods. Discoloration caused by certain stains shall be limited to no more than 33 percent: Brush-off Blast Cleaning – A brush-off, blast-cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, loose mill scale, loose rust and loose coating. Tightly adhered mill scale, rust and coating may remain on the surface.
g. SSPC-SP10 / NACE 2: Near-White Metal Blast Cleaning – The removal of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products and other foreign matter by compressed air nozzle blasting, centrifugal wheels or other specified method. Discoloration caused by certain stains shall be limited to no more than 5 percent of each unit area. Unit area is approximately 9 sq. in.
h. SSPC-SP11: Power Tool Cleaning to Bare Metal – The removal of all visible oil, grease, dirt, mill scale, rust, paint, oxide, corrosion products, and other foreign matter. Slight residues of rust and paint may be left in the lower portion of pits if the original surface is pitted. Differs from SSPC-SP3 in that is requires more thorough cleaning and a surface profile not less than 1 mil (25 microns).

3. SSPC-SP12 / NACE 5: Pressure Categorization:
   a. Water Jetting: Use of water at high or ultrahigh-pressure to prepare a surface for recoating using pressure above 10,000 psi. Water jetting will not produce a profile; rather it exposes the original abrasive-blast surface profile.
   b. Low-Pressure Water Cleaning (LP WC): Cleaning performed at pressures less than 5,000 psi.
   c. High-Pressure Water Cleaning (HP WC): Cleaning performed at pressures from 5,000 psi to 10,000 psi
   d. High-Pressure Water Jetting (HP WJ): Cleaning performed at pressures from 10,000 psi to 25,000 psi.
   e. Ultra-High-Pressure Water Jetting (UHP WJ): Cleaning performed at pressures above 25,000 psi.
4. SSPC-SP12 / NACE 5: Visual Conditions of Surface Cleanliness:
   a. Water jetting shall be performed to meet one of the following four conditions: WJ-1, WJ-2, WJ-3, WJ-4, and a minimum acceptable surface shall have all loose rust, loose mill scale, and loose coatings uniformly removed.
   b. WJ-1: Surface shall be free of all previously existing visible rust, coatings, mill scale, and foreign matter and have a matte metal finish.
   c. WJ-2: Surface shall be cleaned to a matte finish with at least 95% of the surface area free of all previously existing visible residues and the remaining 5% containing only random dispersed stains of rust, coatings, and foreign matter.
   d. WJ-3: Surface shall be cleaned to a matte finish with at least two-thirds of the surface free of all previously existing visible residues (except mill scale), and the remaining one-third containing only randomly dispersed stains of previously existing rust, coatings, and foreign matter.
   e. WJ-4: Surface shall have all loose mill scale, and loose coatings uniformly removed.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-03 Product Data:
      a. Block Fillers.
      b. Primers.
      c. Manufacturer's technical information including label analysis and instructions for handling, storage, and application of each material proposed for use.
      d. Manufacturer's material data and certificates of performance for proposed substitutions.
      e. List each material and cross-reference the specific coating, finish system, and application. Identify each material by the manufacturer's catalog number and general classification.
   2. SD-04 Samples and Mockups:
      a. As specified in Article 1.05.
         1) Provide Samples for initial color selection in the form of manufacturer's color charts. After color selection, furnish color chips of selections made for surfaces to be coated.
   3. SD-06 Certificates:
      a. From manufacturer that products supplied comply with local Regulations controlling use of volatile organic compounds (VOCs).
   4. SD-07 Closeout Submittals:
      a. Per Division 01 General Requirements.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Qualifications:
   1. Per Division 01 General Requirements and as follows:
      a. Engage experienced applicators who have completed painting system applications similar in material and extent to those indicated for the Project that have resulted in a construction record of successful in-service performance.

C. Samples:
   1. On wall surfaces and other exterior and interior components, duplicate finishes of prepared Samples. Provide full-coat finish Samples on at least 100 square feet of surface until required sheen, color, and texture are obtained; simulate finished lighting conditions for review of in-place Work.
      a. Final acceptance of colors will be from Project-applied Samples.
      b. The Engineer will select one room or surface to represent surfaces and conditions for each type of coating and substrate to be painted. Apply coatings in this room or surface according to the Paint Schedules attached and, on the Drawings, or as specified.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Packing, Shipping, Handling, and Unloading:
   1. Deliver materials to the Site in the manufacturer's original, unopened packages and containers bearing manufacturer's name and label, and the following information:
      a. Product name or title of material.
      b. Product description (generic classification or binder type).

c. Manufacturer's stock number and date of manufacture.
d. Contents by volume, for pigment and vehicle constituents.
e. Thinning instructions.
f. Application instructions.
g. Color name and number.

C. Storage and Protection:
1. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 degrees F. Maintain containers used in storage in a clean condition, free of foreign materials and residue. Protect from freezing.
2. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and Work areas are protected from fire and health hazards resulting from handling, mixing, and application.

D. Waste Management and Disposal:
1. Remove all unused material from the site unless Atlantic Richfield Company requests portions of unused material to be provided in properly sealed containers for future repair and maintance of coatings. Transport extra material to Atlantic Richfield Company specified storage facility located at the project site.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

1.08 MAINTENANCE

A. Extra Materials: Furnish as specified below:
1. Extra material is not specifically required.
2. Provide Atlantic Richfield Company the option to retain portions of unused surplus material in properly sealed containers prior to removing from site for disposal.

PART 2 - PRODUCTS

A. Manufacturers:
1. Tnemec.
2. Sherwin Williams (S-W).
3. PPG.
4. Or equal.

2.02 PAINT MATERIALS

A. Provide materials designated by item or area to be painted in Paint Schedules attached and on Drawings. Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers.

B. Provide primers and undercoat paint produced by the same manufacturer as the finish coats.

C. Material compatibility: Provide block fillers, primers, finish coat materials, and related materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by the manufacturer based on testing and field experience.

D. Material quality: Manufacturer's best-quality trade sale paint material of the various coating types specified. Ensure paint material containers display manufacturer's product identification.

E. Colors from the manufacturer's full range of standard colors.

2.03 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions under which painting will be performed for compliance with paint application requirements. Ensure surfaces receiving paint are thoroughly dry before paint is applied. Do not begin to apply paint until unsatisfactory conditions have been corrected.

B. Coordination of Work: Review other Specifications in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers. Notify the Engineer about anticipated problems using the materials specified over substrates primed by others.

3.02 PREPARATION

A. General Requirements:
   1. Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted or provide surface-applied protection prior to surface preparation and painting. Following completion of painting operations in each space or area, ensure workers skilled in the trades involved reinstall items.
   2. Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the various coatings. Remove oil and grease prior to cleaning. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
   3. Clean and prepare surfaces to be painted according to the manufacturer's instructions for each substrate condition and as specified herein. Use more stringent cleaning and surface preparation if manufacturer’s recommendations differ from the requirements specified herein.
      a. Provide barrier coats over incompatible primers or remove and re-prime. Notify Engineer in writing about anticipated problems using the specified finish-coat material with substrates primed by others.
      b. Ensure existing painted surfaces are structurally sound, dry, clean, and free of oil, grease, dirt, mildew, form release agents, curing compounds, efflorescence, loose and flaking paint, or other foreign material. Engineer will approve condition of prepared substrate prior to application of coating system. Test old coatings for lifting per coating manufacturer's recommendations.
   4. Abrasive Blast Surfaces: Shall be coated before any visible rust forms on the surface. Abrasive blast cleaning shall be performed only when the relative humidity is no higher than 85% and the surface temperature of the steel at its coldest point is at least 5 degrees Fahrenheit above the temperature of the dew point. Material that is abrasive blast-cleaned shall be primed in the same shift, no more than 12-hours after the surfaces have been blast-cleaned.

B. New or Previously Uncoated Surfaces:
   1. Prepare to be painted by removing efflorescence, chalk, dust, dirt, grease, oils, loose rust, and release agents.
      a. Concrete Surfaces:
         1) Curing and Sealing Compounds: If curing and sealing compounds have been applied to concrete surfaces, use CSP-1 Acid etch cleaning or CSP-4 light scarification to remove existing curing and sealing compounds.
         2) Abrasive blast-clean to ICRI CSP 2 to CSP 3.
         3) Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces where moisture content exceeds that permitted in manufacturer's printed directions.
      b. Concrete Masonry Block (CMU):
         1) Prepared surface shall be clean and dry.
         2) Low-Pressure Water Cleaning (LP WC) as required to provide clean surface.
      c. Ferrous Metals: Prepare metal according as follows:
         1) Structural steel, Steel Bar Joists, and miscellaneous metal used for interior building framing components that are not exposed to view and are not scheduled to be field painted: SSPC-SP2 prior to “shop coat” with fabricator’s standard primer.
         2) Submerged components: Sandblasted clean in accordance with SSPC-SP10/NACE 2 Near-White Blast Cleaning immediately prior to priming.
         3) All other Ferrous Metals: Sandblasted clean in accordance with SSPC-SP-6 – Commercial Grade, immediately prior to priming.
   2. Galvanized Surfaces: Clean galvanized surfaces with non-petroleum-based solvents so that the surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods in accordance with ASTM D6386.
   3. PVC Pipe: Scarify surface prior to prime coat.

C. Previously Coated Surfaces:
   1. Prepare to be painted by removing efflorescence, chalk, dust, dirt, grease, oils, loose rust, and release agents.
      a. Concrete walls, columns, and ceilings (Excludes Floors): Low-Pressure Water Cleaning (LP WC) to remove existing loose coatings. Pressure shall be less than 5000 psi. 4000 psi minimum should be used to ensure that all weekly adhered coating is removed. Tightly adherent material will be allowed to remain. Tightly adherent is defined by material that cannot be removed when tooling with a dull putty knife.
      b. Concrete Floors: ICRI CSP 5 to CSP-6.
      c. Ferrous metals including structural steel columns and beams: SSPC-SP7 Brush-Off Blast Cleaning to remove all dirt, loose rust, and loose coatings.
      d. Painted metal roof or floor deck: SSPC-SP7 Brush-Off Blast Cleaning to remove all dirt, loose rust, and loose coatings.
      e. Galvanized (corroded) Roof or Floor Deck: SSPC-SP6 Commercial Blast Cleaning or SSPC-SP11 Power Tool Cleaning to Bare Metal.
   2. Coating Compatibility: Check for coating compatibility by applying a test patch of the recommended coating system, covering at least 2-3 square feet. Allow to dry one week before testing adhesion per ASTM D3359. If the coating is incompatible contact engineer and coating manufacturer for recommendations.
   3. Existing Interior Finished Spaces: Where existing interior occupied spaces are schedules to be coated, perform surface preparation and cleaning without damage to

existing finishes, electronics, and equipment that cannot be removed prior to coating. Surface preparation and cleaning shall include the following steps until all efflorescence, chalk, dust, dirt, grease, oils, loose rust, and release agents are removed.
   a. Detergent Scrubbing and rinsing as required to removed dust, dirt, grease, oils, and release agents.
   b. Solvent cleaning.
   c. Hand Tool Cleaning
   d. Power Tool Cleaning.
4. Over-Coating of Hard, High-gloss, or existing epoxy coatings. Overcoating mechanical equipment or other surfaces that would otherwise be damaged by Water Cleaning or Abrasive Blast Cleaning:
   a. Clean existing coating with degreaser or other cleaner recommended by coating manufacturer.
   b. Remove damaged, delaminated, or questionable portions of existing coat from the substrate.
   c. Sand, grind, or abrasive blast existing coating to clean and texture surface to improve bond of over-coat.

3.03 COLOR SELECTION

A. Colors of Finish Coats:
   1. PTE-1: Selected by Architect (Interior Walls).
   2. PT-1: Selected by Architect (Door frames and any exposed steel).
   3. PT-2: Selected by Architect (Exterior wall, concrete surfaces).

3.04 APPLICATION

A. General:
   1. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 degrees F and 90 degrees F.
   2. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45 degrees F and 95 degrees F.
   3. Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85 percent; or to damp or wet surfaces. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by the manufacturer during application and drying periods.
   4. Priming Abrasive Blast Surfaces: Shall be primed before any visible rust forms on the surface. Abrasive blast cleaning shall be performed only when the relative humidity is no higher than 85% and the surface temperature of the steel at its coldest point is at least 5 degrees Fahrenheit above the temperature of the dew point. Material that is abrasive blast-cleaned shall be primed in the same shift, no more than 12-hours after the surfaces have been blast-cleaned.
   5. Carefully mix and prepare paint materials according to manufacturer's directions.
      a. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
      b. Stir material before application to produce a mixture of uniform density; stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.
   6. Use only thinners approved by the paint manufacturer and only within recommended limits.
   7. Apply paint according to manufacturer's directions. Use applicators and techniques best suited for substrate and type of material being applied.

a. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
b. Paint colors, surface treatments, and finishes as indicated in the Paint Schedules.
c. Provide finish coats that are compatible with primers used.
d. The number of coats and the film thickness required are the same regardless of the application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. Sand between applications where sanding is required to produce a smooth even surface according to the manufacturer's directions.
e. Apply additional coats if undercoats, stains, or other conditions show through final coat of paint until paint film is of uniform finish, color, and appearance. Give special attention to ensure that surfaces, including edges, corners, crevices, welds, and exposed surfaces/fasteners, receive a dry film thickness equivalent to that of flat surfaces.
f. The term “exposed surfaces” includes areas visible when permanent or built-in fixtures, convector covers, covers for finned tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.
g. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
h. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint.
i. Paint backsides of access panels and removable or hinged covers to match exposed surfaces.
j. Finish exterior doors on tops, bottoms, and side edges same as exterior faces.
k. Sand lightly between each succeeding enamel or varnish coat.
l. Omit primer on metal surfaces that have been shop-primed and touch-up painted.
m. Prime concrete masonry unit (CMU) walls and apply 1 finish coat prior to installation of any wall mounted equipment, piping, conduits, or fixed objects that would limit access for application of coating system and/or conceal portions of the wall surface. Apply second finish coat after all Work of other trades is completed.

B. Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
1. Allow sufficient time between successive coats to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion.

C. Apply paints and coatings by brush, roller, spray, or other applicators according to the manufacturer's directions.
1. Use brushes best suited for the material applied.
2. Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.
3. Use airless spray equipment with orifice size as recommended by the manufacturer for the material and texture required.

D. Apply materials no thinner than the manufacturers’ recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.

E. Paint only mechanical and electrical work exposed in mechanical equipment rooms and in occupied spaces and paint mechanical, electrical, HVAC, process equipment, and other

utility items as indicated on the Drawings. Do not paint items that are factory painted. Factory applied coating systems are specified in the Specification where the product or item is specified. Items to be painted include:

1. Piping.
2. Pumps.
3. Heat exchangers.
4. Tanks.
5. HVAC ductwork.
6. Insulation.
7. Supports.
8. Motors and mechanical equipment.
9. Accessory items.

F. Ferrous metals indicated on the Drawings to be painted will be provided with a shop primer compatible with the coatings specified. Paint ferrous metals specified in Section 05 50 00 – Metal Fabrications that are not galvanized and indicated to be painted on the Drawings.

G. Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.

3.05 PRIME COATS

A. Before applying finish coats, apply a prime coat of material as recommended by the manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing. Apply prime coat to previously painted surfaces if finish coats are not compatible with existing coating.

3.06 PIGMENTED (OPAQUE) FINISHES

A. Completely cover to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

3.07 PIPE, VALVE/EQUIPMENT IDENTIFICATION AND COLOR CODING

A. Provide identification of pipes, valves and pumps by color as specified in the Section 40 05 13 – Process Pipe and Fittings. Color selections for each system shall be provided by the Engineer and Atlantic Richfield Company.

3.08 COMPLETED WORK

A. Match approved Samples for color, texture, and coverage. Remove, refinish, or repaint Work not complying with specified requirements.

3.09 CLEANING

A. At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from the Site. Clean up debris resulting from Work and dispose in Project on-site trash receptacles.

B. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces.

3.10 PROTECTION

A. Protect Work of other trades, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as acceptable to Engineer.

B. Provide Wet Paint signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their Work after completing painting operations..

C. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.11 REPAIR

A. Hot-dip Galvanized Surfaces:
   1. Field repair all damaged hot-dip galvanized coatings.
   2. Work shall conform to ASTM A780.

B. Coatings:
   1. Repair any damaged shop applied primers and coatings as required to provide the same level of protection as provided by undamaged coating systems.
   2. Color and finish of repairs shall match adjacent undamaged coating.

3.12 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Site/Field tests and inspections: May be required by Atlantic Richfield Company up to 4 times during the period when paint is being applied.
   1. Engage the services of an independent testing agency with minimum 5 years of experience to sample the paint material used. Provide that Samples of material delivered to the Project are taken, identified, sealed, and certified in the presence of the Construction Management General Contractor (CMGC).
   2. The independent testing agency shall perform appropriate tests at no additional cost to the Atlantic Richfield Company for the following characteristics:
      a. Quantitative materials analysis.
      b. Abrasion resistance.
      c. Apparent reflectivity.
      d. Flexibility.
      e. Washability.
      f. Absorption.
      g. Accelerated weathering.
      h. Dry opacity.
      i. Accelerated yellowness.
      j. Recoating.
      k. Skinning.
      l. Color retention.
      m. Alkali and mildew resistance.
   3. If test results show material being used does not comply with specified requirements, stop painting, remove noncomplying paint, repaint surfaces coated with rejected paint, and remove rejected paint from previously painted surfaces if, upon repainting with specified paint, the two coatings are incompatible.

3.13 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

3.14 ATTACHMENTS

A. Paint Schedule.

END OF SECTION

ATTACHMENT – PAINT SCHEDULE

Number of coats scheduled is as a minimum. Painting and finishing shall conform to applicable Laws and building code regarding fire hazard classifications and volatile organic content of finish materials. Products listed shall not be in-contact with Potable Water and do not comply with NSF/ANSI 61. Provide products by the manufacturers named or approved equal.

Refer to the Drawings for building areas to be painted.

Provide paint and coating systems listed below where the Drawings refer to this Specification section or reference any item to be painted or coated, unless a specific paint or coating system is specified elsewhere.

This list is intended to cover all potential conditions that may require painting and not all paint and coating systems listed below may not be included in the Work.

A. Equipment: Exterior Non-Submerged Ferrous Metals (Epoxy, Polyurethane)		
Factory Applied Primer	1. Tnemec: Series 1 Omnithane 2. S-W: Corothane I Galvapac Zinc Primer 1K 3. PPG: Amercoat 68 HS 4. Or Equal	DFT 2.5 – 3.5 mils DFT 3 – 4 mils DFT 2 – 5 mils
Factory Applied Intermediate Coat	1. Tnemec: Series 66HS Hi-Build Epoxoline 2. S-W: Macropoxy 646-100 3. PPG: Amercoat 370 4. Or Equal	DFT 3 – 5 mils DFT 3 – 5 mils DFT 4 – 6 mils
Factory Applied Finish Coat	1. Tnemec: Series 73-color Endura-Shield 2. S-W: Hi-Solids Polyurethane 3. PPG: Amercoat 450H Shield 4. Or Equal	DFT 2.5 – 5 mils DFT 3 – 5 mils DFT 2 – 5 mils
B. Equipment: Interior Non-Submerged Ferrous Metals (Epoxy)		
Factory Applied Primer	1. Tnemec: Series 1 Omnithane 2. S-W: Corothane I Galvapac Zinc Primer 1K 3. PPG: Amercoat 68 HS” 4. Or Equal	DFT 2.5 – 3.5 mils DFT 3 – 4 mils DFT 2 – 5 mils
Factory Applied Intermediate Coat	1. Tnemec: Series 66HS Hi-Build Epoxoline 2. S-W: Macropoxy 646-100 3. PPG: Amerlock2/400 4. Or Equal	DFT 3 – 5 mils DFT 3 – 4 mils DFT 4 – 8 mils
Factory Applied Finish Coat	1. Tnemec: Series 66HS Hi-Build Epoxoline 2. S-W: Macropoxy 646-100 3. PPG: Amerlock2/400 4. Or Equal	DFT 3 – 5 mils DFT 3 – 4 mils DFT 4 –8 mils

C. Equipment: Exterior or Interior Submerged Ferrous Metals (Epoxy)		
Factory Applied Primer	1. Tnemec: Series 1 Omnithane 2. S-W: Corothane I Galvapac Zinc Primer 1K 3. PPG: Amercoat 68HS" 4. Or Equal	DFT 2.5 – 3.5 mils DFT 3 – 4 mils DFT 2 – 5 mils
Factory Applied Intermediate Coat	1. Tnemec: Series 66HS Hi-Build Epoxoline 2. S-W: Dura-Plate 235 3. PPG: Amercoat 370 4. Or Equal	DFT 6 – 8 mils DFT 6 – 8 mils DFT 4 – 6 mils
Factory Applied Finish Coat	1. Tnemec: Series 66HS Hi-Build Epoxoline 2. S-W: Dura-Plate 235 3. PPG: Amercoat 450H Shield 4. Or Equal	DFT 6 – 8 mils DFT 6 – 8 mils DFT 2 –5 mils
D. Hot-Dip Galvanized Field Repair Coating (SSPC Paint 20, Acrylic/Polyurethane)		
Field Applied SSPC Paint Spec 20 (Repair Coat)	1. Tnemec: Series 90-97 Tneme-Zinc 2. S-W: Zinc Clad 200 3. PPG: Amercoat 68 HS 4. Or Equal: conforming to SSPC Paint Spec 20	DFT 2.5 – 3.5 mils DFT 2 – 3 mils DFT 2 – 5 mils
Field Applied (2) Finish Coats (color match Hot-dip finish)	1. Tnemec: Series 1029 Enduratone 2. S-W: Pro-Industrial DTM Acrylic 3. PPG: Amercoat 450H 4. Or Equal	DFT 2– 3 mils/ct DFT 4– 6 mils/ct DFT 4– 5 mils/ct
E. Ferrous Metals: Exterior Exposure (Epoxy, Polyurethane)		
Factory Applied Primer	1. Tnemec: Series 66HS Hi-Build Epoxoline 2. S-W: Macropoxy 646 3. PPG: Amercoat 385 4. Or Equal	DFT 2 – 3 mils DFT 4 – 6 mils DFT 4 – 8 mils
Field Applied Two Finish Coats	1. Tnemec: Series 1095 Endura-Shield 2. S-W: High Solids Polyurethane 3. PPG: Amercoat 450H 4. Or Equal	DFT 2 – 5 mils/ct DFT 3 – 4 mils/ct DFT 2 – 4 mils/ct
F. Ferrous Metals: Interior Exposure (Epoxy)		
Factory Applied (Shop Primer)	1. Fabricator's Standard Shop Primer: only permitted if specified (allowed) in other Specification Sections.	DFT 1 mil
Factory Applied Primer (unless noted otherwise)	1. Tnemec: Series 27 F.C. Typoxy 2. S-W: Recoatable Epoxy Primer 3. PPG: Amerlock 370 4. Or Equal	DFT 2 – 3 mils DFT 4 – 6 mils DFT 4 – 6 mils
Field Applied Two Finish Coats	1. Tnemec: Series 66HS Hi-Build Epoxoline 2. S-W: Macropoxy 646 3. PPG: Amerlock 2 4. Or Equal	DFT 2 – 3 mils/ct DFT 3 – 5 mils/ct DFT 4 – 8 mils/ct

G. Ductile, Cast Iron, Copper, Aluminum, or PVC: Interior or Exterior (Epoxy/Polyurethane)		
Field Applied Prime Coat	1. Tnemec: Series 66HS Hi-Build Epoxoline 2. S-W: Macropoxy 646 3. PPG: Amerlock 2 4. Or Equal	DFT 2 – 3 mils DFT 3 – 5 mils DFT 4 – 8 mils
Field Applied Intermediate Coat	1. Tnemec: Series 66HS Hi-Build Epoxoline 2. S-W: Macropoxy 646 3. PPG: Amerlock 2 4. Or Equal	DFT 4 – 6 mils DFT 3 – 5 mils DFT 4 – 8 mils
Field Applied Finish Coat	1. Tnemec: Series 1095 Endura-Shield 2. S-W: High Solids Polyurethane 3. PPG: Amercoat 250H 4. Or Equal	DFT 2 – 5 mils DFT 4 – 5 mil DFT 4 – 6 mils
H. Ductile Iron Pipe Submerged (Epoxy)		
Field Applied Prime Coat	1. Tnemec: Series 20HS Pota-Pox 2. S-W: Dura-Plate 235 3. PPG: Amerlock 2 4. Or Equal	DFT 2 – 3 mils DFT 4 – 6 mils DFT 4 – 8 mils
Field Applied Intermediate Coat	1. Tnemec: Series 20HS Pota-Pox 2. S-W: Dura-Plate 235 3. PPG: Amerlock 2/400 4. Or Equal	DFT 4 – 6 mils DFT 3 – 4 mils DFT 4 – 8 mils
Field Applied Finish Coat	1. Tnemec: Series 20HS Pota-Pox 2. S-W: Dura-Plate 235 3. PPG: Amerlock 2/400 4. Or Equal	DFT 4 – 6 mils DFT 4 – 6 mil DFT 4 – 8 mils
I. Insulated Pipe Interior or Exterior Exposure (Acrylic)		
Field Applied Prime Coat	1. Tnemec: Series 151-1051 Elasto-Grip F.C. 2. S-W: DTM Acrylic/Primer 3. PPG: Pitt Tech Plus Primer 4. Or Equal	DFT 1 – 1.5 mils DFT 2.5 – 4 mils DFT 2 – 4 mils
Field Applied Intermediate Coat	1. Tnemec: Series 1029 Enduratone 2. S-W: Sher-Cryl HPA 3. PPG: Pitt Tech Plus 90-131 4. Or Equal	DFT 2 – 3 mils DFT 2.5 – 4 mils DFT 2 – 4 mils
Field Applied Finish Coat	1. Tnemec: Series 1029 Enduratone 2. S-W: Sher-Cryl HPA 3. PPG: Pitt Tech Plus 90-131 4. Or Equal	DFT 2 – 3 mils DFT 2.5 – 4 mils DFT 2 – 4 mils
J. Interior Concrete Surfaces		
Field Applied Prime Coat	1. S-W: Loxon concrete and Masonry Primer Sealer, AZ4W8300 2. Or Equal	
Field Applied Two Finish Coat	1. S-W: Pro Industrial Pre-Catalyzed Water Based Epoxy Eg-Shel, K-45 Series 2. Or Equal	
K. Exterior Concrete Surfaces		
Field Applied Finish Coat	1. S-W: Anti-Graffiti Coating 2. Or Equal	

L. Interior Gypsum Board Ceilings (Acrylic) satin finish or low semi-gloss		
Field Applied Prime Coat	1. Tnemec: Series 151-1051 Elasto-Grip FC 2. S-W: PrepRite 200 Latex Primer 3. PPG: Seal Grip Primer 4. Or Equal	DFT 1 – 1.5 mils DFT 1 – 1.5 mils DFT 1 – 1.5 mils
Field Applied Intermediate Coat	1. Tnemec: Series 1029 Enduratone 2. S-W: FastClad HB Acrylic 3. PPG: Break-Through 50 WB Acrylic 4. Or Equal	DFT 2 – 3 mils DFT 2 – 3 mils DFT 2 – 3 mils
Field Applied Finish Coat	1. Tnemec: Series 1029 Enduratone 2. S-W: FastClad HB Acrylic 3. PPG: Break-Through 50 WB Acrylic 4. Or Equal	DFT 2 – 3 mils DFT 2 – 3 mils DFT 2 – 3 mils
M. Interior Gypsum Board Walls Heavy-Abuse Coating (Epoxy) gloss or semi-gloss		
Field Applied Prime Coat	1. Tnemec: Series 151-1051 Elasto-Grip FC 2. S-W: PrepRite 200 Latex Primer 3. PPG: Seal Grip Primer 4. Or Equal	DFT 1– 1.5 mils DFT 1 – 1.5 mils DFT 1 – 1.5 mils
Field Applied Intermediate Coat	1. Tnemec: Series 280 Tneme-Glaze 2. S-W: Pro Industrial WB Catalyzed Epoxy 3. PPG: HPC High Gloss Epoxy 4. Or Equal	DFT 4 – 8 mils DFT 4 – 8 mils DFT 4 – 8 mils
Field Applied Finish Coat	1. Tnemec: Series 280 Tneme-Glaze 2. S-W: Pro Industrial WB Catalyzed Epoxy 3. PPG: HPC High Gloss Epoxy 4. Or Equal	DFT 4 – 8 mils DFT 4 – 8 mils DFT 4 – 8 mils
N. Interior or Exterior Steel Doors and Frames- (Polyurethane)		
Shop Applied Prime Coat	1. Factory Primed Per Section 08 11 00	
Field Applied Two Finish Coats	1. Tnemec: 1095 Endura-Shield 2. S-W: High Solids Polyurethane 3. PPG: Amercoat 450H 4. Or Equal	DFT 2 – 5 mils DFT 3 – 4 mils DFT 2 – 4 mils
O. Bituminous Coating (SSPC Paint 16)		
Shop Applied & (Field Touch-up)	1. Tnemec: Series 46H-413 Tneme-Tar 2. S-W: Targuard Coal Tar Epoxy 3. PPG: Amercoat 78HB 4. Or Equal	2 shop coats DFT 8– 10 mils/ct
P. Concrete Floor Sealer (SC)		
Field Applied Finish Coat	1. H & C Concrete Sealer Wet – Look Water Based 100% Acrylic Sealer 2. Or Equal	
Slip Resistant Additive	1. H & C Shark Grip 2. Or Equal	

END OF ATTACHMENT

SECTION 22 05 00
COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Overall requirements for plumbing installations common to Specifications in Division 22 Plumbing. Also refer to Division 01 General Requirements.
2. Materials and installation methods to conform to applicable standards, guidelines and codes referenced in this section and within Specifications.

1.02 REFERENCES

A. Reference Standards:
1. American Association of State Highway and Transportation Officials (AASHTO):
   a. AASHTO T 99 - Standard Method of Test for Moisture–Density Relations of Soils Using a 5.5-lb Rammer and a 12-in. Drop.
2. American Society of Mechanical Engineers (ASME):
   a. ASME B31 - Code for Pressure Piping.
3. ASTM International (ASTM):
   a. ASTM A36 - Standard Specification for Carbon Structural Steel.
   b. ASTM A575 - Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
   c. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort.
   d. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
   e. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
4. American Welding Society (AWS):
   a. AWS D1.1 - Changes to Structural Welding Code – Steel.
5. Boiler and Pressure Vessel Code (BPVC):
   a. BPVC Section IX - Welding and Brazing Qualifications.
6. International Energy Conservation Code (IECC).
7. Uniform Plumbing Code, 2021 Edition.
8. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry:
   a. SP58 Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
   b. SP-69 Pipe Hangers and Supports - Selection and Application.
9. National Electrical Manufacturers Association (NEMA):
   a. NEMA MG1 - Motors and Generators.
10. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
    a. SMACNA IAQ - Guidelines for Occupied Buildings Under Construction.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-02 Shop Drawings:
      a. Manufacturer's assembly-type Shop Drawings indicating dimensions, weight loading, required clearances and methods of assembly of components.
         1) Field measurements and investigations ensuring equipment and assemblies meet requirements.
         2) If equipment submitted differs in arrangement from that shown, provide Drawings showing rearrangement of associated systems.
   2. SD-03 Product Data:
      a. Manufacturer's technical product data, including rated capacities of selected model clearly indicating weights (shipping, installed and operating), furnished specialties and accessories, and installation and start-up instructions.
      b. Manufacturer Instructions:
         1) Manufacturer's electrical requirements for power supply wiring to electrical equipment. Manufacturer's ladder-type wiring diagrams for interlock and control wiring required for final installation of electrical equipment and controls. Clearly differentiate between factory-installed and field-installed portions.
   3. SD-06 Certificates:
      a. Manufacturer Reports:
         1) Submit computer generated, certified performance and data with system operating conditions indicated.
         2) Certify in writing that manufacturers of major items of equipment have reviewed the drawings and specifications and have jointly coordinated and properly integrated their equipment and controls to provide a complete, functional installation.
   4. SD-07 Closeout Submittals:
      a. Per Division 01 General Requirements:
         1) Maintenance data and parts list for systems, equipment, control and accessories; including "trouble-shooting" maintenance guide.
         2) Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
         3) Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
         4) Servicing instructions and lubrication charts and schedules.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Qualifications: Per Division 01 General Requirements and as follows:
   1. Provide installers with at least 2 years of successful installation experience on projects with mechanical installation work similar to work specified. Equipment and materials to be installed in a neat manner and shall be aligned, leveled, adjusted for satisfactory operation and installed per manufacturer's instructions.
   2. Qualify welding processes and operators for structural steel according to AWS D1.1.
   3. Comply with ASME B31.

4. Provide quality welding processes and operators for piping according to BPVC Section IX, Welding and Brazing Qualifications.
5. Provide items free from defects that would adversely affect performance, maintainability, and appearance of individual components and overall assembly.
6. Products and execution of Work specified in Division 22 to conform to Laws and Regulations.
    a. Notify Engineer of discrepancies between Laws and Regulations and these Specifications.
7. Conform to Federal Act S.3874 requiring the reduction of lead in drinking water.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.07 SITE CONDITIONS

A. Existing conditions: Per Division 01 General Requirements.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.01 EXCAVATION, FILL, BACKFILL COMPACTION

A. Prior to performing Work, verify underground utilities with regional utility locator.

B. Conduct excavation, filling, backfilling, and compacting associated with Work performed.
    1. Excavation:
        a. Protect excavations against frost and freezing.
        b. Dispose of excavated earth as directed.
    2. Dewatering:
        a. Furnish, install and operate equipment and material required to keep trenches and pits free of water.
    3. Filling and Backfilling:
        a. Waste material is not permitted for fill or backfill.
        b. Provide necessary sand and/or CA6 for backfilling.
        c. Backfill materials suitable for required compaction, free of stones greater than 4 inches in diameter.
        d. Lay pipe in a compacted bed of CA6 at least 3 inches deep. Backfill around pipes with CA6 in 6-inch layers; compact each layer. Backfill above pipes with CA6 measuring 6 inches after compacted.
        e. Where fill and backfill will be under a building, floor or paving, compact each layer of fill to 95 percent of maximum density determined by AASHTO T 99 or ASTM D698. Moisture content of soil at time of compaction may not exceed plus or minus 2 percent of optimum moisture content determined by AASHTO T 99 or ASTM D698 test.
    4. Surface Restoration:
        a. Saw cut, when necessary, to assist in surface restoration.
        b. Restore areas to original condition.

3.02 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements. Comply with applicable reference standards listed in Article 1.02.

3.03 STARTUP AND COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.
   1. Conduct testing, adjusting, and balancing to obtain satisfactory system performance including adjustments of associated controls.
   2. Complete manufacturer recommended startup procedures and checklists.
   3. Complete pre-functional checklists provided by commissioning authority.

3.04 CLEANING

A. Prior to final walk through, clean equipment and systems.

B. Remove debris accumulated during construction from the premises.

3.05 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

3.06 PROTECTION

A. Indoor Air Quality (IAQ) Maintenance for Occupied Facilities Under Construction:
   1. Make reasonable efforts to prevent construction activities from affecting air quality of occupied areas of building.
   2. Schedule activities that may affect IAQ to occur during unoccupied periods.
   3. Adhere to Atlantic Richfield Company's IAQ and infection control policies.
   4. In addition to criteria specified, provide measures as recommended in SMACNA IAQ Guidelines for Occupied Buildings Under Construction.

END OF SECTION

SECTION 22 10 00
PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide plumbing piping in accordance with this Section and applicable reference standards listed in Article 1.02.
      a. Pipe and Pipe Fittings.
      b. Valves.
      c. Domestic Water Piping System – Potable and Non-Potable.
      d. Condensate Drainage.

1.02 REFERENCES

A. Reference Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
      b. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
      c. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings: DWV.
      d. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings-DWV.
      e. ASME B16.5 - Pipe Flanges and Flanged Fittings.
      f. ASME B16.9 - Factory Made Wrought Buttwelding Fittings.
      g. ASME B16.51 - Copper and Copper Alloy Press-Connect Pressure Fittings.
      h. ASME B18.2.1 - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
      i. ASME B18.2.2 - Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
      j. ASME BPV Code, Section IX - Welding & Brazing Qualifications.
   2. ASTM International (ASTM):
      a. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      b. ASTM A234 - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
      c. ASTM A312 - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless-Steel Pipes.
      d. ASTM A536 - Standard Specification for Ductile Iron Castings.
      e. ASTM A554 - Standard Specification for Welded Stainless Steel Mechanical Tubing.
      f. ASTM A888 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
      g. ASTM B32 - Standard Specification for Solder Metal.
      h. ASTM B75 - Standard Specification for Seamless Copper Tube.
      i. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
      j. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV).
      k. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.

l. ASTM C1540 - Standard Specification for Heavy-Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
m. ASTM D1238 - Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.
n. ASTM D1784 - Standard Classification System and Basis for Specification for Rigid Poly Vinyl Chloride (PVC) Compounds and Chlorinated Poly Vinyl Chloride (CPVC) Compounds.
o. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications.
p. ASTM D2564 - Standard Specification for Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Piping Systems.

3. American Water Works Association (AWWA):
   a. AWWA C110 - Ductile-Iron and Gray-Iron Fittings.
   b. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
   c. AWWA C111 - Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   d. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.
   e. AWWA C153 - Ductile-Iron Compact Fittings.
   f. AWWA C651 - Disinfecting Water Mains.
   g. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 3/4 In. (19 mm) Through 3 In. (76 mm), for Water Service.
   h. AWWA C906 - Polyethylene (PE) Pressure Pipe and Fittings, 4 In. Through 65 In. (100 mm Through 1,650 mm), for Waterworks.
4. American Welding Society (AWS):
   a. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
   b. AWS D1.1 - Structural Welding – Steel.
5. Cast Iron Soil Pipe Institute (CISPI):
   a. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
6. FM Global (FM):
   a. FM 1680 - Couplings Used in Hubless Cast Iron Systems.
7. NSF International (NSF):
   a. NSF/ANSI 61 - Drinking Water System Components – Health Effects.
8. Underwriters Laboratories (UL):
   a. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-03 Product Data:
      a. For each product type specified.
   2. SD-05 Test Reports:
      a. Testing reports as specified in this Section.
   3. SD-07 Closeout Submittals:
      a. Per Division 01 General Requirements.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Qualifications: Per Division 01 General Requirements and as follows:
   1. Manufacturer's Qualifications: Firm regularly engaged in manufacture of products specified, whose products have been in satisfactory use in similar services for not less than 3 years.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

PART 2 - PRODUCTS

2.01 COLD WATER POTABLE AND NON-POTABLE; HOT WATER - POTABLE AND NON-POTABLE; TEMPERED WATER POTABLE AND NON-POTABLE

A. Design Pressure: 175 psi.

B. Maximum Design Temperature: 200 degrees F.

C. Piping – All Sizes:
   1. Tubing: ASTM B88 Type L hard drawn seamless copper tube.
   2. Joints: Solder with 100 percent ASTM B32 lead-free solder and flux.
   3. Fittings: ASME B16.22 wrought copper solder joint.

D. Piping – 4 Inches and Under (CMGC's Option):
   1. Tubing: ASTM B88 Type L hard drawn seamless copper tube.
   2. Joints: ASME B16.51.
   3. Fittings: ASME B16.22 copper with embedded NSF/ANSI 61 EPDM Oring.
   4. Manufacturers:
      a. Viega ProPress.
      b. Elkhart Xpress.
      c. Nibco Press System Fittings and Valves.
      d. Mueller Streamline PRS.
      e. Or equal.

2.02 COLD WATER POTABLE AND NON-POTABLE (UNDERGROUND)

A. Piping - All Sizes:
   1. Design Pressure: 150 psi.
   2. Maximum Design Temperature: 200 degrees F.
   3. Tubing: ASTM B88 Type K annealed copper tube.
   4. Joints: Solder with 100 percent ASTM B32 lead-free solder and flux.
   5. Joints Under Slab: BCuP silver braze, AWS A5.8.
   6. Fittings: Wrought copper solder joint, ASME B16.22.

B. Piping – 3 Inches and Under:
   1. Design Pressure: 160 psi at 73 degrees F.
   2. Piping: ASTM D3350 PE 3408 high density polyethylene (HDPE) resin compound meeting cell classification 345434C, and ASTM D1238 meeting Type lll, Class C, Category 5, Grade 34.
   3. HDPE pipes shall comply with AWWA C901.

4. Provide fittings of same material as piping. Provide fitting and piping system from the same manufacturer.
5. Joints: Butt-fused fittings, thermo-fused fittings/couplings, or flanged adapters.

2.03 CONDENSATE DRAINAGE

A. Design Pressure: Gravity.

B. Piping – All Sizes: Schedule 40 rigid, unplasticized polyvinyl chloride PVC-DWV, or ABS-DWV, normal impact Type I, with plain ends, conforming to ASTM D2665 or ASTM D2661. Cellular core piping is not acceptable.

C. Joints: Solvent-weld socket type with solvent as recommended by pipe manufacturer.

D. Fittings: Unplasticized polyvinyl chloride PVC-DWV, or ABS-DWV, normal impact Type I, with solvent-weld socket type ends for Schedule 40 pipe.

E. Limitations:
1. Schedule 40 PVC-DWV, or ABS-DWV pipe must not be threaded.
2. Do not use in return air plenums.
3. Not for condensate greater than 140 degrees F.

F. Application: PVC or ABS only where allowed by local jurisdiction. Comply with any special requirements or limitations.

2.04 VALVE OPERATORS

A. Provide handwheels for gate valves and gear operators for butterfly valves.

2.05 VALVE CONNECTIONS

A. Provide all connections to match pipe joints. Valves shall be same size as pipe unless noted otherwise.

PART 3 - EXECUTION

3.01 PREPARATION

A. Install products per manufacturer’s recommendations.

B. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

C. Remove scale and dirt, on inside and outside, before assembly.

D. Connect to equipment with flanges or unions.

E. Use only piping materials rated for the maximum temperature of the application, e.g., do not use PVC for dishwasher drainage or piping that receives boiler blowdown.

3.02 TESTING PIPING

A. Sanitary Drainage, Sanitary Vent, and Storm Drainage:
1. Test piping with water to prove tight.
2. Test piping before insulation is applied.

3. A smoke/air test at the same pressure may be used in lieu of the hydrostatic water test. Exception: Smoke/air test shall not be performed on plastic piping.
4. Test pressures stated above shall be as listed or as required by the authority having jurisdiction, whichever is most stringent.

B. Cold Water - Potable and Non-Potable:
1. Test pipes underground or in chases and walls before piping is concealed.
2. Test all pipes before the insulation is applied. If insulation is applied before the pipe is tested and a leak develops which ruins the insulation, replace damaged insulation.
3. Test the pipe with 100 psi water pressure or equal inert gas such as nitrogen. Exception: Inert gas test shall not be used to test plastic piping.
4. Hold test pressure for at least 2 hours.
5. Test to be witnessed by Engineer if requested.

C. All Other Piping:
1. Test piping at 150 percent of normal operating pressure.
2. Piping shall hold this pressure for one hour with no drop in pressure.
3. Test piping using water, nitrogen, or air as compatible with the final service of the pipe. Do not use combustible fluids.
4. Drain and clean piping after testing is complete.

3.03 CLEANING PIPING

A. Assembly:
1. Before assembling pipe systems, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with good piping practice subject to approval of Engineer. Blow chips and burrs from machinery or thread cutting operation out of pipe before assembly. Wipe cutting oil from internal and external surfaces.
2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing.
3. Notify Engineer before starting any post erection cleaning in sufficient time to allow witnessing the operation. Consult with and obtain approval from Engineer regarding specific procedures and scheduling. Legally dispose of cleaning and flushing fluids.
4. Prior to blowing or flushing erected piping systems, disconnect instrumentation and equipment, open wide valves, and be certain strainer screens are in place.

B. Water Piping:
1. Flush piping until flow is clean.
2. After flushing, thoroughly clean inlet strainers, aerators, and other devices.
3. If necessary, remove valves to clean out foreign material.

3.04 INSTALLATION

A. General Installation Requirements:
1. Provide dielectric connections between dissimilar metals.
2. Route piping in orderly manner and maintain gradient. Install to conserve building space.
3. Group piping whenever practical at common elevations.
4. Install piping to allow for expansion and contraction without stressing pipe, joints, or equipment.
5. Slope water piping and arrange to drain at low points.
6. Install bell and spigot piping with bells upstream.

7. Where pipe supports are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
8. Seal pipes passing through exterior walls with a wall seal. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.
9. Non-potable outlets shall be clearly marked with a permanently affixed laminated sign with 3/8-inch-high lettering saying “Non-Potable Water Not for Human Consumption.” Sign shall have black lettering on a yellow background.
10. Vertical pipe drops to sinks or other equipment installed below the ceiling shall be routed within a wall cavity, unless specifically noted otherwise to be surface mounted.

B. Installation Requirements in Electrical Rooms:
1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending from the floor to the structural ceiling with width and depth equal to the equipment.

C. Valves, Fittings and Accessories:
1. Install shutoff valves that permit the isolation of equipment and fixtures in each room without isolating any other room or portion of the building. Individual fixture angle stops do not meet this requirement. Exception: back-to-back rooms in no more than 2 adjacent rooms.
2. Provide clearance for installation of insulation and access to valves and fittings.
3. Provide access doors for concealed valves and fittings.
4. Install valve stems upright or horizontal, not inverted.
5. Provide one plug valve wrench for every ten plug valves 2 inches and smaller, minimum of one. Provide each plug valve 2-1/2 inches and larger with a wrench with set screw.

D. Underground Piping:
1. Install buried water piping outside the building with at least 5-feet of cover.
2. Exercise care in handling, storing, and laying pipe to avoid damaging factory applied coatings. If any damage occurs, repair the coating to a condition equal to the original.
3. Field application of protective coatings to joints, fittings and to any damaged factory applied coatings shall be similar to factory applied coatings specified above and shall be done in strict accordance with recommendations of the supplier of pipe coatings.
4. After completion of the fabrication, laying and field coating of the joints and fittings, but prior to backfilling, inspect the entire line in the presence of Engineer with an electronic holiday detector. Repair defects in protective coatings in accordance with requirements for original coatings.
5. Coat flange bolts and nuts in pits and below ground at the time of installation with a corrosion protective coating.

3.05 PIPE ERECTION AND LAYING

A. Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be removed from the job immediately.

B. Pipe, fittings, valves, equipment and accessories shall have factory applied markings, stampings, or nameplates with sufficient data to determine their conformance with specified requirements.

C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not install any item that is not clean.

D. Until system is fully operational, openings in piping and equipment shall be kept closed except when Work is being performed on that item or system. Closures shall be plugs, caps, blind flanges or other items specifically designed and intended for this purpose.

E. Run pipes straight and true, parallel to building lines with minimum use of offsets and couplings. Provide only offsets required to provide needed headroom or clearance and to provide needed flexibility in pipelines.

F. Make changes in direction of pipes only with fittings or pipe bends. Changes in size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. Fittings shall be of the long radius type, unless otherwise shown on Drawings or specified.

G. Provide flanges or unions at all final connections to equipment, traps, and valves.

H. Arrange piping and connections so equipment served may be totally removed without disturbing piping beyond final connections and associated shutoff valves.

I. Use full and double lengths of pipe wherever possible.

J. Unless otherwise indicated, install all piping, including shutoff valves and strainers, to coils, pumps and other equipment at line size with reduction in size being made only at control valve or equipment.

K. Cut all pipe to exact measurement and install without springing or forcing except in the case of expansion loops where cold springing is indicated on Drawings.

L. Underground pipe shall be laid in dry trenches maintained free of accumulated water.

3.06 BRANCH CONNECTIONS

A. For domestic water and vent systems only, make branch connections with standard tee or cross fittings of the type required for the service.

B. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.

C. Do not use double wye or double combination wye and eighth bend DWV fittings in horizontal piping.

D. Branch connections from the headers and mains may be mechanically formed using an extraction device. The branch piping connection shall be brazed connection for the following services only:
   1. Domestic water piping above grade.

E. Further limit use of mechanically formed fittings as follows:
   1. Must have at least same pressure rating as the main.
   2. Main must be type K or L copper tubing.
   3. Permanent marking shall indicate insertion depth and orientation.
   4. Branch pipe shall conform to the inner curve of the piping main.
   5. Main must be 1-inch or larger.
   6. Branch must be 3/4 inches or larger.

F. Branch connections from headers and mains may be cut into black steel pipe using forged weldon fittings.

G. Forged weld-on fittings are limited as follows:
   1. Must have at least same pressure rating as the main.
   2. Main must be 2-1/2 inches or larger.
   3. Branch line is at least two pipe sizes under main size.

3.07 JOINING OF PIPE

A. Threaded Joints:
   1. Threads shall conform to ASME B2.1 Pipe Threads.
   2. Ream pipe ends and remove burrs and chips formed in cutting and threading.
   3. Protect plated pipe and valve bodies from wrench marks when making up joints.
   4. Apply thread lubricant to male threads as follows:
      a. Vents and Roof Conductors - Red graphite
      b. All Other Services - Teflon tape

B. Flanged Joints:
   1. Steel pipe flanges shall conform to ASME B16.5. Cast iron pipe flanges shall conform to ASME B16.1. Steel flanges shall be raised face except when bolted to flat face cast iron flange.
   2. Bolting for services up to 500 degrees F shall be ASTM A307 Grade B with square head bolts and heavy hexagonal nuts conforming to ASME B18.2.1 and ASME B18.2.2.
   3. Set flange bolts beyond finger tightness with a torque wrench for equal tension in all bolts. Tighten bolts so those 180 degrees apart are torqued in sequence.
   4. Gaskets for flat face flanges shall be full face type. Gaskets for raised faced flanges shall conform to requirements for "Group I Gaskets" in ASME B16.5. Unless otherwise specified gaskets shall meet the following requirements:
      a. Gasket material and thickness approved by manufacturer for intended service, chemical compatibility, pipe system test pressure, and operating temperature range.
      b. Maximum pressure rating of at least 250 psi.
      c. Minimum temperature rating of -10 degrees F.
      d. Maximum temperature rating of at least 170 degrees F for water systems operating 140 degrees F and less.

C. Solder Joints:
   1. Make up joints with 100 percent ASTM B32 lead-free solder. Cut tubing so ends are perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt and grease just prior to soldering. Apply flux evenly, but sparingly, over all surfaces to be joined. Heat joints uniformly so solder will flow to all mated surfaces. Wipe excess solder, leaving a uniform fillet around cup of fitting.
   2. Flux shall be nonacid type.
   3. Solder end valves may be installed directly in the piping system if the entire valve is suitable for use with 470 degrees F melting point solder. Remove discs and seals during soldering if they are not suitable for 470 degrees F.

D. Brazed Joints:
   1. Make up joints with ASTM B260 silver alloy brazing filler metal BAg1 or BAg2. Cut copper tubing so ends are perfectly square and remove burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove oxide, dirt and grease just prior to brazing. Apply non-corrosive flux recommended by filler alloy manufacturer, evenly, but sparingly, over surfaces to be joined. Heat joints uniformly

using oxygen-acetylene torch with tip size recommended by fitting manufacturer. Wipe and brush joint clean after alloy has set.
2. Remove discs from solder end valves during brazing.

E. Welded Joints:
1. Welding of pipe joints, both as to procedures and qualification of welders, shall be in accordance with Section IX, ASME Boiler & Pressure Vessel Code unless mandatory local codes take precedence.
2. Furnish certificates qualifying each welder to Atlantic Richfield Company prior to start of Work.
3. Atlantic Richfield Company reserves the right to require qualifying demonstration of any welders assigned to the job.
4. Ends of pipe and fittings to be joined by butt welding shall be beveled, cleaned to bare metal and internal diameters aligned before tack welding.

F. Mechanically Coupled Grooved Joints:
1. Mechanical coupling connections shall mechanically engage, lock and seal the grooved pipe ends in a positive couple. Each coupling shall consist of malleable iron housing clamps, steel bolts and nuts, and sealing gasket designed so internal pressure tends to increase the tightness of the seal.
2. Use grooved mechanical couplings and fasteners only in accessible locations.
3. Final tightening of bolts shall be with a torque wrench for equal tension in all bolts.

G. Mechanical Press Connection:
1. Copper press fitting shall be made in accordance with the manufacturer’s installation instructions.
2. Fully insert tubing into the fitting and mark tubing.
3. Prior to making connection, the fitting alignment shall be checked against the mark made on the tube to ensure the tubing is fully engaged in the fitting.
4. Joint shall be pressed with a tool approved by the manufacturer.
5. Installers shall be trained by manufacturer personnel or representative. Provide documentation upon request.

H. Mechanical Push-To-Connect:
1. Copper push-to-connect fittings shall be made in accordance with the manufacturer’s installation instructions.
2. Installers shall be trained by manufacturer personnel or representative. Provide documentation upon request.

I. Mechanical Joints:
1. Joints shall conform to AWWA C111/A21.11. Gasket material shall be neoprene. The standard bolts and nuts of the pipe manufacturer shall be used and shall be coated at the factory with rust preventive lubricant after threading and tapping.
2. Use a torque wrench for final tightening of bolts to ensure equal tension in all bolts.

J. Push-On Joints Pressure Pipe:
1. Joints shall be single gasket type conforming to AWWA C111/A21.11. The bell shall have cast or machined gasket socket recesses, a tapered annular opening and flared socket design to provide deflections up to 5 inches. Plain spigot ends shall be suitably beveled for easy entry into bell, centering in gasket and compression of gasket.
2. Joint shall be liquid tight under all pressures from vacuum to 350 psi.
3. Furnish sufficient lubricant for a thin coat on each spigot end. Lubricant shall be nontoxic, impart no taste or odor to conveyed liquid, and have no deleterious effect on

the rubber gasket. Lubricant shall be of such consistency that it can be easily applied to the pipe in hot and cold weather and shall adhere to either wet or dry pipe.

K. Compression Gasket Joints – Sanitary Pipe and Storm Pipe:
   1. Joint shall be one-piece double seal compression type gasket made specifically for joining cast iron soil pipe. Gasket shall be neoprene, permitting joint to flex as much as 5 degrees without loss of seal. Gasket shall be extra heavy weight class, conforming to ASTM C564.

L. Lead and Oakum Joints – Sanitary Pipe and Storm Pipe:
   1. Pack joint with oakum made of vegetable fiber, cotton, or hemp. Pour joint with molten lead up to top of hub. Ensure leak-free joints by working joint with inside and outside caulking irons.

M. Concrete Pipe Joints:
   1. Tongue and Groove Pipe – Mastic with Geotextile Wrap:
      a. Clean tongue and groove before applying mastic.
      b. Apply mastic to the tongue and groove.
      c. Insert tongue into the groove and seat the joint.
      d. After seating, wipe excess mastic from the inside of the pipe.
      e. Apply and secure geotextile wrap around entire diameter of joint.
   2. Modified Bell and Spigot or Tongue and Groove Pipe Flat Gasket:
      a. Gasket and joint: ASTM C443.
      b. Apply gasket to the pipe spigot/tongue.
      c. Lower pipe into trench.
      d. Lubricate pipe bell/groove and gasket with vegetable oil lubricant.
      e. Check pipe alignment and grade and seat pipe with pry bar or comealong.

N. Solvent Weld Joints (PVC):
   1. Make joints with a two-step process. Use ASTM F656 primer and ASTM D2564 solvent cement.

O. Solvent Weld Joints (CPVC):
   1. Make joints with a one-step process. Use ASTM F493 CPVC cement. A primer is not required.
   2. If a primer is required by Laws and Regulations, provide ASTM F656 primer.

P. Fusion Weld:
   1. Make field cuts of pipe square and true using a pipe cutter designed for plastic pipe.
   2. Make sure proper heating heads are used for male and female situations.
   3. Bevel the leading edge of pipe section with a 45-degree chamfer.
   4. Utilize a fusion welding tool recommended by the pipe and fitting manufacturer.
   5. Not recommended for temperatures below 40 degrees F.
   6. Follow the manufacturer's cold weather installation procedures.
   7. Installers to undergo training provided by manufacturer.
   8. Follow manufacturer’s installation instructions.

Q. Elastomeric Gaskets – Sanitary and Storm Pipe:
   1. Hub and spigot pipe joints with elastomeric gaskets shall be made in accordance with the manufacturer's installation instructions.

R. Sleeve Gaskets (No-Hub) – Sanitary and Storm Pipe:
   1. Gasket: ASTM C564 heavy weight class.
   2. Provide gasket with an internal center stop.

3. Gasket shall be covered by a stainless-steel band secured with a minimum of 4 stainless steel bands per fitting or joint.
4. Install sleeve gaskets according to manufacturer's installation instructions.

3.08 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Complete disinfection of domestic water piping within 3 weeks prior to building occupancy. Provide disinfecting water piping if used by workers during construction; disinfection during construction does not eliminate the requirement for final disinfection prior to occupancy. Complete pipe flushing within 2 weeks prior to building occupancy.

B. Provide necessary connections at start of individual sections of mains for adding chlorine.

C. Before starting Work, verify system is complete, flushed and clean.

D. Ensure pH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

E. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.

F. Bleed water from all outlets to ensure chlorine distribution throughout the entire domestic water system.

G. Verify initial chlorination levels by testing at minimum 15 percent of outlets located throughout entire building, including the last fixture connected to each main and each branch extending over 50-feet from a main.

H. Maintain disinfectant in system for 24 hours. Test at minimum 15 percent of outlets located throughout entire building, including the last fixture connected to each main and each branch extending over 50-feet from a main. If final disinfectant residual tests less than 25 mg/L at any one of the tested outlets, flush the entire system and repeat disinfection and testing procedure.

I. After final disinfectant residuals test at or above 25 mg/L after a minimum 24-hour duration, flush disinfectant from system at a minimum velocity of 3.0 feet per second until residual is equal to that of incoming water or 1.0 mg/L.

J. Take water samples, no sooner than 24 hours after flushing, from 2 percent of outlets and from water entry. Obtain, analyze, and test samples in accordance with AWWA C651 - Verification.

3.09 SERVICE CONNECTIONS

A. Provide new sanitary and/or storm sewer services. Before commencing Work, check invert elevations needed for sewer connections, confirm inverts and verify they can be properly connected with slope for drainage and cover to avoid freezing.

B. Provide new water service with water meter with bypass valves. Provide sleeve in wall for service main.

3.10 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements. Comply with applicable reference standards listed in Article 1.02.

3.11 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 23 05 00
COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Overall requirements for mechanical installations common to Specifications in Division 23 Heating, Ventilating and Air Conditioning (HVAC).
   2. Ensure each mechanical trade is sufficiently familiar with and responsible for electrical operation and wiring of the mechanical system for which they are responsible. Electrical tradesmen may be used by each mechanical trade for the associated portion of wiring, however, require that responsibility for repair and maintenance of each mechanical system is provided by each mechanical trade.

B. Related Requirements:
   1. Division 23 Specifications.

1.02 REFERENCES

A. Reference Standards:
   1. Air Movement and Control Association (AMCA).
   2. Air Conditioning, Heating and Refrigeration Institute (AHRI).
   3. Air Diffusion Council (ADC).
   4. American Conference of Governmental Industrial Hygienists (ACGIH).
   5. American National Standards Institute (ANSI):
      a. ANSI/ASHRAE/IES Standard 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
      b. Other applicable standards.
   6. American Society of Heating, Refrigerating and Air conditioning Engineers (ASHRAE).
   7. American Society of Mechanical Engineers (ASME).
   8. American Society for Testing and Materials (ASTM).
   9. Factory Mutual (FM).
   10. Hydraulic Institute Standards (HI) standards.
   11. Instrumental Society of America (SA) standards.
   12. Manufacturer’s Standardization Society (MSS) standards.
   13. National Electrical Manufacturers Association (NEMA) standards.
   14. National Institute of Standards and Technology (NBS).
   15. National Fire Protection Association (NFPA).
   16. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
   17. Underwriters Laboratory (UL) standards.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures and as specified in individual Specification sections:
   1. SD-07 Closeout Submittals:
      a. Per Division 01 General Requirements.

b. Mark Drawings to indicate revisions to piping and ductwork, size and exterior and interior locations; locations of coils, dampers and other control devices, filters, boxes and similar units requiring periodic maintenance or repair; actual equipment locations dimensioned to column lines; actual inverts and locations of underground piping; concealed equipment and control system devices dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and items requiring maintenance located (such as traps, strainers, expansion compensators, tanks).

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Packing, Shipping, Handling, and Unloading:
   1. Identify products with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

C. Acceptance at Site:
   1. Coordinate deliveries of mechanical materials and equipment to minimize construction Site congestion. Limit each shipment to the items and quantities needed for the smooth and efficient flow of installations.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

PART 2 - PRODUCTS

2.01 NAMEPLATES

A. Provide permanent operational data nameplate on each item of power operated mechanical equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar necessary data. Locate nameplates in accessible location.

2.02 EQUIPMENT

A. Provide equipment meeting ANSI/ASHRAE/IES Standard 90.1.

2.03 COMPONENTS

A. System components are identified throughout the Drawings for proper system operation.

2.04 PIPE SUPPORTS

A. Provide in accordance with Section 40 05 15 – Process Pipe Supports.

2.05 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install equipment and materials to allow required access for servicing and maintenance. Coordinate final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of parts that require replacement or servicing. Extend grease fittings to accessible location.

B. Coordinate equipment and materials for installation with other building components.

C. Verify dimensions by field measurements.

D. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.

E. Sequence, coordinate and integrate installation of mechanical materials and equipment for efficient flow of Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

F. Coordinate cutting and patching of building components to accommodate installation of mechanical equipment and materials.

G. Coordinate installation of mechanical materials and equipment above ceilings with suspension system, lighting fixtures, and other installations.

H. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

I. Coordinate installation of identifying devices after completing coverage and painting where devices are applied to surfaces. Install identifying devices prior to installing acoustical ceilings and similar concealment.

3.02 EQUIPMENT CONNECTIONS

A. Drawings schematically show the order of connection of various terminal units, louvers, valves, and other mechanical equipment but do not show every detail of piping and ductwork. Connect fixtures in accordance with standard details, accepted trade practice, and the intent of the Specifications and Drawings. Coordinate with other trades.

3.03 PIPE SUPPORTS

A. Install in accordance with Section 40 05 15 – Process Pipe Supports.

3.04 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.05 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.06 CLEANING

A. Cap ductwork during construction to protect from dust and debris. Thoroughly clean interior of ductwork and air systems.

B. Clean filters, strainers, and mechanical systems prior to final acceptance.

3.07 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 23 05 29
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide hangers and supports for HVAC piping and equipment in accordance with this Section and applicable reference standards listed in Article 1.02.

1.02 REFERENCES

A. Reference Standards:
   1. American National Standards Institute (ANSI):
      a. ANSI B31.1 - Power and Process Piping Package.
   2. Manufacturer's Standardization Society (MSS):
      a. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
      b. MSS SP-69 - Pipe Hangers and Supports - Selection and Application.
   3. Sheet Metal & Air Conditioning Contractors' National Association (SMACNA):
      a. Seismic Restraint Manual.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-02 Shop Drawings:
      a. Complete sets of Shop Drawings of items to be furnished under this Section including complete layouts, schedules, location plans and complete total bill of materials for all pipe support systems.
      b. Piping layouts shall indicate type of hanger and/or support, location, pipe support reactions transmitted to structure and type of anchor, guide and other pipe supporting appurtenances including structural fasteners.
      c. Pipe loads supported by pipe supports will not be accepted in lieu of pipe support reactions. Only complete piping systems submittals will be accepted.
      d. Where standard hangers and/or supports are not suitable, submit detailed Drawings showing materials and details of construction for each type of special hanger and/or support.
      e. Submit Shop Drawings of individual framing systems, showing all details of installation, including dimensions and types of supports.
   2. SD-03 Product Data:
      a. Representative catalog cut for each type of pipe hanger or support indicating materials of construction, important dimensions and range of pipe sizes for which that hanger is suitable.
      b. Provide detailed information on anti-seize compound.
      c. Description of surface preparation and shop painting including manufacture and dry film thickness.

3. SD-06 Certificates:
    a. Design Data/Submittals:
        1) Submit complete design data for pipe support systems to show conformance with this Section.
4. SD-07 Closeout Submittals:
    a. Per Division 01 General Requirements.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Qualifications: Per Division 01 General Requirements and as follows for independent professional Engineer:
    1. Registered in State.
    2. Minimum 3 years', within last 5 years, experience in analysis, structural design and configuration of pipe supporting systems, including any non-standard supports that need to be designed and certified.

C. Engineer is responsible for Work within design specifications and configuration. Any construction-related deviations in criteria, materials or details within design must be submitted to Engineer. Submittals will be reviewed only for conformance to specifications.

1.06 DELIVERY, STORAGE AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Packing, Shipping, and Handling:
    1. Supports and Hangers: Crated, delivered and uncrated so as to protect against any damage.

C. Storage and Protection:
    1. Protect parts so that no damage or deterioration occurs during a prolonged delay from time of shipment until installation is complete.
    2. Finished metal surfaces not galvanized, not of stainless-steel construction, or that are not coated, shall be grease coated, to prevent rust and corrosion.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

PART 2 - PRODUCTS

2.01 GENERAL

A. Equipment specified is intended to support various types of pipe and piping systems shown on Drawings. Construction Management General Contractor (CMGC) is responsible for developing final details and any details associated with special conditions not already covered, in particular, system temperatures and pressures specified in sections covering pipe.

B. Design supports to adequately secure pipe against excessive dislocation due to thermal expansion and contraction, vibration due to fluid pulsation and/or equipment operation, internal flow forces and probable external forces such as equipment, pipe and personnel contact and seismic forces. Structural steel members required to brace piping from

excessive dislocation shall conform to applicable requirements of Division 05 and be furnished and installed under this Section.

C. Protect uninsulated non-metallic piping from local stress concentrations at each support point by 304L stainless steel protection shields, or other method, as approved by Engineer. Furnish arc shields where pipes are bottom supported 180 degrees. Where 360-degree arc support is required, such as U bolts, provide protection shields for entire pipe circumference. Protection shields: 18-gauge minimum thickness, 12 inches or more in length, and securely fastened to pipe with stainless steel straps not less than 1/2-inch wide.

D. Insulated Pipe: Furnished with rigid foam insulating saddle at each pipe support location, as specified, under respective pipe insulation. Provide protection shields as specified at each support location.

E. Where pipe hangers and supports come in contact with copper piping, provide protection from galvanic corrosion by wrapping pipe with 1/16-inch thick neoprene sheet material and stainless steel protection shield. Isolators: equivalent to Elcen, Figure No. 228; or copper plated or 304L stainless steel hangers and supports. Isolate stainless-steel piping from all ferrous materials, including galvanized steel, by use of neoprene sheet material and protection shields, similar to above methods.

F. Provide pipe supports as follows:
   1. Whenever possible, give preference to floor supports. Typical concrete supports are shown on structural Drawings. Use base elbow and base tees where possible.
   2. For stainless steel piping, provide neoprene isolators between pipe and support components for fixed supports, and Teflon for guide supports.
   3. Support multiple, suspended, horizontal plastic PVC pipe runs, where possible, with V-troughs or ladder type cable trays.
      a. Acceptable Manufacturers:
         1) Electray Ladder by MP Husky.
         2) Globetray by GS Metals Corp.
         3) B-Line Cable Tray Systems by B-Line.
         4) Or equal.
      b. Ladder: Minimum of 403L stainless steel construction with 12-inch rung spacing. Tray width: approximately 6-inches for single runs and 12-inches for double runs. Furnish ladder type cable trays complete with hanger rods, rod couplings, concrete inserts, and hanger clips as required for complete support system. Secure individual plastic pipes to rungs of cable tray by strap clamps or fasteners equivalent to Globe, Model MCAC; HuskyBurndy, Model SCR; or equal. Spacing between clamps shall not exceed 9-feet. Cable trays shall provide continuous support along length of pipe. Individual clamps, hangers and supports, in contact with plastic PVC pipe, shall provide firm support without preventing longitudinal movement due to thermal expansion and contraction.
   4. Pipe supports shall distribute pipe loads evenly along pipe circumference.
   5. Provide pipe supports to minimize lateral forces through valves, both sides of split type and sleeve type couplings, and to minimize all pipe forces on pump housings. Pump housings shall not be utilized to support connecting pipes.
   6. Account for effects of thermal expansion and contraction of pipe when selecting and installing pipe support.

G. Unless otherwise specified, pipe hangers and supports: standard catalogued components, conforming to requirements of MSS SP-58 and SP-69.

1. Acceptable Manufacturers:
    a. Grinnell Co.
    b. Carpenter & Patterson, Inc.
    c. F&S Central.
    d. PHD Manufacturing, Inc.
    e. Or equal.

H. Required pipe supports, for which standard supports specified in this Section are not applicable: fabricated or constructed from standard structural steel shapes, concrete and anchor hardware similar to items previously specified and be subject to approval of Engineer.

I. Expansion Anchors for Wall and Floor Pipe Supports and Appurtenances: Hilti KwikBolt II; Simpson Strong-Tie Wedge-All; Powers Power-Stud, or equal. Length of expansion bolts: sufficient to place wedge portion of bolt a minimum of 1-inch behind steel reinforcement. Use adhesive type concrete anchors for ceiling mounted pipe support and appurtenances.

J. Hanger Rods: Hot rolled stainless steel, machine threaded; strength of rod based on its root diameter. Attach hanger rods to concrete structures using concrete inserts equivalent to F&S, Figures 180, 571 or 150; or continuous concrete inserts per F&S. Use beam clamps, C clamps or welded beam attachments for attaching hanger rods to structural steel members. Where necessary, and as approved by Engineer, expansion anchors may be used for attaching to concrete structures.

K. Pipe Supports: Designed with liberal strength and stiffness to support respective pipes under maximum combination of peak loading conditions to include pipe weight, liquid weight, liquid movement and pressure forces, thermal expansion and contraction, vibrations and all probable externally applied forces including seismic forces. Prior to installation, pipe supports require approval by Engineer.

2.02 SEISMIC RESTRAINTS

A. Provide seismic restraints for piping systems, including but not limited to, free standing, suspended or wall mounted piping installed under this Section. Seismic restraints: sized for Seismic Hazard Exposure Group II and Seismic Performance Category C.

B. Use restraints defined in manual when seismic criteria and size of piping are within limits of latest edition of SMACNA Seismic Restraints Manual at time of bid opening. Select restraints from Tables that represent highest seismic hazard class or level possible within state of Montana. Provide members of material of equal strength to those in standards where materials other than carbon steel are specified.

C. Use same materials of construction as those specified in this Section for pipe hangers and supports. Nuts, bolts and washers: stainless steel, regardless of locations.

2.03 SINGLE PIPE HANGERS

A. Suspend, using trapeze hangers or wall brackets, multiple pipes running parallel in same horizontal plane which are adjacent to each other. Trapeze hangers shall consist of 304L or 316 stainless steel channel supported from stainless steel threaded rod or attached to concrete walls, columns or structural steel support members as required to meet intent of this Section. Channel: equivalent to F&S, Figure 710.

B. Except as otherwise specified, pipe anchors used for attaching pipe to trapeze or multiple pipe wall brackets: stainless steel anchor or pipe chairs equivalent to F&S, Figures 158, 419, 160A, 160B as required. Tighten chair U bolts to allow freedom of movement for normal expansion and contraction except where pipe must be anchored to control direction of movement or act as a thrust anchor.

C. Pipes Less Than 3-Inches in Diameter: Held in position by supports fabricated from stainless steel C channel; welded post base equivalent to Unistrut, Figure P2072A; and pipe clamps equivalent to Unistrut, Figures P1109 thru P1126. Where required, to assure adequate support, fabricate supports using two vertical members and post bases connected together by horizontal member of sufficient load capacity to support pipe. Wherever possible, anchor supports to nearby walls or other structural member to provide horizontal rigidity. More than one pipe may be supported from a common fabricated support.

D. Where shown on Drawings, anchor pipe using concrete anchor posts or pedestals. Securely fasten pipes to posts or pedestals as indicated on Drawings.

2.04 WALL SUPPORTED PIPES

A. When necessary, single or multiple pipes located adjacent to walls, columns or other structural members: supported using welded stainless steel wall brackets equivalent to Carpenter and Patterson, Figure No. 6978, 84, or 134; or C channel with steel brackets equivalent to Unistrut pipe clamps. Securely fasten using double expansion shields, or other method, as approved by Engineer. Provide additional wall bearing plates where required.

2.05 BASE ANCHOR SUPPORT

A. Where pipes change direction from horizontal to vertical via a bend, install a welded or cast base bend support at bend to carry load. Anchor base bend to floor, pipe stanchion, or concrete pedestal using expansion anchors, or other method, as approved by Engineer.

B. Where shown on Drawings, anchor pipe bends using concrete anchor posts. Securely fasten pipes to concrete supports with suitable metal bands as required and approved by Engineer. Use a felt insert to isolate piping from poured concrete.

2.06 VERTICAL PIPE SUPPORTS

A. Where vertical pipes are not supported by a Unistrut system, as specified, support in one of following methods.
   1. For pipes 1/4-inch to 2-inches in diameter, provide extension hanger ring with extension rod and hanger flange. Rod diameter: as recommended by manufacturer for type of pipe being supported. Stainless steel hanger ring: equal to Carpenter & Paterson, Figure No. 81 or 81CT. Anchor flange: stainless steel equivalent to Carpenter and Patterson, Figure No. 85.
   2. For pipes equal to or greater than 2inches in diameter, extended pipe clamps equivalent to Carpenter and Patterson, Figure No. 267 may be used. Attach hanger to concrete structures using double expansion shields, or to stainless steel support members using welding lugs similar to Carpenter and Patterson, Figure No. 220.
   3. Support vertical pipes extending through floor slabs with stainless steel pipe riser clamps equivalent to Carpenter and Patterson, Figure No. 126. Use copper clad or stainless-steel clamps on copper pipes. Remove insulation, without damaging it, from pipes prior to installing riser clamps.

4. Unless otherwise specified, shown, or specifically approved by Engineer, support vertical runs exceeding 6-feet by base elbows/tees, clamps, brackets, wall rests and pipe collars, all located as required to ensure a rigid installation.

2.07 SUPPORTS FOR PLASTIC PIPING 3-INCHES AND SMALLER

A. Provide pipe supports for closely spaced vertical piping systems to provide a rigid installation. Interval of vertical support spacing: as specified, without exceeding 6- feet. Support system shall consist of a framework suitably anchored to floors, ceilings or roofs.

B. Vertical and Horizontal Supporting Members: U shaped channels equivalent to Unistrut, Series P1000. Furnish all nuts, bolts and fittings required for a complete assembly, including end caps, for all Unistrut members. Secure vertical piping to horizontal members by pipe clamps or pipe straps. Use Type 316 stainless steel components for support of exterior pipe, submerged pipe, pipe within outdoor structures and interior pipe within channels and chemical containment areas. In all other areas, use 304L stainless steel components.

C. Acceptable Framework Manufacturers:
   1. Unistrut.
   2. Globe-Strut by GS Metals Corp.
   3. Power Strut.
   4. B-Line Systems.
   5. Or equal.

D. Design of each individual framing system is responsibility of CMGC. Brace completed frames to provide complete rigid structure when all piping has been attached.

E. Supports Not Described in This Section: Fabricated or constructed from standard stainless-steel shapes in accordance with applicable provisions of Division 05, or Unistrut-type frame; have anchor hardware similar to items previously specified, meet minimum requirements listed below, and be subject to approval of Engineer.
   1. Pipe support systems shall meet all requirements of this Section and all related Sections.
   2. Submit complete design details of pipe support system and system components for review and approval as specified in PART 1. Hangers and supports will not be installed without written approval of Engineer.
   3. Pipe support system shall not impose loads on supporting structures in excess of loads for which supporting structure is designed.

2.08 SEALS

A. Link-Seal by Thunderline Corporation or approved equal where a gas tight penetration is not required.

2.09 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. All hangers, supports and appurtenances shall conform to latest applicable requirements of Montana State Building Code and ANSI B31.1, except as supplemented or modified by requirements of this Section.

C. Minimum working safety factor for supporting equipment, with exception of springs: one-fifth ultimate tensile strength of material, assuming minimum 10-feet of water-filled pipe being supported.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:
   1. Proceed with installation of piping and supports only after building structural Work has been completed and new concrete has reached its specified design strength.

3.02 PREPARATION

A. Surface Preparation:
   1. Prepare and shop prime paint all surfaces, except stainless steel, as part of Work of this Section.
   2. All sharp edges and corners within 7-feet of floor or walking surface: ground down and/or protected with plastic protective covers.
   3. Apply anti-seize compound to all nuts and bolts. Supports installed without approved compound: dismantled and correctly installed, at no additional cost to Atlantic Richfield Company.

3.03 INSTALLATION

A. Interface with Other Work:
   1. Installation of pipe support systems shall not interfere with operation of monorails, and access hatches.
   2. Installed systems shall not interfere with maintenance and operational access to any equipment installed under this or any other related Section.
   3. Coordinate support arrangements to eliminate interference with similar support systems to be installed by Plumbing and Electrical; to account for structural expansion joints with co-located piping expansion joints; and to maintain unhindered access to equipment for both operation and removal. Material handling equipment supports shall not be used for piping supports under any circumstances. Do not support from structural struts or braces.

B. Horizontal and Vertical Pipes Requiring Rigid Support: Supported from building structure by methods specified under PART 2. Provide supports at changes in direction and elsewhere, as shown in Drawings, or as specified. Piping shall not be supported from existing precast concrete tees, metal stairs, ladders and walkways unless specifically directed or authorized by Engineer.

C. Support pipe and tubing to prevent significant stresses in material, valves, fittings and other pipe appurtenances and to secure pipe in intended position and alignment.

D. Pipe Supports: Provided to minimize lateral forces through valves, both sides of split type couplings and sleeve type couplings (within four pipe diameters) and to minimize all pipe forces on pump housings and other equipment. Pump housings and other equipment shall not be utilized to support connecting pipes.

E. Inserts for Pipe Hangers and Supports: Installed on forms before concrete is placed. Before setting these items, check all Drawings and figures which have a direct bearing on pipe location. Responsibility for proper location of pipe supports is included under this Section.

F. Continuous metal inserts shall be embedded flush with concrete surface.

G. Support all pipe and appurtenances connected to equipment in manner that prevents strain from being imposed on equipment or piping system.

H. Where flexible couplings are required at equipment, tanks, etc., rigidly support end opposite to piece of equipment, tank, etc. (please change language to be all-inclusive or specify further), to prevent transfer of force systems to equipment. Do not install fixed or restraining supports between flexible coupling and piece of equipment.

I. CMGC may propose minor adjustments to piping arrangements in order to simplify supports, or to resolve minor conflicts in Work. A single trapeze support may be used if minor change to pipe centerline elevation is needed.

J. Place supports sufficiently close together so that sag of pipe is within limits that will permit drainage and avoid excessive bending stresses from concentrated loads between supports.

K. Cast Iron and Ductile Iron, Steel and Stainless-Steel Piping: Supported at a maximum support spacing of 10-feet with minimum of one support per pipe section at joints.

L. Supports for Multiple and Single PVC Plastic Piping: Continuous wherever possible. Individually supported PVC pipes: be supported as recommended by manufacturer, except support spacing shall not exceed 3-feet.

M. Vertical Pipes: Supported at each floor or at intervals of not more than 6- feet by approved pipe collars, clamps, brackets, or wall rests and at all points necessary to insure rigid construction. Secure, using pipe collar, vertical pipes passing through pipe sleeves.

N. Supports: Provided at changes in direction and elsewhere, as shown in Drawings, or as specified. Piping shall not be supported from other piping, or from metal stairs, ladders and walkways, unless specifically directed or authorized by Engineer.

O. Provide sufficient lateral bracing to minimize horizontal motion and vibration of piping due to fluid pulsation and/or equipment vibration to less than 1/8-inch peak-to-peak throughout range of routine operating conditions. Pay special attention to lateral bracing on non-ridged piping systems such as grooved-end.

P. Support spacing, for steel and stainless-steel piping 2-inches and smaller in diameter and copper tubing, shall not exceed 5-feet.

3.04 TESTING

A. Pipe Support Systems: Tested for compliance with this Section. After installation, test each pipe support system in conjunction with respective piping pressure tests. Repair or augment any part of pipe support system that proves to be defective or inadequate to satisfaction of Engineer.

3.05 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. When manufacturers have indicated requirements that piping loads shall not be transmitted to their equipment, submit certification stating that such requirements have been complied with.

3.06 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

B. After startup of equipment and piping systems, provide additional lateral bracing if horizontal vibration exceeds limits stated in Part 2.

3.07 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Provide identification systems for HVAC piping and equipment in accordance with this Section and applicable reference standards listed in Article 1.02.

1.02 REFERENCES

A. Reference Standards:
   1. American National Standards Institute (ANSI):
      a. ANSI A13.1 - Scheme for the Identification of Piping Systems.
      b. ANSI Z535.2 - Environmental and Facility Safety Signs.
   2. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):
      a. ASHRAE 90.1 - Energy Standard for Building Except Low-Rise Residential Buildings.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-03 Product Data:
      a. Manufacturer's technical product data and installation instructions for each identification material and device required.
   2. SD-04 Samples:
      a. Samples of each color, lettering style and other graphic representation required for each identification material or system.
   3. SD-07 Closeout Submittals:
      a. Per Division 01 General Requirements.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Mechanical identification materials to be provided by firms regularly engaged in manufacture of identification devices of types and sizes required and whose products have been in satisfactory use in similar service for not less than 5 years.

1.06 DELIVERY, STORAGE AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

1.08 MAINTENANCE

A. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock, along with required stock of stenciling paints and applicators.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers:
   1. 3M.
   2. W.H. Brady (W.H.).
   3. Seton Name Plate Corp.
   4. Or equal.

2.02 MATERIALS

A. Mechanical Identification Materials:
   1. Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 23 sections. Where more than single type is specified for application, selection is installer’s option, but must provide single selection for each product category.

B. Plastic Pipe Markers:
   1. Provide semi-rigid vinyl or plastic, color-coded pipe markers with pressure sensitive adhesive backing, complying with ANSI A13.1. Provide marker lengths and letter sizes at minimum:

OD of Pipe or insulation	Marker Length	Size of Letters
1-1/4 inches and below	8 inches	½ inch
1-1/2 to 2 inches	8 inches	¾ inch
2-1/2 to 6 inches	12 inches	1-1/4 inches
8 to 10 inches	24 inches	2-1/2 inches
Over 10 inches	32 inches	3-1/2 inches

   2. Uninsulated Pipe Operating Above 125 Degrees F: 1-inch-thick pre-molded fiberglass insulation with all service jacket for each pipe marker.
   3. Provide directional flow arrow for each pipe marker.
   4. Markers attached with ties or painted markers are not acceptable.

C. Valve Tags:
   1. Provide minimum 1-1/2-inch black PVC lamacoid valve tags with engraved white ¼-inch letters identifying sequenced valve numbers and pipe service with hole for fastening.
   2. Provide Manufacturer's standard stainless-steel chain (wire link or beaded type) with solid brass “S” link.

D. Ductwork Identification:
   1. Vinyl markers: colored vinyl with permanent pressure sensitive adhesive backing suitable for indoor and outdoor application.

2. Provide labels with service spelled out (For example: SUPPLY AIR, EXHAUST AIR, etc.) and directional flow arrow.
3. Ductwork systems containing hazardous materials: minimum 2 x 4 inch ANSI Z535.2 biohazard warning labels with custom labeling describing hazard. Refer to table in Part 3 for system and label description.

E. Maintenance Access Door Identification:
1. Doors and/or hatches for access to hazardous ductwork systems: minimum 4 x 6 inch ANSI Z5353.2 biohazard warning label. Label shall read “WARNING – BIOHAZARD. ONLY AUTHORIZED PERSONNEL BEYOND THIS POINT”.
2. Coordinate location of warning label with Atlantic Richfield Company.

F. Plastic Equipment Markers:
1. Provide laminated plastic (lamacoid), color coded equipment markers. Conform to the following color code:
a. Yellow: Heating equipment and components. Provide tagging to match the drawings for equipment. Yellow background and black lettering.
b. Blue: Equipment and components that do not meet any of the above criteria. Blue background and white lettering. Provide tagging to match the Drawings.
c. For hazardous equipment, use colors and designs recommended by ANSI A13.1.
2. Provide approximate 2-1/2 x 4-inch markers for control devices, dampers, and valves.
3. Provide 4-1/2 x 6-inch markers for equipment. Adjust size of labels to fit equipment.

2.03 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install identification after completion of covering and painting, including valve tags in finished mechanical spaces. Install identification prior to installation of any removable concealment.

B. Install all products per manufacturer’s installation instructions.

C. Degrease and clean surfaces to receive adhesive for identification materials.

D. Piping System Identification:
1. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums), and exterior non-concealed locations:
a. Near each valve and control device.
b. Near each branch, excluding short take-offs for fixtures and terminal units.
c. On both sides of walls that pipes penetrate.
d. At access doors, manholes, and similar access points that permit view of concealed piping.
e. Near major equipment items and other points of origination and termination.
f. Spaced intermediately at maximum spacing of 25 feet along each piping run.
g. On each riser and each leg of each “T” joint.
h. At least once in every room and each story in which piping exists.

E. Valve Identification:
   1. Provide valve tags on every valve, cock, and control device in each piping system; exclude plumbing fixture faucets, convenience and lawn-watering hose bibbs and similar rough-in connections of end-use fixtures and units.
   2. Provide or replace numbered tags on all existing valves that are connected to new systems.
   3. Attach tags to handwheel or around valve stem. For lever operated valves, drill the lever to attach the tag.
   4. Provide one Plexiglass framed valve directory listing all valves, with respective tag numbers, uses and locations. Mount directory in location chosen by Atlantic Richfield Company.

F. Ductwork Identification:
   1. Apply ductwork markers, clearly visible, in the following locations:
      a. Not more than 26 linear feet apart.
      b. Both sides of wall penetrations.
      c. All fans and equipment serving ductwork system.
      d. At least once in every room and each story.
      e. On each riser and each leg of each branch connection.
      f. All ductwork access doors.

G. Mechanical Equipment Identification:
   1. Install on each item of mechanical equipment and operational device as follows, but not limited to:
      a. Air handling units, exhaust fans, energy recovery ventilators and condensing units.
      b. Filters, reheat coils and dampers.
      c. Control panels, including safety devices and hazardous units.
      d. Pumps, chillers, cooling towers, heat exchangers and boilers.
      e. Expansion tanks, chemical feed equipment, water treatment equipment air/dirt separators and storage tanks.
   2. Provide permanent label on all mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987.
      a. Permanent Label: Installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE 90.1.
   3. Fasten markers with stainless steel self-tapping screws or permanently bonding cement.

3.02 ADJUSTING

A. Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.

3.03 PIPE IDENTIFICATION SCHEDULE

Pipe Service	Lettering Color	Background Color
Condensate Drain	Black	Yellow
Refrigerant Liquid	Black	Yellow
Refrigerant Suction	Black	Yellow

END OF SECTION

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Furnish the necessary labor, materials, instruments, transportation and devices required to test, adjust and balance the total heating and ventilating systems, both water and air systems. Each system as specified and detailed, shall perform in accordance with the intent of the Drawings and this Section. Systems to be tested, adjusted, and balanced include air and hydronic systems installed by the HVAC Contractor.
   2. Testing, balancing and operation of the systems shall be performed by competent and experienced personnel, having formerly done similar Work and whose qualifications and performance shall be subject to the approval of the Engineer. Test and balance air and water system and submit testing and balancing reports to the Engineer for review and approval. Re balance when required by the Engineer, incorporating all changes and certify the systems have been tested and balanced to meet specified requirements.

1.02 REFERENCES

A. Reference Standards.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-05 Test Results:
      a. Proposed testing schedules and procedures.
      b. Results of periodic field inspections as specified.
      c. Preliminary draft system balancing reports as systems are completed and tested.
      d. Final systems and Project balancing reports as final system adjustments are made as systems are accepted by Atlantic Richfield Com.
   2. SD-06 Certificates:
      a. Certification statements.
      b. Qualifications and experience information and data as detailed.
   3. SD-07 Closeout Submittals:
      a. Per Division 01 General Requirements.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Membership in the AABC or NEBB for air and water testing is required. The testing balancing Contractor may not be affiliated with the on-Site contractors.

C. The balancing contractor shall be prepared to submit credentials and other evidence of qualifications, and Work experience.

D. To perform required professional services, the balancing agency shall have a minimum of 2 test-and-balance Engineers certified by the AABC or NEBB.

E. This certified test-and-balance Engineer shall be responsible for supervision and certification for the total Work specified.

F. The balancing agency shall submit records of experience in the field of air and hydronic system balancing or any other data as requested by the Engineer. The supervisory personnel for the firm shall have at least five years' experience and all the employees used in this Project shall be qualified technicians in this specific field.

G. The balancing agency shall furnish all necessary calibrated instrumentation to adequately perform the specified services. An inventory of all instruments and devices in possession of the balancing agency may be required by the Engineer to determine the balancing agency's performance capability.

1.06 ENGINEERING SERVICES

A. When engineering services are specified to be provided by the Construction Management General Contractor (CMGC), the CMGC shall retain a licensed professional Engineer to perform the services. The Engineer shall be licensed at the time the Work is done and in the State of Montana. If the State issues discipline specific licenses, the Engineer shall be licensed in the applicable discipline. In addition, the Engineer shall be experienced in the type of Work being provided.

B. All Work is to be done according to the applicable regulations for professional Engineers, to include signing, sealing and dating documents. When submittals are required by a professional Engineer, in addition to state required signing and sealing, a copy of the current wallet card or wall certificate indicating the date of expiration shall be included with the submittal.

1.07 SCHEDULE AND PROCEDURES

A. A complete schedule of balancing procedures for each of the buildings or systems shall be submitted in sufficient time in advance so that the Engineer might arrange to observe these procedures as they progress. Before commencing with the balancing of the systems, submit the methods and instruments proposed to be used to adjust and balance the air and water systems.

B. Submit proposed testing programs at least 2 weeks prior to the scheduled test to assure agreement as to personnel and instrumentation required and scope of each testing program.

1.08 DRAWING REVIEW

A. The balancing organization shall thoroughly review the location of all fresh air dampers, return dampers, spill dampers, quadrant dampers, splitter dampers, bypass dampers, face dampers, fire dampers, registers, grilles, diffusers, etc. The purpose of the review is to finalize the optimum locations for dampers, test ports, and balancing valves shown on the Drawings.

1.09 EQUIPMENT CURVES

A. Fan Characteristics Charts: The HVAC Contractor and CMGC shall provide to the Balancing Organization any required characteristic curve charts for all fans to include air conditioning units and air handling units. Characteristic curve charts shall be not less than 8-1/2-in by 11-in and shall show the static pressure, capacity horsepower, and overall efficiency for operating conditions from no load to 130 percent of specified load. The minimum size of the actual fan curve shall be no less than 6-in by 8-in. The use of faxed copies of curves is not acceptable.

B. Pump Characteristic Charts: The HVAC Contractor shall provide to the Balancing Organization any required characteristic curve charts for each water or water/glycol system pump. Charts shall be not less than 8-1/2-in by 11-in showing head developed, efficiency and power required for varying capacities at the operating speeds of the equipment. The minimum size of the actual pump curve shall be no less than 6-in by 8-in. The use of faxed copies of curves is not acceptable

1.10 GUARANTEE

A. The balancing Work shall be guaranteed to be accurate and factual data, based on readings in the field. All typewritten data shall be submitted within 14 working days of the performance of the test. Test data shall not be held until completion but shall be submitted on an interim basis as soon as the test or appropriate groups of tests are finished.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.12 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Furnish gaskets, lubricants and other expendable materials required to be replaced during the execution of this Work.

B. Fixed-pitched pulleys required for fan adjustments shall be furnished on an exchange basis by the party Responsible for the fan installation.

C. Where test results indicate that air quantities at any system fan are below or in excess of the specified amount, the HVAC Contractor and CMGCs, at their own expense, shall change driving pulley ratio or shall make approved changes to obtain the specified or scheduled air quantities.

D. Testing apparatus: Furnish plugs, caps, stops, valves, pumps, compressors, blowers, and similar devices required to perform this Work.
   1. Furnish anemometers, thermometers, gauges, voltmeters, ammeters, lachometers and similar instruments, not part of the permanent installation, but required to record the performance of the equipment and systems.
   2. Testing apparatus, not part of the permanent installation, shall remain the property of the CMGC, but made available to the Engineer.

3. Instruments used for testing shall be certified accurate to within plus or minus 0.10 degrees F for temperature or plus or minus 0.10-in wc for pressure. Calibration of the instruments shall be done within 7 days of testing for this Project and henceforth every 30 days thereafter for the duration of the testing period. Certification of calibration shall be submitted to the Engineer prior to starting the Work.

2.02 TESTING REPORTS

A. Forms: Furnish test report data on 8-1/2-in by 11-in bond AABC or NEBB form paper. Submit format for recording data and receive approval prior to use. Electronic submission shall be in Adobe pdf format.

B. Reports shall be MS Excel spreadsheets format and shall be submitted in PDF format.

C. The report shall contain the following general data in a format selected by the balancing agency:
   1. Project number.
   2. Contract number.
   3. Project title.
   4. Project location.
   5. Project architect.
   6. Project mechanical Engineer.
   7. Test and balance agency.
   8. Test and balance Engineer.
   9. CMGC.
   10. Mechanical Subcontractor.
   11. Dates tests were performed.
   12. Certification.

D. At a minimum, the report shall include:
   1. Preface: A general discussion of the systems, any abnormalities, and problems encountered.
   2. Instrumentation List: The list of instruments including type, model, manufacturer, serial number, and calibration dates.
   3. System Identification: In each report, the VAV boxes, zones, supply, return and exhaust openings and traverse points shall be numbered and/or lettered to correspond to the numbers and letters used on the report data sheets and on the report diagrams.

E. Prepare 11-in by 17-in single line diagrams or 12-in by 18-in half size Drawings showing all duct systems indicating all terminal air outlets including diffusers, grilles and registers, perforated plates, nozzles and other types of air supply, exhaust or return outlets. The minimum scale for diagrams showing the measurement points shall be 1/8-in=1-ft-0-in in the final form as submitted. The use of faxed copies of diagrams is not acceptable. Location of test points shown on the diagrams shall be clear and easy to locate on the diagram. The identification mark of the test points shall be the same as is shown on the test report showing the test data. The identification for test points shall include indication of the units served and shall not have a duplicate in the Project. All supply outlets shall be adjusted so that there are no drafts. Grille and register readings may be made by a vane anemometer, but diffuser readings shall be made by a flow hood or a velometer, using the tip recommended by the diffuser manufacturer. Each test sheet shall include the following data:
   1. Job name and address.
   2. Name of HVAC Contractor.

3. Name of balancing organization.
4. Instruments used to perform the test.
5. Name of test technician or test Engineer.
6. Fan system and/or zone number.
7. Room number or area name.
8. Size of outlet.
9. Type outlet.
10. Manufacturer of outlet.
11. The cfm at each outlet on system and corresponding cfm at each outlet as noted on the plans.
12. Percent deviation of the measured flow versus the design flow.
13. Indication of the branch and terminal that are the open/low that are the basis for balancing the remainder of the system.

2.03 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 - EXECUTION

3.01 INSPECTIONS

A. During construction, the balancing agency shall inspect the installation of pipe systems, sheet metal Work, temperature controls, and other component parts of the heating, ventilating, and air conditioning systems. The inspections shall be performed periodically as the Work progresses. A minimum of two inspections are required as follows: (1) when 60 percent of the ductwork is installed: (2) when 90 percent of the equipment is installed. The Balancing Agency shall submit a brief written report of each inspection to the Engineer.

3.02 START OF BALANCING

A. The CMGC shall notify the Balancing Organization and Engineer when systems become operational and ready for preliminary and final testing, adjusting, and balancing.

B. Final balancing shall not begin until system has been installed complete and is capable of normal operation. Provide personnel to assist in rough balance and calibration.

C. All grilles, dampers, fans, coils, pumps, valves, and linkages shall be verified to be installed and operating.

D. System shall be capable of operating under control as specified and on Drawings.

E. Visually inspect all fire dampers on branch take-offs to each floor to ensure that they are fully open.

F. Verify with straight edge that fan/pump and motor shafts are parallel and that sheaves are in proper alignment.

G. Verify that belts are properly tensioned when unit is operating with no excessive squeal at startup. If not correct, adjust sheaves or motor base accordingly.

H. Start fans and pumps, verify that rotation is correct. If rotation is incorrect, coordinate with electrical Contractor to switch power leads such that the motor rotates correctly.

I. Check nameplate voltage on motor, compare to scheduled voltage. Notify the Engineer immediately of any discrepancies. Measure and record actual voltage across all power leads. Notify the Engineer of discrepancies immediately.

J. Check motor nameplates full load amps, measure, and record amperage across all power leads. If there are marked discrepancies in amperage draws between legs, notify the Engineer immediately.

K. Measure and record fan/pump and motor rpm. Check, that motor rpm agrees with nameplate and scheduled rpm.

L. If, upon commencing the Work, the Balancing Contractor finds that the systems are not ready, or if a dispute occurs as to the readiness of the systems, the balancing agency shall request an inspection to be made by the Engineer. This inspection shall establish to the satisfaction of the represented parties whether or not the systems meet the basic requirements for testing and balancing. Should the inspection reveal the notification to have been premature, all costs for the inspection and Work previously accomplished by the balancing agency shall be paid for by the CMGC. Furthermore, such items that are not ready for testing and balancing shall be completed and placed in operational readiness before testing and balancing services shall be recommenced.

M. Leaks, damage, and defects discovered or resulting from startup, testing and balancing shall be repaired or replaced to like-new condition with acceptable materials. Tests shall be continued until system operates without adjustments or repairs.

3.03 REQUIRED ACCURACY

A. Systems shall be balanced to be within the following limits of the capacity shown on the Drawings. Limits shall be applied to both individual components and to the system totals.

B. General Systems (plus/minus 10 percent)

3.04 TESTING

A. HVAC Air Systems:
   1. Balance the supply return and exhaust air systems in accordance with AABC or NEBB Standards by the use of direct reading instruments such as an "AnemoTherm" or velometer, which has been properly calibrated.
   2. Temporarily add static pressure to the system, to simulate the effect of dirty filters, by blanking off portions of the filter section, covering filter section with cheesecloth or other suitable means. Confirm static has been added with new static pressure reading across fan. Remove cheesecloth, etcetera, after traverses are complete.
   3. If so instructed by the Engineer, further balancing of temperature shall be made either by thermometer or by temperature recorder.
   4. The sequence of air balancing shall be as follows:
      a. First, establish airflow quantity at supply fan by main duct traverse.
      b. Next, establish airflow quantities in main ducts and branches.
      c. Finally, establish airflow quantities at outlets, using proportional balancing among branch outlets. All multiple opening systems shall be left with at least one "open low" inlet or outlet, to which all other system openings shall be proportionally balanced. The "open low(s)" on each system shall be indicated in the report.
      d. After all outlets are adjusted to within the tolerances specified elsewhere in this Section, re-measure all system outlets, and re-traverse all branch and main ducts to establish final "as balanced" flows.

e. All main air ducts shall be traversed, using a Pitot tube and manometer. The manometer shall be calibrated to read two significant figures in all velocity pressure ranges. The static pressure reading at the traverse point shall be recorded for each successive traverse.
    1) A main duct is defined as either a duct emanating from a fan or a plenum. All other ducts are branch ducts.
    2) The intent of this operation is to measure by traverse, the total air quantity handled by the fan and to verify the distribution of air to zones and to adjust system pressure to minimum level required to satisfy the farthest air outlet.
f. Adjust fan speeds if results of system capacity tests are not within tolerances specified and repeat Paragraphs 3.04A4c, d and e above, as required.
g. Mark all final balancing damper positions with a permanent marker.
h. For systems which modulate between different flow modes (e.g. minimum outside air to 100 percent outdoor air or 100 percent return air to 100 percent exhaust) measure and report system flow under both extremes of modulation and check for excessive system flow deviation above design, when system is modulating between its end points.

5. Furnish data in excel spreadsheet format tabulating the following:
    a. Opening number, type, size, and design flow rate.
    b. Quantity of air in cfm at each air outlet and inlet.
    c. Dry bulb temperature in each room.
    d. Dry bulb temperature of the supply air.
    e. Outdoor dry and wet bulb temperature at the time the above tests are conducted (wet bulb temperature only required for AC systems).
6. Adjust belts, sheaves, and the alignment of air handling equipment.
7. Where various combinations of sheaves must be installed on fan systems to achieve the correct air delivery, change the sheaves, and continue to take successive readings until the correct combinations are installed.
8. Furnish data in excel spread sheet format taken at each air moving device, to include fans, packaged units and air handling units, tabulating the following:
    a. Manufacturers, model number and serial number of units.
    b. All design and manufacturer's rated data.
    c. Total quantity of supply air in cfm.
    d. Total quantity of return air in cfm.
    e. Total quantity of exhaust or relief air in cfm.
    f. Total quantity of outside air in cfm.
    g. Outlet velocity - fpm.
    h. The rpm of each fan or blower.
    i. Maximum tip speed - fpm.
    j. The rpm of each motor.
    k. Voltage and ampere input of each motor (one reading for each phase leg on 3 phase motors).
    l. Pressure in inches w.g. at inlet of each fan or blower.
    m. Pressure in inches w.g. at discharge of each fan or blower.
    n. Pressure drops across system components such as louvers, filters, coils, and mixing boxes.
    o. Submit the actual fan operating point on a copy of the fan Shop Drawing showing operating curve.
    p. List the following data from all fan motors installed:
        1) Manufacturer model and size.
        2) Motor horsepower, service factor, and rpm.
        3) Volts, phases, cycles, and full load amps.

4) Equipment locations.

3.05 STANDBY EQUIPMENT

A. Where systems are provided with standby equipment, the system shall be balanced for operation in standby as well as normal operation.

3.06 FINAL ACCEPTANCE

A. At the time of final inspection, the balancing agency shall recheck, in the presence of the Engineer, specific and random selections of data recorded in the certified test-and-balance report.

B. Points and areas for recheck shall be selected by the Engineer.

C. Measurements and test procedures shall be the same as the original test and balance.

D. Selections for recheck, specific plus random, shall not normally exceed 15 percent of the total number tabulated in the report, except where special air systems require a complete recheck for safety reasons.

E. If the specific rechecks are more than 5 percent deviation from the report or specified flows, all of the systems, that require specific recheck, shall be rebalanced. If 5 percent or five of the random checks, whichever is less, exceeds a 10 percent deviation from the specified flows, the report shall be rejected. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, a new certified test-and-balance report submitted, and a new inspection test made, all at no additional cost to the Group.

3.07 OPPOSITE SEASON TEST

A. The balancing agency shall perform an inspection of the HVAC system during the opposite season from that in which the initial adjustments were made. The balancing agency shall make any necessary modifications to the initial adjustments to produce optimum system operation.

3.08 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.09 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.10 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 23 07 19
HVAC PIPING INSULATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide HVAC piping insulation and insulation jackets in accordance with this Section and applicable reference standards listed in Article 1.02.

B. Related Requirements:
   1. Section 09 90 00 – Painting and Coating.
   2. Section 23 05 00 – Common Work Results for HVAC.

1.02 REFERENCES

A. Reference Standards:
   1. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
      a. ASHRAE Standard 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
   2. ASTM International (ASTM):
      a. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
      b. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
      c. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
      d. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation.
      e. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
      f. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
      g. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
      h. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation.
      i. ASTM C1729 - Standard Specification for Aluminum Jacketing for Insulation.
      j. ASTM C1767 - Standard Specification for Stainless Steel Jacketing for Insulation.
      k. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
      l. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
   3. National Fire Protection Association (NFPA):
      a. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
      b. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
      c. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
   4. Underwriters Laboratories (UL):
      a. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-03 Product Data:
      a. List of materials including manufacturer's technical descriptive literature, performance data, catalog cuts, installation instructions, product number, kvalue, thickness and furnished accessories including adhesives, sealants and jackets for each mechanical system requiring insulation.
   2. SD-06 Certificates:
      a. Qualifications statements.
   3. SD-07 Closeout Submittals:
      a. Per Division 01 General Requirements.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Qualifications: Per Division 01 General Requirements and as follows:
   1. Manufacturers: Firms regularly engaged in manufacture of mechanical insulation products specified, whose products have been in use in similar service for minimum 3 years.
   2. Installers: Firm with minimum 5 years' installation experience on projects with mechanical insulation specified.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Packing, Shipping, Handling, and Unloading: Deliver to Site with manufacturer's product label displaying fire hazard indexes.

C. Storage and Protection: Protect insulation from dirt, water, chemical, and mechanical damage. Do not install wet or damaged insulation and remove from Site.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

PART 2 - PRODUCTS

2.01 STANDARD PRODUCTS

A. Comply with applicable reference standards listed in Article 1.02.

B. Provide standard products from manufacturers regularly engaged in manufacture of specified products in satisfactory use in similar service for a minimum of 2 years.

2.02 INSULATION

A. Type A:
   1. ASTM C547 glass fiber; 0.24 maximum k value at 75 degrees F; non-combustible. All purpose, white kraft jacket bonded to aluminum foil and reinforced with fiberglass yarn, 25/50 flame spread/smoke developed rating when tested according to ASTM E84 and UL 723.
      a. Manufacturers:
         1) CertainTeed Manson.
         2) Knauf Fiber Glass.
         3) Johns Manville.
         4) Owens/Corning Fiberglas Corporation.
         5) Or equal.

B. Type B:
   1. ASTM C534 ethylene propylene diene monomer (EPDM) elastomeric cellular foam; flexible plastic; 0.24 maximum k value at 75 degrees F, 25/50 flame spread/smoke developed rating when tested according to ASTM E84 and UL 723. Maximum 1-inch thick per layer where multiple layers are specified. Vinyl - Nitrile Rubber Blends (NBR/PVC) cellular foam is not permitted.
      a. Manufacturers:
         1) Armacell.
         2) Mueller Industries.
         3) Rubatex.
         4) Johns Manville.
         5) Or equal.

2.03 ADHESIVES

A. Provide NFPA 90A, NFPA 90B and ASTM C916 nonflammable, fire-resistant adhesive.

2.04 VAPOR BARRIER JACKETS

A. Provide kraft reinforced foil vapor barrier with self-sealing adhesive joints; Beach puncture resistance ratio of at least 50 units; tensile strength: 35 psi minimum. Provide single, self-seal acrylic adhesive on longitudinal jacket laps and butt strips.

2.05 JACKET COVERINGS

A. Aluminum Jackets: ASTM C1729 minimum 0.016-inch stucco embossed finish with Z edge seams and aluminum bands for outdoor use. Provide factory-applied hard film acrylic paint colored jacket covers as specified, in color selected by Atlantic Richfield Company.

B. Stainless Steel Jackets: ASTM C1767 Type 316 stainless steel, minimum 0.010-inch thick, smooth finish with Z edge seams and stainless-steel bands for outdoor use.

C. Plastic Jackets and Fitting Covers: High impact, glossy white, 0.030 in. self-extinguishing plastic, suitable for indoor or outdoor use with ultraviolet inhibitors, and minus 40 degrees F to 150 degrees F. 25/50 maximum flame spread/smoke developed.

2.06 REMOVABLE INSULATION JACKETS

A. Provide removable insulation jackets with outer covering, interstitial insulation material, and inner covering.

B. Provide inner and outer covering constructed from minimum minus 16.5 oz/yd2 polytetrafluoroethylene (PTFE) fiberglass composite, suitable for insulating surface temperatures up to 550 degrees F.

C. Provide minimum 1.5-inch-thick interstitial insulation blanket consisting of one of the following.
   1. Minimum 6 lb/ft^3 density silica and glass-fiber insulation felts and blankets.
   2. Minimum 6 lb/ft^3 density E-type glass-fiber felts and blankets.
   3. Inner and outer covering joined into a single assembly with 4-6 stiches per inch double sewn lock stitch, with thread able to withstand minimum 550 degrees F surface temperatures without degradation. Use of hog rings, staples, and wires for assembly closure are not permitted. Insulation pins are not allowed to prevent insulation from shifting.

D. Raw cut jacket edges may not be exposed.

E. Provide jacket coverings with inner covering edge and continuous strip of hook & loop closure parallel to seam, overlapping outer covering by minimum of 2 inches.

F. Manufacturers:
   1. Firwin Corp.
   2. Lewco Specialty Products
   3. ThermaXX Jackets.
   4. Or equal.

2.07 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements. Comply with applicable reference standards listed in Article 1.02.

PART 3 - EXECUTION

3.01 PIPE INSULATION SYSTEMS INSTALLATION

A. General:
   1. Install materials per manufacturer's instructions, building codes and Industry Practice.
   2. Continue insulation of vapor barrier through insulated piping penetrations. Maintain fire rating of penetrations.
   3. On insulated piping, provide insert of same thickness and contour as adjoining insulation at each support and between pipe and insulation jacket to prevent insulation from sagging and crushing. Provide insert suitable for planned temperatures, pipe material, and a 180 degree cylindrical segment same length as metal shields. Provide cellular glass inserts for all temperature ranges, or molded hydrous calcium silicate for pipe with operating temperatures above 70 degrees F, with minimum compressive strength of 50 psi. Polyisocyanurate insulation with minimum compressive strength of 24 psi is acceptable for pipe sizes 3 inches and below; minimum 60 psi for pipe sizes 4 inches and above; operating below 300 degrees F. Factory fabricated inserts may be used. Rectangular blocks, plugs, or wood material are not allowed. Temporary wood blocking may be used by piping contractor for proper height but must be removed and replaced with proper inserts by insulation contractor.
   4. Neatly finish insulation at supports, protrusions, and interruptions.
   5. Install half round, flared edge galvanized sheet metal shields between hangers or supports and pipe insulation. Adhere shields to insulation. Seal shields on cold piping, vapor-tight to insulation to maintain vapor barrier, or add separate vapor barrier jacket.

6. Provide shields at minimum, according to the following lengths and gauges.

Pipe Size	Shield Size
0.5 - 3 in	12 in long x 18 gauge
4 in	12 in long x 16 gauge
5 - 6 in	18in long x 16 gauge
8 - 14 in	24 in long x 14 gauge
16 - 24in	24 in long x 12 gauge

B. Insulated Piping Operating Below 60 Degrees F:
   1. Insulate fittings, valves, unions, flanges, strainers, flexible connections, flexible hoses, and expansion joints. Seal penetrations of vapor barrier.
   2. Provide Type B insulation on piping operating below 60 degrees F in locations not mechanically cooled.
   3. Insulate balance valves with fluid operating below 60 degrees F with a removable plug wrapped with vapor barrier tape to allow reading and valve adjustment.

C. Insulated Piping Operating Between 60 Degrees F and 140 Degrees F:
   1. Bevel and seal ends of insulation. Insulate fittings, valves and strainers. Do not insulate flanges and unions.

D. Insulated Piping Operating Above 140 Degrees F:
   1. Insulate fittings, valves, flanges, float and thermostatic steam traps, and strainers. Extend insulation on gate valves to cover entire valve bonnet, leaving only stem portion above the bonnet and valve operator exposed.
   2. Insulate balance valves with fluid operating above 140 degrees F and leave opening in insulation to allow reading and valve adjustment.
   3. Removable insulation jackets are acceptable for insulating large and non-cylindrical shaped piping components.

E. Refrigerant Piping:
   1. Provide insulation coupling at each strut or clevis support on refrigerant piping 25 degrees F and above, not required to meet the 25/50 flame/smoke rating, to accept insulation thickness of adjoining insulation, support pipe, and prevent sagging and crushing. Provide 360 degree, 1piece cylindrical segment coupling suitable for planned temperatures, and use with specified pipe material. Use mechanical fasteners where coupling cannot be installed on pipe during installation. Apply adhesive to ends of insulation entering insulation coupling to maintain vapor barrier.

F. Exposed Piping:
   1. Provide 0.016-inch cylindrical smooth or stucco aluminum sheet metal guard around insulation where exposed insulated piping extends 12 inches above floor. Fit tightly to insulation.

3.02 INSULATION INSTALLATION

A. Type A Insulation:
   1. Seal longitudinal joints of All Service Jackets (ASJ) with self-seal laps using a single pressure sensitive adhesive system. Do not staple.
   2. Insulation without self-seal lap may be used if installed with Benjamin Foster 85-20, 3M, Childers, or equivalent lap adhesive.
   3. Apply insulation with laps on top of pipe.

4. Insulate fittings, valve bodies and flanges of 4-inch and smaller pipes with 1 lb/ft^3 density insulation wrapped under compression to a thickness equal to adjacent pipe insulation. Use mitered segments of pipe insulation for pipes over 4 inches. Finish with preformed plastic fitting covers. Secure fitting covers with pressure sensitive tape at each end. Overlap tape at least 2 inches on itself. On pipes operating below 60 degrees F, seal fitting covers with vapor retarder mastic in addition to tape.

B. Type B Insulation:
   1. Where possible, slip elastomeric cellular foam insulation over open end of pipe without slitting. Seal butt ends, longitudinal seams, and fittings with adhesive. Use mitered connections at elbows and tees. Do not compress or crush insulation at cemented joints. Seal joints without puckering or wrinkling. Paint outside of outdoor insulation with 2 coats of latex enamel paint recommended by manufacturer.
   2. Self-seal insulation may be used on pipes operating below 170 degrees F.

3.03 JACKET COVER INSTALLATION

A. Fasten jackets to equipment and piping components using hook and loop straps and minimum 1-inch slide buckles.

B. Metal Covering:
   1. Provide vapor barrier specified for insulation type A. Cover with jacket with seams located on bottom of horizontal piping. Include fittings, joints and valves.
   2. Seal interior and exterior butt joints with metal draw bands and sealant. Seal exterior joints watertight. Interior joints do not need to be sealed.
   3. Use metal covering on the following pipes:
      a. Exterior piping.
   4. Use colored aluminum jacket covers on exterior piping.

C. Plastic Covering:
   1. Provide vapor barrier specified for insulation type. Cover with plastic jacket covering. Position seams to shed water.
   2. Solvent weld joints with manufacturer recommended cement.
   3. Overlap all laps and butt joints 1.5-inch minimum for watertight installation. Repair ends not securely sealed. Solvent weld fitting covers in same manner.
   4. Use plastic insulation covering on exposed pipes including the following:
      a. Exposed piping as noted on Drawings.
      b. Exposed piping in locker rooms.
      c. Exposed piping lower than 8-feet above floor.
      d. Piping in mechanical rooms or tunnels subject to damage from normal operations.
      e. Kitchen areas.
   5. Elastomeric piping insulation may have 2 coats of latex paint instead of plastic jacket.
   6. Use colored plastic covering on exterior piping.

3.04 PAINTING AND FINISHING

A. Provide painting according to Section 00 90 00 – Painting and Coating.

3.05 PROTECTION

A. Protect insulation Work during construction to prevent damage and deterioration.

3.06 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements. Comply with applicable reference standards listed in Article 1.02.

3.07 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

3.08 SCHEDULE

A. Refer to Insulation Schedule on plans.

END OF SECTION

SECTION 23 23 00
REFRIGERANT PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide refrigerant piping for direct expansion HVAC systems in accordance with this Section and applicable reference standards listed in Article 1.02.

B. Related Requirements:
   1. Section 23 05 00 – Common Work Results for HVAC.
   2. Section 23 05 19 – Meters and Gauges for HVAC Piping.
   3. Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

1.02 REFERENCES

A. Reference Standards:
   1. Air Conditioning, Heating, and Refrigeration Institute (AHRI):
      a. AHRI 730 - Flow Capacity Rating of Suction Line Filters and Suction Line Filter Driers.
      b. AHRI 750 - Performance Rating of Thermostatic Refrigerant Expansion Valves.
      c. AHRI 760 - Performance Rating of Solenoid Valves for Use with Volatile Refrigerants.
   2. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
      a. ASHRAE 15 - Safety Standard for Refrigeration Systems.
      b. ASHRAE 17 - Method of Testing Capacity of Thermostatic Refrigerant Expansion Valves.
      c. ASHRAE 63.1 - Method of Testing Liquid Line Refrigerant Driers.
   3. American Society of Mechanical Engineers (ASME):
      a. ASME A13.1 - Scheme for the Identification of Piping Systems.
      b. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
      c. ASME B16.24 - Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves: Classes 150, 300, 600. 900, 1500, and 2500.
      d. ASME B31.5 - Refrigeration Piping and Heat Transfer Components.
      e. ASME B40.100 - Pressure Gauges and Gauge Attachments.
      f. ASME B40.200 - Thermometers, Direct Reading and Remote Reading.
   4. ASTM International (ASTM):
      a. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      b. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      c. ASTM B32 - Standard Specification for Solder Metal.
      d. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
      e. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
   5. American Welding Society (AWS):
      a. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding
      b. AWS Brazing Handbook.
   6. Environmental Protection Agency (EPA).

7. National Electrical Manufacturers Association (NEMA):
    a. NEMA 250 - Enclosures for Electrical Equipment (1,000 Volts Maximum).
    b. NEMA Z535.1 - Safety Colors.
8. Underwriters Laboratories (UL):
    a. UL 429 - Standard for Electrically Operated Valves.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
    1. SD-01 Preconstruction Submittals:
        a. Design Data/Submittals:
            1) Furnish two copies of design manual of refrigerant valves and accessories.
    2. SD-02 Shop Drawings:
        a. Layout of refrigerant piping and accessories, including flow capacities, valve locations, oil traps, slopes of horizontal runs, floor/wall penetrations, and equipment connection details.
        b. Schematic piping diagram showing all accessories necessary, such as stop valves, level indicators, liquid receivers, oil separator, gauges, thermostatic expansion valves, solenoid valves, moisture separators and driers, to make a complete installation.
    3. SD-03 Product Data:
        a. Complete information for components, including valves and refrigerant piping accessories, to determine compliance with drawings and specifications.
        b. Manufacturer instructions.
    4. SD-06 Certificates:
        a. Copies of certificates for welding procedure.
        b. Qualification Statements:
            1) Performance qualification record, and list of welders' names and symbols.
    5. SD-07 Closeout Submittals:
        a. Per Division 01 General Requirements.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Storage and Protection: Protect refrigerant system during construction against entrance of foreign matter, dirt, and moisture. Tightly cap open ends of piping and connections to compressors, condensers, evaporators, and other equipment until assembly.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

PART 2 - PRODUCTS

2.01 PIPING AND FITTINGS

A. Refrigerant Piping:
   1. Provide ASTM B280 cleaned, dehydrated and sealed copper refrigerant tube for piping up to 4-inches, marked air-conditioning and refrigeration field service (ACR) on hard temper straight lengths and ASTM B280 coils. For piping over 4-inches provide ASTM A53 black seamless steel tube.

B. Water and Drain Piping:
   1. ASTM B88 Type M or L copper water tube.

C. Fittings, Valves, and Accessories:
   1. Copper fittings: ASME B16.22 wrought copper.
      a. Brazed joints, refrigerant tubing: cadmium free, AWS A5.8, 45- percent silver brazing alloy, Class B Ag-5.
      b. Solder joints, water, and drain: ASTM B32, Grade 95TA, 955 tinantimony.
   2. ASTM Wrought Steel Fittings:
      a. Refrigerant Piping: Welded joints.
   3. Flanges and Flanged Fittings: ASME B16.24.
   4. Refrigeration Valves:
      a. Stop Valves: brass or bronze alloy, pack-less or packed type with gas-tight cap, frost proof, back seating.
      b. Pressure Relief Valves:
         1) ASME Boiler and Pressure Vessel Code.
         2) ASTM A126, Grade B forged brass with non-ferrous, corrosion resistant internal working parts of high strength cast iron bodies. Set valves in accordance with ASHRAE 15.
      c. AHRI 760 and UL 429 two-position solenoid valves; direct acting or pilot-operated; moisture and vaporproof corrosion resisting materials, and solder-end connections. Fit with NEMA 250 enclosure type required by location and normally open, or closed per equipment requirements, holding coil.
      d. AHRI 750 brass body thermostatic expansion valves with stainless steel or non-corrosive non-ferrous internal parts; diaphragm and spring-loaded, direct-operated type with sensing bulb; distributor with side connection for hot-gas bypass and external equalizer; and solder-end connections. Size and operating characteristics recommended by evaporator manufacturer and factory set for superheat requirements. Testing and rating in accordance with ASHRAE 17.
      e. Check Valves: Swing or lift type brass or bronze alloy designed for low pressure drop, with tight closing resilient seals for silent operation and solder-end connections. Direction of flow: permanently indicated on valve body.
   5. Strainers: Designed to permit removal of screen without removing strainer from piping system, provided with 80 to 100 mesh screens in liquid lines diametre nominel (DN) nominal pipe size 25 (NPS 1) and smaller, 60 mesh in liquid lines larger than DN 25 (NPS 1), and 40 mesh in suction lines. Provide strainers in liquid line serving each thermostatic expansion valve, and in suction line serving each refrigerant compressor not equipped with integral strainer.
   6. Refrigerant Moisture/Liquid Indicators: Doubleported type having heavy sight glasses sealed into forged bronze body. Incorporate means of indicating refrigerant charge and moisture indication. with screwed brass seal caps.
   7. Refrigerant Filter-Driers: ARI 730 and ASHRAE 63.1, UL angle or inline type, as shown on Drawings. Heavy gauge steel shell protected with corrosion-resistant paint; and

perforated baffle plates to prevent desiccant bypass. Furnish 1 spare element of each type and size for driers with replaceable filters. Size as recommended by manufacturer for service and capacity of system with connection not less than line size in which installed.

8. Flexible Metal Hose: Seamless bronze corrugated hose covered with bronze wire braid, with standard copper tube ends. Provide in suction and discharge piping for each compressor.

2.02 GAUGES

A. Temperature gauges: ASME B40.200 industrialduty type with adjustable pointer in temperature range required for service installed. Scale: 2-degree F graduations, with black numbers on a white face. Provide rigid stem type gauges in thermal wells located within 5-feet of finished floor. Provide universal adjustable angle type or remote element type gauges in thermal wells located 5 to 7 feet above finished floor. Provide remote element type gauges in thermal wells located 7-feet above finished floor. Refer to Section 23 05 19.

B. Vacuum and pressure gauges:
   1. ASME B40.100 with throttling type needle valve or pulsation dampener and shut- off valve. Gauge: minimum of 3-1/2 inches in diameter with range from 0 kPa (0 psig) to approximately 1.5 times maximum system working pressure. Select gauge range so needle is within middle-third of range at normal operating pressure.
      a. Suction: 101 kPa (30 inches Hg) vacuum to 1723 kPa (gage) (250 psig).
      b. Discharge: 0 to 3445 kPa (gage) (0 to 500 psig).

2.03 THERMOMETERS AND WELLS

A. Refer to Section 23 05 19 – Meters and Gauges for HVAC Piping.

2.04 PIPE SUPPORTS

A. Refer to Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

2.05 REFRIGERANTS AND OILS

A. Provide EPA approved refrigerant and oil for proper system operation.

2.06 PIPE INSULATION FOR DX HVAC SYSTEMS

A. Flexible Elastomeric Insulation Manufacturers:
   1. Armacell.
   2. ISOCLIMA (pre-insulated).
   3. PDM US, Gelcopper (Pre-Insulated).
   4. Or equal.

2.07 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install refrigerant piping and refrigerant containing parts in accordance with ASHRAE 15 and ASME B31.5.

1. Install piping as short as possible, with minimum number of joints, elbows, and fittings.
2. Install piping with adequate clearance between pipe and adjacent walls and hangers to allow for service and inspection. Space piping, including insulation, to provide minimum 1-inch clearance between adjacent piping or other surface. Use pipe sleeves through walls, floors, and ceilings, sized to permit installation of pipes with full thickness insulation.
3. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Locate valve stems in overhead piping in horizontal position. Provide a union adjacent to 1 end of threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on Drawing.
4. Install hangers and supports per ASME B31.5 and refrigerant piping manufacturer's recommendations.

B. Joint Construction:
1. Provide according to AWS Brazing Handbook for brazed joints, and with AWS A5.8 for filler materials.
   a. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper tubing.
   b. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.
   c. Swab fittings and valves with manufacturer recommended cleaning fluid to remove oil and other compounds prior to installation.
   d. Pass nitrogen gas through pipe or tubing to prevent oxidation as each joint is brazed. Cap system with reusable plug after each brazing operation to retain nitrogen and prevent entrance of air and moisture.

C. Firestopping: Refer to Division 07.

3.02 PIPE AND TUBING INSULATION

A. Install flexible elastomeric insulation where concealed and in mechanical and equipment rooms according to manufacturer’s instructions.

B. Apply thickness as indicated on INSULATION SCHEDULE on Drawings.

C. Apply 2 coats of weatherresistant finish recommended by manufacturer to insulation exposed to outdoor weather.

3.03 SIGNS AND IDENTIFICATION

A. Provide a permanent sign for each refrigerating system easily accessible indicating name and address of installer, type and number of pounds of refrigerant required for normal operations, and field test pressure applied.

B. Provide ASME A13.1 and NEMA Z535.1 signs for systems containing more than 110-pounds of refrigerant with letters a minimum height of 1/2-inch designating the following:
1. Valves and switches for controlling refrigerant flow, ventilation, and refrigerant compressors.
2. Name of refrigerant and letters high pressure (HP) or low pressure (LP) on exposed high and low pressure piping installed outside of machinery room.

3.04 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Site/Field Tests and Inspections:
   1. Prior to initial operation, inspect piping system for conformance to specifications and ASME B31.5. Correct rejected equipment, material, or Work for defects or nonconformance with specifications and ANSI codes for pressure piping.
   2. After completion of piping installation and prior to initial operation, conduct test on piping system according to ASME B31.5. Furnish materials and equipment required for tests. Perform tests in presence of Engineer. If test fails, correct defects and perform test until results are satisfactory and joints are proved tight.
   3. After complete installation and before operation, test and prove tight every refrigerant-containing part of system erected on the premises, except compressors, condensers, evaporators, safety devices, pressure gauges, control mechanisms, and systems that are factory tested.
   4. Test and prove tight high and low side of each system at not less than the lower of design pressure or setting of pressure relief device protecting high or low side of system, respectively, except systems erected on premises using non-toxic and non-flammable Group A1 refrigerants with copper tubing not exceeding DN 18 (NPS 5/8). This may be tested by means of refrigerant charged into system at saturated vapor pressure of refrigerant at minimum 68 degrees F.
   5. Use a suitable dry gas, such as nitrogen, for pressure testing. Means used to build up test pressure shall have either a pressure-limiting or pressure-reducing device with a pressure relief device and a gauge on outlet side. Set pressure relief device above test pressure but low enough to prevent permanent deformation of system components.
   6. System test and charging: as recommended by equipment manufacturer.

3.05 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 23 31 00
DUCTWORK

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide ductwork in accordance with this Section and applicable reference standards listed in Article 1.02.

1.02 REFERENCES

A. Reference Standards:
   1. Air Duct Council (ADC)
   2. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):
      a. ASHRAE Standard 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
   3. ASTM International (ASTM):
      a. ASTM A653 - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      b. ASTM A924 - General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
      c. ASTM A90 - Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
      d. ASTM E84 - Surface Burning Characteristics of Building Materials.
      e. ASTM G154 - Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials.
   4. National Fire Protection Association (NFPA):
      a. NFPA 70 - National Electrical Code (NEC).
      b. NFPA 90A - Standard for Installation of Air-Conditioning and Ventilating Systems.
      c. NFPA 90B - Standard for Installation of Warm Air Heating and Air-Conditioning Systems.
   5. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
      a. SMACNA 022 - Phenolic Duct Construction Standards.
      b. SMACNA - Fibrous Glass Duct Construction Standards.
   6. Underwriters Laboratories (UL):
      a. UL 181A-P - Closure Systems for use with Rigid Air Ducts.
      b. UL 181B-M - Closure Systems for use with Flexible Air Ducts and Air Connectors.
      c. UL 214 - Safety Tests for Flame-Propagation of Fabrics and Films.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

B. Drawings indicate the extent and general arrangement of the systems. If any departures from the Drawings or Specifications are deemed necessary, provide details of such departures and the reasons for said departure as soon as practical for review.

C. Construction Management General Contractor (CMGC) assumes full responsibility for coordination of the HVAC systems, including scheduling, and verification that structures, ducts, piping, and mounting of equipment are compatible.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-02 Shop Drawings:
      a. Provide detailed duct layout drawings at a 1/4-inch minimum scale complete with the following:
         1) Actual ductwork routing, fittings, dimensions including insulation liner and wrap, duct hanger and support types, ductwork accessories, etc. with lengths and weights noted.
         2) Room names and numbers, ceiling types and ceiling heights.
         3) Indicate location of all beams, bar joists, etc. along with bottom of steel elevations for each member.
         4) Verify clearances and interferences with other trades prior to preparing drawings.
   2. SD-03 Product Data:
      a. For each product type specified.
   3. SD-05 Test Reports:
      a. As specified in this Section.
   4. SD-07 Closeout Submittals:
      a. Per Division 01 General Requirements.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Inspect materials for size, quality and quantity against approved Shop Drawings upon delivery.

C. Pack materials suitable for shipment and long-term storage. Label each package to indicate the project and the contents. Where applicable, mark equipment designation on the container.

D. Protect equipment from during transit.

E. Store materials in a covered dry location off the ground.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

PART 2 - PRODUCTS

2.01 GALVANIZED DUCTWORK

A. General Requirements:
   1. Provide duct and reinforcement materials in accordance with ASTM A653 and A924.
   2. Interior Ductwork, Reinforcements and Supports: G60 galvanized (per ASTM A90) unless noted otherwise.
   3. Exterior Ductwork, Reinforcements and Supports: G90 galvanized (per ASTM A90) unless noted otherwise. G60 is not acceptable for exterior use.

4. Provide galvanized steel strap hanger of minimum 1-inch width attached to the bottom of the ducts. Provide spacing of strap hangers per SMACNA.
5. Slip cable hangers are acceptable for 18 inch nominal diameter round ductwork or smaller. Provide protective sleeve tubing on the cable when supporting duct with exterior insulation.
6. Provide corner saddles when supporting rectangular ductwork.
7. Provide galvanized or cadmium plated fasteners.

2.02 ALUMINUM DUCTWORK

A. General Requirements:
   1. Material:
      a. ASTM B209, alloy 5052 for aluminum sheet and alloy 6061-T6 or equivalent strength for aluminum connectors, fasteners and bar stock.
   2. Provide aluminum ductwork reinforcement.
   3. Provide aluminum, galvanized steel or painted ductwork supports. Slip cable hangers are acceptable.
   4. Provide duct gauges and reinforcement per SMACNA HVAC Duct Construction Standards.
   5. Provide corner saddles when supporting rectangular ductwork.
   6. Provide galvanized or cadmium plated fasteners.

2.03 STAINLESS STEEL DUCTWORK

A. General Requirements:
   1. Provide Type 304L stainless steel, 16-gauge minimum.
   2. Provide #3 finish on exposed ductwork.
   3. Provide stainless steel ductwork reinforcement.
   4. Provide stainless steel ductwork supports. Slip cable hangers are acceptable.
   5. Provide galvanized or cadmium plated fasteners.

2.04 DUCTWORK REINFORCEMENT

A. General:
   1. Provide reinforcement external to ductwork.
   2. Tie Rods are acceptable if the following limitations are adhered to:
      a. Ductwork: Greater than 18 inches wide.
      b. Ductwork Dimensions: Increased 2 inches in one dimension for each row of tie rods installed.
      c. Tie Rods: ½ inches diameter or smaller.
      d. Manufacturer of tie rod system must certify pressure classifications of various arrangements.

2.05 DUCTWORK SEALANTS

A. One-Part Joint Sealers: Water-based mastic systems, maximum 48 hour cure time, service temperature from -20 to 175 degrees F, mold and water resistant, flame/smoke spread rating below 25/50 in accordance with ASTM E84, suitable for all SMACNA seal classes and pressure classes and be marked with UL 181B-M.

B. Two-Part Joint Sealers: Minimum 3-inch-wide mineral-gypsum compound impregnated fiber tape and a liquid sealant.
   1. Sealant System:
      a. Maximum 48-hour cure time.

b. Service temperature of 0 degrees F to 200 degrees F.
c. Resistant to mold, mildew and water.
d. Flame spread rating and smoke developed rating below 25 50, respectively when tested in accordance with ASTM E84.
e. Suitable for all SMACNA seal classes and pressure classes.

2. One-Part and Two-Part Sealers for Outdoor Applications: Service temperatures from -20 to 175 degrees F, 2000-hour minimum UV resistance per ASTM G154.
3. Pressure Sensitive Tape: Minimum 2.5 inches wide, listed and marked UL 181A-P, minimum 60 oz/inch peel adhesion to steel and service temperature of -20 degrees F to 250 degrees F.

2.06 RECTANGULAR DUCTWORK – SINGLE WALL

A. Provide ductwork construction, gauges and reinforcements as listed in SMACNA Duct Construction Standards.

B. Acceptable exceptions and modifications to the HVAC Duct Construction Standards:
1. All Ductwork: Cross-broken or beaded.
2. Snap-lock seams are not permitted.
3. Elbows with different size inlet and outlet must be radius type.
4. Provide smooth radius elbows constructed per SMACNA.
a. Provide RE1 with centerline duct radius R/W of 1.0.
b. If space does not permit R/W of 1.0, then Type RE3 elbow with 3 vanes and R/W of 0.6 is acceptable.
c. RE1 or RE3 may be used where mitered elbows are shown on Drawings.
5. Mitered elbow are not permitted unless shown on drawings. Provide turning vanes in all 90-degree mitered elbows unless noted otherwise on Drawings.
a. Turning Vanes: Single wall, 22-gauge minimum, 3-1/2 inch blade spacing and 4 to 4-1/2 inch radius.
b. Runners: Installed a 45-degree angle.
c. Omitting every other vane is not permitted.
6. Provide 45-degree entry type rectangular branch and tee connections in ductwork with pressure class greater than 1 inch. Straight taps are not permitted above 1 inch pressure class.
7. Provide 60-degree angle minimum (space permitting) on all bellmouth fittings in return ductwork.
8. Round Taps off Rectangular Ductwork:
a. Provide flanged conical or bellmouth type or
b. 45-degree rectangular take-off with transition to round.
9. Provide dovetail joints on lined ductwork where round or conical taps occur.

C. Alternate duct construction: factory fabricated joint systems may be offered as an alternate form of construction. System offered shall meet SMACNA requirements. Alternate joint systems acceptable level of quality: equivalent to Ductmate System manufactured by Ductmate Industries, Inc. Install in accordance with manufacturer's recommendations.

2.07 ROUND SPIRAL SEAM DUCTWORK

A. Provide ductwork construction, minimum gauges and reinforcements as listed in SMACNA Duct Construction Standards.

B. Provide smooth radius elbows with R/D of minimum 1.5.

C. Spot weld and bond all fitting seams in the pressure shell. Coat damaged ductwork with corrosion resistant paint to match duct color.

D. Transverse Joint Connections:
   1. Crimped joints are not permitted.
   2. Provide slip joint connections for ducts and fittings 36 inches in diameter and smaller. Size fitting ends to slip inside mating duct sections with minimum 2-inch insertion length and a stop bead. Use inside slip couplings for duct-to-duct joints, and outside slip couplings for fitting-to-fitting joints.
   3. Provide flanged connections for ducts and fittings larger than 36 inches.
   4. Secure joints with at least 4 sheet metal screws per fitting, 6 inches on center maximum and equally spaced along the perimeter of the fitting.

2.08 FLEXIBLE DUCTWORK

A. Provide flexible ductwork listed and labeled as UL 181 Class 1 Air Duct Material and in compliance with NFPA 90A and 90B.

B. Provide flexible ductwork bearing the ADC Seal of Certification.

C. Flame/spread smoke developed ratings of less than 25/50 per ASTM E84.

D. Corrosion resistant wire helix bonded to a liner preventing air from contacting the insulation.

E. Insulation:
   1. Minimum 1-1/2 inch thick, 3/4 lb/ft³ density fiberglass insulation blanket sheathed in vapor barrier of metalized polyester film laminated to glass mesh.

F. Suitable for 6 inches WC of static pressure through 10 inch diameter and suitable for 4 inches WC of static pressure for 12-inch to 16-inch diameter.

G. Minimum R-value of 6.0.

H. Temperature range of 0 to 180 degrees F.

I. Do not exceed 36 inches in length.

J. Install per the SMACNA Flexible Duct Manual. Secure inner layer with draw band. Wrap with pressure sensitive tape for protection prior to installing draw band. Pressure sensitive tape alone is not acceptable

2.09 VIBRATION ISOLATION FOR DUCTWORK

A. Provide a flexible duct connector approximately 6 inches in width in locations that sheet metal ductwork is connected to HVAC equipment. Provide metal edges and fasteners with equal to or greater corrosion resistance as the ductwork.

B. Material for indoor applications: glass fabric coated with neoprene and in accordance with UL 214 and NFPA 90A.

C. Material for exterior applications: coated glass fabric. Acceptable level of quality: equivalent to DuPont Hypalon Fabric. UV resistant and in accordance with UL 214 and NFPA 90A.

2.10 ACCESS DOORS

A. Provide hinged access doors conforming to SMACNA 1966 in ductwork and plenums where indicated and at all air flow measuring primaries, automatic dampers, fire dampers, coils, thermostats, inlet side of centrifugal fans and heating coils, and other apparatus requiring service and inspection in the duct system. Provide access doors upstream and downstream of air flow measuring primaries and heating and cooling coils.

B. Access Doors:
   1. Minimum 24 inches by 24 inches in ducts 26 inches and larger. Provide largest door that can be accommodated for duct sizes less than 26 inches.
   2. Same material as the duct, pan type construction for metal ductwork, with smooth edges and fitted seals, constructed and installed for air tight fit with ease of opening and closing.
   3. Substantially butt hinged, with heavy sash locks and substantial door pulls.
   4. Provide bar stock or angle stock reinforced door openings and door frames.
   5. Provide insulated access door in insulated ducts.

2.11 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 - EXECUTION

3.01 INSTALLATION OF DUCTWORK

A. Provide openings in ductwork for thermometers, controllers and all appurtenances as shown on Drawings.

B. Locate ductwork with space around equipment for normal operation and maintenance.

C. Do not install ductwork or other equipment above electrical equipment in accordance with the NFPA 70.

D. Provide means of preventing dust from entering ductwork during installation.

E. Repair all damaged ductwork insulation.

F. Install manual volume dampers in branch supply ducts in a manner that allows all outlets to be adjusted. Do not install dampers at air terminal devices or outlets unless shown on Drawings.

G. Insulate terminal air box reheat coils including vapor barrier.

H. Install flexible ductwork in accordance with ADC Flexible Duct Performance and Installation Standards.

I. Install all exterior ductwork per SMACNA Figure 6-3. Seal, watertight, all exterior ductwork seams and joints and pitch ductwork to shed water.

J. Provide all adhesives, sealants, tapes, vapor retarders, films and other supplementary materials with flame spread/smoke developed ratings of under 25/50 per ASTM E84.

K. Duct support shall extend directly to building structure. Do not support ductwork from pipe hangers. Do not allow lighting or ceiling supports to be hung from ductwork or ductwork supports.

L. Do not install any equipment or materials until Atlantic Richfield Company and Engineer have approved all submittals.

M. Cross break sheet metal in accordance with SMACNA duct construction standard. Apply cross breaking to the sheet metal between the standing seams or reinforcing angles.

N. Beading as specified in SMACNA will be acceptable in lieu of cross breaking.

O. Secure casings to curbs according to SMACNA Duct Construction Standards.

P. Pitch ductwork carrying moist air that pass-through areas that could cause condensation. Low points of such ducts shall be provided with drains.

Q. Provide factory drilled flanged connections in ductwork connections to units that require corrosion resistant coatings. Provide resilient washers suitable for the environment to protect the coating from the bolts in the flange. The use of self-tapping screws or other fastening methods that will damage the coating is not acceptable.

3.02 INSULATION VALUES

A. All ducts shall be insulated with not less than R-12 insulation.

3.03 SCHEDULES

DUCTWORK APPLICATION SCHEDULE

USAGE	MATERIAL	PRESSURE CLASS	SEAL CLASS†	USAGE
Supply Duct from ERU	Galvanized Sheet Metal - Rectangular	+2 inches	A	Supply Duct from ERU & MUA
Duct Mounted Coil Headers	--	--	(Note 2)	All Terminal Air Box/ Reheat Coil Headers and Duct Mounted Coil Headers

† Seal Class is per SMACNA HVAC Air Duct Leakage Test Manual.
± Type A insulation (Flexible Fiberglass Wrap) R-values noted are based on installed values (25% compression).
Note 1: Apply aluminum based adhesive sealant tape at non-flanged joints on ducts serving dedicated outside air supply (DOAS) and exhaust system in addition to Class A sealant.
Note 2: Apply aluminum based adhesive sealant tape on TAB boxes (all seams and joints of the box and duct connections) serving dedicated outside air supply (DOAS) system.

3.04 HANGERS

A. Spacing and size of hangers: as recommended in the SMACNA standards.

B. Install hangers plumb and securely suspended from supplementary steel or inserts in concrete slabs. Sufficiently thread lower ends of hanger rods to allow adequate vertical adjustment. Do not use building siding or metal decking to hang ductwork.

C. Support duct systems in accordance with the SMACNA HVAC Duct Construction Standards: Metal and Flexible and the SMACNA Seismic Restraint Manual where applicable.

D. Provide retainer straps with C clamp type hangers.

3.05 SEALING OF DUCTWORK

A. Unless otherwise indicated, seal all ductwork joints and seams using sealant in accordance with the instructions of the sealant manufacturer and this Section. Do not use pressure sensitive tape as the primary sealant unless it has been certified to comply with UL 181A or UL 181B by an independent testing laboratory and the tape is used in accordance with that certification.

B. Application of Sealant:
   1. Thoroughly clean seams and joints of dirt, oil, grease, or other coatings which might interfere with the adhesion of the duct sealant before sealant is applied.
   2. Apply mastic-based ductwork sealants with minimum 3 inch wide by 20 mil thick bands using brush, putty knife, trowel, or spray, unless manufacture's data sheet specifies other applications methods or requirements.

C. Uncured sealant may be forced into the slotted side of the seam or joint before shop or field assembly and the joint or seam completed while the sealant is still uncured. Excess sealant shall be removed from both the inside and outside of the duct before it sets.

D. Sealing systems shall be suitable for the environment.

E. Test installed ductwork systems in accordance with the SMACNA - HVAC Air Duct Leakage Test Manual.

3.06 DUCTWORK FITTINGS AND ACCESSORY ITEMS

A. Flexible Fabric Connectors:
   1. Install flexible connectors for vibration isolation at ductwork connections to fans, fan units or blowers, air handling units, and air conditioning unit ventilators. Make connections substantially airtight at seams and joints.
   2. Where construction of the flexible connection or vibration isolator results in a cross-sectional area of the connection which is less than 90 percent of the adjacent ductwork, increase the size of the connection to provide a cross sectional area equal to or greater than 90 percent of the adjacent ductwork.
   3. Provide flexible duct connections at both the intake and discharge connections for fans and air handling units except as noted below:
      a. Wall and roof fans that have integral motor/fan wheel isolation.
      b. Air handling units where the fan is isolated from the intake and discharge connections by internal flexible connections or separations, and the unit is mounted without vibration isolators between the unit and the support structure.

B. Access Doors:
   1. Provide access doors at the following locations (minimum requirements):
      a. Motorized dampers, linkage side.
      b. Duct mounted temperature controllers.
      c. Smoke detectors.
      d. Plenums.
      e. Fire dampers.

f. Manual dampers and splitters.
g. Inlet side of centrifugal fans.
h. Inlet and outlet ductwork to fans and air handlers.
i. Inlet side of all heating coils.

2. Where access doors are required in ductwork located above ceilings, coordinate location of the access doors to clear the ceiling support system and to be accessible through the ceiling grid.

3.07 DUCTWORK PENETRATIONS

A. Provide fire or fire/smoke dampers at all ductwork penetrations of firewalls and where required by code.
   1. Damper fire rating: compatible with rating of wall assembly. Verify actual rating of any wall being penetrated with Engineer.

B. Seal duct penetrations of walls that are not fire rated by caulking or packing with fiberglass. Install trim strip to cover vacant space and raw construction edges of openings in finished rooms. Install escutcheon ring at round duct openings in finished rooms. Trim strips and rings to be same material and finish as exposed duct.

3.08 DUCTWORK TERMINATIONS AT MASONRY OR CONCRETE

A. Where ducts terminate at masonry or concrete openings, place a continuous 2-1/2 inch by 2-1/2 by 3/16-inch angle, that matches the ductwork material, around the ductwork. Use 316 stainless steel angles for PVC ductwork. Bolt the angle to the construction and make airtight by applying caulking compound on the angle before it is drawn down tight to construction.

B. Fasten plenums to concrete curbs with 3 by 3 by 1/4-inch continuous angle. Concrete curbs are provided under another division. Mount angle on a continuous bead of caulking compound and anchor to the curb on 16-inch centers. Terminate ductwork at the curb and bolt to the angle. Seal the ductwork to the curb with a continuous bead of caulking compound. Apply neoprene filler strip to level curb surface as necessary.

3.09 TESTING

A. General:
   1. Test Procedure: As listed in the latest edition of the SMACNA HVAC Duct Leakage Manual, with the following additional requirements:
      a. Test pressure to be the specified duct pressure class. Testing at reduced pressures and converting the results mathematically is not acceptable. This is required to test the structural integrity of the duct system.
      b. Totaling leakage from several tested sections and comparing them to the allowable leakage for the entire system is not acceptable. Each section must pass the test individually.
      c. Upon completion of the pressure test, submit an air duct leakage test summary report as outlined in the SMACNA HVAC Duct Leakage Test Manual.
      d. Access doors, taps to terminal air boxes, and other accessories and penetrations must be installed prior to testing. Including terminal air boxes in the test is not required.
      e. Positive pressure leakage testing is acceptable for negative pressure ductwork.

B. Ductwork 2 Inches WC or Less (Positive or Negative):
   1. Testing of these systems is not normally required for interior ductwork. However, leak tests will be required if, in the opinion of the Engineer, the leakage appears excessive.
   2. Perform testing of exterior ductwork prior to application of insulation or wrapping.
   3. Systems cannot leak more than shown in Table 4-1 of SMACNA HVAC Air Duct Leakage Test Manual for Seal Class A.
   4. Leak test requires capping and sealing all openings.
   5. Seal ducts to bring the air leakage into compliance.

C. Ductwork 3 Inches WC and Above:
   1. Test a minimum of 25 percent of interior ductwork identified by Atlantic Richfield Company and all exterior ductwork.
   2. Leak test requires capping and sealing all openings.
   3. Seal ducts to bring air leakage into compliance.

3.10 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01, General Requirements.

3.11 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01, General Requirements.

3.12 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01, General Requirements.

END OF SECTION

SECTION 23 37 00
AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide air outlets and inlets in accordance with this Section and applicable reference standards listed in Article 1.02.

1.02 REFERENCES

A. Reference Standards:
   1. Acoustical Society of America (ASA):
      a. ASA S12.60 - American National Standard Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools.
   2. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):
      a. ASHRAE Standard 70 - Method of Testing the Performance of Air Outlets and Air Inlets.
      b. ASHRAE Standard 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
   3. ASTM International (ASTM):
      a. ASTM D117 - Standard Guide for Sampling, Test Methods, and Specifications for Electrical Insulating Liquids.
      b. ASTM D870 - Standard Practice for Testing Water Resistance of Coatings Using Water Immersion.
   4. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
      a. SMACNA 006 - HVAC Duct Construction Standards - Metal and Flexible.
   5. Underwriters Laboratories (UL).

1.03 ADMINSTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-01 Preconstruction Submittals:
      a. Design Data and Submittals:
         1) Schedule of air outlets and inlets indicating type, size, location, quantity and noise criteria.
         2) Data sheets for each type of air outlet and inlet and accessory furnished indicating construction, finish, and mounting details.
   2. SD-02 Shop Drawings:
      a. Manufacturer's assembly-type Shop Drawing for each type of air outlet and inlet, indicating materials, methods of assembly of components, wiring diagrams, safety controls and manufacturer’s installation instructions.
   3. SD-03 Product Data:
      a. Manufacturer's literature and data including full item description and optional features and accessories, dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.

4. SD-07 Closeout Submittals:
    a. Per Division 01 General Requirements.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Qualifications: Per Division 01 General Requirements and as follows:
    1. Manufacturers: Firms regularly engaged in manufacture of air outlets and inlets of types and capacities specified, whose products have been in use in similar service for not less than 5 years.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Packing, Shipping, Handling, and Unloading:
    1. Deliver air outlets and inlets wrapped in factory-fabricated fiber-board type containers. Identify outlet or inlet type and installation location on outside of container.
    2. Ship fire rated air devices completely assembled, one assembly per carton, enclosed in plastic shrink wrap with installation instructions.

C. Storage and Protection:
    1. Store air outlets and inlets in original cartons and protect from weather and construction traffic. Where possible, store indoors. Store above grade and enclose with waterproof wrapping if stored outdoors.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

PART 2 - PRODUCTS

2.01 GRILLES AND REGISTERS

A. Provide manufacturer’s standard air devices as indicated on Drawings and schedules.

B. Provide air device with 3/4-inch blade spacing and steel friction pivots to fit wall construction or ceiling module with adequate support, and border styles compatible with adjacent ceiling or wall system. Noise may not exceed 35 dBA or 55 dBc according to ASA S12.60 and ASHRAE 70.

C. Manufacturers:
    1. Titus.
    2. Price Industries.
    3. Krueger.
    4. Or equal.

D. Provide anodic acrylic paint finish, baked at 315 degrees F for 30 minutes, unless otherwise indicated on Drawings. Pencil hardness must be HB to H.

E. Paint must pass a 100-hour ASTM D117 corrosive environments salt spray test without creepage, blistering, or deterioration of film, and an ASTM D870 250-hour water immersion test.

F. Provide pre-assembled UL air devices designated for fire rated systems with radiation damper and thermal blanket.

2.02 DIFFUSERS

A. Provide manufacturer's standard air devices as indicated on Drawings and schedules.

B. Provide air device to fit wall construction or ceiling module with adequate support, and border styles compatible with adjacent ceiling or wall system. Noise may not exceed 35 dBA or 55 dBc per ASA S12.60 and ASHRAE 70.

C. Architectural Square Panel Diffusers:
   1. Solid square panel diffuser flush with ceiling; smooth, flat surface free of visible fasteners.
   2. Back Pan: 1-piece, stamped with integral inlet.
   3. Face Panel: Mechanically fastened to back panel with steel components.

2.03 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements. Comply with applicable reference standards listed in Article 1.02.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas and conditions for air outlets and inlets installation. Do not proceed with Work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install air outlets and inlets according to manufacturer's written instructions and recognized Industry Practices.

B. Coordinate with other Work, including ductwork and duct accessories, to interface installation of air outlets and inlets with other Work.

C. Install diffusers to ductwork with air tight connections.

D. Provide sheet metal oval-to-round transitions where required. Do not join flexible ducts to flat-oval connections.

E. Direct supply grille and register blades to provide adequate air distribution.

F. Provide manual volume dampers on duct take-off to diffusers when there are multiple connections to a common duct. Locate volume dampers as far as possible from air inlet or outlet.

G. Test and rate performance of air inlets and outlets according to ASHRAE 70.

3.03 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.04 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.05 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 23 72 00
AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Furnish, install, test and make ready for operation; Air-to-Air Energy Recovery Equipment as specified, as indicated in the Schedules and as shown on the Drawings. Provide all related appurtenances and accessories for a complete and operational system.

1.02 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-02 Shop Drawings:
      a. Submit shop drawings for all products and materials in accordance with Division 01 General Requirements.
      b. Within 30 days of receipt of approved shop drawings, submit for review operation and maintenance manuals in accordance with Division 01, General Requirements. In addition to requirements specified in Division 01, operation and maintenance manuals shall also include detail drawing/schematic of the propeller fan being provided, complete parts list including part numbers, list of recommended spare parts, maintenance and lubrication schedules, motor horsepower/efficiency, and nameplate information.
   2. SD-03 Product Data:
      a. Complete materials list of all items to be provided, including supplier and estimated delivery schedule.
      b. Submit catalog cuts, complete parts listing showing materials of construction with applicable ANSI, ASTM, AMCA, or other standards, Manufacturer's specifications and product data to demonstrate compliance with requirements.
      c. Submit details of construction including extent of shop assembly of unit and Manufacturer's recommended installation procedures.
   3. SD-07 Closeout Submittals:
      a. Per Division 01 General Requirements.

1.03 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

C. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

1.04 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Lift and support units with the Manufacturer's designated lifting or supporting points.

C. Disassemble and reassemble units as required for movement into the final location following Manufacturer's written instructions.

D. Deliver energy recovery units as a factory assembled unit to the extent allowable by shipping limitations, with protective crating and covering.

PART 2 - PRODUCTS

2.01 ENERGY RECOVERY VENTILATORS

A. General:
   1. Package Energy Recovery Ventilator, static enthalpic energy recovery plate. UL listed and ARI certified. Provide the following energy recovery ventilation equipment as specified and as indicated on the Drawings.

B. Unit Construction:
   1. Casing shall be double wall, 20 gauge galvanized steel with lapped corners. In between double wall casing shall be insulated with 1 inch FSK high-density board insulation. Access doors shall provide adequate access to blowers, energy transfer unit, and filters. Access doors shall have gasket seal. Unit shall have flanged ductwork connections.

C. Energy Exchanger:
   1. Shall be fixed-plate energy exchanger, cross-flow construction with no moving parts. No condensate shall be formed on the energy exchanger plate. No means of frost control shall be required. Exhaust air and fresh air shall travel in separate passages at all times, positive air stream separation. Water vapor transport shall be through hydroscopic resin. Airflow shall be laminar to avoid depositing particulates on energy exchanger plate.

D. Motors:
   1. Blower motors shall be thermally protected with automatic reset.

E. Filters:
   1. Energy exchanger shall be protected on each side with MERV 8 rated, 2 inch pleated filter.

F. Coating:
   1. Provide corrosion resistant Heresite coatings for ERVs as indicated in the schedules on the Drawings.

G. Capacity:
   1. Unit capacities shall be as indicated on Drawings.

H. Acceptable Manufacturers:
   1. Renewaire (Basis of Design).
   2. Munters Corporation.
   3. Venmar CES Inc.
   4. Greenheck.
   5. Engineer approved equal.

PART 3 - EXECUTION

3.01 GENERAL

A. Install energy recovery units level and plumb, in accordance with Manufacturer's written instructions. Support units as described below, using the vibration control devices indicated.

3.02 ADJUSTING, CLEANING, AND PROTECTING

A. Clean unit cabinet interiors to remove foreign material and construction dirt and dust.

3.03 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.04 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

B. Final Checks Before Start Up: Perform the following operations and checks before start up:
   1. Remove shipping blocking and bracing.
   2. Verify unit is secure on mountings and supporting devices and those connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
   3. Perform cleaning and adjusting specified in this Section.
   4. Lubricate bearings, pulleys, belts, and other moving parts with factory recommended lubricants as required.

3.05 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 23 81 26
SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.01 SUMMARY

A. Provide split-system air-conditioners in accordance with this Section and applicable reference standards listed in Article 1.02.

1.02 REFERENCES

A. Reference Standards:
   1. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):
      a. AHRI 210/240 - Performance Rating of Unitary Air-conditioning and Air-source Heat Pump Equipment.
      b. AHRI 270 - Sound Performance Rating of Outdoor Unitary Equipment.
   2. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
   3. ASTM International (ASTM):
      a. ASTM B1003 - Standard Specification for Seamless Copper Tube for Linesets.
      b. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
      c. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
   4. American Society of Mechanical Engineers (ASME):
      a. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
   5. International Energy Conservation Code (IECC).
   6. International Organization for Standardization (ISO):
      a. ISO 9001 - Quality Management Systems – Requirements.
      b. ISO 14001 - Environmental Management Systems – Requirements with guidance for use.
   7. National Fire Protection Association (NFPA):
      a. NFPA 70 - National Electrical Code (NEC).
   8. Underwriters Laboratories (UL):
      a. UL 1995 - Heating and Cooling Equipment.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-02 Shop Drawings:
      a. Drain, electrical and refrigeration rough-in connections.
   2. SD-03 Product Data:
      a. Provide unit size, sensible capacity, and latent capacity.
   3. SD-07 Closeout Submittals:
      a. Per Division 01 General Requirements.
      b. Submit startup report with O&M Manuals.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.
   1. Provide verification of installation Site conditions as part of start-up testing and training.

PART 2 - PRODUCTS

2.01 SPLIT SYSTEM WALL AND CEILING MOUNTED UNITS

A. Manufacturers:
   1. Daikin Applied.
   2. Mitsubishi Electric.
   3. Samsung.
   4. Or equal.

B. General:
   1. Provide UL 1995 packaged, air-cooled, factory assembled, pre-wired and pre-piped unit consisting of cabinet, fans, filters, remote condensing unit, controls and factory supplied cleanable air filters. Provide wall-mounted units with integral wall-mounting bracket and mounting hardware.
   2. Performance: As scheduled on Drawings.
   3. Provide AHRI 210/240 units listed in the AHRI directory as a matched system, manufactured in an ISO 9001 and ISO 14001 registered facility.
   4. Provide NFPA 70 wiring.

C. Indoor Evaporator Cabinet and Frame:
   1. Evaporator Fan:
      a. Provide variable speed, direct driven, statically and dynamically balanced fan with permanently lubricated motor bearings.
      b. Provide unit with single motor containing internal overload protection.
   2. Evaporator Coils:
      a. Provide direct expansion cooling coil comprised of copper tubes expanded into aluminum fins.
      b. Provide single refrigerant circuit with externally equalized expansion valve.
      c. Provide factory pressure tested coils.
      d. Provide with corrosion resistant condensate pan with drain underneath the coil.
   3. Electrical:
      a. Provide service connections, wiring and disconnect requirements according to NFPA 70 and local electrical codes.
   4. Integral Condensate Pump:
      a. Provide pump matched to evaporator unit including float switch, motor assembly, check valve, and reservoir.
      b. Provide alarm indicating high level reservoir.
      c. Provide pump powered from evaporator unit with field connections.

5. Control:
    a. Provide unit with a hard-wired 7-day programmable remote controller and wall-mounting bracket to perform input functions, including the following:
        1) Power On/Off switch.
        2) Automatic On/Off timer.
        3) Mode selector – Cool, Dry, Heat, Auto Modes.
        4) Temperature adjustment.
        5) Fan speed settings.
        6) Adjustable swing louver for supply discharge.
        7) Self-diagnostic controller.
    b. Temperature changes in 1 degree F increments with a range from 59 to 89 degrees F.
    c. Microprocessor in indoor unit sensing return air temperature and indoor coil temperature, receiving and processing commands from controller, providing emergency operation, and controlling outdoor unit.
    d. System automatically restarting and operating at previously selected conditions after power interruption.

D. Outdoor Units:
1. General:
    a. Provide outdoor unit matched to indoor unit size, factory assembled and pre-wired with electronic and refrigerant controls.
2. Cabinet:
    a. Galvanized steel, bonderized, finished with electrostatically applied, thermally fused acrylic or polyester powder coating corrosion protection.
3. Fan:
    a. Direct drive propeller fan with fan guard.
    b. Motor with permanently lubricated bearings, protected by internal thermal overload protection.
    c. Statically and dynamically balanced blades.
4. Coil:
    a. Non-ferrous outdoor unit coil with lanced or corrugated plate fins on copper tubing.
    b. Outdoor coil with integral metal guard and corrosion resistant coating.
5. Compressor:
    a. Provide hermetic or scroll inverter driven refrigerant compressors with resilient suspension system, oil strainer, sight glass, internal motor protection, high pressure switch and crankcase heater.
    b. Provide outdoor unit with accumulator and 4-way reversing valve.
6. Refrigerant flow from outdoor unit regulated by electronically controlled, precision, linear expansion valve.
7. Outdoor unit capable of heating operation at a minus 13 degrees F.

E. Electrical:
1. Provide electrical power for unit as indicated on Drawings.

F. Refrigerant Piping:
1. Design Pressure: 450 psi.
2. Maximum design temperature: 250 degrees F.
3. Piping 4 inches and under:
    a. Tubing: ASTM B1003 ACR seamless copper tube line sets. Sizes indicated are nominal designation.
    b. Joints: brazed with silver solder.
    c. Fitting: ASME B16.22 wrought copper solder joint.

d. Special Requirements:
    1) Piping: cleaned, dehydrated, pressurized with dry nitrogen, plugged and tagged by manufacturer for refrigeration service.
e. Insulation:
    1) ASTM C534 ethylene propylene diene terpolymer (EPDM) elastomeric cellular foam, flexible plastic 0.24 maximum k value at 75 degrees F, 25/50 flame spread/smoke developed rating when tested according to ASTM E84. Maximum 1 inch thick per layer where multiple layers are specified. NBR/PVC blend is not permitted.
f. Jacket Coverings:
    1) High impact, 0.030-inch, glossy white self-extinguishing plastic jackets and fitting covers with ultraviolet inhibitors for indoor or outdoor use. Suitable for minus 40 degrees F to 150 degrees F. 25/50 maximum flame spread/smoke developed.

2.02 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements. Comply with applicable reference standards listed in Article 1.02.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install system according to manufacturer's instructions and Drawings.

B. Provide control wiring according to manufacturer's recommendations.

C. Coordinate mounting location of indoor and outdoor units with architectural and electrical Work. Coordinate installation of ceiling-mounted units with ceiling grid layout. Provide additional ceiling grid reinforcement or modification as required and coordinate Work. Locate indoor unit to be readily accessible for maintenance and filter changes.

D. Verify location of wall-mounted remote controller prior to installation. Coordinate mounting heights with other wall-mounted devices. Height above finished floor may not exceed 48 inches.

E. Install condensate piping with trap, and route from drain pan to nearest drain. Discharge to nearest code-approved receptor or properly vented indirect waste fitting. Flush piping prior to final connections to units.

F. During brazing operations, continuously purge tubing interior with nitrogen to prevent oxide formation.

G. Comb coils to repair bent fins. Install filters.

H. Provide factory-authorized service agent to assist in commissioning and inspecting installation prior to startup.

I. Insulate refrigerant pipes, fittings, valves, and specialty refrigerant components between heat pump and indoor units. Provide insulation with continuous vapor barrier passing through hangers and supports unbroken. Paint exterior insulated piping with minimum 1 coat of ultraviolet (UV) resistant paint. Over-size hangers and supports to allow insulation to pass through unbroken. Provide insulation as required on plans.

3.02 PERSONNEL TRAINING

A. Train operating personnel in operating, adjusting, and maintaining system.

3.03 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements. Comply with applicable reference standards listed in Article 1.02.

3.04 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.05 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 23 82 39
UNIT HEATERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide unit heaters in accordance with this Section and applicable reference standards listed in Article 1.02.

1.02 REFERENCES

A. Reference Standards:
   1. Underwriters Laboratories (UL):
      a. UL 1995 - Heating and Cooling Equipment.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-03 Product Data:
      a. Manufacturer's Literature and Data:
         1) Full item description and optional features and accessories.
         2) Dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
         3) Rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.
   2. SD-06 Certificates:
      a. Submit certification that terminal heat transfer units, accessories, and components will withstand seismic forces specified in Section 23 05 50. Include the following:
         1) Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.
            (a) The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
         2) Dimensioned outline drawings of equipment unit: identify center of gravity and locate and describe mounting and anchorage provisions.
         3) Detailed description of equipment anchorage devices on which certification is based and installation requirements.
   3. SD-0-7 Closeout Submittals:
      a. Per Division 01 General Requirements.
      b. Operation and Maintenance (O&M) Manuals.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Provide UL unit heaters.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

PART 2 - PRODUCTS

2.01 ELECTRIC UNIT HEATERS

A. Provide UL listed, horizontal or vertical discharge unit heaters as scheduled on Drawings.

B. Casing:
   1. Corrosion resistant, heavy gauge steel with powder coat or enamel finish.

C. Heating Elements:
   1. Provide non-glowing design consisting of 80/20 nickel-chromium resistance wire, embedded in magnesium oxide and enclosed in a metal sheath to which metal plated fins are copper brazed.
   2. Paint heating elements with aluminized paint for corrosion resistance and cover the entire discharge area for uniform heating.

D. Fans:
   1. Direct drive propeller type constructed of aluminum, factory balanced, with fan guards and totally enclosed motors with integral thermal overload protection.

E. Provide unit with adjustable outlet air louvers.

F. Provide unit with threaded pipe connections for hanger rods.

G. Provide unit mounted and wired disconnect.

H. Provide unit with thermal cutout to automatically shut off the heater in the event of overheating and reactivate when temperature returns to normal.

I. Provide resiliently mounted fan guard/motor support.

J. Provide unit with line-voltage remote adjustable thermostat.

K. Manufacturers:
   1. Modine.
   2. Q-Mark.
   3. Trane.
   4. Or equal.

2.02 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements. Comply with applicable reference standards listed in Article 1.02.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions under which unit heaters and convectors are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 UNIT HEATERS

A. Install unit heaters where indicated and as scheduled, in accordance with manufacturer's installation manual and in compliance with recognized industry practices.

B. Provide access clearances around unit heaters for service as specified in manufacturer’s installation manual.

C. Provide wiring and means of disconnect in accordance with Division 26 if not provided by the manufacturer.

D. Provide piping, wiring, valves, supports and all appurtenances for a complete and functional system.

3.03 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Site/Field Tests and Inspections:
   1. Verify operation of each unit heater by measuring input voltage and current simultaneously for ten minutes of continuous operation.
   2. Start and verify proper operation of each unit heater in accordance with manufacturer’s installation manual.

3.04 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.05 CLEANING

A. Clean factory finished surfaces. Repair marred or scratched surfaces with manufacturer's touch-up paint.

3.06 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 31 00 00
EARTHWORK

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. All excavation, embankment, and grading work shall be completed in accordance with these Specifications and in accordance with the lines, grades, and elevations shown on the Construction Drawings or as established by the Atlantic Richfield Company Representative.

B. This section covers excavation, embankment, trenching, and backfilling for roadways, structures, ditches, drainage features, culverts, pipelines and appurtenances unless specifically noted for construction under another section. This item shall consist of all necessary clearing, grubbing, and site preparation; removal and disposal of debris; handling and storage of materials to be used for fill and backfill; all necessary bracing, shoring, and protection; pumping and dewatering as necessary; all backfill; preparation of subgrades; and final grading, dressing, and cleanup of the site.

C. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

D. Excavation: This work shall consist of performing all operations necessary to excavate, grade, and satisfactorily dispose of all materials encountered during excavation at the areas designated on the Construction Drawings. The work shall include roadway excavation, structure excavation, excavation of ditch or channel excavation, any general unclassified excavation, and all other excavation not covered under other subsections of these Technical Specifications.

E. Embankment: This work shall consist of performing all operations necessary to prepare, backfill, compact, and grade all areas requiring embankment or fill as shown on the Construction Drawings. The work shall include roadway embankment, structure embankment, dike embankment, backfilling depressions, cut and fill terracing, and all other backfilling or embankment not covered under other subsections of these Technical Specifications.

F. Stripping: When crossing existing or prospective cultivated areas, gravel streets or other developed surfaces, the CMGC shall strip the cover material to full depth at the existing surfacing. This surfacing shall be stockpiled and placed back over the trench after backfilling to the extent that it is acceptable and usable for that purpose as determined by the Atlantic Richfield Company Representative. Topsoil shall be removed to full depth of the topsoil, or to a maximum depth of 12 inches, whichever is less or as directed by the Atlantic Richfield Company Representative.

G. Existing Utilities and Private Property: The CMGC is reminded of the utility notification, identification, preservation, and repair requirements in the Contract Documents.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred within the text by the basic designation only.
   1. American Water Works Association (AWWA):
      a. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances.

2. American Welding Society (AWS):
    a. AWS D1.1/D1.1M - Structural Welding Code – Steel.
3. American Wood Protection Association (AWPA):
    a. AWPA C2 - Lumber, Timber, Bridge Ties and Mine Ties - Preservative Treatment by Pressure Processes.
    b. AWPA P5 - Standard for Waterborne Preservatives.
4. ASTM International (ASTM):
    a. ASTM A139/A139M - Standard Specification for Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and over).
    b. ASTM A252 - Standard Specification for Welded and Seamless Steel Pipe Piles.
    c. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
    d. ASTM C33/C33M - Standard Specification for Concrete Aggregates.
    e. ASTM D422 - Particle-Size Analysis of Soils.
    f. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
    g. ASTM D698 - Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.)).
    h. ASTM D1140 - Standard Test Methods for Determining the Amount of Material Finer than 75-µm (No. 200) Sieve in Soils by Washing.
    i. ASTM D1556/D1556M - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
    j. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3).
    k. ASTM D1883 - Standard Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils.
    l. ASTM D2216 - Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
    m. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.\
    n. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
    o. ASTM D3786/D3786M - Standard Test Method for Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method.
    p. ASTM D4355/D4355M - Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus.
    q. ASTM D4491/D4491M - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
    r. ASTM D4533/D4533M - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
    s. ASTM D4632/D4632M - Grab Breaking Load and Elongation of Geotextiles.
    t. ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.
    u. ASTM D4759 - Standard Practice for Determining the Specification Conformance of Geosynthetics.
    v. ASTM D4833/D4833M - Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
    w. ASTM D5084 - Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
    x. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

5. American Association of State Highway and Transportation Officials (AASHTO):
    a. AASHTO T 99 - Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.
    b. AASHTO T 147 - Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.
    c. AASHTO T 181 - In-Place Density of Compacted Base Course Containing Large Sizes of Coarse Aggregates.
6. U.S. Environmental Protection Agency (EPA):
    a. EPA SW-846.3-3 - Test Methods for Evaluating Solid Waste: Physical/Chemical Methods.
7. U.S. Federal Highway Association (FHWA):
    a. MUTCD - Manual of Uniform Traffic Control Devices for Streets and Highways.

1.03 DEFINITIONS

A. Capillary Break: A component of an engineered cap consisting of a layer of aggregate materials placed in select unlined areas to prevent the upward migration of groundwater through capillary action, limiting the potential for impacted groundwater to adversely impact surface soils (i.e., cap or cover soils) and develop salt/metal slickens which could distress shallow-rooted vegetation.

B. Capillary Water Barrier: A layer of clean, poorly graded crushed rock, stone, or natural sand or gravel having a high porosity which is placed beneath a building slab with or without a vapor barrier to cut off the capillary flow of pore water to the area immediately below a slab.

C. Degree of Compaction: Degree of compaction is expressed as a percentage of the maximum density obtained by the test procedure presented in [ASTM D698][ASTM D1557], for general soil types, abbreviated as percent laboratory maximum density.

D. Hard Materials: Weathered rock, dense consolidated deposits, or conglomerate materials which are not included in the definition of "rock", but which usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.

E. Rock: Solid homogeneous interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers.

F. Pile Supported Structure: As used herein, a structure where both the foundation and floor slab are pile supported.

G. Cohesionless and Cohesive Materials: Cohesionless materials include materials classified in ASTM D2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM, GP-GM, GW-GM, SW-SM, SP-SM, and SM shall be identified as cohesionless only when the fines are non-plastic (plasticity index equals zero). Materials classified as GM and SM will be identified as cohesive only when the fines have a plasticity index greater than zero.

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
    1. SD-01 Preconstruction Submittals:
        a. The CMGC shall prepare a project-specific Construction Execution Plan (CEP) describing the following construction components for the Site:

1) Excavation, Backfill, and Grading Plans: Plans detailing the general sequence of activities and the means and methods for earthwork activities including excavation, backfill, and grading.
2) Utility and Existing Infrastructure Protection Plan: Plan for protecting all existing utilities and infrastructure that are not planned for demolition, replacement, or removal. Some utilities may require utility owner design and/or approval of protection plan.
3) Dewatering Work Plan: Submit procedures for accomplishing dewatering work.
4) Cofferdam Plan: Plan for design and sequencing of coffer dams for surface water diversion.
5) Shoring and Sheeting Plan: Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheeting of excavations.
6) Traffic Control Plan: Plan to detail measures that will be implemented to address traffic safety and to coordinate and control the movement of workers, construction vehicles, and equipment within the work zone and surrounding area. The Traffic Control Plan shall be a standalone attachment to the project-specific CEP, and shall include State and County approvals, as necessary.

2. SD-05 Test Reports:
   a. Submit copies of all laboratory and field test reports within 24 hours of the completion of the test.
      1) Borrow Site Testing.
      2) Select Material Test.
      3) Porous Fill Test for Capillary Water Barrier.
      4) Moisture and Density: Characteristics using AASHTO T 99 for embankment or backfill material and excavated subgrades. As material types change during construction, additional moisture-density characteristics may be required by the Atlantic Richfield Company Representative. Proctors shall be completed by CMGC as necessary to complete moisture and density testing.
      5) Imported Material: Imported material from an off-site source shall be tested and results submitted, including source location, gradation, and moisture-density characteristics. Laboratory test results shall be submitted to demonstrate compliance with the appropriate Material Suitability Criteria defined in Article 2.03 of this Section.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Perform in a manner to prevent contamination or segregation of materials.

1.06 REQUIREMENTS FOR OFF-SITE SOIL

A. Soils brought in from off-site shall meet the appropriate Material Suitability Criteria as defined in Article 2.03 of this Section.

1.07 QUALITY CONTROL

A. Shoring and Sheeting Plan:
   1. Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheeting of excavations meeting the requirements of applicable references specified in Section 01 34 00 – Safety, Health, and Emergency Response. Drawings shall include material sizes and types, arrangement of members, and the sequence and method of installation and removal. Calculations shall include data and references used.

2. The CMGC is required to hire a Professional Geotechnical Engineer to provide inspection of excavations and soil/groundwater conditions throughout construction. The Geotechnical Engineer shall be responsible for performing pre-construction and periodic site visits throughout construction to assess site conditions. The Geotechnical Engineer shall update the excavation, sheeting and dewatering plans as construction progresses to reflect changing conditions and shall submit an updated plan if necessary. A written report shall be submitted, at least monthly, informing the CMGC and Atlantic Richfield Company Representative of the status of the plan and an accounting of the CMGC's adherence to the plan addressing any present or potential problems. The Geotechnical Engineer shall be available to meet with the Atlantic Richfield Company Representative at any time throughout the contract duration.

B. Dewatering Work Plan:
   1. Submit procedures for accomplishing dewatering work in the project-specific CEP and the CMGC's Environmental Protection Plan (EPP) as detailed in Section 01 35 00 – Environmental Protection.

C. Utilities:
   1. Prior to construction, CMGC must submit for Atlantic Richfield Company approval, a plan to protect all existing utilities. Some utilities may require Atlantic Richfield Company design and/or approval of protection plan.
   2. Movement of construction machinery and equipment over pipes and utilities during construction shall be at the CMGC's risk. Perform work adjacent to utilities as indicated in accordance with procedures outlined by utility company. Excavation made with power-driven equipment is not permitted within two feet of known utilities or subsurface construction. Any deviation requires Atlantic Richfield Company approval. For work immediately adjacent to or for excavations exposing a utility or other buried obstruction, refer to Section 01 32 00 General Requirements. Support uncovered lines or other existing work affected by the contract excavation until approval for backfill is granted by the Atlantic Richfield Company Representative. Report damage to utility lines or subsurface construction immediately to the Atlantic Richfield Company Representative.

D. Cofferdams:
   1. Prepare and submit a plan for cofferdam placement for approval by Atlantic Richfield Company as part of the project-specific CEP and the CMGC's EPP. Use a cofferdam system when it is not practical to route stream flow around a work area. The cofferdam system is not intended to be watertight or exclude all flows. Rather, the objectives are, but not limited to, provide a safer and more efficient work environment, protect work from all flows, aid in placement of materials, and reduce sediment releases.

PART 2 - PRODUCTS

2.01 ON-SITE MATERIALS

A. Stumps, trees, rubbish, vegetation, frozen lumps, or other unsuitable materials shall not be placed in embankments or used as backfill unless approved by the Atlantic Richfield Company Representative.

2.02 ROADWAY MATERIALS

A. Requirements for roadway materials are specified in the Construction Drawings and/or these technical specifications and in Section 32 01 12 – Base Course.

2.03 IMPORTED MATERIALS

A. Imported material from an off-site source shall be tested and results submitted, including source location, gradation, and moisture-density characteristics.

B. Backfill:
   1. Imported backfill must meet the Backfill Material Suitability Criteria outlined in Appendix 1, Table 2, of the Further Remedial Elements Scope of Work (FRESOW) included as Attachment C to Appendix D of the Consent Decree for the Butte Priority Soils Operable Unit.

C. Cover Soil/Topsoil:
   1. Provide as specified in Section 31 01 20 – Growth Media (Cover Soil) and in conformance with the Engineered Caps/Cover Systems Material Suitability Criteria outlined in Appendix 1, Table 3, of the FRESOW included as Attachment C to Appendix D of the Consent Decree for the Butte Priority Soils Operable Unit. .
   2. Natural, friable soil representative of productive, well-drained soils in the area, free of subsoil, stumps, rocks larger than one inch diameter, brush, weeds, toxic substances, and other material detrimental to plant growth.

D. Aggregates:
   1. Clean sand, crushed rock, or gravel meeting the requirements in Section 31 38 00 – Granular Fill Material.

E. Unsatisfactory Materials:
   1. Materials which do not comply with the requirements for satisfactory materials shall be removed from site and disposed in a proper permitted facility at no additional cost to Atlantic Richfield Company.

2.04 BORROW

A. Obtain borrow materials as specified in the Contract documents and/or as approved by Atlantic Richfield Company. The Atlantic Richfield Company borrow areas are located [as indicated]. The CMGC shall perform clearing, grubbing, and stripping required for providing access to suitable borrow material with approval from the Atlantic Richfield Company Representative. Dispose of materials from clearing and grubbing operations as indicated. Existing topsoil shall be removed to full depth of the topsoil, or to a maximum depth of 12 inches, whichever is less or as directed by the Atlantic Richfield Company Representative. Stockpile and seed topsoil soil as directed by the drawings or Atlantic Richfield Company Representative. After removal of borrow material, regrade borrow pit using stockpiled soil material to contours which will blend in with adjacent topography. Maximum side slopes shall be two and a half horizontal to one vertical (2.5H:1V). Excavation and backfilling of borrow pit shall ensure proper drainage.

B. Prior to excavation at the borrow area and placement in the work area, CMGC will install all BMPs specified for the borrow area as shown on the Drawings, as identified in CMGC's site-specific Erosion Control Plan, and as requested by the Atlantic Richfield Company Representative. CMGC will excavate the materials in a manner that minimizes ponding of surface water and erosion. CMGC will immediately reduce slopes of excavation cut faces to 2H:1V slope or flatter when equipment is not working that area. CMGC will flatten all slopes to 2H:1V at the end of every working day. CMGC will monitor all slopes for stability, potential safety concerns, water erosion, and dust control and correct dangerous or unsuitable conditions as they arise. CMGC will apply water for dust control within the borrow area and placement areas as requested by the Atlantic Richfield Company Representative.

2.05 FILTER FABRIC

A. Provide filter fabric as indicated in Section 31 05 00 – Geotextile.

PART 3 - EXECUTION

3.01 GENERAL

A. Suitable materials meeting the Material Suitability Criteria as defined in Article 2.03 of this Section shall be used for backfill and in embankments.

3.02 SITE PREPARATION

A. All areas scheduled for excavation and embankment shall be cleared and grubbed in accordance with Section 31 01 10 – Clearing and Grubbing.

B. Prior to excavation and embankment work, all suitable topsoil and subsoil in the scheduled work areas shall be salvaged in accordance with Section 31 01 20 – Growth Media (Cover Soil) or as directed by the Atlantic Richfield Company Representative.

3.03 LINE AND GRADE CONTROL

A. Prior to excavation, backfill, grading, and embankment operations, the CMGC shall perform all necessary surveys for control of line and grade utilizing the Atlantic Richfield Company established stable and protected monuments for reference throughout the construction period. A sufficient number of such monuments shall be provided throughout the work to permit verification of the work within the tolerances specified.

3.04 UNDERGROUND UTILITIES

A. Location of the existing utilities indicated is approximate. The CMGC shall physically verify the location and elevation of the existing utilities indicated prior to starting construction. The CMGC shall contact the 811 or 1800-424-5555 for assistance in locating existing utilities. The CMGC shall scan the construction site with electromagnetic and sonic equipment and mark the surface of the ground where existing underground utilities are discovered. CMGC shall verify all physical locates are in place and all known utility owners have responded to the locate request. CMGC shall keep all physical locates valid by submitting a new locate request every 30 days.
   1. Machinery and Equipment: Movement of construction machinery and equipment over pipes during construction shall be at the CMGC's risk. Repair or remove and provide new pipe for existing or newly installed pipe that has been displaced or damaged.

3.05 EXCAVATION

A. General:
   1. The CMGC shall utilize excavating equipment appropriate for the work being performed. The method of excavation shall be the CMGC's responsibility. All methods and equipment used shall result in finished work meeting the construction tolerances specified. No work shall be performed beyond the construction limits without prior written approval from the adjoining landowners and Atlantic Richfield Company.
   2. Excavate to contours, elevation, and dimensions indicated on the Construction Drawings. Reuse excavated materials that meet the Material Suitability Criteria as defined in Article 2.03 of this Section for the material type required at the intended location. Keep excavations free from water. Excavate soil disturbed or weakened by CMGC's operations, soils softened or made unsuitable for subsequent construction

due to exposure to weather at no expense to Atlantic Richfield Company. Excavations below indicated depths will not be permitted except to remove unsatisfactory material unless requested by the Atlantic Richfield Company Representative. Unsatisfactory material encountered below the grades shown shall be removed as directed by Atlantic Richfield Company. Unless specified otherwise, refill excavations cut below indicated depth with approved material and compact to [95] percent of [ASTM D698] [ASTM D1557] maximum density. Satisfactory material removed below the depths indicated, without specific direction of the Atlantic Richfield Company Representative, shall be replaced with satisfactory materials to the indicated excavation grade at no additional cost to Atlantic Richfield Company. Determination of elevations and measurements of approved over-depth excavation of unsatisfactory material below grades indicated shall be done under the direction of the Atlantic Richfield Company Representative.

B. Pile Cap Excavation and Backfilling:
   1. Excavate to bottom of pile cap prior to placing or driving piles, unless authorized otherwise by the Atlantic Richfield Company Representative. Backfill and compact over-excavations and changes in grade due to pile driving operations to 95 percent of ASTM D698 maximum density.

C. Pipe Trenches:
   1. Excavate to the dimension indicated and in accordance with appropriate Division 33 Section. Grade bottom of trenches to provide uniform support for each section of pipe after pipe bedding placement. Tamp, if necessary, to provide a firm pipe bed. Recesses shall be excavated to accommodate bells and joints so that pipe will be uniformly supported for the entire length. Rock, where encountered, shall be excavated to a depth of at least 6 inches below the bottom of the pipe.

D. Hard Material [Rock and Slag] Excavation:
   1. Remove hard material to elevations indicated in a manner that will leave foundation material in an unshattered and solid condition. Roughen level surfaces and cut sloped surfaces into benches. Protect from conditions causing decomposition along joints or cleavage planes and other types of erosion. Removal of hard material beyond lines and grades indicated will not be grounds for a claim for additional payment unless previously authorized by the Atlantic Richfield Company Representative. Excavation of the material claimed as rock shall not be performed until the material has been cross sectioned by the CMGC and approved by the Atlantic Richfield Company Representative. Common excavation shall consist of all excavation not classified as rock excavation.

E. Excavated Materials:
   1. Satisfactory excavated material required for fill or backfill meeting the Backfill Material Suitability Criteria defined in Article 2.03 of this Section shall be placed in the proper section of the permanent work required or shall be separately stockpiled if it cannot be readily placed. Satisfactory material in excess of that required for the permanent work and all unsatisfactory material shall be disposed of as specified by the Atlantic Richfield Company Representative.

F. Final Grade of Surfaces to Support Concrete:
   1. Make excavations the size and depth to permit compacting of backfill on all sides to the specified density. The requirements for removing water and other applicable portions of these specifications apply to excavation.

G. Drainage:
   1. Provide for the collection and disposal of surface water encountered during construction as specified in section 01 35 00 – Environmental Protection.
   2. Completely drain construction site during periods of construction to keep soil materials sufficiently dry. The CMGC shall establish/construct storm drainage features (ponds/basins) at the earliest stages of site development, and throughout construction. Grade the construction area to provide positive surface water runoff away from the construction activity and/or provide temporary ditches, dikes, swales, and other drainage features and equipment as required to maintain dry soils, prevent erosion and undermining of foundations. When unsuitable working platforms for equipment operation and unsuitable soil support for subsequent construction features develop, remove unsuitable material and provide new soil material as specified herein. It is the responsibility of the CMGC to assess the soil and ground water conditions presented by the plans and specifications and to employ necessary measures to permit construction to proceed. Excavated slopes and backfill surfaces shall be protected to prevent erosion and sloughing. Excavation shall be performed so that the site, the area immediately surrounding the site, and the area affecting operations at the site shall be continually and effectively drained.

H. Dewatering:
   1. Provide for the collection and disposal of subsurface water encountered during construction as specified in Section 01 35 00 – Environmental Protection.
   2. Groundwater flowing toward or into excavations shall be controlled to prevent sloughing of excavation slopes and walls, boils, uplift, and heave in the excavation and to eliminate interference with orderly progress of construction. French drains, sumps, ditches or trenches will not be permitted within 3 feet of the foundation of any structure, except with specific written approval by the Atlantic Richfield Company representative, and after specific contractual provisions for restoration of the foundation area have been made. Control measures shall be taken by the time the excavation reaches the water level in order to maintain the integrity of the in-situ material. While the excavation is open, the water level shall be maintained continuously for a human and environment safety.

I. Shoring, Sheeting, and Bracing:
   1. The CMGC shall do all shoring, bracing, and tight sheeting required to prevent caving and to protect his workers, in accordance with the Occupational Safety and Health Administration (OSHA) Regulation Requirements, AR Defined Practices, and to protect adjacent property and structures.

J. Surplus and Waste Material:
   1. During excavation, where the ground foundation for embankments is composed of muck or other unstable materials, such materials shall be removed to the depth shown on the Construction Drawings or as determined in the field by the Atlantic Richfield Company Representative and satisfactorily disposed of as stated in Section 02 11 10 – Excavation and Handling. All holes created by removal of soft or unstable material shall be backfilled as specified. Backfill shall be obtained from the most select material encountered in excavation or from stockpiles designated by the Atlantic Richfield Company Representative.
   2. When unsuitable material or debris is encountered during excavation the Atlantic Richfield Company Representative shall be notified before further excavation. The Atlantic Richfield Company Representative shall determine the necessity and/or depth of excavation. Suitable material shall then be placed and compacted to bring the area to grade.

K. Maintenance of Subgrade and Drainage:
   1. During excavation, the subgrade shall be maintained in such a condition that it will be well drained at all times. Side ditches emptying from cuts to embankments shall be constructed to avoid damage by erosion.
   2. If it is necessary in the action of the work to interrupt existing surface drainage, temporary drainage facilities shall be provided and maintained at the CMGC's expense until permanent drainage facilities are completed. The CMGC shall be responsible to take all necessary precautions to protect and preserve any and all existing subsurface drains, conduits, utilities, and other underground structures or parts thereof which may be affected by the construction, and which in the opinion of the Atlantic Richfield Company Representative may be properly continued in use without any change. The CMGC shall, at his own expense, repair all damage to facilities or structures which results from any of his operations or his negligence.

3.06 STRUCTURE EXCAVATION

A. All Structures:
   1. Excavation adjacent to existing structures shall not commence until authorized by the Atlantic Richfield Company Representative.
   2. Excavations for structures or structure footings shall be to the lines and grades or elevations shown on the Construction Drawings. They shall be of sufficient size to permit the construction of structures or structure footings. The elevations of the bottoms of footings, as shown on the Construction Drawings, shall be considered as approximate.
   3. Boulders, wood, and any other unsuitable materials encountered in the excavation shall be removed and disposed of under Section 02 11 10 – Excavation and Handling.
   4. The CMGC shall notify the Atlantic Richfield Company Representative when each excavation is complete. Footings shall not be placed without first notifying the Atlantic Richfield Company Representative.
   5. Excavation stability shall remain in accordance with OSHA regulations. When the laying back of excavation slopes is precluded, supporting systems shall be used to retain the sides of excavations greater than 4 feet deep. Sides of excavations less than 4 feet deep shall also be effectively protected when hazardous ground movement may be expected.
   6. Where concrete is to be placed on any excavated surface, special care shall be taken not to disturb the bottom of the excavation more than necessary. When the excavation is at the required depth, all water shall be pumped out for cleaning the foundation bed for inspection. All loose and disintegrated rock and thin strata shall be removed. All seams or crevices in rock strata shall be cleaned out and filled with concrete mortar. When the foundation material is soft or otherwise unsuitable, the unsuitable material shall be removed, and the area shall be backfilled with approved compacted, granular material.

B. Cofferdams:
   1. Watertight cofferdams or cribs shall be used wherever water bearing strata are encountered above the elevation of the bottom of the excavation. For this purpose, a cofferdam or crib is defined as an enclosed single- or double-wall braced structure with walls sheeted with timber, concrete or steel, and which shall extend well below the bottom of the excavation when practical. Earthen or rock filled dikes, dams, or embankments are not considered cribs or cofferdams for this purpose.
   2. The design and construction of supporting systems, if used, shall be the responsibility of the CMGC in accordance with the following provisions. The CMGC shall submit a Cofferdam Plan for the proposed method of cofferdam or crib construction and the

design calculations, fully annotated and referenced. The design calculations and Construction Drawings submitted shall bear the signature and seal of a State of Montana registered Professional Engineer.

3. Supporting systems shall be designed to withstand the expected loads and pressures, including surcharge, water and earth, which may occur during the period for which they are used. Surcharge, earth, and water pressure diagrams, and the method of supporting system analysis and design, shall meet accepted engineering practice. For new materials, the allowable working stresses of the materials shall be as recommended by the manufacturer for the construction conditions encountered. For used materials or when manufacturer's recommendations are not available or applicable, the allowable working stresses shall be as specified in AASHTO's "Standard Specifications for Highway Bridges".
4. In general, the interior dimensions of cofferdams shall be sufficient to give clearance for the construction of forms and the inspection of their exteriors, and to permit pumping outside of the forms. Cofferdams or cribs that are tilted or moved internally during the process of sinking shall be righted or enlarged to provide the necessary clearance.
5. When conditions make it impracticable to dewater the foundation before placing a footing, a concrete foundation seal with dimensions as necessary to resist uplift pressures shall be constructed. The concrete for the seal shall be placed as shown on the Construction Drawings. The foundation shall then be dewatered, and the footing placed. When weighted cribs are employed and the weight is utilized to partially overcome the hydrostatic pressure acting against the bottom of the foundation seal, special anchorage such as dowels or keys shall be provided to transfer the entire weight of the crib to the foundation seal. When a foundation seal is placed under water, the cofferdam shall be vented or ported at low water level.
6. Cofferdams shall be constructed to protect green concrete against damage from sudden rising of water levels and to prevent damage to the foundation by erosion. Timber or bracing that extends into substructure masonry shall not be left in cofferdams or cribs.
7. Pumping from the interior of any foundation enclosure shall be done in a manner that will not carry concrete materials away.
8. All pumping required during the placing of concrete, or for a period of at least 24 hours thereafter, shall utilize a suitable sump located outside the concrete forms. Pumping to dewater a sealed cofferdam shall not start until the seal has set sufficiently to withstand the hydrostatic pressure.
9. Cofferdams or cribs, and all sheeting and bracing shall be removed after completion of the substructure. Removal shall not disturb, or mar finished masonry.

3.07 TRENCH EXCAVATION

A. General:
   1. All excavation, trenching and shoring, and the like, under this Contract shall be performed in a manner that meets the OSHA and Department of Labor, Safety, and Health Regulations for Construction and the AR-RM HSSE Management System Practices, Procedures, and Guidance.
   2. The CMGC shall excavate as necessary at the locations shown on the Construction Drawings, staked in the field, or otherwise specified for the installation of pipelines.
   3. The CMGC shall take precautions and protect all adjoining private and public property and facilities, including underground and overhead utilities, driveways, structures, and fences. Any disturbed or damaged facilities will be suitably restored or replaced at no cost to Atlantic Richfield Company or Landowner.

4. During excavation, materials suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. Excavated materials shall be piled on one side of the trench only unless directed otherwise by the Atlantic Richfield Company Representative. Surface drainage of adjoining areas shall be unobstructed.
5. All excavated materials not required or suitable for backfill shall be removed from the site and stockpiled as directed by the Atlantic Richfield Company Representative.
6. Grading shall be done to prevent surface water from flowing into excavations, and any other water accumulating therein shall be promptly removed. Under no circumstances shall water be permitted to rise in un-backfilled trenches until after the pipe has been placed, tested, and covered with backfill. Any pipe having its alignment or grade changed as a result of a flooded trench shall be re-laid at no additional cost to Atlantic Richfield Company.
7. The bottom of the trenches shall be accurately graded to the line and grade shown on the Construction Drawings. Bedding material shall provide uniform bearing and support for each section of the pipe at every point along its entire length. Bell holes and depressions for joints shall be dug after the trench bedding has been graded, and shall be only of such length, depth, and width as required for properly making the particular type joint. Unauthorized excavation over depths shall be backfilled with bedding material at the CMGC's expense.
8. Excavation shall include the removal and subsequent handling of all earth, gravel, rock, or other material encountered regardless of the type, character, composition, or condition of the material.
9. All trenches will be adequately shored, sheathed, or sloped in accordance with the soil class. The CMGC is responsible for classifying the soil and selecting the shoring or sloping method based on the soil class in accordance with OSHA Regulations ant the AR-RM HSSE Management System Practices, Procedures, and Guidance. Existing conditions may not allow for sloping (existing infrastructure, utilities, etc.). CMGC must attain Atlantic Richfield Company Representative Approval prior to trench sloping.

B. Trench Dimensions:
   1. Width:
      a. The width of the trench shall be such to provide adequate working room for men to install and join the pipe in the specified manner and shoring methods to prevent cave-in or collapse. Do not exceed the specified trench dimensions without approval from the Atlantic Richfield Company Representative.
   2. Depth of Trench:
      a. Trench depth shall be as required for the invert grade or pipe bury shown on the Construction Drawings plus the specified bedding material or specified elsewhere. Care shall be taken not to excavate below the required depth. If ledge rock, boulders, or large stones are encountered at the bottom of the trench, excavating shall be directed by the Atlantic Richfield Company Representative.
      b. When soft or unstable material is encountered at the subgrade which will not uniformly support the pipe, such material shall be excavated to an additional depth as determined by the Atlantic Richfield Company Representative and backfilled bedding material specified by the Atlantic Richfield Company Representative.
   3. Equipment:
      a. The use of trench digging machinery will be permitted except in places where its operation will cause damage to existing structures or features; in which case hand methods shall be employed.

4. Dewatering:
    a. Where ground water is encountered in excavation, it shall be removed to avoid interfering with pipe laying and other construction operations and in accordance with Section 01 35 00 – Environmental Protection.
5. Shoring, Sheeting, and Bracing:
    a. The CMGC shall do all shoring, bracing, and tight sheeting required to prevent caving and to protect his workmen, in accordance with OSHA requirements, the AR-RM HSSE Management System Practices, Procedures, and Guidance and to protect adjacent property and structures. No extra payment shall be made for these items. The cost thereof shall be considered a part of the cost for Trench Excavation.
6. Excavation for Appurtenances:
    a. Excavations for all appurtenances shall be sufficient to leave 12 inches minimum and 24 inches maximum clearance on all sides unless indicated on the construction drawings or Atlantic Richfield Company Representative. The depth, provisions for removing water and other applicable portions of these specifications shall apply to excavation for appurtenances.

C. Trench Backfill:
1. General:
    a. After the select pipe bedding material has been placed and compacted as specified above, the remainder of the trench backfilling shall be done.
    b. Trench backfill from the top of the pipe bedding material to ground surface or to the subgrade of street surfacing is separated into two classifications. Locations of the types of backfill required shall be as shown on the Construction Drawings.
    c. The surface treatment for all trenches shall match adjacent ground and may include gravel, sub-base, or base. For graveled roads, the backfill shall be completed by blading the stripped gravel back over the trench.
2. Backfill:
    a. All trenches shall be backfilled immediately after grade, alignment, and jointing of the pipe has been inspected and approved by the Atlantic Richfield Company Representative. Leakage tests, pressure tests, or tests for alignment and grade shall be performed after backfilling. If any test fails, the CMGC shall be responsible for work required to correct the defects at no additional cost to Atlantic Richfield Company.
    b. Use backfill material free of sticks, sod, frozen soil, or other deleterious matter. Do not permit stones, rocks, chunks of broken concrete, or other material larger than 3 inches (75 mm) within the top 2 feet (610 mm) of the top of water and sanitary sewer lines and within 1-foot (305 mm) of the pipe top for all other installations.
    c. Replace the top 2 feet (610 mm) of backfill for excavations in existing roadway sections “in-kind” at no expense to Atlantic Richfield Company.
    d. Place backfill material in maximum 6-inch (150 mm) layers loose thickness and compact. Firmly tamp the backfill under the pipe haunches. Extend the backfill material placed above the excavation limits or the ground line beyond each side of the pipe equal to twice the pipe diameter or 12 feet (3.7 m), whichever is less.
    e. Compact backfill equally on each side of the pipe to at least 1-foot (305 mm) above the pipe top. Use equipment and methods for backfilling and compacting that do not distort, misalign, or damage the pipe. Replace pipe that is distorted, misaligned, or damaged at CMGC expense. Do not allow heavy equipment to pass over any pipe until at least 4 feet (1.2 m) or one-half pipe diameter of backfill, whichever is greater, is placed and compacted over the pipe.

f. Materials used for bedding and backfill shall be carefully deposited in layers suitable to the equipment used for compaction, wetted to optimum moisture content, and compacted to at least 95% of maximum Standard Proctor Density.
g. The upper 6 inches layer forming the subgrade for pavement which is to be replaced shall be compacted to a density of at least 97% of maximum Standard Proctor Density.
h. Compaction by flooding will not be permitted. Wherever the trenches have not been properly filled, or if settlement occurs, they shall be re-opened to the depth required for proper compaction and refilled and recompacted at no cost to Atlantic Richfield Company.

3. Pipe Bedding:
   a. Bedding material 6 inches under and around the pipe to 6 inches above the top of the pipe shall be placed by hand in maximum layers of 6 inches and thoroughly compacted by tamping. Special care shall be taken to assure complete compaction under the haunches of the pipe. Backfill material shall be placed in the trench for its full width on each side simultaneously. Compaction of Pipe Bedding shall be not less than 95% of the maximum density.
   b. Water settling of this portion of the trench will not be allowed, and the addition of water shall be limited to that required for optimum moisture for maximum compaction of the material.
   c. Additional bedding material shall be used to replace soft, spongy, or other unsuitable material encountered in trench bottom, to the depth necessary to support the pipe as determined by the Atlantic Richfield Company Representative.
4. Backfilling for Appurtenances:
   a. Backfill around appurtenances shall be deposited in such a manner as not to disturb the appurtenance from its proper alignment and compacted to the finished grade. Backfill material, compaction, and backfill procedures shall conform to the requirements of the related backfill as specified for trenches.
5. Backfill Above Original Ground for Minimum Cover Requirements:
   a. Where shown on the Construction Drawings, the CMGC shall provide embankment over the pipe above the original ground surface to a height which will satisfy the minimum depth of cover requirements. Such embankment shall be constructed to the cross section shown on the Construction Drawings. No additional compensation will be paid for embankment unless shown as a specific item on the Bid Form.
6. Time of Open Trenches:
   a. The CMGC will be required to conduct his work so that trenches will remain open a minimum possible time.
   b. No trench excavation shall begin until approved compaction equipment is at the site where the excavating is to take place. All backfill and compacting shall be completed in all trenching and structural excavations within a maximum distance of 300 feet behind the end of newly installed pipe and the maximum distance between the newly installed pipe and the excavator shall be 200 feet. For each work group consisting of a trench excavator, a pipe laying crew, and a backfilling and compacting crew, the maximum allowable open ditch at any time will be 300 feet. The maximum distance behind the end of the new pipe shall be 1,500 feet for gravel replacement or for base placement or pavement replacement.
   c. Certain conditions, as provided in the Contract Documents, may necessitate the closing of certain sections of trench prior to daily, weekend or holiday shutdown.
7. Testing:
   a. Field moisture and density testing is the responsibility of the CMGC and will be performed at the CMGC's expense to ensure that specified moisture and density are being obtained. Density testing will be run at a minimum rate of 1 test for each

150 linear feet of pipe trench or 1 test for each 1,000 square yards. Two field moisture and density tests are required for each structure constructed or placed. Testing is required for all finished surfaces and for each 12-inches of material placed. Moisture and density test results must be provided to Atlantic Richfield Company for review prior to inspection of any embankment or backfill.

8. Trench Maintenance:
   a. The CMGC shall, for a period of 1 year after completion and final acceptance of the work, maintain, and repair any trench settlement which may occur and shall make suitable repairs to any pavement, sidewalks, or other structures, which may become damaged as a result of backfill settlement.

3.08 EMBANKMENT

A. Foundation Preparation:
   1. Following soil salvage to the base grades shown on the Construction Drawings, all areas which will be receiving fill, including drainage rock, shall be proof loaded with a minimum 10-ton smooth drum roller or loaded dump truck. Under the proof load, the subgrade soils shall not deflect more than one inch. If the deflection is greater than one inch, the CMGC shall improve the subgrade using the procedures set forth in Paragraphs 3.08.A.3.a. or Paragraph 3.08.A.3.b. If any seepage of groundwater from the subgrade is noted, the CMGC shall improve the subgrade using the procedures set forth in Paragraph 3.08.A.3.b. Upon completion of the subgrade improvements, proof loading shall be conducted again to assess the suitability of the improved subgrade subject to the same deflection limit present above.
   2. When embankments are to be placed on a hillside with a slope greater than 3 Horizontal(H):1 Vertical(V), or where new fill is to be placed against existing embankment with a slope greater than 3(H):1(V), the slope of the original hillside, or old fill respectively, shall be benched or stepped by cutting into it horizontally, for a minimum distance of 12 inches. These measures will provide a secure bond between the new and existing materials. Each bench shall be cut as close to the one below as the slope of the ground will permit.
   3. CMGC is required to survey the prepared foundation surface, prior to the placement of any base drainage system and provide a certification that the design grading has been achieved.
      a. Scarification and Re-compaction:
         1) Scarification of the upper 12 inches of the subgrade soil shall be completed. Recompact and then proof roll the subgrade as described in Paragraph 3.08.A.1. The CMGC may scarify the upper 12 inches of the subgrade soil and recompact the subgrade with a minimum of three passes of a vibratory roller. The roller shall meet the minimum specifications as described in Paragraph 3.08.A.1.
      b. Over-Excavation and Replacement:
         1) In the proof rolling criteria described in Paragraph 3.08.A.1. are not met, the CMGC may over-excavate the subgrade until soils that meet the proof rolling criteria are found as approved by the Atlantic Richfield Company Representative. The Atlantic Richfield Company Representative shall determine the maximum over-excavation depth, lateral dimensions, geotextiles and backfill material of all over-excavation instances.

B. Placement:
   1. Embankment and backfill materials shall not be placed until the required excavation and foundation preparation have been completed and the foundation has been inspected and approved by the Atlantic Richfield Company Representative. Fill

materials shall not be placed upon frozen surfaces, nor shall it contain snow, ice or frozen materials.

2. Embankment and Backfill material shall not be excessively dry or wet when placed. If necessary, the CMGC shall manipulate the material as required to assure that compaction will be performed at or near the optimum moisture content given in the moisture-density curve. Jetting or ponding of the backfill materials will not be allowed.
3. The site shall be adequately dewatered prior to placing any embankment or attempting compaction such that ground water is not intruding into the material.
4. If it should become necessary because of weather or other conditions to suspend grading operations, the entire area worked upon shall be bladed until smooth, free of depressions and ruts, and crowned so no water can collect or be impounded.
5. Areas inaccessible to rollers shall be compacted by hand or mechanical tampers (jumping jack, plate compactor, etc.) or other means until the density conforms to adjacent embankment, compacted in accordance with these Technical Specifications.
6. Whenever the surface of a proposed cut or the side of an embankment is frozen or is covered with snow or ice sufficient to impair the stability of the work, the frozen earth material and snow and ice must be removed at no cost to Atlantic Richfield Company. Work of this nature shall be completed at least 300 feet in advance of the excavation and placing of the embankment and backfill material. Frozen excavation or that lying under a blanket of snow of such extent as to preclude its placement in the embankment will be considered cause for suspending grading operations.
7. Earthwork during the winter shall be refinished to grade, cross-section, and compaction requirements after the frost is out of the ground and the embankment is in suitable condition for work. Earthwork during winter shall be approved by the Atlantic Richfield Company Representative.

C. Structure Embankment:
   1. Adjacent to structures, backfill materials shall be placed in a manner which will prevent damage to the structures and allow the structures to assume the loads from fill gradually and uniformly. The height of the fill adjacent to a structure shall be increased at approximately the same rate on all sides of the structure. The maximum size of rock fragments in backfill adjacent to the structure shall be 2 inches.
   2. Backfill materials shall not be placed and compacted against any structure for a minimum period of 14 days after the placement of concrete, or until 90% of design strength has been attained through testing.

3.09 REMOVAL AND PLACEMENT OF DEFECTIVE FILL

A. Earthwork materials not conforming to the density and moisture requirements shall be reworked until the requirements are achieved or removed and replaced by acceptable fill. The replacement fill, foundations, abutment and fill surfaces upon which it is placed shall conform to all requirements of specifications for Foundation Preparation, Placement, Moisture and Density Requirements contained herein.

3.10 MOISTURE AND DENSITY REQUIREMENTS

A. Each layer of roadways, structural embankment and backfill material shall be compacted until the in-place density exceeds 95% of its maximum dry density unless specified otherwise. In no case will compaction be less than that of adjacent undisturbed material. For excavation cuts, compaction shall be equal to or greater than that of the adjacent undisturbed material or as specified.

B. Water required shall be sufficient to obtain optimum moisture content within plus or minus 2% as reported by the test results of the material. The CMGC shall measure the degree of

compaction (field density) during embankment construction. Measurements will be based on optimum moisture and maximum density curves submitted.

C. The CMGC is responsible for attaining moisture and density proctors from an approved laboratory and moisture and density testing.

D. Field or in-place density refers to the dry density expressed in pounds per cubic foot of a layer of compacted material in place at the site as determined by a sample representative of the compacted layer. The field density shall be determined in accordance with AASHTO T 147, AASHTO T 181, ASTM D 1556, ASTM D 2167, or ASTM D 6938.

3.11 SUBGRADE PREPARATION

A. Unsatisfactory material in surfaces to receive fill or in excavated areas shall be removed and replaced with satisfactory materials as directed by the Atlantic Richfield Company Representative. The surface shall be scarified to a depth of 6 inches before the fill is started. Sloped surfaces steeper than 1 vertical to 4 horizontal shall be plowed, stepped, benched, or broken up so that the fill material will bond with the existing material. When subgrades are less than the specified density, the ground surface shall be broken up to a minimum depth of 6 inches, pulverized, and compacted to the specified density. When the subgrade is part fill and part excavation or natural ground, the excavated or natural ground portion shall be scarified to a depth of 12 inches and compacted as specified. Material shall not be placed on surfaces that are muddy, frozen, or contain frost. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Material shall be moistened or aerated as necessary to plus or minus 2 percent of optimum moisture. Minimum subgrade density shall be as specified herein.
   1. Proof Rolling:
      a. Proof rolling shall be done on an exposed subgrade free of surface water (wet conditions resulting from rainfall) which would promote degradation of an otherwise acceptable subgrade. Proof roll the existing subgrade of the with six passes of equipment approved by the Atlantic Richfield Company Representative. Operate the equipment in a systematic manner to ensure the number of passes over all areas, and at speeds between 2 1/2 to 3 1/2 miles per hour. Notify the Atlantic Richfield Company Representative a minimum of 3 days prior to proof rolling. Proof rolling shall be performed in the presence of the Atlantic Richfield Company Representative. Rutting or pumping of material shall be undercut as directed by the Atlantic Richfield Company Representative and replaced with approved material.

3.12 SUBGRADE FILTER FABRIC

A. Place synthetic fiber filter fabric as indicated in Section 31 05 00 - Geotextile.

3.13 CAPILLARY BREAK LAYER

A. Construct a capillary break layer in the locations and to the extents shown on the Construction Drawings. The capillary break layer shall be constructed atop prepared subgrade or backfill material prior to the construction of the final engineered cap or cover.
   1. General:
      a. Applicable to select areas outside of any impermeable liners and where the final surface completion will not be subject to heavy loads (e.g., buildings, heavy traffic).

2. Materials:
    a. Aggregate meeting the material specifications provided in Section 31 38 00 – Granular Fill Material. No filter fabric or other geosynthetics shall be placed as part of the capillary break layer construction.
3. Thickness:
    a. Construct to a minimum thickness of 1 foot to the extents shown on the Construction Drawings. Place in 6-inch lifts. Do not place over wet or frozen areas.

3.14 FILLING AND BACKFILLING

A. Fill and backfill to contours, elevations, and dimensions indicated. Compact each lift as specified in the contract before placing overlaying lift.
    1. Imported Material Placement:
        a. Use satisfactory materials. Place in 6-inch lifts. Compact areas not accessible to rollers or compactors with mechanical hand tampers. Aerate material excessively moistened by rain to a satisfactory moisture content. Finish to a smooth surface by blading, rolling with a smooth roller, or both.
    2. Granular Fill Material Placement:
        a. Provide for paved areas and under concrete slabs, except where select material is provided. Place in 6-inch lifts. Do not place over wet or frozen areas. Place backfill material adjacent to structures as the structural elements are completed and accepted. Backfill against concrete only when approved. Place and compact material to avoid loading upon or against the structure.
    3. Select Material Placement:
        a. Provide under structures not pile supported. Place in 6-inch lifts. Do not place over wet or frozen areas. Backfill adjacent to structures shall be placed as structural elements are completed and accepted. Backfill against concrete only when approved. Place and compact material to avoid loading upon or against structure.
        b. Backfilling shall not begin until construction below finish grade has been approved, underground utilities systems have been inspected, tested and approved, forms removed, and the excavation cleaned of trash and debris. Backfill shall be brought to indicated finish grade. Where pipe is coated or wrapped for protection against corrosion, the backfill material up to an elevation 2 feet above sewer lines and 1 foot above other utility lines shall be free from stones larger than 1 inch in any dimension. Heavy equipment for spreading and compacting backfill shall not be operated closer to foundation or retaining walls than a distance equal to the height of backfill above the top of footing; the area remaining shall be compacted in layers not more than 4 inches in compacted thickness with power-driven hand tampers suitable for the material being compacted. Backfill shall be placed carefully around pipes or tanks to avoid damage to coatings, wrappings, or tanks. Backfill materials shall not be placed and compacted against any structure for a minimum period of 14 days after the placement of concrete, or until 90% of design strength has been attained through testing as required in the Contract Documents; whichever is longer. As far as practicable, backfill shall be brought up evenly on each side of the wall and sloped to drain away from the wall.
    4. Porous Fill Placement:
        a. Provide under floor and area-way slabs on a compacted subgrade. Place in 4 inch lifts with a minimum of two passes of a hand-operated plate-type vibratory compactor.
    5. Trench Backfilling:
        a. Backfill as rapidly as construction, testing, and acceptance of work permits. Place and compact backfill under structures and paved areas in maximum 6 inch lifts to

top of trench and in 6 inch lifts to one foot over pipe outside structures and paved areas.

3.15 BORROW

A. Where satisfactory materials are not available in sufficient quantity from required excavations, approved borrow materials shall be obtained at no additional cost to Atlantic Richfield Company as specified herein.

3.16 COMPACTION

A. The CMGC is responsible for attaining all density proctors and moisture content from an approved laboratory at no cost to Atlantic Richfield Company. All Compaction shall be in accordance with the Buffalo Gulch Geotechnical Report Prepared by Pioneer Technical Services (2022).
   1. General Site:
      a. Compact underneath areas designated for vegetation and areas outside the 5-foot line of the paved area or structure to 95 percent of ASTM D698.
   2. Structures, Spread Footings, and Concrete Slabs:
      a. Compact top 12 inches of subgrades to 95 percent of ASTM D698. Compact backfill material to 95 percent of ASTM D698.
   3. Adjacent Area:
      a. Compact areas within 5 feet of structures to 95 percent of ASTM D698.
   4. Paved Areas:
      a. Compact top 12 inches of subgrades to 95 percent of ASTM D698. Compact fill and backfill materials to 95 percent of ASTM D698.

3.17 PIPELINE CASING UNDER RAILROAD

A. Provide new smooth wall steel pipeline casing under existing railroad by the boring and jacking method of installation. Provide each new pipeline casing, where indicated and to the lengths and dimensions shown, complete and suitable for use with the new piped utility as indicated.
   1. Earthwork for Pipeline Casings:
      a. Provide excavation, sheet piling, shoring, dewatering, and backfilling for pipeline casings under this section.
   2. Steel Cased Pipelines:
      a. Install pipeline casing by dry boring and jacking method as follows:
         1) Hole for Pipeline Casing:
            (a) Mechanically bore holes and case through the soil with a cutting head on a continuous auger mounted inside the casing pipe. Weld lengths of pipe together in accordance with AWS D1.1/D1.1M. Do not use water or other fluids in connection with the boring operation.
         2) Cleaning:
            (a) Clean inside of the pipeline casing of dirt, weld splatters, and other foreign matter which would interfere with insertion of the piped utilities by attaching a pipe cleaning plug to the boring rig and passing it through the pipe.
         3) Piped Utilities:
            (a) Provide in casing using wood supports adjusted to obtained grades and elevations indicated.

4) End Seals:
(a) After installation of piped utilities in pipeline casing, provide watertight end seals at each end of pipeline casing between pipeline casing and piping utilities. Provide watertight end seals as indicated.

3.18 RIP-RAP CONSTRUCTION

A. Construct rip-rap in accordance with Section 31 37 00 – Riprap and MT State Standard and Drawings in the areas indicated.
1. Preparation:
a. Trim and dress indicated areas to conform to cross sections, lines and grades shown within a tolerance of 0.1 foot.
2. Bedding Placement:
a. Spread bedding material uniformly to a thickness as specified on prepared subgrade as indicated. Compaction of bedding is at the discretion of Atlantic Richfield Company with no additional cost to Atlantic Richfield Company. Finish bedding to present even surface free from mounds and windrows.
3. Stone Placement:
a. Place rock on prepared bedding material to produce a well graded mass with the minimum practicable percentage of voids in conformance with lines and grades indicated. Distribute larger rock fragments, with dimensions extending the full depth of the rip-rap throughout the entire mass and eliminate "pockets" of small rock fragments. Rearrange individual pieces by mechanical equipment or by hand as necessary to obtain the distribution of fragment sizes specified above.
4. Grouting:
a. Prior to grouting, wet rip-rap surfaces. Grout rip-rap in successive longitudinal strips, approximately 10 feet in width, commencing at the lowest strip and working up the slope. Distribute grout to place of final deposit and work into place between stones with brooms, spades, trowels, or vibrating equipment. Take precautions to prevent grout from penetrating bedding layer. Protect and cure surface for a minimum of 7 days.

3.19 FINE GRADING

A. After the earthwork has been substantially completed and after all underground utilities, drainage facilities, etc. have been installed or adjusted to grade, the embankment shall be brought to the lines, grades, and cross-sections shown on the Construction Drawings, and compacted to the required density.

B. The CMGC shall increase heights above grade and increase widths as necessary to allow for settlement, consolidation, or compaction. Side slopes shall be finished to a reasonable uniform but rough surface that blends to the contours of surrounding undisturbed ground. Smooth surfaces shall be scarified perpendicular to the slope of the ground.

3.20 TOPSOILING AND CLEANUP

A. After fine grading work is accepted, salvaged topsoil shall be replaced to cover those areas to be seeded as designated on the Construction Drawings and according to Section 31 01 20 – Growth Media (Cover Soil).

B. The CMGC shall remove all tools, equipment, excess materials, debris, etc., from the vicinity of the Work.

3.21 CONTRACTOR'S SAFETY RESPONSIBILITIES

A. When conducting trench excavation, the CMGC shall be responsible for enforcing safety and maintaining safe working conditions in all trenching, shoring, and blasting operations to conform to Section 01 34 00 – Safety, Health, and Emergency Response.

3.22 TRAFFIC CONTROL AND WARNING DEVICES

A. Work shall be performed in accordance with the CMGC's Traffic Control Plan.

B. The CMGC shall construct the project in such a manner as to minimize the interruption of the use of roads, highways or streets involved and shall provide for emergency runs at all times.

C. The CMGC is responsible for providing adequate barricades of high visibility design, flares, lanterns, signs, flag persons, and pre-warning devices to alert the public, motorists, and pedestrians of hazardous conditions in accordance with the latest issue of the Manual of Uniform Traffic Control Devices for Streets and Highways (MUTCD) published by the U.S. Department of Transportation.

3.23 CLEANUP

A. As work progresses, that portion of the work completed shall be cleared of debris and brought to the finished grade. Upon completion of the work, the entire site shall be cleared of all debris and ground surfaces shall be finished to smooth, uniform slopes and shall present a neat and workmanlike appearance. All rocks brought to the ground surface by excavation or backfilling operations shall be removed.

3.24 FIELD QUALITY CONTROL

A. Sampling:
   1. Take the number and size of samples required to perform the following tests.

B. Testing:
   1. Perform one of each of the following tests for each material used. Provide additional tests for each source change.
      a. Fill and Backfill Material Testing:
         1) Test fill and backfill material in accordance with ASTM C136/C136M for conformance to ASTM D2487 gradation limits; ASTM D1140 for material finer than the No. 200 sieve; ASTM D4318 for liquid limit and for plastic limit; ASTM D698 or ASTM D1557 for moisture density relations, as applicable. Backfill must also meet the Backfill Material Suitability Criteria defined in Article 2.03 of this Section.
      b. Select Material Testing:
         1) Test select material in accordance with ASTM C136/C136M for conformance to ASTM D2487 gradation limits; ASTM D1140 for material finer than the No. 200 sieve; ASTM D698 or ASTM D1557 for moisture density relations, as applicable.
      c. Porous Fill Testing:
         1) Test porous fill in accordance with ASTM C136/C136M for conformance to gradation specified in ASTM C33/C33M.
      d. Density Tests:
         1) Test density in accordance with ASTM D1556/D1556M, or ASTM D6938. When ASTM D6938 density tests are used, verify density test results by performing an ASTM D1556/D1556M density test at a location already ASTM

D6938 tested as specified herein. Perform an ASTM D1556/D1556M density test at the start of the job, and for every 10 ASTM D6938 density tests thereafter. Test each lift at randomly selected locations every [500] [_____] square feet of existing grade in fills for structures and concrete slabs, and every [500] [_____] square feet for other fill areas and every [500] [_____] square feet of subgrade in cut. Include density test results in daily report.

2) Bedding and Backfill in Trenches: One test per [50] [_____] linear feet in each lift.

e. Moisture Content Tests:

1) In the stockpile, excavation or borrow areas, a minimum of two tests per day per type of material or source of materials being placed is required during stable weather conditions. During unstable weather, tests shall be made as dictated by local conditions and approved moisture content shall be tested in accordance with ASTM D2216. Include moisture content test results in daily report.

END OF SECTION

SECTION 31 01 10
CLEARING AND GRUBBING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This work shall consist of clearing, grubbing, removing, and otherwise disposing of vegetation and debris within the clearing limits as designated on the Construction Drawings and by the Atlantic Richfield Company Representative. Vegetation and objects designated to remain shall be preserved free from injury and defacement.

B. If any evidence of cultural or other historical activity or occupation is encountered, the Construction Management General Contractor (CMGC) shall immediately stop work and notify the Atlantic Richfield Company Representative, who shall contact Atlantic Richfield Company.

C. The CMGC shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-03 Product Data:
      a. Tree and Shrub Paint:
         1) CMGC shall submit product data for asphaltum base paint to be used on cut or scarred surfaces of trees or shrubs selected for retention.

1.03 DEFINITIONS

A. Clearing: Clearing shall consist of the falling of trees and disposal of stumps, brush, windfalls, logs, limbs, sticks, piles of sawdust, rubbish, debris, vegetation, and other objectionable matter existing within the clearing limits or that interfere with excavation and embankment.

B. Grubbing: Grubbing shall consist of the removal and disposal of roots, stumps, stubs, rock, roots, debris, and other objectionable matter from the grubbing limits.

C. Disposal: Disposal shall consist of disposing of the refuse accumulations from clearing and grubbing operations.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

A. Clearing and grubbing shall be done at times and in a manner that the surrounding vegetation, adjacent property, and anything designated to remain shall not be damaged. Dragging, piling, disposing of debris, and other work that may be injurious to vegetation

shall be confined to areas that carry no vegetation or that will be covered by embankments or disturbed by excavations.

B. Vegetation adjacent to streams, ponds, or lakes shall be preserved and protected from injury unless the vegetation conflicts with construction operations and is designated on the Construction Drawings to be removed. If any vegetation designated to be preserved becomes damaged or destroyed by the CMGC, it shall be replaced to the satisfaction of the Atlantic Richfield Company Representative at no cost to Atlantic Richfield Company.

C. The Atlantic Richfield Company Representative may designate trees, shrubs, plants, or other objects to be protected or to remain. The CMGC shall preserve all objects so designated.

D. The CMGC shall not injure trees, shrubbery, vines, plants, grasses, and other vegetation growing outside of the limits of excavation. The CMGC shall paint all cut or scarred surfaces of trees or shrubs selected for retention. The paint shall be an approved asphaltum base paint prepared especially for tree surgery.

E. Where scour is likely to occur, resulting from clearing or grubbing conducted in advance of excavation work, temporary erosion control settling basins or other BMPs shall be constructed prior to any scour occurring in accordance with EPP in Section 01 35 00 – Environmental Protection.

3.02 CLEARING

A. All areas within the neat lines of cut or fill areas shall constitute the clearing limits.

B. Unless specifically designated to be saved, all trees, stumps, brush, windfalls, logs, and other objectionable matter occurring within clearing limits shall be cut off and disposed of. All stumps within the clearing limits of which are not to be grubbed, shall be cut not more than the diameter of the stump, and in any instance not more than 12 inches, above the ground.

3.03 GRUBBING

A. All areas within the neat lines of cuts, and all areas to be covered by embankments shall constitute the grubbing limits.

B. All stumps, roots, logs, or other timber more than 3 inches in diameter, and all brush, matted roots, rock, and other debris within the grubbing limits not suitable for structural foundation shall be pulled or otherwise removed to a depth of not less than 6 inches below the original ground.

3.04 DISPOSAL OF MATERIALS

A. Logs, stumps, roots, brush, rotten wood, and other refuse from the clearing and grubbing operations shall be stockpiled and hauled to the designated disposal location(s) as indicated on the Construction Drawings or as directed by the Atlantic Richfield Company Representative.

END OF SECTION

SECTION 31 01 20
GROWTH MEDIA (COVER SOIL)

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Topsoil and subsoil shall be called growth media (cover soil) after it has been excavated and shall be used to cover all areas to be seeded as specified on the Construction Drawings and as directed by the Atlantic Richfield Company Representative.

B. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

C. Cover Soil (Atlantic Richfield Company Designated/Approved Source): This work item includes performing all operations required for loading, hauling, stockpiling, spreading, and seedbed preparation of approved cover soil material and/or a site which is outside the project limits specified herein or shown on the Construction Drawings. Imported cover soil sources will be either designated on the Construction Drawings or determined/approved by the Atlantic Richfield Company Representative.

1.02 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-01 Preconstruction Submittals:
      a. The CMGC shall prepare a project-specific Construction Execution Plan (CEP) describing the following construction components for the Site:
         1) Backfill and Grading.
         2) Revegetation and Planting.
   2. SD-05 Test Reports:
      a. Cover soil test reports including source location, gradation, and moisture-density characteristics.
      b. Laboratory analytical results demonstrating compliance with the Engineered Caps/Cover Systems Material Suitability Criteria defined in Article 2.01 of this Section.

PART 2 - PRODUCTS

2.01 COVER SOIL

A. Cover soil suitability shall be determined in accordance with the Engineered Caps/Cover Systems Material Suitability Criteria outlined in Appendix 1, Table 3, of the Further Remedial Elements Scope of Work (FRESOW) included as Attachment C to Appendix D of the Consent Decree for the Butte Priority Soils Operable Unit. Cover soil shall be obtained from designated stockpile or borrow locations or CMGC provided sources approved by Atlantic Richfield Company. The suitable cover soil used shall be reasonably free of trash, hard lumps of soil, stumps, or brush. Noxious weeds shall be pulled and disposed of properly prior to excavation of the cover soil.

B. Suitable cover soil shall contain amounts of humus and other organic materials to promote plant growth. The addition of organic material shall be in accordance with Section 31 01 30 – Amendments.

PART 3 - EXECUTION

3.01 COVER SOIL PLACEMENT (ALL SOURCES)

A. Cover soil shall not be placed until the areas to be covered have been properly prepared and all construction work in the area has been completed and approved by the Atlantic Richfield Company Representative. All slopes to receive cover soil shall have a rough surface and shall be approved by the Atlantic Richfield Company Representative prior to placement. Smooth slopes shall be scarified perpendicular to slope to facilitate holding cover soil in place.

B. The cover soil shall be brought to a friable condition to an average depth of 4 inches, or to the depth specified in the Construction Drawings.

END OF SECTION

SECTION 31 01 30
AMENDMENTS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This work item includes incorporation of organic material (compost) into the cover soil used for the project. Compost shall be incorporated at a nominal rate determined by (dry weight basis) for the cover soil source identified by Atlantic Richfield Company or provided by the Construction Management General Contractor (CMGC). This nominal mixing ratio is designed to provide a target value of 3.0% Total Organic Carbon Matter Content in the upper 6-inches of the amended cover soil. The compost shall be mixed sufficiently with the cover soil so that samples of the amended soil provide results of 3.0% (+/-0.5%) Total Organic Carbon Matter Content when analyzed according to the Walkley-Black Total Organic Carbon Matter Content Method (EPA Method 3.2.13), Field and Laboratory Methods Applicable to Overburdens and Mine Soils.

B. Collect and provide for laboratory analysis samples from the amended cover soil to determine the organic matter content of the amended cover soil as directed by the Contract or Atlantic Richfield Company Representative. The analyses shall be performed by a reputable independent laboratory and furnished to the Atlantic Richfield Company Representative for review; sample analyses will be paid for by the CMGC. The CMGC shall coordinate tasks so that construction progress is not delayed during the laboratory analysis period.

C. The organic amended soil shall be used as cover soil on specified areas shown on the Construction Drawings. The organic material incorporation shall be complete and uniform as approved by the Atlantic Richfield Company Representative. It will be the CMGC's responsibility to furnish the organic material necessary to be equivalent to the number of tons required on a dry weight basis. Moisture content of compost is typically in the range of 40% to 50% (weight basis); therefore, the actual mix ratio will require an increased amount of wet pounds of compost per cubic yard of cover soil.

D. The CMGC shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred within the text by the basic designation only.
   1. U.S. Composting Council (USCC):
      a. TMECC - Test Methods for the Examination of Composting and Compost.
   2. U.S. Environmental Protection Agency (EPA):
      a. US EPA 40 CFR Part 503 - Standards for the Use or Disposal of Sewage Sludge.
      b. US EPA Method 3050B - Acid Digestion of Sediments, Sludges, and Soils.
      c. US EPA-600/2-78-054 - Field and Laboratory Methods Applicable to Overburdens and Minesoils.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-01 Preconstruction Submittals:
      a. The CMGC shall submit a project-specific Construction Execution Plan (CEP) that includes the following:
         1) Compost Mixing Plan: Compost mixing plan shall describe CMGC's planned operation for stockpiling and incorporating organic amendment into the cover soil. The Compost Mixing Plan shall describe the proposed application and incorporation methods and necessary equipment.
         2) Delivery, Storage, and Handling Schedule:
            (a) CMGC shall submit a delivery schedule of compost five days prior to delivery of any compost to the Site. Delivery of compost will be accepted under the following conditions:
               (i) All compost deliveries shall have weighed gross and tare weights for each delivered load.
               (ii) All compost deliveries shall be completed during normal workdays and hours, no deliveries will be allowed after hours or non-scheduled workdays.
               (iii) All compost delivery trucks shall be enclosed when transporting compost to the site.
   2. SD-03 Product Data:
      a. Supplier Information:
         1) Name and location of supplier.
      b. Compost Process Certification:
         1) Compost process certification from supplier verifying that the compost has completed the thermophilic process and curing.
   3. SD-05 Test Reports:
      a. Organic Matter Test Reports:
         1) CMGC shall submit laboratory reports from supplier for the tests specified below:

TABLE 1: ORGANIC MATTER (COMPOST) SPECIFICATIONS

Specification	**Reporting Method**	**Threshold Value**	**Units**	**Test method***
Compost Class	Class A or B	Class A	-	Defined by US EPA 40 CFR Part 503
Wet Bulk Density	Pounds/cubic yard as received material	Report Value, No Specification	lbs/cy	TMECC Test Method 03.01-C - Bulk Density
Moisture Content	Percent as Received	50% (maximum)	%	TMECC Test Method 03.09-A - Moisture Content at 70 deg C
Organic Matter	Percent Organic Matter as Dry Weight Basis	30 % (minimum)**	%	TMECC Test Method 02.02 Laboratory Sample Preparation, Methods 02.02-C, 02.02-D and 02.02.E and TMECC Test Method 05.07A-Loss on Ignition (at 550 deg C)
Gradation	Percent passing 1-inch screen	100%	%	TMECC Test Method 02.02-B - Sample Sieve

TABLE 1: ORGANIC MATTER (COMPOST) SPECIFICATIONS				
Specification	**Reporting Method**	**Threshold Value**	**Units**	**Test method***
Carbon:Nitrogen Ratio	Ratio C:N	18 to 28:1	-	TMECC Test Method 05.02-A Carbon to Nitrogen Ratio
Soil Fertility	NPK		N:P:K	TMECC Test Method 04.02-B-Nitrate Nitrogen; 04.03-B-Water Soluble Phosphorus; 04.04-B-Water Soluble Potassium
pH	Standard Units (s.u.)	6.5 (minimum)8.5 (maximum)	s.u.	TMECC Test Method 0411-A 1:5 Slurry pH
Deleterious Material	Percent based on visual observation as received	<0.1 percent by weight or volume	%	Visual Inspection
Electrical Conductivity	Microsiemens per centimeter as received	10 microsiemens per centimeter (micro S/cm)	micro S/cm	TMECC Test Method 0410-A 1:5 Slurry Method, Mass Basis
Total Metals	milligram per kilogram	See maximum value for each element below	mg/kg	Defined by US EPA 40 CFR Part 503
Arsenic	milligram per kilogram	See Waste Identification Criteria, Section 02 11 10 – Excavation and Handling	mg/kg	TMECC Test Method 04.12A Microwave-Assisted Nitric Acid Digestion of Compost (modified US EPA Method 3050B
Cadmium	milligram per kilogram	See Waste Identification Criteria, Section 02 11 10 – Excavation and Handling	mg/kg	TMECC Test Method 04.12A Microwave-Assisted Nitric Acid Digestion of Compost (modified US EPA Method 3050B
Copper	milligram per kilogram	See Waste Identification Criteria, Section 02 11 10 – Excavation and Handling	mg/kg	TMECC Test Method 04.12A Microwave-Assisted Nitric Acid Digestion of Compost (modified US EPA Method 3050B
Lead	milligram per kilogram	See Waste Identification Criteria, Section 02 11 10 – Excavation and Handling	mg/kg	TMECC Test Method 04.12A Microwave-Assisted Nitric Acid Digestion of Compost (modified US EPA Method 3050B
Mercury	milligram per kilogram	See Waste Identification Criteria, Section 02 11 10 – Excavation and Handling	mg/kg	TMECC Test Method 04.12A Microwave-Assisted Nitric Acid Digestion of Compost (modified US EPA Method 3050B
Zinc	milligram per kilogram	See Waste Identification Criteria, Section 02 11 10 – Excavation and Handling	mg/kg	TMECC Test Method 04.12A Microwave-Assisted Nitric Acid Digestion of Compost (modified US EPA Method 3050B

PART 2 - PRODUCTS

2.01 COMPOST

A. Compost will be procured by the CMGC and stockpiled on site as approved by the Atlantic Richfield Company Representative.

B. Compost shall be derived from green material consisting of chipped, shredded, or ground vegetation or clean, processed, recycled wood products or a Class A, exceptional quality biosolids composts, as required by the U.S. Environmental Protection Agency (EPA), 40 CFR, Part 503c regulations or a combination of green material and biosolids compost. The compost shall be free of weed seeds, pathogens, and deleterious material, and shall not contain paint, petroleum products, herbicides, fungicides, or other chemical residues. Twine, plastic, glass, metal, or rocks shall not exceed 0.1 percent by weight or volume.

C. Compost shall appear dark brown with no visible parent material (feedstock) and no ammonia or anaerobic odor.

D. Compost shall have undergone a minimum internal temperature of 135 degrees F for at least 15 continuous days during the composting process. The compost shall be thoroughly turned a minimum of 5 times during the compost process and shall go through a minimum 90-day curing period after the 15-day thermophilic compost process.

E. Compost Mixing Rate: The target dry organic matter application rate shall be 3.0% by weight (0.030 tons OM per ton soil). Field application rate shall be determined based on the percent OM on dry basis of compost and percent moisture content of compost based on the following equation:

Field Application Rate = Target Dry OM Application Rate/(Compost Percent OM Dry Basis X (1-Compost Percent Moisture))

F. Example: Compost material has 30 percent organic matter on dry basis and has 40 percent moisture. Calculate field application rate as tons compost per cubic yard (cy) soil and tons compost per acre-foot soil.

Field Application Rate = (3.0/100)/(30/100*(1-40/100)) = 0.166 tons compost/ton soil

G. Application rate can be converted to volume basis, assuming soil bulk density of 80 pounds per cubic foot (lb/cf):

0.166 tons compost/ton soil*(80 lb/cf)*(27 cf/cy)/(2000 lb/ton) = 0.180 tons compost/cy soil

H. Example calculations provide the maximum compost field application rate for the range of material properties shown in the above table. Amendment using a pug mill or equivalent shall be on a per mass or volume basis. Soil density for screened overburden and in-place parent ground shall be assumed as 80 lb/cf and 110 lb/cf, respectively. CMGC shall provide amendment method and rate calculations in writing to the Atlantic Richfield Company Representative for approval prior to start of work.

I. CMGC shall initially collect as many amended cover soil samples as necessary to determine the correct mixing ratio and obtain the target organic carbon matter content of 3.0% plus or minus 0.5% according to Total Organic Carbon Matter Content Walkley Black (EPA 3.2.13), US EPA-600/2-78-054. Once the mixing rate is obtained, CMGC shall sample amended cover at a frequency of 1 sample per 3,000 cubic yards of amended cover soil placed according to Total Organic Carbon Matter Content Walkley Black (EPA 3.2.13), US EPA-600/2-78-054.

PART 3 - EXECUTION

3.01 GENERAL

A. CMGC shall provide all labor, equipment, materials and incidentals necessary to complete the Work as required.

3.02 COMPOST

A. Delivery, Storage, and Handling:
   1. CMGC shall submit a delivery schedule of compost for approval by the Atlantic Richfield Company Representative five days prior to delivery of any compost to the Site. Delivery of compost will only be accepted under the following conditions:
      a. Scale tickets (weighed tare and gross weight) for each load of compost delivered to and removed from the Site. Each weight slip shall contain the following: date, unit number, gross weight, time of gross weight, tare weight, time of tare weight, name of project, contract number, name of CMGC, and signature of scale operator.
      b. All compost deliveries shall be completed during normal workdays and hours, no deliveries will be allowed after hours or non-scheduled workdays.
      c. All compost delivery trucks shall be enclosed when transporting compost to the Site.
   2. Compost shall be stored and handled in accordance with Technical Specifications.

B. Collect samples of compost delivered to the Site and provide for laboratory analysis to determine the equivalent dry weight basis every 500 tons. The analysis shall utilize Test Methods for the Examination of Composting and Compost (TMECC) Test Method 03.09-A - Moisture Content at 70 deg Celsius and shall be performed by a reputable independent laboratory. Test results shall be furnished to Atlantic Richfield Company for review. The CMGC shall determine the compost amendment rate on an equivalent dry weight basis.

C. The Atlantic Richfield Company Representative will visually inspect for deleterious materials and to confirm that no ammonia or anaerobic odor is present. Presence of deleterious materials and ammonia and/or anaerobic odor shall cause rejection and non-payment of that load.

D. CMGC shall submit to Atlantic Richfield Company Representative the mixing location and overall plan for incorporating compost into cover soils as part of the CMGCs mixing plan. It is anticipated that CMGC will need to apply and incorporate compost into soils prior to placement.

END OF SECTION

SECTION 31 05 00
GEOTEXTILE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This subsection covers the procurement, manufacturer and installer qualifications and installation of geotextile materials as shown on the Construction Drawings. The work includes all necessary site preparation, furnishing and installing geotextile materials, and any incidental work required.

B. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 REFERENCES

A. The publications listed below form a part of the specification to the extent referenced. The publications are referred to within the text by the basic designation only.
   1. ASTM International (ASTM):
      a. ASTM D 3786 - Standard Test Method for Bursting Strength of Textile Fabrics - Diaphragm Bursting Strength Tester Method.
      b. ASTM D 4354 - Sampling of Geosynthetics for Testing.
      c. ASTM D 4355 - Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus.
      d. ASTM D 4491 - Water Permeability of Geotextiles by Permittivity.
      e. ASTM D 4533 - Trapezoid Tearing Strength of Geotextiles.
      f. ASTM D 4632 - Grab Breaking Load and Elongation of Geotextiles.
      g. ASTM D 4751 - Determining Apparent Opening Size of a Geotextile.
      h. ASTM D 4759 - Determining the Specification Conformance of Geosynthetics.
      i. ASTM D 4833 - Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
      j. ASTM D 4873 - Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
      k. ASTM D 5261 - Measuring Mass Per Unit Area of Geotextiles

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-03 Product Data:
      a. Manufacturer's catalog cuts and product specifications.
      b. Manufacturer's certification, installation recommendations, and warranty.
      c. Shipping, handling, and storage recommendations for uninstalled materials.

1.04 MANUFACTURER'S QUALIFICATIONS

A. Geotextile manufacturers shall have a minimum of 5 years of successful experience in the manufacture of like products.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Delivery, storage, and handling of geotextile shall be in accordance with ASTM D 4873.

1. Delivery:
    a. Rolls shall be packaged in an opaque, waterproof, protective plastic wrapping. The plastic wrapping shall not be removed until deployment. If quality assurance samples are collected, rolls shall be immediately rewrapped with the plastic wrapping. Geotextile or plastic wrapping damaged during storage or handling shall be repaired or replaced, as directed. Each roll shall be labeled with the manufacturer's name, geotextile type, roll number, roll dimensions (length, width, gross weight), and date manufactured.
2. Storage:
    a. Rolls of geotextile shall be protected from construction equipment, chemicals, sparks and flames, temperatures in excess of 160 degrees Fahrenheit, or any other environmental condition that may damage the physical properties of the geotextile. To protect geotextile from becoming saturated, rolls shall either be elevated off the ground or placed on a sacrificial sheet of plastic in an area where water will not accumulate. Storage areas shall be free of weeds.
3. Handling:
    a. Geotextile rolls shall be handled and unloaded with load carrying straps, a forklift with a stinger bar, or an axial bar assembly. Rolls shall not be dragged along the ground, lifted by one end, or dropped to the ground.

PART 2 - PRODUCTS

2.01 NON-WOVEN FILTER FABRIC

A. Non-woven filter fabric shall be a non-woven pervious sheet of polymeric material and shall consist of long-chain synthetic polymers composed of at least 85 percent by weight polyolefins, polyesters, or polyamides. The use of woven slit film geotextiles (i.e. geotextiles made from yarns of a flat, tape-like character) will not be allowed. Stabilizers and/or inhibitors shall be added to the base polymer, as needed, to make the filaments resistant to deterioration by ultraviolet light, oxidation, and heat exposure. Regrind material, which consists of edge trimmings and other scraps that have never reached the consumer, may be used to produce the geotextile. Post-consumer recycled material shall not be used. Geotextile shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including the edges. Geotextiles shall meet the requirements specified in Table 1. Where applicable, the property values in Table 1 represent minimum average roll values (MARV) in the weakest principal direction. Values for AOS represent maximum average roll values.

TABLE 1
MINIMUM PHYSICAL REQUIREMENTS FOR DRAINAGE GEOTEXTILE

Property	Units	Acceptable Values	Test Method
Grab Elongation	percent	>50	ASTM D 4632
Grab Tensile Strength	lbs	160	ASTM D 4632
Puncture	lbs	310	ASTM D 6241
Trapezoid Tear	lbs	90	ASTM D 4533
Sewn Seam Strength	lbs	145	ASTM D 4632
Apparent Opening	U.S. Sieve	30 (<0.60)	ASTM D 4751
Permittivity	sec^{-1}	0.02	ASTM D 4491

Property	Units	Acceptable Values	Test Method
Ultraviolet Degradation	percent	>50 at 500 hrs.	ASTM D 4355

2.02 THREAD

A. Sewn seams shall be constructed with high-strength polyester, nylon, or other approved thread type. Thread shall have ultraviolet light stability equivalent to the geotextile and the color shall contrast with the geotextile.

2.03 STRUCTURAL GEOGRID

A. Furnish and install biaxial or triaxial structural geogrid meeting or exceeding the physical properties of Tensar TX140 or Mirifi BXG12 where specified on the Drawings.

2.04 COIR FABRIC

A. Use Woven Coir 1000 Fabric as the outer layer in the middle streambanks. The woven fabric shall be a high-strength coir (100% coconut fiber), continuously woven mat (without seams) with the following minimum average roll properties:

Property	Test Method	Criteria
Thickness	ASTM D 5199	0.35 in.
Weight	ASTM D 5261	33.3 oz./yd^2 (1130 g/m^2)
Wide Width Tensile Strength MD x TD (Primary Layer)	ASTM D 4595	1,008 x 936 lbs./ft.
Maximum Elongation MD x TD (Primary Layer)	ASTM D 4595	30% x 26%
Wide Width Tensile Strength MD x TD (Secondary Layer)	ASTM D 4595	612 x 468 lbs./ft.
Maximum Elongation MD x TD (Secondary Layer)	ASTM D4595	8% x 9%
Flexural Rigidity	ASTM D 1388	0.692 x 0.690 oz-in (49.8 x 49.7 g-cm)
Water Absorption	ASTM D 1117	146%
Permittivity	ASTM D 4491	3.07/sec
Permeability	ASTM D 4491	1.03 in/sec
Flow Rate	ASTM D 4491	229 gallons/min/ft^2
Roll Width	Measured	3 meters (10 feet)

B. Stakes for installation of all coir fabric shall be 18 inches long and shall have a top (head)dimension of at least 3.5 inches square. Construct stakes by diagonally rip cutting a 2 x 4 piece of lumber, from top to bottom, across the 4-inch-wide surface such that the top meets the minimum width and thickness specifications.

2.05 MANUFACTURING QUALITY CONTROL SAMPLING AND TESTING

A. The Manufacturer shall be responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. Documentation describing the quality control program shall be made available upon request. Manufacturing quality control sampling and testing shall be performed in accordance with the manufacturer's approved quality control manual. As a minimum, geotextiles shall be randomly sampled for testing in accordance with ASTM D 4354, Procedure A. Acceptance of geotextile shall be in accordance with ASTM D 4759. Tests not meeting the specified requirements shall result in the rejection of applicable rolls.

PART 3 - EXECUTION

3.01 GENERAL

A. Geotextile installation shall be performed by qualified, adequately supervised workmen.

3.02 INSTALLATION

A. See Section 35 40 00 – New Stream Channel Construction for coir fabric installation.

B. Subgrade Preparation: The surface underlying the geotextile shall be smooth and free of ruts or protrusions which could damage the geotextile. Subgrade materials and compaction requirements shall be in accordance with Section 31 00 00 – Earthwork.

C. Placement: The CMGC shall notify the Atlantic Richfield Company Representative a minimum of 24 hours prior to installation of geotextile. Geotextile rolls which are damaged or contain imperfections shall be repaired or replaced as directed. The geotextile shall be laid flat and smooth so that it is in direct contact with the subgrade. The geotextile shall also be free of tensile stresses, folds, and wrinkles. On slopes steeper than 10 horizontal on 1 vertical, the geotextile shall be laid with the machine direction of the fabric parallel to the slope direction.

3.03 SEAMS

A. Overlap Seams:
   1. Geotextile panels shall be continuously overlapped a minimum of 12 inches at all longitudinal and transverse joints. Where seams must be oriented across the slope, the upper panel shall be lapped over the lower panel. If approved, sewn seams may be used instead of overlapped seams.
   2. Overlap geogrid seams a minimum of one (1) foot and tie the area together with zip ties. Place Geogrid as shown on the construction drawings or as directed by the Atlantic Richfield Company Representative.

B. Sewn Seams:
   1. Factory and field seams shall be continuously sewn on all slopes steeper than 1 vertical on 4 horizontal. The stitch type used shall be a 401-locking chain stitch or as recommended by the manufacturer. For field and factory seams which are sewn, the CMGC shall provide at least a 2-meter sample of sewn seam before the geotextile is installed. For seams that are field sewn, the seams shall be sewn using the same equipment and procedures as will be used for the production seams. If seams are sewn in both the machine and cross machine direction, samples of seams from both directions shall be provided. Quality Assurance seam samples shall be provided to Atlantic Richfield Company at the request of the Atlantic Richfield Company Representative. Seam strength shall meet the minimum requirements specified in the

respective Table. The thread at the end of each seam run shall be tied off to prevent unraveling. Skipped stitches or discontinuities shall be sewn with an extra line of stitching with a minimum of 18 inches of overlap.

3.04 PROTECTION

A. The geotextile shall be protected during installation from clogging, tears, and other damage. Damaged geotextile shall be repaired or replaced as directed. Adequate ballast (e.g., sand bags) shall be used to prevent uplift by wind. The geotextile shall not be left uncovered for more than 1 day after installation.

3.05 REPAIRS

A. Torn or damaged geotextile shall be repaired. Clogged areas of geotextile shall be removed. Repairs shall be performed by placing a patch of the same type of geotextile over the damaged area. The patch shall extend a minimum of 12 inches beyond the edge of the damaged area. Patches shall be continuously fastened using approved methods. The machine direction of the patch shall be aligned with the machine direction of the geotextile being repaired. Geotextile rolls which cannot be repaired shall be removed and replaced. Repairs shall be performed at no additional cost to Atlantic Richfield Company.

3.06 PENETRATIONS

A. Engineered penetrations of the geotextile shall be constructed by methods recommended by the geotextile manufacturer.

3.07 COVERING

A. Geotextile shall not be covered prior to inspection and approval by the Atlantic Richfield Company Representative. Cover soil shall be placed in a manner that prevents soil from entering the geotextile overlap zone, prevents tensile stress from being mobilized in the geotextile, and prevents wrinkles from folding over onto themselves. On side slopes, riprap backfill shall be placed from the bottom of the slope upward. Riprap material shall not be dropped onto the geotextile from a height greater than 1 foot. No equipment shall be operated directly on top of the geotextile. Equipment with ground pressures less than 7 pounds per square inch (psi) shall be used to place the first lift over the geotextile. Equipment placing riprap shall not stop abruptly, make sharp turns, spin their wheels, or travel at speeds exceeding 5 mph.

3.08 CLEANUP

A. After completion of cover installation, the site shall be thoroughly cleaned of all construction debris, tools, and foreign materials.

END OF SECTION

SECTION 31 05 10
GEOCOMPOSITE DRAINAGE LAYER

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required for installing and anchoring the geocomposite drainage layer as shown on the Construction Drawings.

B. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
   1. ASTM International (ASTM):
      a. ASTM D 1238 - Melt Flow Rates of Thermoplastics by Extrusion Plastometer.
      b. ASTM D 1505 - Density of Plastics by the Density-Gradient Technique.
      c. ASTM D 1603 - Carbon Black Content in Olefin Plastics.
      d. ASTM D 4218 - Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
      e. ASTM D 4355 - Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus.
      f. ASTM D 4491 - Water Permeability of Geotextiles by Permittivity.
      g. ASTM D 4533 - Trapezoid Tearing Strength of Geotextiles.
      h. ASTM D 4632 - Grab Breaking Load and Elongation of Geotextiles.
      i. ASTM D 4716 - Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head.
      j. ASTM D 4751 - Determining Apparent Opening Size of a Geotextile.
      k. ASTM D 5035 - Breaking Force and Elongation of Textile Fabrics (Strip Method).
      l. ASTM D 5261 - Measuring Mass Per Unit Area of Geotextiles.
      m. ASTM D 6241 - Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.
      n. ASTM D 7005 - Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites.

1.03 SUBMITTALS

A. Atlantic Richfield Company approval is required for submittals listed below. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-03 Product Data:
      a. Sampling and Testing:
         1) Manufacturer's quality control manual.
      b. Penetrations:
         1) Penetration details.
      c. Construction Quality Control (QC) Laboratory:
         1) Qualifications of laboratory.
   2. SD-04 Samples:
      a. Geocomposite Drainage Layer.

b. Seams and Overlaps:
    1) One properly identified 24 by 24-inch minimum size geosynthetic drainage layer sample; fasteners proposed for use; and the method of seaming and overlapping.

3. SD-05 Test Reports:
    a. Sampling and Testing:
        1) Construction quality control test results.
    b. Geocomposite Drainage Layer:
        1) Manufacturer's quality control test results.

1.04 QUALITY CONTROL

A. Provide a construction quality control (QC) laboratory that has also performed quality assurance (QA) testing, if required, of geocomposite drainage layers for at least five completed projects, having a total minimum area of 2 million square feet. The laboratory shall carry current accreditation via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests it will be required to perform.

1.05 DELIVERY, STORAGE, AND HANDLING

A. The QC inspector shall be present during delivery and unloading of the geocomposite drainage layer. Ensure the drainage layer material has not been damaged during shipping, storage, or handling. Any drainage layer material found to be damaged shall be repaired or replaced. Accept delivery of material only after the required submittals have been approved. Each roll shall be labeled with the manufacturer's name, product identification, lot number, roll number, and roll dimensions. Rolls that have attached geotextiles shall be individually wrapped in plastic. Store the rolls in a level and dry area.

PART 2 - PRODUCTS

2.01 GEOCOMPOSITE DRAINAGE LAYER

A. Geocomposite shall be a Syntec, TENFLOW 770-2 Double-Sided Geocomposite, or approved equivalent. The polymer used to manufacture the geonet component of the geocomposite drainage layer shall be polyethylene which is clean and free of any foreign contaminants. Regrind material which consists of edge trimmings and other scraps may be used to manufacture the geonet; however, post-consumer recycled materials shall not be used. Conform the geocomposite drainage layer to the property requirements listed in Table 1. Component criteria for the geonet alone and geotextile alone are also listed in Table 1. The geonet shall be covered on both sides with nonwoven geotextile. The geotextile shall not be bonded to the drainage net within 6 inches of the edges of the rolls. Where applicable, Table 1 property values represent minimum average roll values (MARV). The value for AOS represents the maximum average roll value (MaxARV).

TABLE 1 – GEOCOMPOSITE DRAINAGE LAYER PROPERTIES			
PROPERTY	**TEST METHOD**	**TEST VALUE**	**MINIMUM MQC TESTING FREQUENCY**
GEONET			
Polymer Density, minimum average	ASTM D 1505	0.94 g/cc	100,000 SF
Carbon Black Content	ASTM D 1603 ASTM D 418	2-3 percent	100,000 SF
Melt Flow Index	ASTM D 1238	1.0 g/10min	100,000 SF
Tensile Strength, minimum average, Note 1	ASTM D 5035	65 lbs/in	100,000 SF
GEOTEXTILE			
Mass/Unit Area, MARV	ASTM D 5261	10 oz/sy	100,000 SF
Grab Strength, MARV	ASTM D 4632	160 lbs	100,000 SF
Grab Elongation, MARV	ASTM D 4632	50 percent	100,000 SF
Tear Strength, MARV	ASTM D 4533	60 lbs	100,000 SF
Puncture Strength, MARV	ASTM D 6241	400 lbs	100,000 SF
Permittivity, MARV	ASTM D 4491	1.4/sec	500,000 SF
AOS(095), MaxARV	ASTM D 4751	70 sieve	500,000 SF
UV Stability, percent retained (500 hrs)	ASTM D 4355	70 percent	Note 2
GEOCOMPOSITE			
Transmissivity, min, including attached geotextiles, Note 3	ASTM D 4716	1.94×10^{-3} m^2/sec	500,000 SF
Geonet/Geotextile Adhesion, minimum avg, Note 4	ASTM D 7005	0.5 lbs/inch	100,000 SF

Note 1: This is the average peak value for five equally spaced machine direction tests across the roll width.

Note 2: Manufacturer's historical data.

Note 3: Measure manufacturing quality control transmissivity tests using a gradient of 0.33 under a normal pressure of 1,000 psf. Use a minimum seating period of 15 minutes. Perform the test between rigid end platens.

Note 4: Average of five tests across the roll width. Discounting the outer 305 mm of each side of the roll, collect samples at the 10, 30, 50, 70, and 90 percent positions across the roll width. Test both sides for double sided geocomposites.

2.02 SAMPLING AND TESTING

A. Manufacturing Quality Control Testing:
   1. Manufacturing quality control test methods and frequencies shall be in accordance with Table 1 unless otherwise approved.

B. Conformance Testing:
   1. Conformance testing shall be performed by an independent Quality Control (QC) Laboratory retained by the CMGC. A Quality Control Technician (QCT) will obtain samples from the delivered material, mark the machine direction and identification number. Samples shall be taken at a frequency as indicated in Table 1 and at least once per lot whichever is greater. A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. This sampling frequency may be increased as deemed necessary by the Atlantic Richfield Company Representative. The samples shall be taken across the entire roll width and shall not include the first 3-ft. The following conformance tests shall be conducted at the laboratory:
      a. Density (ASTM D 1505).
      b. Carbon Black Content (ASTM D 1603/ASTM D 4218).
      c. Transmissivity (ASTM D 4716).
      d. Tensile Strength (ASTM D 5035).
      e. Mass Per Unit Area (ASTM D 5261).
   2. All conformance test results shall be reviewed by the Atlantic Richfield Company Representative and accepted or rejected, prior to the deployment of the drainage net. All test results shall meet, or exceed, the property values listed in Table 1 above. In case of failing test results, the CMGC may request that other samples be tested by the QC Laboratory with the Manufacturer's technical representative present during the testing procedures. All testing and retesting shall be paid for by the CMGC. The Manufacturer may obtain additional samples from rolls immediately before and after the failing roll or as directed by the Atlantic Richfield Company Representative and have them tested by the QC Laboratory at his/her own expense. If these rolls pass, then only the failing roll will be rejected. If they fail, then the entire lot will be rejected.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Surface Preparation:
   1. Prior to placement of the geocomposite drainage layer, the subgrade shall be smooth and free of all materials which could damage the drainage layer.

B. Placement:
   1. The geocomposite drainage layer shall not be damaged during placement. Unroll the drainage layer in the direction of maximum slope, keeping the net flat against the subgrade to minimize wrinkles and folds. The drainage layer shall not be dragged across textured geomembrane if a geotextile is attached to the surface facing the geomembrane. Place adequate ballast (e.g. sandbags) to prevent uplift by wind prior to covering.
   2. Geocomposite drainage net shall only be cut using cutting tools approved by the Manufacturer that will not damage the underlying geosynthetics. Care shall be taken not to leave tools on the geocomposite drainage net.
   3. During placement of geocomposite drainage net, care shall be taken not to entrap in the geocomposite drainage net dirt or excessive dust that could cause clogging of the drainage system and/or stones and bones that could damage the adjacent geomembrane. If dirt or excessive dust is entrapped in the geocomposite drainage net,

it shall be hosed clean prior to placement of the next material on top of it. In this regard, care shall be taken in handling the sandbags, to prevent rupture or damage of the sandbag. CMGC shall cover geocomposite drainage net within 15 days of geocomposite drainage net installation with liner or fabric to prevent dirt or rocks from washing/blowing into the geonet and to protect from sun exposure. CMGC shall mark on the geocomposite the date at the start and finish of each day's deployment and keep a deployment log of the roles deployed by date and the area covered.

4. For protection and proper performance, no machinery or equipment shall be allowed on the geocomposite unless previously approved by the Atlantic Richfield Company Representative and Manufacturer. Use of a low ground pressure rubber tired or rubber tracked equipment may be used to install the geosynthetics if approved by the Atlantic Richfield Company Representative and Manufacturer. Vehicles, machinery, and equipment shall be operated to avoid abrupt stops, starts, and/or turns if approved for use.

C. Seams and Overlaps:
   1. Geonet Side Seams: Overlap geonet side seams a minimum of 6 inches. Side seam fastener spacing shall be a maximum of 5 feet. In anchor trenches, fastener spacing shall be a maximum of 6 inches.
   2. Geonet End Seams: Overlap geonet end seams a minimum of 1 foot. End seam fastener spacing shall be a maximum of 6 inches. The overlaps shall be in the direction of flow.
   3. Geonet Fasteners: Tie geonet rolls together with plastic fasteners. The fasteners shall be a contrasting color from the geonet and attached geotextiles. Metallic fasteners will not be allowed.
   4. Geotextile Seams: The geotextile panels shall be sewn together or thermally bonded as approved by the Atlantic Richfield Company Representative. The thread used to sew the panels shall be of the same composition as the geotextile and as recommended by the Manufacturer. The amount of overlap and type of stitch used to join geotextile panels shall be as recommended by the Manufacturer and approved by the Atlantic Richfield Company Representative. For thermal bonding, fusion welding techniques recommended by the Manufacturer shall be used. If thermal bonding is used, care shall be taken to avoid burn through of the geotextile, and the area welded shall be clean and dry.
   5. Geotextile Cap Strips: Place geotextile cap strips over any exposed edges of geocomposite. Cap strips shall be a minimum of 2 feet in width and shall be thermally bonded to the geotextile component of the geocomposite.
   6. Stacked Geosynthetic Drainage Layers: When geosynthetic drainage layers are to be stacked, stagger roll ends and edges so that joints do not lie above one another.
   7. Corners: In the corners of lined side slopes, install an extra layer of drainage layer material from the top to the bottom of the slope.
   8. Penetrations: Mechanically attach a geotextile apron to pipes and other appurtenances penetrating through the drainage layer so that soil is prevented from getting into the drainage layer. The apron of the attached geotextile shall extend out from the pipe or appurtenance a minimum of 2 feet. The apron geotextile shall be thermally bonded to the geotextile component of the geocomposite.

3.02 REPAIRS

A. Geonet Damage:
   1. Make repairs by placing a patch of the geocomposite drainage layer over the damaged area. Extend the patch a minimum of 2 feet beyond the edge of the damage. Use approved fasteners, spaced every 6 inches around the patch, to hold the patch in

place. If more than 25 percent of the roll width is damaged, Atlantic Richfield Company Representative approval must be obtained to repair or replace the damaged roll.

B. Geotextile Damage:
   1. Repair damaged geotextile by placing a patch of geotextile over the damaged area with a minimum of 12 inches of overlap in all directions. The geotextile patch shall be thermally bonded in place.

3.03 PROTECTION AND BACKFILLING

A. Cover the installed geocomposite drainage layer with the specified materials within 5 days of acceptance. Place cover soil as directed by the construction drawings or Atlantic Richfield Company Representative and shall not be dropped directly onto the drainage layer from a height greater than 3 feet. The cover soil shall be pushed out over the geocomposite drainage layer in an upward tumbling motion so that wrinkles in the drainage layer do not fold over. No equipment shall be operated on the top surface of the geocomposite drainage layer without permission from the Atlantic Richfield Company Representative. The initial loose soil lift thickness shall be 12 inches. Use equipment with ground pressures no greater than 7 psi to place the first lift of soil. A minimum of 36 inches of soil shall be maintained between construction equipment with a ground pressure greater than 7 psi and the geocomposite drainage layer. Cover soil compaction and testing requirements are described in Section 31 00 00 – Earthwork.

END OF SECTION

SECTION 31 05 20
GEOMEMBRANE HDPE

PART 1 - GENERAL

1.01 SUMMARY

A. Provide installation and testing of geomembrane in accordance with this Section and applicable reference standards listed in Article 1.02.

1.02 REFERENCES

A. Geosynthetic Research Institute (GRI):
   1. GRI – GM13 - Standard Specification for Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes.
   2. U.S. Environmental Protection Agency (EPA):
      a. EPA/530/SW-91/051 - Inspection Techniques for the Fabrication of Geomembrane Field Seams.
      b. EPA/530/SW-89/069 - The Fabrication of Polyethylene FML Field Seams.
      c. EPA/600/R-93/182 - Quality Assurance and Quality Control for Waste Containment Facilities.
   3. ASTM International (ASTM):
      a. ASTM D1004 - Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting.
      b. ASTM D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.
      c. ASTM D1603 - Standard Test Method for Carbon Black Content in Olefin Plastics.
      d. ASTM D5994 - Standard Test Method for Measuring Core Thickness of Textured Geomembranes.
      e. ASTM D5596 - Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.
      f. ASTM D6693 - Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes.
      g. ASTM D7466 - Standard Test Method for Measuring the Asperity Height of Textured Geomembrane.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-02 Shop Drawings:
      a. Proposed Panel Layout:
         1) Submit Drawings prepared by the installer showing the proposed placement of panels on the area to be lined as shown on the Drawings. Show panel sizes and indicate the location of field seams on a layout plan. Configure the panel layout to minimize seams parallel to contour lines.
   2. SD-03 Product Data:
      a. Submit product data prior to commencement of liner installation, including:
         1) Certification by the manufacturer of successful production and installation of 10-million square feet of geomembrane material for hydraulic lining or capping.

2) Certification from the manufacturer of the sheeting, stating that the sheeting meets physical property requirements for the intended application.

3. SD-04 Samples:
   a. A minimum 60-square feet of each specific geomembrane materials to be used on this Project. Samples to be used for interface shear strength testing, as specified in Section 02 32 17.
4. SD-05 Test Reports:
   a. Submit installers daily reports that documents welding conditions, equipment used, crew, panel deployment, test welds, seam testing, and repairs.
5. SD-06 Certificates:
   a. Submit manufacturer's quality control (QC) certificates for each batch of resin used in the manufacture of rolled goods and extrusion welding rod utilized for this Project. Identify the resin Supplier, the production plant, brand name, and number. Match the QC certificates to the resin lot number with the roll numbers on materials provided for the Work.
   b. Submit manufacturer's QC certificates for material delivered to the job Site to show that the material delivered to the job Site meets the specified physical properties.
   c. Submit manufacturer's certification that the geomembrane resin and extrusion welding rod stock resin have the same physical properties.
   d. Qualifications of geomembrane Installation Supervisor, Master Seamer, and Seamers.
6. SD-07 Closeout Submittals:
   a. Submit Record Drawings identifying roll number, panel placement, seam locations, pipe penetrations, repairs, and destructive seam test locations to the Engineer at least 30 days prior to substantial completion.

1.04 QUALITY CONTRIL

A. Geomembrane Installation:
   1. Manufacturer: Demonstrate a minimum of 5 years' experience manufacturing geomembrane of polyethylene materials comparable to the specified products minimum 10 million sf. Obtain all geomembrane materials and associated components from a single manufacturer.
   2. Installer: A minimum of 5 years' experience performing the installation of polyethylene sheets using the dual hot wedge seaming method on projects with similar requirements; and which is acceptable to or licensed by the manufacturer of the primary materials for the installation of these materials.
   3. Supervision: Perform installation under the direction of an installation supervisor who will always remain on-site during the geomembrane installation and be in responsible charge. The installation supervisor must have supervised a minimum of 10,000,000 square feet of polyethylene (PE) geomembrane installation.
   4. Overall quality for the geomembrane installation Work is to be ensured by the combined efforts of the manufacturer, installer, Contractor, and Engineer. A Geosynthetic Construction Quality Assurance (GCQA) Representative will assist the Engineer.
   5. Participate in and conform to all items contained in the CQA Plan, which is an appendix to the Contract Documents.
   6. Require the installer designate an installation supervisor who is responsible for the geomembrane installation and for the quality of the geomembrane installation. The installation supervisor is responsible for coordinating the timing and sequencing of geomembrane installation and testing with the Engineer.

PART 2 - PRODUCTS

2.01 GEOMEMBRANES

A. Manufactured of polyethylene with nominal thickness and surface texture as indicated on the Drawings, complying with all applicable properties and testing frequencies set forth in GRI Test Method GM 13 - Test Methods, Test Properties, and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes.

B. Produce geomembrane material to be free of holes, blister, undispersed raw materials, or any sign of contamination by foreign matter.

C. Supply the geomembrane material in rolls bearing labels indicating the thickness, length, and width of the roll, and manufacturer's roll production number.

D. Fabricate boots of the same material and quality as the geomembrane except that smooth (non-textured) material may be used.

E. Manufacture geomembrane with smooth (non-textured) edges of a width suitable for field seaming.

2.02 FACTORY QUALITY CONTROL

A. The manufacturer shall randomly sample all compound ingredients of the geomembrane material upon delivery to the manufacturing plant to verify compliance with Specifications.

B. Sample the production run and test in accordance with GRI GM 13 to verify that the minimum Specifications are met.

C. All welding resin and extradite rod material of a type recommended and supplied by the manufacturer.

2.03 SEAMING AND TESTING EQUIPMENT

A. Seaming Equipment:
   1. Fusion Welding Devices: Self-propelled machinery designed to weld geomembrane liner, equipped with a gauge displaying the heating element temperature, and a method to indicate the drive speed.
   2. Extrusion Welding Devices: Hand-held machinery designed to weld geomembrane liner, equipped with a gauge displaying the extrudate temperature and preheater temperature.

B. Testing Equipment:
   1. Testing equipment is subject to rejection by the Owner. Maintain the following items on-site and in good working order.

C. Field Tensiometer:
   1. A motor driven tensiometer with jaws capable of traveling at a measured rate of 2 and 20 inches per minute, equipped with a gauge that measures the force in unit pounds exerted between the jaws. Keep with the tensiometer a written certification the tensiometer was calibrated within the past 6 months.

D. Vacuum Box:
   1. A rigid housing with a transparent viewing window on top, and a soft, closed-cell neoprene gasket attached to the bottom of the housing. Connect a vacuum source the

housing so that a negative pressure of 3 - 5 psi can be created and maintained inside the box.

E. Air Pressure Test Equipment:
   1. An air pump capable of generating and maintaining a positive pressure between 25 and 35 psi, and a manometer capable of reading up to 35 psi. The manometer attached to a needle or nipple used to pressurize the air channel in the seam.

PART 3 - EXECUTION

3.01 CONSTRUCTION

A. Deploy the geomembrane layer as soon as practical after completion and approval by the Engineer of the underlying materials or portions. Secure each sequential section of liner and continuously welded to the adjacent sections.

B. Take actions necessary to prevent damage to the underlying material and repair all damage at no additional cost to the Owner.

C. Supervise the geomembrane installation by an individual with documented supervision of at least 10 million square feet of similar installation projects.
   1. Seaming Operations:
      a. To be supervised by a master seamer, if separate from the installer's supervisor, who can document supervision of at least 1 million square feet of geomembrane installation.
   2. Temperature Constraints:
      a. Take temperature readings of the ambient air at the level 0.5 feet above the geomembrane subgrade and record in a daily report a minimum of 3 times per day. The Cold Weather Plan, Paragraph 3.07, becomes effective when the recorded temperature is below 32 degrees F.
      b. Do not make geomembrane seams when the geomembrane sheet temperature exceeds 140 degrees F, as measured by an infrared thermometer or surface contact thermocouple. Higher temperatures may be allowed at the discretion of the Engineer. More frequent test welds may be required.
   3. Precipitation:
      a. Seaming of the geomembrane are not permitted during periods of rain or snow.

3.02 GEOMEMBRANE CONFORMANCE TESTING

A. Sampling:
   1. Following manufacturing of the geomembrane, the Engineer will obtain 1 Sample for every 50,000 square feet of material, or 1 Sample per lot, whichever is greater, for conformance testing. A lot is defined as rolls of geomembrane manufactured from the same batch of resin on the same production line. Sample size is 3 feet by full roll width and will not include the first 3 feet of the material on the roll.

B. Testing:
   1. Conduct the following testing on the conformance Samples:
      a. Density, ASTM D 1505.
      b. Asperity height, ASTM D7466.
      c. Carbon black content, ASTM D 1603.
      d. Carbon black dispersion, ASTM D 5596.
      e. Thickness, ASTM D5994.
      f. Tensile properties, machine and cross machine directions, ASTM D 6693.

g. Tear resistance, ASTM D 1004.

C. Test Results:
1. All conformance test results will be made available to the Contractor and reviewed by the Engineer prior to deployment of the materials. All test results must meet or exceed values specified for the material. If a test result is out of conformance with the Specification, the entire lot of material will be rejected.

D. Retesting:
1. In the event of failing conformance tests, the manufacturer may elect to retest the failed lot(s). All costs of retesting are the responsibility of the Contractor. Retesting consists of one of the following two options:
a. The Engineer selects and samples each lot of failed rolled goods, obtaining at least 1 Sample for every 100,000 square feet of material. Samples will be tested at 2 different independent laboratories acceptable to the Engineer and the manufacturer. If both laboratories produce passing results, the material lot will be accepted. If either lab produces failing results, the entire lot will be rejected.
b. The Engineer samples each roll within the failed lot. Testing will be performed at the independent laboratory. Rejection or acceptance of the retested materials in the lot is made on a roll-by-roll basis.

3.03 SUBGRADE PREPARATION

A. Conditions:
1. Smooth roll surfaces to be covered with geomembrane. Remove all vegetation, rocks, stones, sticks, roots, sharp objects, or debris of any kind. Do not install geomembrane on areas of standing water, snow, ice or where precipitation has increased the moisture content of the soil subgrade. Provide a firm, unyielding foundation with no sharp changes or abrupt breaks in grade. Rounded corners at all directional changes to avoid sharp bends in the geomembrane.

B. Acceptance:
1. A written certificate from the installer the surface to be lined is acceptable. Submittal of the written acceptance may proceed incrementally according to the installation schedule. Do not place geomembrane on subgrade deemed unsuitable by the installer and the Engineer.

3.04 INSTALLATION

A. General:
1. Place the geomembrane over the prepared subgrade with minimum handling. Placed sheets to minimize field seaming. Unpackage and place in position only those sheets of geomembrane material which can be anchored or seamed together in one day. Minimized seams and run as close to the line of slope as possible, particularly in corners.
2. In areas where wind is prevalent, start geomembrane installation upwind and proceed downwind. Secure the leading edge of the geomembrane at all times with sandbags or other acceptable means sufficient to hold deployed materials in place.
3. Do not drag materials, equipment, or other items across the surface of the geomembrane or be allowed to slide down the slopes of the geomembrane. Wear soft-soled shoes walking or working upon the geomembrane. Upon direction of Engineer replace any geomembrane surface showing injury due to installation.

4. Closely fit and seal geomembrane sheets around inlets, outlets, and other projections. Seal piping, structures, and other projections through the geomembrane as shown on the Drawings and specified.

B. Penetrations:
   1. Install geomembrane around pipes as shown on the Drawings or as recommended by the manufacturer and approved by Engineer. Install to provide an effective, watertight seal. Perform construction and installation of the pipe boot in the presence of the GCQA Representative. Pipe boots not constructed in the presence of the GCQA Representative are subject to immediate rejection unless the integrity of the boot is proven by testing. Test pipe boots as described in Paragraph 3.06I.
   2. Provide pipe boots, vents, and patches of the same material as the geomembrane sheet. Use 316-stainless steel mechanical fasteners, clamps, bolts, nuts of sizes and type as indicated on the Drawings. Gaskets, sealing materials, or other means used to secure the geomembrane must be compatible with the geomembrane.
   3. Take care to protect the geomembrane from damage due to settling around concrete collars beneath the liner. Smooth trowel finish concrete collars and meet minimum surface tolerance requirements of 0.25 inches in 10 feet as measured by a 10-foot straight edge.

C. Concrete Joined to the Geomembrane:
   1. Adjacent concrete pads, ramps, and appurtenances shall be constructed prior to placing the geomembrane liner.
   2. Concrete ramps, pads, and appurtenances shall have approved premanufactured geomembrane embedment strips cast into the concrete per the manufacturer's specifications. The concrete Contractor shall obtain the embedment strips from the liner installer along with the manufacturer's installation instructions. The embedment strips shall be stored at locations where excessive heat or sunlight will not cause deformation of the strip. The embedment strips shall be fully embedded into the concrete with no gaps between the strips. Joints between the strips shall be extrusion welded or an approved expanding sealant material placed under the joint.

D. Concrete or Grout Pillows Placed Over the Geomembrane:
   1. Concrete or grout pillow pads, ramps, and appurtenances shall be constructed in a manner that does not puncture the geomembrane and does not jeopardize the integrity or performance of the geomembrane liner in any way. The Contractor shall submit shop drawings, which include all details necessary to ensure compliance with this specification, to the Engineer at least five business days prior to the anticipated date of concrete construction. Concrete or grout pillow construction shall not occur until the Contractor obtains written approval of the shop drawings from the Engineer.

E. Thermal Contraction:
   1. Install geomembrane to accommodate thermal contraction at the lowest anticipated operating temperature of 30 degrees F, with no occurrence of bridging evident during installation. Cut areas which show evidence of tension and install a compensation panel to eliminate the condition.

3.05 FIELD SEAMS

A. General:
   1. Conduct seaming without interruptions. Temporary seams may be allowed for protection of the geomembrane subgrade, upon concurrence of the Engineer, and redone after the weather clears. Under no circumstances will the temporary seamasm

be allowed as a permanent seam. Artificial cooling of welds of any type is not acceptable.

2. Utilize the dual hot wedge seaming method whenever possible. Extrusion welding is acceptable only for repairs, patches, and poorly accessible areas such as pipe penetrations, unless otherwise approved by the Engineer.
3. Produce double-track seam with a self-propelled wedge welding apparatus. Vary weld temperature, machine speed and pressure settings according to ambient conditions to maintain and demonstrate a consistent, acceptable weld.
4. Produce extrusion seam by extruding molten resin between flat weld, or at the edge of fillet weld, two overlapped sheets of geomembrane to create a homogeneous bond. Vary temperature and flow rate according to ambient conditions to maintain and demonstrate a consistent, acceptable weld. Keep extrudate material free of dirt, debris, and foreign matter.

B. Preparation:
   1. Keep welding area dry and free of dirt or dust. Do not weld when the subgrade contains ponded water or is fully saturated.
   2. Dual track wedge seaming: Do not roughen sheet surface by grinding or any other means. Weld only clean and dry surfaces.

C. Extrusion Seaming:
   1. Roughen seam interfaces with a hand-held rotary grinder with grit paper no coarser than #80, nor finer than #100. For fillet welds only, the leading edge of the upper geomembrane sheet grind a 45-degree bevel so both the upper and lower sheet are sufficiently roughened. Angle grinding to produce grind marks perpendicular to the seam.
   2. Grind to approximately 5 percent of the sheet thickness, and in no case, exceed 10 percent of the sheet thickness.
   3. Grind marks shall not appear beyond 0.25 inches of the extrudate for a length of more than 10 feet.
   4. Perform grinding no more than 15 minutes before seaming takes place to prevent surface oxidation of the area to be welded.
   5. Repair areas where maximum depth or exposed grind area has been exceeded by placement of a cap strip over the entire affected area.
   6. Purge the extruder of all heat degraded or cooled extrudate in the barrel prior to beginning each seam and each time the extruder is restarted after a downtime of greater than 2-minutes. Do not discard the purged extrudate onto the geomembrane surface or on the subgrade.

D. Seaming Procedures:
   1. Overlap sheets a minimum of 3 inches. Place the overlap in a shingle fashion to shed water to the down-gradient side. Aligned panels to create a smooth and wrinkle free surface in the overlap area.
      a. Dual Hot Wedge Seaming: Properly position the dual hot wedge welder so that both surfaces to be joined come into intimate contact with the welder anvil. Only use apparatus equipped with a thermometer that reads the machine welding temperature. Verify temperature readings regularly or as directed by the Engineer. Set temperature controllers according to sheet thickness, ambient temperature, and rate of travel, and adjust as necessary based on results of test welds. Where necessary, use a temporary support surface between the geomembrane and the subgrade.
      b. Extrusion Welding: After surface preparation has been completed, position the geomembrane sheets, and tack them with a hot air welder to maintain proper

alignment and intimate contact between sheets. No heat distortion on the surface of the upper sheet shall be evident. Use welders equipped with a functioning temperature controller that displays the temperature in the extrusion barrel. Set temperature controllers and adjusted as necessary, based on results of test welds. The extrudate thickness shall be approximately 2 times the geomembrane thickness as measured from the top of the lower sheet to the top of the extrudate. Where fillet welds are temporarily terminated, grind surface prior to application of new extrudate over the existing seam. Visible bubbles or pock marks in the weld are not allowed.

E. Repairs:
   1. Perform all repairs as specified or as acceptable to the Engineer. Non-destructively test all repairs. Grinding and re-welding is not an acceptable method of repair, unless approved by the Engineer.
   2. Fabricate repair patches using the same thickness and type geomembrane and have rounded corners. Size patches to extend a minimum of 6 inches in all directions beyond defect. Clean surfaces to be welded, removing dirt, debris, and moisture. Use extrusion welding to affix patch.
   3. Repair fishmouths or folds of the geomembrane by cutting along the top ridge. Once the ridge is cut, the lay the sides flat. Where the overlap is greater than 3 inches length, repair by seaming. Where the overlap is 3 inches or less, repair by patching.
   4. Repair small holes, less than or equal to 1/4" diameter, and cuts by extrusion welding. Clean surfaces to be welded, removing dirt, debris, and moisture. Repair by extruding a resin strip over the defect. Repair holes or cuts larger than 1/4" in diameter by patching.
   5. Repair scratches on the surface of the liner which have a depth less than 10 percent thickness of geomembrane sheet by extruding a resin strip over the defect. Repair scratches which have depth greater than 10 percent of the geomembrane thickness with a patch or cap strip.
   6. Repair or replace defects to the geomembrane surface such as creases or stress from rough subgrade as directed by the Engineer.

3.06 QUALITY CONTROL DURING INSTALLATION

A. Test Welds:
   1. Perform test welds to verify equipment settings at ambient conditions to maintain the integrity of the field seams.

B. Test Weld Frequency:
   1. At the beginning of each 4-hour seaming period perform test welds each welding machine and its operator Perform additional test welds if a new operator begins seaming, a breakdown of the welding equipment occurs, seaming has been suspended for more than 60 minutes prior to resuming seaming operations, or upon direction by the Engineer.

C. Size and Distribution Test Weld Sections:
   1. The test weld a strip at least 5 feet, measured along the length of the seam, and with a width which extending a minimum of 12 inches on either side of the seam. Perform the test weld under the same conditions that will exist for seaming of the geomembrane sheet. Divide the test weld strip into 2 equal sections. Label each section with date of test weld, welding machine identification, operator, and ambient temperature. One section will be retained by the installer for field-testing and one section given to the Engineer to archive.

D. Pass/Fail Criteria:
   1. Cut 5 coupons each 1.0 inch wide across the seam of the sample section using a template. Test 3 coupons in peel orientation and 2 in shear orientation. Test all samples in the field tensiometer with a pull rate of 20 inch per minute.
      a. Shear Strength:
         1) Samples tested in shear shall register not less than 90% of parent material.
      b. Peel Adhesion:
         1) Samples tested in peel shall register not less than 60% of parent material or 70% of specified yield stress value, whichever is greater.
      c. Break Code:
         1) All sample shear and peel test must exhibit passing locus-of-break codes. Locus-of-break codes are defined by ASTM D6392.
         2) Passing locus-of-break codes by seam welding procedure are:
            (a) Hot Wedge Weld: BRK, SE1, SE2, AD-BRK less than or equal to 25 percent, and SIP.
            (b) Extrusion Weld: AD-WLD when minimum seam strength is achieved, SE1, SE2, SE3, BRK1, BRK2, AD-BRK, HT, and SIP.
            (c) If the seam fails to pass the seaming apparatus cannot be used for seam fabrication until the deficiency has been corrected. Verify the correction by the production and successful testing of 2 consecutive series of test welds.

E. Parent Material:
   1. Parent material references the yield strength from the lesser test of materials on either side of the seam established by testing 1-inch-wide coupons from each side of the seam. All samples shall be cut in the direction perpendicular to the seam.
   2. Alternatively, parent material yield strength may be defined as the average of all tensile tests obtained through manufacturer quality control data and the quality assurance conformance testing performed on the actual geomembrane material designated for installation.

F. Non-Destructive Testing:
   1. Non-destructively test all seams, all geomembrane penetrations, and all repairs to verify integrity. Perform non-destructive testing concurrently with installation. Test prefabricated field seams that will be inaccessible after installation, such as those under structures, as specified below.

G. Vacuum Testing:
   1. Perform vacuum testing on all extrusion welded seams and areas of dual hot wedge welded seams which cannot be isolated using air pressure testing in accordance with ASTM D5641. In addition, vacuum test the repairs to holes created during air pressure testing. Apply a sudsy solution to the section of seam being tested and place the vacuum box over the section. Apply suction and visually examine the vacuum box for 10 to 15 seconds at 3-psi vacuum to determine whether bubbling of the soapy solution is occurring. The vacuum box is then repositioned and the process is repeated on the adjacent section. Maintain a minimum 3-inch overlap between test sections. With a high visibility paint clearly mark all locations where bubbling of the sudsy solution is observed for repairs. Repair and retest any failed portion of seam.

H. Air Pressure Testing:
   1. Perform air pressure testing of all seams developed by the dual hot wedge welder. Establish continuity along the entire length of seam by sealing off one end of the seam, and pumping air into the channel. Inspect the opposite end of the seam to ensure that

air is passing through it. Seal the open ends of the channel, insert a manometer and pump air into the channel until the test pressure range is established. Allow the pressure in the channel to stabilize with the ambient temperature prior to starting the test. Once the pressure has stabilized, take an initial reading of the pressure in the channel. Observe and record the decrease in pressure on the manometer after 5 minutes to verify the continuity of the air channel then release the pressure by slitting the air channel at the opposite end of the seam.

Nominal Geomembrane Thickness	Test Pressure Range	5-Minute Pressure Drop
30 mil	15 psi to 25 psi	5.0 psi
40 mil	20 psi to 30 psi	4.0 psi
60 mil	25 psi to 35 psi	3.0 psi
80 mil	25 psi to 35 psi	2.0 psi

2. Reject the seam if a pressure drop greater than allowable is observed or if the required pressure cannot be reached. Identify, repair, and retest all faulty areas along the seam.

I. Pipe Boot Testing:
   1. Test pipe boots that surround penetrations through the liner in the presence of the GCQA Representative. Use vacuum test to evaluate the extrusion welds along the new flange where it is attached to the geomembrane liner. Perform the vacuum test in accordance with Paragraph 3.06G where pipe boot has been extrusion welded to the geomembrane. Repeat repair and test until no leaks are evident.

J. Visual Inspection:
   1. Clean the geomembrane surface so it is free of dust, mud, debris, or any other material that may inhibit a thorough visual examination of the surface. Examine the entire geomembrane surface, including all seams, repairs, and patches to confirm that it is free of any defects, holes, blisters, creases, scratches, undispersed raw materials, contamination by foreign matter, signs of injury from installation, penetration from foreign objects, or stresses induced by a rough subgrade. Clearly mark any areas requiring repair. Repaired or replace to the satisfaction of the Engineer.

K. Destructive Testing:
   1. Verify the physical properties of the geomembrane field seams by removing and laboratory testing samples of the seams. Concurrently sample and test while seaming so that laboratory verification of field seam properties is made as the Work progresses and to ensure that corrective action is taken as soon as possible. Repair the area from which the destructive test sample is taken in accordance with the procedures given in Paragraph 3.05E and non-destructively test the repair with procedures specified.
      a. Frequency of Destructive Tests:
         1) Take samples at locations directed by the Engineer at a frequency of 1 per 1,000 linear feet of seam. Increase the frequency of destructive testing at the direction of the Engineer based on the results of previous testing, weather conditions, faulty seaming equipment, or any other reason in which the quality of the seam would be affected.
      b. Size and Distribution of Samples:
         1) The destructive test sample strip size is at least 45-inches measured along the length of the seam and a width extending a minimum of 9 inches on either side of the seam. Divide the sample strip into three 15-inch-long sections and distributed as follows: one to installer for field testing, one to Engineer to archive, one to GCQA Representative for laboratory testing. Label each

sample with date, location of sample, orientation with respect to machine direction, welding machine identification, and operator.

c. Laboratory Testing Methods:
   1) Cut and test ten 1-inch coupons from the sample sent to the laboratory; test 5 seam coupons for shear, and 5 seam coupons for peel. Additionally, two coupons will be taken from each side, to determine parent material strength. Perform shear and peel tests in accordance with ASTM D6392. Test both tracks of dual hot wedge seams.
d. Pass/Fail Criteria for Laboratory Testing:
   1) Pass/fail criteria for the tests must conform to the following. Repair seams failing laboratory testing as outlined in Paragraph 3.05E.
e. Shear Strength:
   1) 4 of 5 samples tested in shear shall register not less than 90% of parent material. The failing sample shall register greater than 50% of parent material.
f. Peel Adhesion:
   1) 4 of 5 samples tested in peel shall register not less than 60% of parent material or 70% of specified yield stress value, whichever is greater. The failing sample shall register greater than 50% of parent material.
g. Break Code:
   1) All shear and peel test Samples must exhibit passing locus-of-break codes. Locus-of-break codes are defined by ASTM D6392. Passing locus-of-break codes by seam welding procedure are:
      (a) Hot Wedge Weld: BRK, SE1, SE2, AD-BRK less than or equal to 25 percent, and SIP.
      (b) Extrusion Weld: AD-WLD when minimum seam strength is achieved, SE1, SE2, SE3, BRK1, BRK2, AD-BRK, HT, and SIP.
      (c) For purpose of laboratory testing of field seams, parent material references the yield strength from the lesser test of materials on either side of the seam established by testing 1-inch-wide coupons from each side of the seam by ASTM D-638. All samples shall be cut in the direction perpendicular to the seam.
      (d) Alternatively, parent material yield strength may be defined as the average of all tensile tests obtained through manufacturer quality control data and the quality assurance conformance testing performed on the actual geomembrane material designated for installation.
h. Failed Tests:
   1) In the event of a non-passing destructive test, take 2 additional destructive test samples approximately 10 feet on either side of the failed test location. Test the samples with the field tensiometer in both shear and peel. If one or both of these samples fail the field-testing, continue tracing along the seam at 10 feet increments until a passing result is recorded on each side of the failed test location.
   2) At these locations take samples for laboratory testing in accordance with the procedures described above. If laboratory testing shows the seam to be unacceptable, further trace the unacceptable seam until acceptable laboratory test results are recorded in both directions. Place a cap strip over the entire length of failed seam and 100 percent non-destructively tested.
   3) Non-destructively test reconstructed seams less than 150 feet in length in accordance with Paragraph 3.06B. Destructively test reconstructed seams greater than 150 feet in length in accordance with requirements contained herein.
   4) Each day record the temperature readings taken in the field, describe the Work being performed, document the total square footage of membrane,

document the linear footage of seam installed each day, and outline results of all testing. Document the welding machine temperatures and speeds and record locations and identification of all panels, field seams, and destructive test Samples on the Record Drawing panel layout plan. Coordinate the numbering sequence of the panels in the field with the numbering of the rolled goods as stated on the QC certificates.

3.07 COLD WEATHER PLAN FOR SEAMING PROCEDURES

A. General: When the recorded temperature falls below 32 degrees F, implement the additional procedures specified.

B. Temperature Constraints Below 32 degrees F:
   1. Increase the frequency of ambient temperature readings to once per hour.
   2. Do not perform seaming if the recorded temperature is below 5 degrees F.

C. Test Welds:
   1. In addition to required test welds, perform at least 1 additional test weld each day.
   2. Perform additional test welds if the recorded temperature increases or decreases by 10 degrees F or if an increase in wind speed of over 10 mph is observed since the production of the previous test weld. Complete the seam in progress before performing another test weld.
   3. Test weld length for dual hot wedge seaming required increased to 15 feet.

D. Site and Surface Preparation:
   1. The use of movable enclosure to protect the area of seaming is at the discretion of the installer with the approval of the GCQA Representative.
   2. Remove all snow or ice from the areas to be seamed. Use of sharp or metal tools is prohibited. Use plastic shovels and brooms whenever possible. All snow and ice removal procedures must be approved by the GCQA Representative.
   3. Remove all frost from the opposing surfaces of the geomembrane in the region where seaming is to be performed. Dry the area to be seamed after removing frost. A hand-held hot air device may be used to remove frost and moisture if the procedure is successfully demonstrated.
   4. At temperatures below 20 degrees F, apply hot air preheat 6 to 12 inches in front of the welding apparatus. On a test weld demonstrate that this procedure can produce a quality seam.

E. Additional Testing:
   1. Perform additional field testing of a 6-inch length destructive sample removed from the end of each continuous production seam applying test welds Pass/Fail criteria.

3.08 PROTECTION OF GEOMEMBRANE

A. Provide covering of the geomembrane with subsequent soil layers as soon as possible in order to prevent damage to installed, exposed, geomembrane surfaces.

B. Place soils above the geomembrane using procedures to prevent geomembrane surface damage, stress, tension, movement, folding over, or cause other damage to the geomembrane and its seams. Immediately report any damage resulting from these operations to the Engineer.

C. Except as provided, maintain 1-foot minimum cover above the geomembrane for low ground pressure tracked vehicles, and 3-foot minimum cover for wheeled vehicles or heavy

tracked vehicles. Low ground pressure tracked vehicles have contact pressure of 8-psi or less. Heavy tracked vehicles are considered having ground contact pressures above 8-psi.

D. On slopes flatter than 15 percent grade, the soil cover above the geomembrane proceed in a direction aligning with the shingling of the geomembrane seam overlaps. On slopes steeper than 15 percent grade proceed soil cover placement from the bottom of the slope upward.
   1. All-Terrain Vehicle (ATV): The use of an ATV to deploy geosynthetics is acceptable within specified conditions. Any misuse of the ATV observed by the Owner or Engineer will result in the immediate termination of the ATV. The adhere to the following conditions regarding the use of an ATV for geosynthetic materials deployment:
      a. Prohibit turning of the ATV while traversing over any deployed geosynthetic material.
      b. Prohibit fast braking, except in emergencies related to worker or construction safety, on any deployed geosynthetic material.
      c. Prohibit bouncing or other potential impacts of the ATV on any deployed geosynthetic material.
      d. Limit the operation of the ATV to 1 installer employee with 1 employee as an alternate operator.
   2. When indicated by the Drawings, place the crushed stone drainage layer and piping systems on the surface of the geomembrane in such a manner to prevent any geomembrane damage. Immediately report any damage resulting from these operations to the Engineer.

END OF SECTION

SECTION 31 37 00
RIPRAP

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This work item shall consist of hauling, loading, and placing suitable riprap material in areas designated on the Construction Drawings.

B. Riprap shall consist of a revetment composed of stone or fragmented rock placed as a protective and erosion-resistant covering on the slopes of embankments, dikes, or streambanks (not streambeds), at culvert inlets and outlets, on bottoms and side slopes of channels, at abutment wings, at structure foundations, and in accordance with the lines, grades, and thicknesses shown on the Construction Drawings or established by the Atlantic Richfield Company Representative.

C. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-03 Product Data:
      a. Supplier's name and quarry location.

PART 2 - PRODUCTS

A. General: Stone shall be hard, durable, angular in shape, resistant to weathering and to water action, free from overburden, spoil, shale, structural defects, and organic material, and shall meet the gradation requirements for the class specified. Neither breadth nor thickness of a single stone shall be less than one third its length. Rounded stone or boulders from a stream bed source will not be accepted. Shale or stone with shale seams is not acceptable.

2.02 RIPRAP

A. The type of material used for riprap shall be as shown on the Construction Drawings. The sizes of material for the different types and thicknesses and the range of gradation shall be as follows:

TABLE 1 RIPRAP CLASS GRADATIONS[1]			
Class	**Weight of Stone (pounds)**	**Equivalent Spherical Diameter[2] (feet)**	**% Of Total Weight That Must Be Smaller Than Given Size**
I	100 60 25 2	1.05 0.88 0.66 0.27	100 70-90 40-60 0-10
II	700 500 200 20	2.00 1.79 1.32 0.61	100 70-90 40-60 0-10
III	25 11 3 0.5	0.67 0.50 0.33 0.167	100 50 15 0
IV	15 2 -	0.5 0.25 0.083	100 50 10

Based on unit weight of 165 pounds per cubic foot.

B. Additional Requirements:
   1. Cover Riprap shall conform to:
      a. Specific Gravity Requirements: Specific Gravity is a measure of the rock Density (ASTM C127). The rock surface shall have a bulk specific gravity (saturated, surface dry) of 2.4 or greater.
      b. Absorption Requirements: Absorption is a measure of rock porosity (ASTM C127). The rock shall have an absorption value of 3 percent or lower.
      c. Los Angeles Abrasion Requirements: The Los Angeles Abrasion test is an indicator of hardness and structural soundness (ASTM C535). The rock shall have a test value of 40 percent or less for 500 revolutions.
      d. Sodium Sulfate Soundness Requirements: Sodium Sulfate Soundness test is an indicator of durability against disintegration (AASHTO T104-94). The rock shall have a test value of 15 percent loss or less for five cycles.
   2. Channel Lining Riprap shall conform to:
      a. Specific Gravity Requirements: Specific Gravity is a measure of the rock Density (ASTM C127). The rock surface shall have a bulk specific gravity (saturated, surface dry) of 2.5 or greater.
      b. Absorption Requirements: Absorption is a measure of rock porosity (ASTM C127). The rock shall have an absorption value of 2 percent or lower.
      c. Los Angeles Abrasion Requirements: The Los Angeles Abrasion test is an indicator of hardness and structural soundness (ASTM C535). The rock shall have a test value of 35 percent or less for 500 revolutions.
      d. Sodium Sulfate Soundness Requirements: Sodium Sulfate Soundness test is an indicator of durability against disintegration (AASHTO T104-94). The rock shall have a test value of 12 percent loss or less for five cycles.
   3. Bedding: Where specified on the Drawings, aggregate bedding material shall be Type E or Type F riprap filter bedding material as specified in Section 31 38 00 – Granular Fill Material.

4. Grout Cement grout shall conform to American Concrete Institute requirements and meet the following:
    a. Strength: 2,000 – 2,5000 psi.
    b. Cement shall be Type V or Equivalent as specified in Section 03 31 00 – Structural Concrete.
    c. Aggregate: American Society for Testing and Materials (ASTM) C-33 Fine Aggregate with a maximum aggregate size of ¾ inch.
    d. Slump: 4 to 6 inches.
    e. Air Entrainment: 5 to 7%.
5. Aspect Ratio: The maximum aspect ratio (greatest dimension: least dimension) of any piece of rock for size ranges shall be not greater than 3:1 when measured across mutually perpendicular axis. Not more than 25 percent (25%) of the stones within a gradation range shall have an aspect ratio greater than 2.5:1. A maximum of 10 percent flat and elongated pieces by weight will be acceptable. A flat and elongated piece of riprap is defined as having a ratio of width to thickness or length to width greater than 3:1.
6. Chemical Contamination Requirement: All riprap shall be free from contamination by heavy metals in accordance with the Waste Identification Criteria outlined in Section 02 11 10 – Excavation and Handling.

PART 3 - EXECUTION

3.01 BASE PREPARATION

A. Areas on which riprap is to be placed shall be graded and/or dressed to conform to cross sections shown on the Contract Drawings within an allowable tolerance of plus or minus 3 inches from the theoretical lines and grades. The prepared base shall be approved by the Atlantic Richfield Company Representative. Where such areas are below the allowable minus tolerance limit, they shall be brought to grade by fill with earth similar to the adjacent material and then compacted to a density equal to the adjacent in place material.

3.02 HAND-LAID RIPRAP

A. In the case of hand laid riprap, each stone or fragment shall not be less than 3 inches thick or contain less than 1/2 cubic foot in volume or weigh less than 75 pounds, except for rock spalls. All stones and fragments shall extend through the revetment, with the exception of spalls used to chock the larger stones solidly in position and to substantially fill voids between the major stones.

B. A trench of the design and dimensions shown on the Construction Drawings shall be excavated along the toe of the slope to a stable foundation or carried to a point below scour, but in no case less than 2 feet below the toe of the slope. A course consisting of the largest stone shall be placed in the trench. The angle of repose of the material shall not be less than the angle of the slope to be protected.

C. The stones shall be placed with their beds at right angles to the slope and, so far as practicable, the larger stones shall be used in the lower courses. They shall be laid in close contact so as to break joints and so placed that each stone will rest on the slope of the embankment and not wholly on the stone beneath it. The spaces between the stones shall be filled with smaller stones or fragments and securely rammed into place. Ends of riprap walls shall be keyed into the earth or embankment slopes a minimum of 24 inches from the outer face of the riprap for the full height of the riprap wall. The finished work shall present an even, tight, and reasonable plane surface varying not more than 3 inches from the general contour of the revetment.

D. Where hand-laid riprap thickness is not shown on the Construction Drawings, it shall be at least 12 inches measured perpendicular to the slope.

3.03 PLACEMENT OF RIPRAP

A. Placement shall begin at the bottom of the area to be covered and continue up slope. Subsequent loads of material shall be placed against previously placed material in such a manner as to ensure a relatively homogenous mass. The large stones shall be well distributed and the entire mass of stones in their final position shall be graded to conform to the gradation specified. The finished riprap shall be free from objectionable pockets of small stones and clusters of larger stones. The rock shall be manipulated by hand or machine methods sufficiently to secure a regular surface and mass stability. Placing riprap in layers will not be permitted. Placing riprap by dumping it into chutes, or by similar methods likely to cause segregation of the various sizes, shall not be permitted. Placing riprap by dumping it at the top of the slope and pushing it down the slope shall not be permitted. Riprap shall be placed to its full course thickness in one operation and in such manner as to avoid displacing the bedding material.

B. Riprap shall be placed within the limits shown on the Construction Drawings. A tolerance of plus or minus 3 inches from the slope lines and grade on Construction Drawings will be allowed in the finished surface of the riprap except that the extreme of this tolerance shall not be continuous over an area greater than 1,000 square feet.

C. Placement Around Pipe Openings: When riprap is specified for placement around pipe openings, special care shall be taken in placing and handling. Manipulation of individual rocks during placement of riprap shall be required as determined by the Atlantic Richfield Company Representative. Pipe that is damaged shall be repaired or replaced at no expense to Atlantic Richfield Company.

D. Placement for Bank Protection: When bank protection riprap is specified, the inclusion of rock spalls or gravel will be required in a quantity not in excess of that required to fill the voids in the material, as determined by the Atlantic Richfield Company Representative. Riprap shall be fee from overburden spoil, shale, structural defects, and organic material.

END OF SECTION

SECTION 31 38 00
GRANULAR FILL MATERIAL

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required to obtain and install materials from either an offsite source or Atlantic Richfield Company provided source for gravel materials.

B. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
   1. ASTM International (ASTM):
      a. ASTM C 127 - Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.
      b. ASTM C 128 - Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate.
      c. ASTM C 136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
      d. ASTM D 422 - Particle-Size Analysis of Soils.
      e. ASTM E 11 - Wire Cloth and Sieves for Testing Purposes.
   2. Montana Department of Transportation (MDT):
      a. Standard Specifications for Road and Bridge Construction, Section 701 Aggregates.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-05 Test Reports:
      a. Gravel Gradation:
         1) Drain Aggregate.
         2) Structural Fill.
         3) Pipe Bedding:
            (a) Type 1.
            (b) Type 2.
         4) Capillary Break Material.

1.04 WEATHER LIMITATIONS

A. Crushed rock materials shall not be installed when the atmospheric temperature is less than 35 degrees F unless approved by the Atlantic Richfield Company Representative. Crushed rock materials shall not be installed on subgrades that are frozen or contain frost. If the temperature falls below 35 degrees F, completed areas shall be protected against any detrimental effects of freezing.

1.05 STOCKPILING MATERIALS

A. Materials shall be stockpiled in the manner and at locations designated on the Construction Drawings or as approved by the Atlantic Richfield Company Representative. Before stockpiling of material, storage sites shall be cleared, and sloped to drain. Differing materials and materials obtained from different sources shall be stockpiled separately.

1.06 SAMPLING AND TESTING

A. The following sampling and testing requirements outlined below are only required for CMGC provided materials provided from an off-site source.

1.07 GENERAL REQUIREMENTS

A. Sampling and testing shall be performed by an approved commercial testing laboratory or by facilities furnished by the CMGC. No work requiring testing shall be permitted until the facilities have been inspected and approved. All inspections shall be at the expense of the CMGC.

1.08 TEST RESULTS

A. Results shall verify that materials comply with this specification. When deficiencies are found, the initial analysis shall be repeated, and the material already placed shall be retested to determine the extent of unacceptable material. All in-place unacceptable material shall be replaced or modified to meet specification requirements.

1.09 SIEVE ANALYSIS

A. Before starting work, at least one sample of material shall be tested at the material source in accordance with ASTM C 136 and ASTM D 422 on sieves conforming to ASTM E 11. For each type of granular material listed in Paragraph 2.01, testing shall be conducted at a frequency of one test per 3,000 cubic yards of material.

PART 2 - PRODUCTS

2.01 MATERIALS

A. When material is produced at an Atlantic Richfield Company provided borrow source, the Atlantic Richfield Company Representative may approve a material product similar to the required gradations specified in this Section provided the CMGC can show reasonable effort to achieve the specified gradation and the ability to produce such a material consistently. Specified gradations have been previously tested and approved for use. CMGC utilizing existing Atlantic Richfield Company stockpile materials will not be required to test these materials prior to use. All deviations from specifications listed below must be approved by the Atlantic Richfield Company Representative.

B. Gravel Aggregates:
   1. General: Gravel material shall be durable and sound, free from lumps of clay, organic matter, objectionable coatings, and other foreign material. Material retained on a No. 4 sieve shall be known as coarse aggregate and that passing the No. 4 sieve shall be known as binder material. Gravel fill shall be used as indicated on the Construction Drawings.

2. Drain Aggregate:

Gravel Gradation – Drain Aggregate

Sieve Size	Percent Passing
6-inch	100
¾-inch	0-10
No. 4	0-5

3. Structural Fill:

Gravel Gradation – Structural Fill

Sieve Size	Percent Passing
3-inch	100
No. 4	25-60
No. 40	10-30
No. 200	2-10

4. Pipe Bedding Material:
   a. Type I Pipe Bedding:
      1) Type 1 Pipe Bedding includes the material placed from 4 inches (100mm) below the bottom of the pipe, around the pipe, and up to the springline of the pipe.
      2) Provide Type 1 Bedding consisting of sand, sandy gravel, or gravel having a maximum 3/4 inch size (19mm) and a maximum plasticity index of 6, determined by AASHTO T89 and T90 or by ASTM D4318.
      3) Where trench excavation encounters wet or unstable material, Type 1 Pipe Bedding must be free draining and non-plastic.
   b. Select Type I Bedding:
      1) Select Type 1 Bedding includes the material placed from the springline of the pipe to 6 inches (15cm) over the pipe.
      2) Select Type I Bedding shall consist of soil, sand or fine gravel, free from clods, lumps of frozen material, or rock exceeding 1-1/2 inches (38mm) in its greatest dimension.
      3) Excavated trench material may be screened or sorted for use as backfill subject to approval of the Atlantic Richfield Company Representative.
      4) Where trench excavation encounters wet or unstable material, Select Type 1 Bedding must be free draining and non-plastic.
   c. Type 2 Pipe Bedding:
      1) Type 2 Pipe Bedding is used as directed by the Engineer to replace unsuitable material encountered in the trench bottom.
      2) Place Type 2 Pipe Bedding from the bottom of the Type 1 Bedding material to the depth required to adequately support the pipe.
      3) Type 2 Bedding shall consist of granular material meeting the following gradation:

Gravel Gradation – Type 2 Pipe Bedding

Sieve Size	Percent Passing
3-inch	100
No. 4	0-25
No. 40	0-10

5. Capillary Break Material:
   a. Natural sand having hard, strong, durable particles consistent with the MDT specification for Fine Aggregate for Concrete and meeting the following gradation:

Gravel Gradation – Capillary Break Material

Sieve Size	Percent Passing
3/8-inch	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	5-30
No. 100	0-10
No. 200	0-3

   b. Alternatives to the MDT Fine Aggregate for Concrete meeting the following requirements may be placed as a capillary break upon approval of the Atlantic Richfield Company Representative:
      1) Durable, non-carbonate, natural aggregate.
      2) Non-plastic and without gap grading (i.e., no sharp breaks in the gradation line curvature indicating absence of certain particle sizes).
      3) Material is classified as SP or SW per Unified Soil Classification System (UNCS).
      4) Maximum percent (by weight) of clay lumps and friable particles (per AASHTO T 112): 3%.
      5) Maximum particle diameter: 9.5 mm.
      6) Maximum percent passing the No. 200 (0.075 mm) sieve: 5%.
      7) Maximum particle diameter where 15 percent of material is finer: 0.7 mm.
      8) Minimum particle diameter where 10 percent of material is finer: 0.15 mm.

PART 3 - EXECUTION

3.01 PREPARATION OF UNDERLYING COURSE AND PLACEMENT OF GRANULAR FILL

A. General Requirements: Areas where granular fill material is required shall be graded and/or dressed to conform to lines and grades shown on the Construction Drawings. Prior to the placing of granular fill material, the surface of underlying subgrade, sub-base or base course shall be bladed smooth and shaped to the cross section as shown on the Construction Drawings. No granular fill material shall be placed upon wet or muddy subgrade or sub-base. The granular fill material shall be placed in successive horizontal layers of not more than 12-inch lifts in loose depth. Each layer shall be compacted to a firm and unyielding surface utilizing vibratory compaction equipment prior to placing the overlaying lift. All areas shall be compacted to provide a stable, uniform surface. Compaction requirements are provided in Section 31 00 00 - Earthwork and/or shown on the Construction Drawings.

B. Grade Control: Underlying material shall be excavated to sufficient depth so that the finished stabilized course with any subsequent course will meet the fixed grade. Finished and completed course shall conform to the lines, grades, cross section, and dimensions indicated on the Construction Drawings. If the thickness of placed granular fill is greater than specified, including allowed tolerances, no payment will be made for the additional thickness and the CMGC will have the choice of modifying the finish grade.

3.02 COMPACTION REQUIREMENTS

A. Field moisture and density testing is the responsibility of the CMGC and will be performed at the CMGC's expense to ensure that specified moisture and density are being obtained. Density testing will be run at a minimum rate of 1 test for each 300 linear feet of roadway or pipe trench or 1 test for each 1,000 square yards for other areas according to Section 31 00 00 – Earthwork.

B. The compaction process including water and number of passes shall be recorded and applied throughout construction as a level of performance-based criterion for compaction.

C. Throughout the construction process the Atlantic Richfield Company Representative may, at his discretion, require re-verification of compaction, if any area is revealed to have deficient compaction.

END OF SECTION

SECTION 31 66 15
HELICAL FOUNDATION PILES

PART 1 - GENERAL

1.01 SUMMARY

A. Description: Provide helical pile foundation where indicated on the Drawings including all materials, tools, equipment and labor required for the design, preparation, shop fabrication, shipping, supervision and installation in accordance with this Specification, the Drawings and applicable reference standards listed in Article 1.02.

B. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 REFERENCES

A. Reference Standards:
   1. American Concrete Association (ACI):
      a. ACI 318 - Building Code Requirements for Structural Concrete.
   2. American Institute of Steel Construction (AISC):
      a. AISC 360 - Specification for Structural Steel Buildings.
   3. American Society for Testing and Materials (ASTM):
      a. ASTM A29 - Steel Bars, Carbon and Alloy, Hot-Wrought and Cold Finished.
      b. ASTM A36 - Structural Steel.
      c. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
      d. ASTM A153 - Zinc Coating (Hot Dip) on Iron and Steel Hardware.
      e. ASTM A193 - Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service.
      f. ASTM A252 - Welded and Seamless Steel Pipe Piles.
      g. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
      h. ASTM A500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
      i. ASTM A513 - Standard Specification for Electric Resistance Welded Carbon and Alloy Steel Mechanical Tubing.
      j. ASTM A572 - HSLA Columbium-Vanadium Steels of Structural Quality.
      k. ASTM A618 - Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing.
      l. ASTM A656 - Hot-Rolled Structural Steel, High-Strength Low-Alloy Plate with Improved Formability.
      m. ASTM A775 - Electrostatic Epoxy Coating.
      n. ASTM A1018 - Steel, Sheet and Strip, Heavy Thickness Coils, Hot Rolled, Carbon, Structural, High-Strength Low-Alloy, Columbium or Vanadium, and High-Strength Low-Alloy with Improved Formability.
      o. ASTM D1143 - Method of Testing Piles Under Static Axial Compressive Load.
      p. ASTM D3689 - Method of Testing Individual Piles Under Static Axial Tensile Load.
   4. American Welding Society (AWS):
      a. AWS D1.1 - Structural Welding Code – Steel.
      b. AWS D1.4 - Structural Welding Code – Steel Reinforcing Bars.

5. Society of Automotive Engineers (SAE):
    a. SAE J429 - Mechanical and Material Requirements for Externally Threaded Fasteners.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 QUALITY CONTROL

A. Installer Qualifications: Installation shall be performed by an installation contractor authorized by helical pile manufacturer.

B. All helical piles shall be installed in the presence of a designated representative of Atlantic Richfield Company unless said representative informs the CMGC otherwise. The designated representative shall have the right of access to any and all field installation records and test reports.

C. Welding: Meet requirements of AWS D1.1 and/or D1.4, latest edition(s). All welders shall be AWS certified.

1.05 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
    1. SD-01 Preconstruction Submittals:
        a. At least four weeks prior to the start of helical pile construction, the CMGC shall submit a project reference list to the Engineer (Woodard & Curran) for approval. The reference list shall be used to verify the successful completion by the CMGC of at least three separate foundation projects within the last five years with helical piles and similar subsurface conditions. A brief description of each project and a contact person's name and current phone number shall be included for each project listed.
        b. At least 14 calendar days prior to the start of pile installation, the CMGC shall prepare and submit to the Engineer and Geotechnical Engineer, working drawings and design calculations for the helical piles intended for use based on the subsurface conditions encountered at the site, the applicable Building Code, the structural loads provided in the Drawings, the requirements of this Specification, and the recommendations included in the Geotechnical Engineering Report.
            1) Design criteria include the following:
                (a) Compression: Allowable working load shall not exceed 0.6*Fy*A where Fy is yield strength of central shaft and A is area of central shaft.
                (b) Tension: Allowable working load shall not exceed Sut/2. Sut is minimum ultimate tensile strength of central shaft (at coupling joint).
                (c) Except where noted otherwise on the project plans, all helical piles shall be designed and installed to provide a minimum safety factor for ultimate applied load of FS = 2.0 and a maximum axial displacement at working load of 1 inch.
                (d) The overall length and installed torque of a helical pile shall be specified such that the required in-soil capacity is developed by end-bearing on the helix plate(s) in an appropriate strata(s). Required soil parameters are available in the geotechnical report.
                (e) Lateral Load and Bending: Where indicated on Drawings, helical piles are subjected to lateral loads. The bending moment from these loads shall be determined using lateral load analysis program such as LPILE or equal

commercially available software. The required soil parameters for use with LPILE or equal are available in the geotechnical report. Allowable deflection due to lateral working load is 1 inch. The combined bending and axial load factor of safety of the helical pile shall be FS = 2.0.

(f) Down-Drag/Negative Skin Friction: For helical shafts > 4 inches in diameter used in compressible soils or where expansive or frozen soils can cause pile jacking, helical pile shafts should be provided with a no-bond zone along a specified length to prevent load transfer that may adversely affect pile capacity. Alternately, helical piles can be provided with sufficient axial load capacity to resist down-drag/negative skin friction forces.

(g) The helical pile structure attachment (pile cap) shall distribute the design load to the pile cap such that the concrete bearing stress do not exceed those in ACI 318 and the stresses in the steel plates/welds does not exceed AISC allowable stresses.

(h) Corrosion Protection: Galvanized full length. See Article 2.07.

2) The working drawings shall include the following:

(a) Helical pile number, location and pattern by assigned identification number.

(b) Helical pile design load and required safety factor.

(c) Type and minimum size of central steel shaft.

(d) Minimum number of helix plates.

(e) Minimum overall depth.

(f) Inclination angle of helical pile.

(g) Cut-off elevation.

(h) Helical pile attachment to pile caps, grade beams, etc.

(i) Detailed description of construction procedures and major equipment.

2. SD-02 Shop Drawings:
   a. At least 14 days prior to the start of drilled pier construction, the CMGC shall submit shop drawings for all helical pile components, including corrosion protection and pile top attachment to the Engineer for review and approval. This includes helical pile lead/starter and extension section identification (manufacturer's catalog numbers). Shop drawings shall include certified mill test reports, ultimate strength, yield strength, % elongation, and chemistry composition.
3. SD-03 Product Data:
   a. Manufacturer's Warranty:
      1) Submit, for Atlantic Richfield Company's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Atlantic Richfield Company may have under Contract Documents.
4. SD-05 Test Reports:
   a. The CMGC shall submit plans for production testing (where required) of the helical piles to the Engineer for review and acceptance prior to beginning load tests. The purpose of the test is to determine the load versus displacement response of the helical pile and provide an estimation of ultimate capacity.
   b. The CMGC shall submit to the Engineer copies of calibration reports for each torque indicator or torque motor and all load test equipment to be used on the project. The calibration tests shall have been performed within 6 months of the date submitted. Helical pile installation and testing shall not proceed until the Engineer has received the calibration reports. These calibration reports shall include but are not limited to, the following information:
      1) Name of project and Contractor.
      2) Name of testing agency.

3) Identification (serial number) of device calibrated.
4) Description of calibrated testing equipment.
5) Date of calibration.
6) Calibration data.

c. The CMGC shall submit to the Engineer copies of field test reports within 24 hours after completion of the load tests. These test reports shall include, but are not limited to, the following information:
1) Name of project and Contractor.
2) Name of Contractor's supervisor during installation.
3) Name of third party test agency.
4) Date, time and duration of test.
5) Location of helical pile by assigned identification number.
6) Type of test (i.e., tension or compression).
7) Description of calibrated testing equipment and test set-up.
8) Actual helical pile type and configuration – including lead section, number and type of extension sections (manufacturer's SKU numbers).
9) Steps and duration of each load increment.
10) Cumulative pile-head movement at each load step.
11) Comments pertaining to test procedure, equipment adjustments, or other relevant information.
12) Signed by third party test agency rep., registered professional engineer, or as required by local jurisdiction.

5. SD-06 Certificates:
a. At least 14 days prior to the start of drilled pier construction, the CMGC shall submit a list identifying the on-site supervisor(s) and operator(s) assigned to the project for review by the Engineer. A detailed summary of each individual's experience in helical pile construction should be included.

6. SD-07 Closeout Submittals:
a. The CMGC shall provide the Engineer copies of helical pile installation records. These records shall include, but are not limited to, the following information:
1) Name of project and Contractor.
2) Name of Contractor's supervisor during installation.
3) Date and time of installation.
4) Name and model of installation equipment.
5) Type of torque indicator used.
6) Location of helical pile by assigned identification number.
7) Actual helical pile type and configuration – including lead section (number and size of helix plates), number and type of extension sections (manufacturer's SKU numbers).
8) Helical pile installation duration and observations.
9) Total length of installed helical pile.
10) Cut-off elevation.
11) Inclination of helical pile.
12) Installation torque at one-foot intervals for the final 10 feet.
13) Comments pertaining to interruptions, obstructions, or other relevant information.
14) Rated load capacities.

B. All submittals shall be signed and sealed by a Registered Professional Engineer licensed in the State of Montana with a minimum of four years of experience as an engineer knowledgeable in helical pile foundation analysis and design.

C. Approvals: Work shall not begin until all the required pre-installation submittals have been accepted in writing by the Engineer. All procedural acceptances given by the Engineer shall not relieve the CMGC of the responsibility to satisfactorily complete the work.

1.06 HELICAL PILE PRECONSTRUCTION MEETING

A. A preconstruction meeting shall be held at least five working days prior to the CMGC beginning helical pile construction at the site to review construction procedures, schedule and required testing. At a minimum the CMGC, Engineer and Geotechnical Engineer shall attend the preconstruction meeting.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

1.08 WARRANTY

A. Manufacturer's 30-year warranty on materials and workmanship.

PART 2 - PRODUCTS

2.01 APPROVED MANUFACTURERS

A. Manufacturers:
   1. AB Chance.
   2. Pier Tech.
   3. Heli Pile.
   4. Equivalent products of other manufacturers may be considered should they exceed performance criteria of specified products on approval of Engineer. Requests for substitution will be reviewed, if submitted within 10 days after execution of CMGC's Contract, and include the respective manufacturer's technical literature for each product giving the name, generic type, descriptive information and certified test reports showing results to equal performance criteria as specified. No request for substitution shall be considered that would change the generic type of pile system specified.

2.02 CENTRAL STEEL SHAFT

A. The central steel shaft, consisting of lead sections, helical extensions, and plain extensions, shall be square shaft, round shaft or a combination of the two.
   1. Approved Materials:
      a. ASTM A29 hot-rolled round-corner solid steel bar, modified medium carbon steel (similar to AISI 1044), Minimum yield strength = 70 ksi (AB Chance SS5).
      b. ASTM A29 hot-rolled round-corner solid steel bar, High Strength Low Alloy (HSLA), low to medium carbon steel, Minimum yield strength = 90 ksi (AB Chance SS125, SS150, SS175, SS200, SS225).
      c. ASTM A500 or A513 structural steel tube or pipe, welded or seamless, minimum wall thickness = 0.203", Minimum yield strength = 50 ksi (AB Chance RS2875).
      d. ASTM A53, A252, A500 or A618 structural steel tube or pipe, semless or straight-seam welded, minimum wall thickness = 0.300" (schedule 80), Minimum yield strength = 50 ksi (AB Chance RS3500).
      e. ASTM A500 or A513 structural steel tube or pipe, seamless or straight-seam welded, minimum wall thickness = 0.337" (schedule 80), Minimum yield strength = 50 ksi (AB Chance RS4500).

f. For combination square/round shafts, approved materials above may be used with a welded adapter for the transition.

2.03 HELIX BEARING PLATE

A. Shall be hot-rolled carbon steel sheet, strip or plate formed on matching metal dies to true helical shape and uniform pitch. Bearing plate material shall conform to the following ASTM specifications.
   1. Approved Materials:
      a. ASTM A572, A1018 or A656, Minimum yield strength = 50 ksi, Minimum thickness = 3/8” (AB Chance SS5).
      b. ASTM A572, Minimum yield strength = 50 ksi, Minimum thickness = 3/8” (AB Chance SS125, SS1375).
      c. ASTM A656 or A1018, Minimum yield strength = 80 ksi, Minimum thickness = 3/8” (AB Chance SS150, SS175).
      d. ASTM A656 or A1018, Minimum yield strength = 80 ksi, Minimum thickness = 1/2” (AB Chance SS200, SS225).
      e. ASTM A36 or A572, Minimum yield strength = 36 ksi, Minimum thickness = 3/8” (AB Chance RS2875).
      f. ASTM A36, A572, A1018 or A656, Minimum yield strength = per requirements cited above, Minimum thickness = 3/8” (AB Chance RS2875).
      g. ASTM A572, Minimum yield strength = 50 ksi, Minimum thickness = 1/2” (AB Chance RS4500).

2.04 BOLTS

A. The size and type of bolts used to connect the central steel shaft sections together shall conform to the following ASTM specifications.
   1. Approved Bolts:
      a. For Square Shaft: 5/8” minimum diameter, ASTM A325 or A193 Grade B7.
      b. For Round Shaft: 3/4” minimum diameter, SAE J429 Grades 5 or 8.

2.05 COUPLINGS

A. For square shaft material, the coupling shall be formed as an integral part of the plain and helical extension material as hot upset forged sockets.

B. For round shaft material, the couplings shall either be formed as an integral part of the plain and helical extension material as hot forge expanded sockets, or as internal sleeve wrought steel connectors. The steel connectors can be either tubing or solid steel bar with holes for connecting shaft sections together.

2.06 PILE CAP

A. Depending on the application, the pile cap shall be a welded assembly consisting of structural steel plates and shapes designed to fit the pile and transfer the applied load. Structural steel plates and shapes for helical pile top attachments shall conform to ASTM A36 or A572 Grade 50.

2.07 CORROSION PROTECTION

A. Epoxy coating (if required in Drawings): the thickness of coating applied electrostatically to the central steel shaft shall be 7-12 mils. Epoxy coating shall be in accordance with ASTM A775. Bend test requirements are not required. Coupling bolts and nuts are not required to be epoxy coated.

B. Galvanization (if required in Drawings):
   1. Square Shafts: Hot-dipped or electrodeposited in accordance with ASTM A153 or B633 after fabrication.
   2. Round Shafts: Hot-dipped or electrodeposited in accordance with ASTM A153 or A123 or B633 after fabrication.

PART 3 - EXECUTION

3.01 PREPARATION

A. Prior to commencing helical pile installation, the CMGC shall inspect the work of all other trades and verify that all said work is completed to the point where helical piles may commence without restriction.

B. The CMGC shall verify that all helical piles may be installed in accordance with all pertinent codes and regulations regarding such items as underground obstructions, right-of-way limitations, utilities, etc.

C. In the event of a discrepancy, the CMGC shall notify the Engineer. The CMGC shall not proceed with helical pile installation in areas of discrepancies until said discrepancies have been resolved. All costs associated with unresolved discrepancies shall be the responsibility of the Engineer.

3.02 INSTALLATION EQUIPMENT

A. Shall be rotary type, hydraulic power-driven torque motor with clockwise and counter-clockwise rotation capabilities. The torque motor shall be capable of continuous adjustment to revolutions per minute (RPM's) during installation. Percussion drilling equipment shall not be permitted. The torque motor shall have torque capacity 15% greater than the torsional strength rating of the central steel shaft to be installed.

B. Equipment shall be capable of applying adequate down pressure (crowd) and torque simultaneously to suit project soil conditions and load requirements. The equipment shall be capable of continuous position adjustment to maintain proper helical pile alignment.

3.03 INSTALLATION TOOLING

A. Shall consist of a Kelly Bar Adapter and drive tools for square or round shaft used in accordance with manufacturer's written installation instructions.

B. A torque indicator shall be used during helical pile installation. The torque indicator can be an integral part of the installation equipment or externally mounted in-line with the installation tooling.
   1. Shall be capable of providing continuous measurement of applied torque throughout installation.
   2. Shall be capable of torque measurements in increments of at least 500 ft-lb.
   3. Shall be calibrated prior to pre-production testing or start of work. Torque indicators which are an integral part of the installation equipment, shall be calibrated on-site. Torque indicators which are mounted in-line with the installation tooling, shall be calibrated either on-site or at an appropriately equipped test facility. Indicators that measure torque as a function of hydraulic pressure shall be calibrated at normal operating temperatures.
   4. Shall be re-calibrated, if in the opinion of the Engineer and/or CMGC reasonable doubt exists as to the accuracy of the torque measurements.

3.04 INSTALLATION PROCEDURES

A. The helical pile installation technique shall be such that it is consistent with the geotechnical, logistical, environmental and load carrying conditions of the project.

B. The lead section shall be positioned at the location as shown on the working drawings. The helical pile sections shall be engaged and advanced into the soil in a smooth, continuous manner at a rate of rotation of 5 to 20 RPM's. Extension sections shall be provided to obtain the required minimum overall length and installation torque as shown on the working drawings. Connect sections together using coupling bolt(s) and nut torqued to 40 ft-lb.

C. Sufficient down pressure shall be applied to uniformly advance the helical pile sections approximately 3 inches per revolution. The rate of rotation and magnitude of down pressure shall be adjusted for different soil conditions and depths.

3.05 TERMINATION CRITERIA

A. The torque as measured during the installation shall not exceed the torsional strength rating of the central steel shaft.

B. The minimum installation torque and minimum overall depth criteria as shown on the working drawings shall be satisfied prior to terminating the helical pile installation.

C. If the torsional strength rating of the central steel shaft and/or installation equipment has been reached prior to achieving the minimum overall length required, the CMGC shall have the following options:
   1. Terminate the installation at the depth obtained subject to the review and acceptance of the Engineer.
   2. Remove the existing helical pile and install a new one with fewer and/or smaller diameter helix plates. The new helix configuration shall be subject to review and acceptance of the Engineer. If re-installing in the same location, the top-most helix of the new helical pile shall be terminated at least (3) three feet beyond the terminating depth of the original helical pile.
   3. If the minimum installation torque as shown on the working drawings is not achieved at the minimum overall length, and there is no maximum length constraint, the CMGC shall have the following options:
      a. Install the helical pile deeper using additional extension sections.
      b. Remove the existing helical pile and install a new on with additional and/or larger diameter helix plates. The new helix configuration shall be subject to review and acceptance of the Engineer. If re-installing in the same location, the top-most helix of the new helical pile shall be terminated at least (3) three feet beyond the terminating depth of the original helical pile.
      c. De-rate the load capacity of the helical pile and install additional helical pile(s). The de-rated capacity and additional helical pile location shall be subject to the review and acceptance of the Engineer.
   4. If the helical pile is refused or deflected by a subsurface obstruction, the installation shall be terminated and the pile removed. The obstruction shall be removed, if feasible, and the helical pile re-installed. If the obstruction can't be removed, the helical pile shall be installed at an adjacent location, subject to review and acceptance of the Engineer.
   5. If the torsional strength rating of the central steel shaft and/or installation equipment has been reached prior to proper positioning of the last plain extension section relative to the final elevation, the CMGC may remove the last plain extension and replace it with a shorter length extension. If it is not feasible to remove the last plain extension,

the CMGC may cut said extension shaft to the correct elevation. The CMGC shall not reverse (back-out) the helical pile to facilitate extension removal.

6. The average torque for the last two feet of penetration shall be used as the basis of comparison with the minimum installation torque as shown on the working drawings. The average torque shall be defined as the average of the last three readings recorded at one-foot intervals.

3.06 TOLERANCES

A. Allowable Tolerances:
   1. Centerline of helical piles shall not be more than 2 inches from indicated plan location.
   2. Plumbness shall be with 5 degrees of design alignment.
   3. Top elevation of helical pile shall be within +/- 1 inch of the design vertical elevation.

3.07 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Pre-Production Load Tests: Only where explicitly required in Drawings.

C. Production Load Tests – Axial: Only where explicitly required in Drawings.
   1. The CMGC shall perform proof tests on a minimum of 10% of the total production helical piles. The helical piles to be tested will be selected by the Engineer. At the CMGC's suggestion, but with the Engineer's permission, tension tests may be performed in lieu of compression tests up to 100% of the design load for helical piles with sufficient structural tension capacity.
   2. The CMGC shall determine a test sequence and acceptance criteria including load steps, hold times and the maximum test load. Maximum test load shall be selected so as to ensure that the production pile is not permanently damaged. The production test plan shall be submitted to the Engineer for review and acceptance.
   3. If a production pile that is tested fails to meet the acceptance criteria, the CMGC shall be directed to proof test another helical pile in the vicinity. For failed helical piles and further construction of other foundations, the CMGC shall modify the design, construction procedure or both. These modifications include but are not limited to, installing replacement helical piles, modifying the installation methods and equipment, increasing the minimum effective installation torque, changing the helix configuration, or changing the helical pile material (ie central steel shaft). Modifications that require changes to the structure shall have prior review and acceptance of Atlantic Richfield Company and Engineer. Any modifications of design or construction procedures shall be at the CMGC's expense.

D. Production Load Tests - Lateral: Only where explicitly required in Drawings.

3.08 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 32 01 12
BASE COURSE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
      b. AASHTO T 224 - Standard Method of Test for Correction for Coarse Particles in the Soil Compaction Test.
      c. AASHTO T 88 - Standard Method of Test for Particle Size Analysis of Soils .
   2. ASTM International (ASTM):
      a. ASTM C117 - Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing.
      b. ASTM C131/C131M - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
      c. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
      d. ASTM C29/C29M - Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate.
      e. ASTM D1556/D1556M - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
      f. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3) (2700 kN-m/m^3).
      g. ASTM D2167 - Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
      h. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
      i. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
      j. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
      k. ASTM D75/D75M - Standard Practice for Sampling Aggregates.
      l. ASTM E11 Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves.

1.03 DEGREE OF COMPACTION

A. Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum laboratory dry density obtained by the test procedure presented in ASTM D1557 abbreviated as a percent of laboratory maximum dry density.

Since ASTM D1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4 inch sieve, the degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve will be expressed as a percentage of the laboratory maximum dry density in accordance with AASHTO T 180 Method D and corrected with AASHTO T 224.

1.04 SUBMITTALS

A. Atlantic Richfield Company approval is required for submittals in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-03 Product Data:
      a. Plant, equipment, and tools.
      b. Waybills and delivery tickets.
   2. SD-05 Test Reports:
      a. Initial tests.
      b. In-place tests.

1.05 EQUIPMENT, TOOLS, AND MACHINES

A. All plant, equipment, and tools used in the performance of the work will be subject to approval by the Atlantic Richfield Company Representative before the work is started. Maintain all plant, equipment, and tools in satisfactory working condition at all times. Submit a list of proposed equipment, including descriptive data. Use equipment capable of minimizing segregation, producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

1.06 QUALITY CONTROL

A. Sampling and testing are the responsibility of the CMGC. Perform sampling and testing using a laboratory approved in accordance with this Section. Work requiring testing will not be permitted until the testing laboratory has been inspected and approved. Test the materials to establish compliance with the specified requirements and perform testing at the specified frequency. The Atlantic Richfield Company Representative may specify the time and location of the tests. Furnish copies of test results to the Atlantic Richfield Company Representative within 24 hours of completion of the tests.
   1. Sampling:
      a. Take samples for laboratory testing in conformance with ASTM D75/D75M. When deemed necessary, the sampling will be observed by the Atlantic Richfield Company Representative.
   2. Tests:
      a. Sieve Analysis:
         1) Perform sieve analysis in conformance with ASTM C117 and ASTM C136/C136M using sieves conforming to ASTM E11. Perform particle-size analysis of the soils in conformance with AASHTO T 88.
      b. Liquid Limit and Plasticity Index:
         1) Determine liquid limit and plasticity index in accordance with ASTM D4318.
      c. Moisture-Density Determinations:
         1) Determine the laboratory maximum dry density and optimum moisture in accordance with paragraph DEGREE OF COMPACTION.
      d. Field Density Tests:
         1) Measure field density in accordance with ASTM D1556/D1556M, ASTM D2167, or ASTM D6938. For the method presented in ASTM D1556/D1556M, use the base plate, as shown in the drawing. For the method presented in ASTM D6938, check the calibration curves and adjust them, if necessary,

using only the sand cone method as described in paragraph Calibration, of the ASTM publication. Tests performed in accordance with ASTM D6938 result in a wet unit weight of soil and ASTM D6938 will be used to determine the moisture content of the soil. Also check the calibration curves furnished with the moisture gauges along with density calibration checks as described in ASTM D6938. Make the calibration checks of both the density and moisture gauges using the prepared containers of material method, as described in paragraph Calibration, in ASTM D6938, on each different type of material to be tested at the beginning of a job and at intervals as directed. Submit calibration curves and related test results prior to using the device or equipment being calibrated.

e. Wear Test:
   1) Perform wear tests on base course material in conformance with ASTM C131/C131M.

f. Weight of Slag:
   1) Determine weight per cubic foot of slag in accordance with ASTM C29/C29M.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Perform construction when the atmospheric temperature is above 35 degrees F. When the temperature falls below 35 degrees F, protect all completed areas by approved methods against detrimental effects of freezing. Correct completed areas damaged by freezing, rainfall, or other weather conditions to meet specified requirements.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Rigid Pavement Base Course:
   1. Provide aggregates consisting of crushed stone, gravel, sand, or other sound, durable, approved materials processed and blended or naturally combined. Provide aggregates which are durable and sound, free from lumps and balls of clay, organic matter, objectionable coatings, and other foreign material. Provide base course meeting the criteria listed in the Tables below.
   2. Meet the following requirements for crushed base course:

Table of Gradation Base Course			
Percentage by Weight Passing Square Mesh Sieves			
Sieve Size	**1 ½" Minus**	**1" Minus**	**¾" Minus**
1 ½ Inch	100		
1 Inch		100	
3/4 Inch			100
½ Inch			
No. 4	25-60	40-70	40-70
No. 10		25-55	25-55
No. 200	0-8	2-10	2-10

   a. As determined by AASHTO Methods T11 and T27, furnish material for the grading specified in the contract documents including binder or filler, which may have been added at the plant or at the site, meeting the requirements of that grading in the preceding Table of Gradations.

b. Up to 5% "oversized" material is permitted provided that the "oversized" material passes the screen size immediately larger than the top size specified. The produced material between the maximum screen opening and the No.4 sieve shall be reasonably well graded.
c. Suitability of the aggregate is based on samples obtained during placement in the project within limits allowed in the table for the particular grading specified.
d. The portion of the fine aggregate passing the No. 200 sieve must be less than 60 percent of that portion passing the No. 40 sieve.
e. The liquid limit for that portion of the fine aggregate passing a No. 40 sieve cannot exceed 25, nor the plasticity index exceed 6, as determined by AASHTO T89 and T90.

2.02 TESTS, INSPECTIONS, AND VERIFICATIONS

A. Initial Tests:
1. Perform one of each of the following tests on the proposed material prior to commencing construction to demonstrate that the proposed material meets all specified requirements prior to installation. Complete this testing for each source if materials from more than one source are proposed.
a. Sieve Analysis including 0.02 mm size material.
b. Liquid limit and plasticity index.
c. Moisture-density relationship.
d. Analytes required to demonstrate materials do not classify as contaminated per the Waste Identification Criteria defined in Section 02 11 10 – Excavation and Handling.
2. Submit certified copies of test results for approval not less than 30 days before material is required for the work.

B. Approval of Material:
1. Tentative approval of material will be based on initial test results.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

A. Provide adequate drainage during the entire period of construction to prevent water from collecting or standing on the working area.

3.02 OPERATION OF AGGREGATE SOURCES

A. Condition aggregate sources on private lands in accordance with local laws and authorities. Clearing, stripping, and excavating are the responsibility of the CMGC. Condition aggregate sources on Atlantic Richfield Company property to readily drain and leave in a satisfactory condition upon completion of the work.

3.03 STOCKPILING MATERIAL

A. Clear and level storage sites prior to stockpiling of material. Stockpile all materials, including approved material available from excavation and grading, in the manner and at the locations designated. Stockpile aggregates on the cleared and leveled areas designated by the Atlantic Richfield Company Representative to prevent segregation. Stockpile materials obtained from different sources separately.

3.04 PREPARATION OF UNDERLYING COURSE OR SUBGRADE

A. Clean the underlying course or subgrade of all foreign substances prior to constructing the structural fill and/or base course. Do not construct the subbase and base courses on underlying course or subgrade that is frozen. Construct the surface of the underlying course or subgrade to meet specified compaction and surface tolerances. Correct ruts or soft yielding spots in the underlying courses, areas having inadequate compaction, and deviations of the surface from the specified requirements set forth herein by loosening and removing soft or unsatisfactory material and adding approved material, reshaping to line and grade, and recompacting to specified density requirements. For cohesionless underlying courses or subgrades containing sands or gravels, as defined in ASTM D2487, stabilize the surface prior to placement of the overlying course. Stabilize by mixing the overlying course material into the underlying course and compacting by approved methods. Consider the stabilized material as part of the underlying course and meet all requirements of the underlying course. Do not allow traffic or other operations to disturb the finished underlying course and maintain in a satisfactory condition until the overlying course is placed.

3.05 GRADE CONTROL

A. Provide a finished and completed base course conforming to the lines, grades, and cross sections shown. Place line and grade stakes as necessary for control.

3.06 MIXING AND PLACING MATERIALS

A. Mix and place the materials to obtain uniformity of the material at the water content specified. Make such adjustments in mixing or placing procedures or in equipment as may be directed to obtain the true grades, to minimize segregation and degradation, to reduce or accelerate loss or increase of water, and to insure a satisfactory base course.

3.07 LAYER THICKNESS

A. Compact the completed course to the thickness indicated. Compact the courses to a total thickness that is within 1/2 inch of the thickness indicated. Where the measured thickness is more than 1/2 inch deficient, correct such areas by scarifying, adding new material of proper gradation, re-blading, and recompacting as directed. Where the measured thickness is more than 1/2 inch thicker than indicated, the course will be considered as conforming to the specified thickness requirements. The average job thickness will be the average of all thickness measurements taken for the job and must be within 1/4 inch of the thickness indicated. Measure the total thickness of the course(s) at intervals of one measurement for each 500 square yards of completed course. Measure total thickness using 3-inch diameter test holes penetrating the completed course.

3.08 COMPACTION

A. Compact each layer of the material, as specified, with approved compaction equipment. Maintain water content during the compaction procedure to within plus or minus (±2%) percent of optimum water content determined from laboratory tests as specified in this Section. Begin rolling at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Slightly vary the length of alternate trips of the roller. Adjust speed of the roller as needed so that displacement of the aggregate does not occur. Compact mixture with hand-operated power tampers in all places not accessible to the rollers. Continue compaction of the base course until each layer is compacted through the full depth to at least 95 percent of laboratory maximum density. Make such adjustments in compacting or finishing procedures as may be directed by the Atlantic Richfield Company Representative to obtain true grades, to

minimize segregation and degradation, to reduce or increase water content, and to ensure a satisfactory base courses. Remove any materials that are found to be unsatisfactory and replace with satisfactory material or rework, as directed, to meet the requirements of this specification.

3.09 PROOF ROLLING

A. In addition to the compaction specified, proof roll base course in areas designated on the drawings. A coverage is defined as the application of one tire print over the designated area. In the areas designated, apply proof rolling to the top layer of the completed base course. Maintain water content of the top layer of the base course as specified in paragraph COMPACTION from start of compaction to completion of proof rolling. Remove any base course materials that produce unsatisfactory results by proof rolling and replace with satisfactory materials. Then recompact and proof roll to meet specifications.

3.10 EDGES OF BASE COURSE

A. Place approved material along the outer edges of the base course in sufficient quantity to compact to the thickness of the course being constructed. When the course is being constructed in two or more layers, simultaneously roll and compact at least a 2-foot width of this shoulder material with the rolling and compacting of each layer of the base course, as directed.

3.11 FINISHING

A. Finish the surface of the top layer of rigid pavement base course after final compaction and proof rolling by cutting any overbuild to grade and rolling with a steel-wheeled roller. Do not add thin layers of material to the top layer of rigid pavement base course to meet grade. If the elevation of the top layer of rigid pavement base course is 1/2 inch or more below grade, scarify the top layer to a depth of at least 3 inches and blend new material in and compact and proof roll to bring to grade. Make adjustments to rolling and finishing procedures as directed by the Atlantic Richfield Company Representative to minimize segregation and degradation, obtain grades, maintain moisture content, and insure an acceptable rigid pavement base course. Should the surface become rough, corrugated, uneven in texture, or traffic marked prior to completion, scarify the unsatisfactory portion and rework and recompact it or replace as directed.

3.12 SMOOTHNESS TEST

A. Construct the top layer so that the surface shows no deviations in excess of 3/8 inch when tested with a 12-foot straightedge. Take measurements in successive positions parallel to the centerline of the area to be paved. Also take measurements perpendicular to the centerline at 50-foot intervals. Correct deviations exceeding this amount by removing material and replacing with new material, or by reworking existing material and compacting it to meet these specifications.

3.13 FIELD QUALITY CONTROL

A. In-Place Tests:
   1. Perform one of each of the following tests on samples taken from the placed and compacted base course. Take samples and test at the rates indicated.
      a. Perform density tests on every lift of material placed and at a frequency of one set of tests for every 500 square yards, or portion thereof, of completed area.
      b. Perform sieve analysis on every lift of material placed and at a frequency of one sieve analysis for every 1,000 square yards, or portion thereof, of material placed.

c. Perform liquid limit and plasticity index tests at the same frequency as the sieve analysis.
d. Measure the thickness of each course at intervals providing at least one measurement for each 500 square yards or part thereof. Measure the thickness using test holes, at least 3 inches in diameter through the course.

B. Approval of Material:
1. Final approval of the materials will be based on tests for gradation, liquid limit, and plasticity index performed on samples taken from the completed and fully compacted course(s).

3.14 TRAFFIC

A. Do not allow traffic on the completed base course without approval from the Atlantic Richfield Company Representative. Completed portions of the base course may be opened to limited traffic, provided there is no marring or distorting of the surface by the traffic. Do not allow heavy equipment on the completed rigid pavement base course except when necessary for construction. When it is necessary for heavy equipment to travel on the completed rigid pavement base course, protect the area against marring or damage to the completed work.

3.15 MAINTENANCE

A. Maintain the completed course in a satisfactory condition until the full pavement section is completed and accepted. Immediately repair any defects and repeat repairs as often as necessary to keep the area intact. Retest any course that was not paved over prior to the onset of winter to verify that it still complies with the requirements of this specification. Rework or replace any area that is damaged as necessary to comply with this specification. All maintenance conducted by the CMGC is considered incidental to the contract and no separate payment will be made.

3.16 DISPOSAL OF UNSATISFACTORY MATERIALS

A. Dispose of any unsuitable materials as directed by the Atlantic Richfield Company Representative. No additional payments will be made for materials that have to be replaced.

END OF SECTION

SECTION 32 01 13
ASPHALT SURFACE TREATMENT, TACK, AND PRIME COAT

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. AASHTO T 102 (2009; R 2013) - Standard Method of Test for Spot Test of Asphaltic Materials.
   2. ASTM International (ASTM):
      a. ASTM C131/C131M (2014) - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
      b. ASTM C136/C136M (2014) - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
      c. ASTM C88 (2018) - Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
      d. ASTM D1139/D1139M (2015) - Aggregate for Single or Multiple Bituminous Surface Treatments.
      e. ASTM D140/D140M (2016) - Standard Practice for Sampling Asphalt Materials.
      f. ASTM D2028/D2028M (2015) - Cutback Asphalt (Rapid-Curing Type).
      g. ASTM D2397/D2397M (2017) - Standard Specification for Cationic Emulsified Asphalt.
      h. ASTM D2995 (1999; R 2009) - Determining Application Rate of Bituminous Distributors.
      i. ASTM D3625/D3625M (2012) - Standard Practice for Effect of Water on Bituminous-Coated Aggregate Using Boiling Water.
      j. ASTM D6373 (2016) - Standard Specification for Performance Graded Asphalt Binder.
      k. ASTM D75/D75M (2014) - Standard Practice for Sampling Aggregates.
      l. ASTM D946/D946M (2015) - Penetration-Graded Asphalt Cement for Use in Pavement Construction.
      m. ASTM D977 (2017) - Standard Specification for Emulsified Asphalt.

1.03 SUBMITTALS

A. Atlantic Richfield Company approval is required for submittals in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-03 Product Data:
      a. Waybills and delivery tickets.
      b. Cutback asphalt.
      c. Emulsified asphalt.

d. Asphalt cement.
e. Paint.

2. SD-05 Test Reports:
   a. Tests.

1.04 QUALITY CONTROL

A. Safety Precautions: Smoking or open flames will not be permitted outside of designated areas.

B. Sampling and Testing: Sampling and testing are the responsibility of the CMGC. Perform sampling and testing using an approved commercial testing laboratory, or by the CMGC, subject to approval. Sampling must be in accordance with ASTM D75/D75M for aggregates and ASTM D140/D140M for bituminous material, unless otherwise directed. Perform aggregate gradation tests on each sample in accordance with ASTM C136/C136M. Perform all other aggregate tests on the initial source samples and repeat tests when there is a change of source. Perform sieve analyses daily from material samples including an analysis of each gradation of material. Perform tests in sufficient number to ensure that materials meet specified requirements. Submit copies of test results, within 24 hours after completion of each test. Repeat aggregate testing (wear, soundness, deleterious material and stripping) for each 20,000 tons of aggregate used in the project.

C. Wear Test: Perform the wear test in accordance with ASTM C131/C131M to ensure that aggregates have a percentage of wear not exceeding 40 percent after 500 revolutions.

D. Soundness Test: Perform the soundness test as specified by ASTM C88 to ensure that aggregates have a weight loss not greater than [_____][18] percent when subjected to five cycles of the magnesium sulfate test or [_____] [12] percent when subjected to five cycles of the sodium sulfate test.

E. Stripping Test: Perform stripping tests meeting the requirements of ASTM D3625/D3625M. Deleterious substances must not exceed the requirements of ASTM D1139/D1139M.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Inspect the materials delivered to the site for contamination and damage. Unload and store the materials with a minimum of handling. Store aggregates preventing segregation and contamination.

1.06 EQUIPMENT, TOOLS, AND MACHINES

A. Provide equipment dependable and adequate for the purpose intended and properly maintained in satisfactory and safe operating condition at all times. Discontinue the use of equipment which fails to produce satisfactory work and replace with satisfactory equipment. Equipment such as asphalt distributors, scales, batching equipment, spreaders and similar equipment, must have been calibrated by an approved calibration laboratory within [12] [_____] months prior to commencing work [and every [____3_] months thereafter, by such laboratory from the date of last calibration, during the term of the contract.

1. Bituminous Distributors:
   a. Provide a self-propelled distributor with pneumatic tires of such size and number to prevent rutting, shoving or otherwise damaging the surface being sprayed. Calibrate the distributer in accordance with ASTM D2995. Design and equip the distributor to spray the bituminous material in a uniform coverage at the specified temperature, at readily determined and controlled total liquid rates from 0.03 to 1.0

gallons per square yard, with a pressure range of 25 to 75 psi and with an allowable variation from the specified rate of not more than plus or minus 5 percent, and at variable widths. Include with the distributor equipment a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading the temperature of tank contents, and a hand hose attachment suitable for applying bituminous material manually to areas inaccessible to the distributor. The distributor will be capable of circulating and agitating the bituminous material during the heating process.

2. Single-Pass, Surface-Treatment Machines:
   a. Use only machines capable of spraying bituminous material and spreading aggregate in one pass. Use only bituminous spraying equipment conforming to the requirements given above for a bituminous distributor. Use only machines capable of spreading aggregates at controlled amounts per square yard as specified. In addition, only use single-pass, surface-treatment machines capable of placing a surface treatment adjacent to an existing surface treatment, forming a joint of the same thickness and uniformity as other portions of the surface treatment. Ridges or blank spaces will not be permitted. Form joints in the second application at least 1 foot from those formed in the first application.
3. Heating Equipment for Storage Tanks:
   a. Use equipment consisting of coils and equipment for producing steam or hot oil and designed to prevent the introduction of steam or hot oil into the material. Affix an armored thermometer with a range of 100 to 400 degrees F to the tank so the temperature of the bituminous material may be determined at all times.
4. Power Rollers:
   a. Use only steel-wheeled or pneumatic-tired type power rollers conforming to the following requirements:
      1) Use only steel-wheeled rollers having at least one steel drum and weigh a minimum of 5 tons. Equip steel wheels of the rollers with adjustable scrapers.
      2) Use only self-propelled pneumatic-tired rollers having wheels mounted on two axles in such manner that the rear tires will not follow in the tracks of the forward group. Maintain uniform tire inflation to not less than 60 psi nor more than 80 psi pressure. Equip pneumatic-tired rollers with boxes or platforms for ballast loading. Load rollers so that the tire print width of each wheel is not less than the clear distance between tire prints.
5. Mechanical Spreaders:
   a. Use only adjustable spreaders capable of spreading aggregate at controlled amounts per square yard, as specified.
6. Brooms and Blowers:
   a. Use only power type brooms and blowers capable of cleaning surfaces to be treated.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Apply bituminous surface treatment only when the existing surface or base course is dry or contains moisture not in excess of the amount that will permit uniform distribution of the asphalt material and provide the desired adhesion between the asphalt material and the materials underneath and above. Do not apply bituminous surface treatment when either the atmospheric temperature, in the shade, is below [50][60] degrees F or the pavement surface to be treated is below 70 degrees F unless otherwise directed.

PART 2 - PRODUCTS

A. Use mineral aggregate and bituminous material of the following types, gradations, grades, and consistencies that meet the requirements of stripping, wear, deleterious materials, and soundness tests as specified in paragraph sampling and testing.

2.02 MINERAL AGGREGATE

A. Provide aggregate consisting of crushed stone and/or crushed gravel of such nature that thorough coating of bituminous material, used in the work, will not strip off upon contact with water when testing using ASTM D3625/D3625M. Maintain aggregate moisture content so that the aggregate will be readily coated with the bituminous material. Drying may be required, as directed. Use aggregate conforming to the gradation shown below. Determine gradation of the aggregates by ASTM C136/C136M.

AGGREGATE GRADATION DESIGN REQUIREMENTS				
	Type A	**Type B**	**Type C**	**Job Mix Tolerances**
1 inch	100			
3/4 inch	91-93	100		± 7
1/2 inch	76-89	83-93	100	± 7
3/8 inch	61-79	73-87	91-93	± 7
No. 4	41-54	47-63	51-71	± 6
No. 10	31-39	32-43	34-46	± 6
No. 40	16-27	15-25	16-26	± 5
No. 200	4-7	5-7	5-9	± 2

1. Crushed Stone:
   a. Provide crushed stone consisting of clean, sound, durable particles, free of soft or disintegrated pieces, dust, contamination, or foreign matter.
2. Crushed Gravel:
   a. Provide crushed gravel consisting of clean, sound, durable particles, free of soft or disintegrated pieces, contamination, or foreign matter. At least 90 percent by weight of the particles must have at least two fractured faces.
3. Aggregate Quantities:
   a. Spread the bituminous material and aggregate within the quantity limits shown below. The individual quantities of bituminous material and aggregate may be varied to meet specific field conditions at all times during progress of the work, as directed, without adjustments to contract unit prices. Provide aggregate and additive mixtures as shown in the table that follows.

Plant Mix Specifications							
Property	**Job Mix Target Limits**			**Job Mix Tolerance**	**Start-Up Job Mix Range[3]**		
	Type A	**Type B**	**Type C**		**Type A**	**Type B**	**Type C**
VMA	13.0 to 17.0	13.5 to 18.0	16.1 to 18.4	±0.6	12.4 to 17.6	12.9 to 18.6	15.5 to 19.0
FVA	65 to 80			±5.0	60 to 85		
VTM@N_{des}[1]	3.4 to 4.0			±1	2.4 to 5.0		
D/A[2]	0.6 to 1.4			±0.2	0.6 to 1.4		
Commercial Plant Mix Requirements							
VMA	12.4 to 17.6	12.9 to 18.6	15.5 to 19.0	N/A	N/A		
VFA	60 to 85			N/A	N/A		
VTM[1]	2.4 to 5.0			N/A	N/A		
D/A	0.6 to 1.4			N/A	N/A		

Choose the design and production air voids target to be the lowest value, within the range in the Table below inclusive of 3.4 and 4.0, such that all other criteria are met.

[1] Percentages or quantities of hydrated lime will not be subtracted from the aggregate gradation.

[2] Start-up job mix range only applies to production before initial target set. Tolerances do not apply to start up job mix range.

Mixture Design and Production Requirements								
20 Year Design ESALs[1]		**Number of Compactive Gyrations**			**percent of Rice**			**Coarse Agg Angularity**
Total (million)	**Daily**	**Initial (N_{ini})**	**Design (N_{des})**	**Max (N_{max})**	**Max@N_{ini}**	**Max@N_{des}**	**Max@N_{max}**	**1 face/2 Face**
≤0.3	≤41	7	75	115	91.5	96 to 96.6	98	75/-
0.3 to ≤10	41 to ≤1370				90.5			85/80
≥10	≥1370				89			95/90

Mixture Design and Production Requirements Cont.							
20 Year Design ESALs[1]		**VMA percent**			**VFA percent**	**VTM percent (Air Voids)**	**DP (Dust to effective binder ratio)[2]**
Total (million)	**Daily**	**Initial (N_{ini})**	**Design (N_{des})**	**Max (N_{max})**	**Range@N_{des}**	**Range@N_{des}**	**Range (P0.075/Pbe)**
≤0.3	≤41	≥13.0	≥13.5	≥15.5	75 to 80	3.4 to 4.0	0.6 to 1.4
0.3 to ≤10	41 to ≤1370				65 to 78		
≥10	≥1370				89		

[1] If ESAL's are not specified in the contract, use the 0.3 to 10 million ESAL design requirements to develop the mix design, unless directed by the Atlantic Richfield Company Representative.

[2] In addition to meeting the DP requirement at Mix Design, report the D/A for the mix design target asphalt content.

2.03 BITUMINOUS MATERIALS

A. Cutback Asphalt:
   1. Use rapid curing cutback asphalt conforming to ASTM D2028/D2028M, Designation [RC-250] [RC-800] [RC-3000]. Submit temperature-viscosity relationship of cutback asphalt.

B. Emulsified Asphalt:
   1. Use rapid-setting emulsified asphalt conforming to ASTM D977, Grade RS-1 or RS-2 or ASTM D2397/D2397M, Grade CRS-1 or CRS-2.

C. Asphalt Cement:
   1. Use asphalt cement conforming to ASTM D946/D946M, Penetration Grade [120-150] [200-300] or ASTM D6373, Performance Graded Asphalt Binder [PG 58-22] [PG 58-28] [PG 64-22] [64-28, Polymer Modified]. Submit temperature-viscosity relationship of asphalt cement.

D. Asphalt Binder Material:
   1. Furnish Asphalt binder material to be used as specified in the contract documents and meet the type and grade specified requirements in the Table below.
   2. The percentage of asphalt by weight, to be added to the aggregate will be, generally, between 4 and 8 percent of the weight of the total mix. The mix design will establish the exact percentage of asphalt in the mix, based upon preliminary laboratory tests, sieve analysis and grading and character of the aggregate furnished within the specification limits. No claim is allowed for the payment for rejecting any batch or load of mixture containing an excess or deficient amount of asphalt binder varying more than 0.4 of a percent from the fixed mix design percentage.
   3. Obtain Atlantic Richfield Company Representative approval of the asphalt material source before shipments are made to any project. The source of supply cannot change after work is started unless approved in writing by the Atlantic Richfield Company Representative. Atlantic Richfield Company is not liable for the quantity shipped.
   4. Samples of asphalt binder material may be taken, as directed by the Atlantic Richfield Company Representative, and placed in uncontaminated one-quart containers. When sampled, these shall be taken from the tanker car or truck at the point of delivery on the project and submitted to the Atlantic Richfield Company Representative.
   5. All transport vehicles must be equipped with a spigot or gate valve installed in either: (1) the unloading line, (2) in the tanker at the centerline on the tank, (3) in the pressure line from the unloading pump, or other locations approved by the Engineer. Assure the spigot or gate valve has a diameter of between 3/8 inch (1 cm) and 3/4 inch (2.5 cm). The spigot valve must be located to prevent contamination from plant dust or other contaminants.
   6. The supplier furnishing the asphalt binder material shall inspect each tanker car or truck before it is loaded and ship only in clean, uncontaminated, fully insulated cars or trucks, sealed after loading by the supplier.
   7. The material supplier shall issue, in duplicate, a certificate showing full compliance with the specifications for the designated grade of material, together with the following information. Project number, date of shipment, source of the material, car or truck initial and number, destination, gross quantity loaded, loading temperature, and net quantity in gallons at 60° F (15.5° C) or tons, whichever unit of measurement is stipulated. Assure the certificate of compliance accompanies the shipment and is furnished to the Engineer. The certificate, signed by the supplier representative, must also certify that the conveyance vessel was inspected and found to be free of contaminating material.

8. The certificate of compliance is the basis for tentative acceptance and use of the material. Samples taken according to applicable sampling methods and retained by the Engineer may be tested at the Atlantic Richfield Company Representative's discretion. Failure of the asphalt material to meet these specifications may result in rejection of the entire, associated work. If rejected, removed and replace rejected work.
9. Apply asphalt material at temperatures that assure uniform mixing or spreading. Application temperature ranges for each grade of material should be accompanied with the mix design. Application temperature for mixing applications will be in accordance with the mix design.
10. Upon request by the Atlantic Richfield Company Representative, furnish the Atlantic Richfield Company Representative and/or laboratory (responsible for completing the mix design) with data or a report showing the temperature-viscosity relationship of each asphalt binder used on the project. Assure this data covers the range of temperatures used for mixing and compaction. In addition, the Engineer may request a complete set of test results from the Table below for each grade used on the project.

Performance Graded Asphalt Binder (PGAB)					
Performance Grade	**PG 58**		**PG 64**		**Test Method**
	-22	-28	-22	-28	
Average 7 Day Max. Pavement Design Temperature (°C)	<58		<64		
Minimum Pavement Design Temperature (°C)	>-22	>-28	>-22	>-28	
Original Binder					
Flash Point Temp. Minimum (°C)	230				AASHTO T48
Viscosity: Maximum, 3Pa (3000 CP_, Test Temp. (°C)	135				ASTM D4402
Dynamic Shear: G*/sin delta, Minimum 1.00 kPa Test temp @ 10 rad/s, (°C)	58		64		AASHTO TP56
Rolling Thing Film Oven (AASHTO T240) or Thin Film Over (T179) Residue					
Mass Loss, Maximum percent	1.0				AASHTO T240
Dynamic Shear: G*/sin delta, Minimum, 2.20 kPa Test Temp @ 10 ras/s, (°C)	58		64		AASHTO TP5
Pressure Aging Vessel Residue (AASHTO PP1)					
PAV Aging Temp, (°C)	100		100		
Dynamic Shear: G*/ Sin delta, Maximum, 5000 kPa Test Temp @ to rad/s (°C)	22	19	25	22	AASHTO PP1
Creep stiffness [a]: S, Minimum 300 MPa m-value, Minimum, 0.300 Test Temp, @ 60 sec, (°C)	-12	-18	-12	-18	AASHTO TP1

Performance Graded Asphalt Binder (PGAB)					
Performance Grade	**PG 58**		**PG 64**		**Test Method**
	-22	-28	-22	-28	
Direct Tension [a]:Failure Strain, Minimum, 1.0 percent, Test Temp @ 1.0 mm/min (°C)	-12	-18	-12	-18	AASHTO TP3

[a] If creep stiffness is below 300 MPa, the direct tension test is not required. If the creep stiffness is between 300 and 600 MPa the direct tension failure strain requirement can be used in lieu of the creep stiffness requirement. The m-value requirement must be satisfied in both cases.

E. Hydrated Lime for Asphalt Concrete:
   1. Mineral filler may be incorporated in the asphalt concrete mixture. Furnish hydrated lime as filler when specified. Assure it is free of lumps and extraneous material and meets the following gradation requirements as per ASTM D242:

Sieve	Percent Passing
No. 30	100
No. 80	95-100
No. 200	70-100

   2. Assure the hydrated lime meets requirements of ASTM C1097.
   3. Where required, the mineral filler will be effectively mixed with the hot plant mix asphaltic concrete.

PART 3 - EXECUTION

3.01 OBLITERATE ROADWAY

A. Obliterate roadway includes removal of the existing roadway and related items, rehabilitating the abandoned roadway area by scarifying and shaping, and seeding.

B. Grade and contour abandoned roadways to blend with the new roadway or existing terrain. If not specified in the contract, dispose of the existing bituminous materials in accordance with the CMGCs Waste Management Plan (WMP) and in conformance with applicable laws, rules, regulations and the Montana Solid Waste Management Act. After the old roadway surfacing is removed, salvage the topsoil from areas to be graded and perform the rough grading. Grade and contour the obliterated roadway to blend with the new roadway and adjacent terrain. Spread the salvaged topsoil and seed the obliterated roadway area. Work construction scars, sharp breaks, and steep slopes or cuts to blend with the terrain. Existing aggregate surfacing material may be used to construct fills when covered with 12 inches (305 mm) of soil capable of supporting plant growth. Remove and dispose of bituminous materials, old structures, guardrail, and other non-salvageable items not included in other contract items for removal at CMGC expense. Remove and neatly store all material designated as salvageable to prevent damage. The species of seed, seed bed preparation, fertilizing, mulching, and application rate is specified in the contract.

3.02 COLD MILLING

A. This work is the removal of existing bituminous pavement at the locations and depth specified in the contract.

B. Construction Requirements:
   1. Use a power-operated cold milling machine equipped to control cross slope and to establish profile grade from the existing pavement or an external reference.
   2. Do not start cold milling until the surfacing plant is fully operational. Starting at the center of the road, begin milling on a longitudinal line parallel to the centerline with succeeding passes progressing to the outer edge of the pavement, unless approved by the Atlantic Richfield Company Representative.
   3. Remove all thin delaminated or loose layers of existing pavement left after cold milling. Replace the milled pavement at bridge ends and cattle guards with new bituminous surfacing the same day leaving no transverse joints in the milled areas. If new surfacing cannot be placed on the milled area the same day, transition at no less than a 50H:1V to the original surface.
   4. The completed milled surface is to be free from transverse and longitudinal irregularities exceeding 1/4-inch (6 mm) when measured with a 10-foot (3 m) straightedge. Each successive pass will be pulled even with the previous and not staggered. After cold milling, do not leave the remaining pavement exposed to traffic more than 72 hours before placing the plant mix surfacing. The 72-hour duration may be modified by the project manager depending on the durability of the milled surface. The CMGC will be responsible to repair any damage that occurs to the roadway prior to plant mix paving. Do not proceed with paving without the approval of the Atlantic Richfield Company Representative. Replacing existing pavement is a separate operation from any succeeding overlay or lift.

C. Milling:
   1. Connections: Mill the existing bituminous surfacing from bridge decks, bridge approaches, cattle guards, and project connections at the locations specified in the contract or as directed by the Project Manager.
      a. Bridge Decks:
         1) Mill the depth shown in the contract or as adjusted to meet field conditions.
      b. Bridge Ends:
         1) Mill full depth from the bridge end out for a distance of 30 feet (10 m) prior to the milling taper.
         2) For milling depths less than or equal to 0.35 feet (105 mm), mill a taper distance of 200 feet (60 m).
         3) For milling depths greater than 0.35 feet (105 mm), mill a taper distance based on a rate of 30 feet per 0.05 feet (10 m per 15 mm) of milling depth.
      c. Cattle Guards or Railroad Crossings:
         1) Mill full depth from the cattle guard or railroad crossing out for a distance of 15 feet (5 m) prior to the milling taper.
         2) Mill a taper distance of 50 feet (15 m).
      d. Project Connections:
         1) For milling depths less than or equal to 0.35 feet (105 mm), mill a taper distance of 200 feet (60 m).
         2) For milling depths greater than 0.35 feet (105 mm), mill a taper distance based on a rate of 30 feet per 0.05 feet (10 m per 15 mm) of milling depth.
   2. Milling at Other Designated Areas: Mill the existing pavement at the locations, widths and depths specified. The depth is measured below the existing pavement plane projected from points on un-distorted pavement near the centerline and the edge of the driving lane.
   3. Cold Milling for Seal and Cover: Meet the following requirements when seal and cover go directly on the cold mill surface:
      a. Use a cold milling cutting head having maximum 1/4-inch (6 mm) tooth spacing.

b. Equip the milling machine with automatic controls and sensors on both sides to maintain the specified grade and transverse slope.
c. Do not operate the milling machine in excess of 75 feet/minute (23 m/minute) unless it can be demonstrated to the Project Manager that the milled surface can meet the plant mix overlay surface tolerance.
d. Do not begin placing the seal and cover until all cold millwork is complete.

4. Salvage Pavement Millings: Haul and stockpile the milled pavement to the specified site. Milled pavement is the CMGC's property when specified and must be removed from the project.
5. Replacing Removed Pavement Pave: All milled areas in the contract with the specified bituminous mixture, placed to the specified depth. Set a wire line for grade control with intermediate supports to prevent wire deflection exceeding 3⁄16-inch (5 mm). Stop paving if the deflection exceeds 3⁄16-inch (5 mm) and make appropriate corrections. Apply a tack coat on all milled areas before paving.

3.03 SURFACE PREPARATION

A. Immediately before applying the first course of bituminous material, clean the surface of loose material with power brooms or power blowers. Take care to remove all dirt, clay, and other loose or foreign matter. Flush the surface with water, when necessary to achieve a clean surface and only when directed by the Atlantic Richfield Company Representative; allow the surface to dry after flushing.

3.04 TACK AND PRIME COAT

A. General:
1. Following preparation and subsequent inspection of the surface, apply the bituminous prime or tack coat with the bituminous distributor at the specified rate with uniform distribution over the surface to be treated. Properly treat all areas and spots, not capable of being sprayed with the distributor, with the hand spray. Until the succeeding layer of pavement is placed, maintain the surface by protecting the surface against damage and by repairing deficient areas at no additional cost to Atlantic Richfield Company. If required, spread clean dry sand to effectively blot up any excess bituminous material. No smoking, fires, or flames other than those from the heaters that are a part of the equipment are permitted within 25 feet of heating, distributing, and transferring operations of cutback materials. Prevent all traffic, except for paving equipment used in constructing the surfacing, from using the underlying material, whether primed or not, until the surfacing is completed. The bituminous coat requirements are described herein.

B. Prime Coat:
1. Spray the asphalt prime coat, under average conditions, from 0.20 to 0.50 gallons per square yard (0.9 to 8.2 liters per square meter) of low viscosity MC-70 asphalt on the prepared surface of a non-asphaltic base course.
2. Immediately before applying the prime coat, clean the surface to be primed of all dirt and loose materials using blowers or a power broom, supplemented by hand brooming if necessary. Finish the surface to receive the asphalt material to the specified requirements for smoothness, compaction, and grade. Apply prime coat when the surface is dry or slightly damp and when the air temperature in the shade is not less than 50° F (10° C). Apply asphalt material using a pressure distributor at the rate or rates directed by the Engineer.
3. Before spraying, spread building paper over the surface from the joint back, for the distance required for the spray bar to begin spraying and operating at full force when

the surface to be treated is reached. Once the asphalt is applied, remove and dispose of the building paper. Assure the spray bar is shut off instantaneously at each construction joint to assure a straight line and full application of asphalt prime up to the joint. If required to prevent dripping, insert a drip pan under the nozzle where the application ends. Use a hand sprayer to apply primer material to touch up all spots missed by the distributor.

4. Protect the surfaces of structures and trees adjacent to the area being treated from being spattered or marred. Do not discharge asphalt material into borrow pits or gutters. After the prime coat has been applied, assure it is left undisturbed for at least 24 hours or until it is cured or blotted. Blot all excess asphalt material remaining on the surface after 24 hours with sand before opening the surface to traffic. Maintain the primed or tacked surface until the surfacing has been placed. Maintenance includes spreading any additional sand required to prevent asphalt material adhering to the tires of vehicles using the surface and patching all breaks in the
5. surface with additional bituminous material. Any area of surface disturbed by traffic or otherwise, is to be cleaned before the next course is placed. Before placing the surface course, sweep all excess and/or loose sand used for blotter from the surface.

C. Tack Coat:
   1. The asphalt tack coat is the application of a diluted, slow-breaking, SS-1 or SS-1h asphalt emulsion to ensure bond between the surface being paved and the overlying course. Immediately before applying the tack coat, clean the surface to be tacked of all dirt and loose materials using blowers or power brooms, supplemented by hand brooming if necessary.
   2. Apply tack coat when the surface is dry or slightly damp, and when the air temperature in the shade is at least 50° F (10° C).
   3. Dilute the asphalt emulsion, SS-1 or S-1h, with water at one part emulsion to one part water. Apply the diluted emulsion using a pressure distributor at the rate of 0.1 gallon per square yard (4.5 liters per square meter).
   4. Before application, spread building paper over the surface, from the joint back, for the required distance for the spray bar to begin spraying and operating at full force when the surface to be treated is reached. Once the asphalt is applied, remove and dispose of the building paper. Shut off the spray bar instantaneously at each construction joint to assure a straight line and full application of asphalt prime up to the joint. If required to prevent dripping, insert a drip pan under the nozzle where the application is stopped. Use a hand sprayer to apply primer material for touching up all spots missed by the distributor.
   5. After the tack coat has been applied, assure it is undisturbed until the asphalt emulsion has “broken”, generally within 30 minutes of application. Place the next paving course after the emulsion has broken.
   6. Schedule operations so that all tack coats are placed with the asphalt-paving course in the same day.

3.05 CURING PERIOD

A. Following application of the bituminous material and prior to application of the succeeding layer of asphalt mixture, allow the bituminous coat to cure and water or volatiles to evaporate prior to overlaying. Maintain the tacked surface in good condition until the succeeding layer of pavement is placed, by protecting the surface against damage and by repairing and recoating deficient areas. Allow the prime coat to cure without being disturbed for a period of at least 48 hours or longer, as may be necessary to attain penetration into the treated course. Furnish and spread enough sand to effectively blot up excess bituminous material.

3.06 FIELD QUALITY CONTROL

A. Obtain certificates of compliance for all asphalt material delivered to the project. Obtain samples of the bituminous material under the supervision of the Atlantic Richfield Company Representative. The sample may be retained and tested by Atlantic Richfield Company at no cost to the CMGC.

3.07 APPLICATION OF FIRST COURSE

A. Bituminous Material:
   1. Apply bituminous material by means of a bituminous distributor at the temperature specified in paragraph APPLICATION TEMPERATURE OF MATERIALS, below or as directed; and within the limits specified in paragraph QUANTITY LIMITS in PART 1. Apply bituminous material in such a manner that uniform distribution is obtained over all surfaces treated. Unless the distributor is equipped to obtain a satisfactory result at the junction of previous and subsequent applications, spread building paper on the surface for a sufficient distance back from the ends of each application so that flow through the sprays may be started and stopped on the paper in order that all sprays will operate at full force on the surface treated. Immediately after application, remove and destroy the building paper. Properly treat areas inaccessible to the distributor with bituminous material using the hose attachment. Protect adjacent buildings, structures, and trees to prevent their being spattered or marred.

B. Brooming and Rolling:
   1. Roll the surface with a pneumatic-tired and a steel-wheeled roller after sufficient aggregate is spread. Continue rolling until no more aggregate can be worked into the treated surface. The use of the steel-wheeled roller will be discontinued, or a lighter weight steel wheel roller substituted, as directed, if the roller being used causes excessive crushing and shattering of the aggregate. If the aggregate is not distributed properly, broom the surface as soon as possible after the first coverage by the roller, but not until the surface has set sufficiently to prevent excessive marking. Continue brooming, rolling, and supplemental spreading of aggregate until the surface is cured and rolled sufficiently to key and set the aggregate. In places not accessible to rollers, compact the aggregate with pneumatic tampers. Remove aggregate that has become contaminated with foreign matter and replace with clean aggregate and reroll as directed. Maintain and protect the treated areas by use of barricades until properly cured.

3.08 APPLICATION OF SECOND COURSE

A. Bituminous Treatment:
   1. Apply the bituminous material for the second course within 48 hours after construction of the first course, weather permitting. Remove excess aggregate prior to the second application of bituminous material. If the treated surface is excessively moistened by rain, allow the surface to dry for such time as deemed necessary. Perform the second application of bituminous material in the manner specified in paragraph APPLICATION OF FIRST COURSE, including temperature and QUANTITY LIMITS.

B. Brooming and Rolling Second Course:
   1. Roll and broom the surface in the manner specified for the first course until a thoroughly bonded, smooth, even-textured surface is produced. Sweep off the surface surplus aggregate and remove it prior to final acceptance.

3.09 APPLICATION TEMPERATURE OF MATERIALS

A. Cutback Asphalt:
   1. Apply cutback asphalt in the range of 100 to 200 degrees F.

B. Emulsified Asphalt:
   1. Apply asphalt emulsions in the range of 120 to 160 degrees F.

C. Asphalt Cement:
   1. Apply asphalt cement in the range of 325 to 350 degrees F.

D. Constructing Joints:
   1. Continuously place each lift and provide at least a 6-inch (150 mm) offset between longitudinal joints in successive lifts. Offset transverse joints in successive lifts by at least 6 feet (1.8 m). Uniformly coat the exposed face of all joints, excluding those formed by echelon paving, with a double shot of emulsified asphalt before placing the abutting course. Construct longitudinal joints in the top lift of plant mix at the centerline or lane line. If these locations are not practical, construct the joint outside the wheel paths as approved by the Atlantic Richfield Company Representative.
   2. Construct a vertical transverse joint the full lift depth. Remove loose material, brush the joint face with asphalt, and compact the fresh mix against the joint face when paving is resumed. Taper the end of paving lifts at bridge ends and on roadways under traffic to a minimum 50H:1V ratio. When paving of the lift resumes, remove the taper and construct the transverse joint. Ensure transverse joints in lifts of plant mix surfacing or other lifts to be used by traffic for 15 calendar days or more do not vary more than 3/8-inch (9.5 mm) from any point on a taut 25-foot (7.6 m) string line placed parallel to centerline. Taper the longitudinal paving joint edges at a 4H:1V to 6H:1V slope. Compact the joint between abutting passes to the specified plant mix density. Do not permit an exposed longitudinal joint length to exceed one day's paving run. Sign the new pavement end at the close of work each day meeting the project's traffic control plan and the contract. Construct the joints at bridge ends or other rigid structures after the existing base is prepared and compacted. Apply a coat of emulsified asphalt to the portions of structures abutting the plant mix surfacing.

E. Pavement Repair:
   1. Cut out the defective pavement section to at least 0.15-foot (45 mm) depth or as directed by the Project Manager. Clean the sides and bottom of the repair area and apply tack coat to the surfaces. Fill the repair area with contract specified mix, level, and compact to the specified density and surface smoothness.

3.10 TRIAL APPLICATION

A. Preliminary to providing a complete surface treatment, treat [three] [_____] lengths of at least 100 feet each for the full width of the distributor bar. Use the appropriate typical application rates specified herein for one surface treatment trial. Make other surface treatment trials using various amounts of materials as may be deemed necessary.

3.11 PROTECTION

A. Keep all traffic off surfaces freshly treated with bituminous material. Provide sufficient warning signs and barricades so that traffic will not travel over freshly treated surfaces. Protect the treated areas from traffic for at least 24 hours after final application of bituminous material and aggregate, or for such time as necessary to prevent picking up.

Immediately prior to opening to traffic, roll the entire treated area with a self-propelled pneumatic-tired roller.

3.12 TESTING AND ACCEPTANCE

A. Bituminous materials are accepted on the test results of samples selected and tested by the CMGC. Collect samples and test using the applicable AASHTO method. The Atlantic Richfield Company Representative may permit using bituminous materials before the test results are available, if the test results of material previously furnished by the refiner have consistently been satisfactory. The use of bituminous materials before receipt of the test results as permitted by the Atlantic Richfield Company Representative does not waive the right to accept or reject materials under these specifications.

B. Conduct sampling and testing under the applicable ASTM/AASHTO Standards.
   1. Sampling and Testing:
      a. General: Take bitumen samples, other than products accepted under quality assurance, at the point of delivery on the project. The CMGC or designated representative is responsible for sampling the bituminous materials on the project at no additional cost to Atlantic Richfield Company. Drain off and discard at least 1 gallon (3.8 L) of the bituminous material before drawing samples. Draw 2 one quart (0.9 L) samples from each shipment, witnessed by the Atlantic Richfield Company Representative. Submit both samples to an approved laboratory for testing. One sample will be tested and the 2nd sample will be retained. Equip all transport vehicles with a spigot or gate valve in the unloading line, or in the tanker at the centerline of the tank, or in the pressure line from the unloading pump, or at another approved location. The spigot or gate valve diameter must be between 3/8- and 3/4-inch (9.5 and 19 mm). Locate the spigot or valve to prevent plant dust or other sample contamination.
         1) The first sample shall be tested and accepted if it is within result limits of the applicable ASTM/AASHTO tests. If the first sample is tested outside of the limits, the second sample shall be tested. The second test shall be accepted if within the limits. If the second test fails it is subject to rejection or acceptance per the Atlantic Richfield Company Representative. The Atlantic Richfield Company Representative reserves the right to test the second sample at any time at no additional cost to Atlantic Richfield Company.
      b. Asphalt Sampling (Quality Assurance Sampling): Provide a sample of the asphalt cement entering the mixing plant. One approved inline sampling device is shown in AASHTO T 40. Place the samples in approved containers. Submit the samples to an approved laboratory for testing. The Atlantic Richfield Company Representative will randomly designate the time of sampling based on the tons (MT) of asphalt cement incorporated into the completed mix produced. The approximate quantity of asphalt cement represented by each sample is 25 tons (25 MT). The Atlantic Richfield Company Representative may require additional samples and testing. Six samples represent approximately 150 tons (150 MT) of asphalt cement and constitute a lot whenever production schedules or material continuity permit. The Atlantic Richfield Company Representative may establish a lot consisting of the quantity represented by any number of consecutive random samples, from 3 to 7 inclusive, when necessary to represent short production runs, significant material changes, or other unusual characteristics of the work.
      c. Compaction, Compaction Control Testing, and Density Acceptance Testing: Complete compaction rolling within the temperature range recommended by the asphalt cement manufacturer included in the mix design or before the mat temperature falls below 175°F (80 °C). Compaction rolling after the temperature is

below 175 °F (80 °C) is cause to suspend paving operations. Compaction rolling is rolling in the vibratory mode. The Atlantic Richfield Company Representative may adjust the minimum 175 °F (80 °C) temperature if compaction rolling damages the new pavement or has received written approval from the asphalt cement manufacturer.

1) Perform all necessary density testing to control compaction. Once the plant mix is spread, struck off, and surface irregularities are corrected, compact to the plant mix to at least 93.0 percent of target maximum specific gravity with the following exceptions:
   (a) 92.0 percent - 3/8-inch (9.5 mm) mixes with plan depths of less than 0.12-foot (36 mm).
   (b) 92.0 percent - any mix placed directly on a crushed aggregate surfacing.
2) Compact plant mix placed over any typical section containing CTB to 93.0 percent for the full width of the typical section.
3) Provide core samples of the compacted plant mix from the roadway. Core locations will be randomly selected based on the tons (MT) of mix placed. Core the locations selected after all rolling is complete and before the roadway is opened to traffic. The center of the core location will not be within 12 inches (305 mm) of longitudinal paving joints, 12 inches (305 mm) of a shoulder hinge point, or where the planned nominal thickness is less than 0.10-foot (30 mm). The pavement density is determined from cores taken at randomly selected locations after all rolling is complete and before the roadway is open to traffic. Density acceptance by cores does not apply to leveling or isolation lifts that have a depth of less than 0.10-foot (30 mm) thick. Take cores after all rolling is complete. Provide two, 4-inch (100 mm) cores the full depth of the plant mix surfacing, extracted from within a 5-inch (125 mm) radius of each designated location. Mark the core as directed. Separate the plant mix lift to be tested from the total core. Cut the core to the actual lift thickness within ± 0.15-inch (4 mm). The Department recommends using a saw to separate the lift to be tested from the total core. Perform this work within the project limits or other approved location.
4) The Inspector will witness all of the above activities before traffic is permitted to use the plant mix lift being tested.
5) Furnish the core immediately to the Inspector after it is removed, marked and separated. Do not remove the cores from the Inspector's visual control at any time. Re-core as directed any time either the CMGC requirements or procedures within this section are not met. The test results of the replacement core to be used in the QA evaluation for the lot represented will be the actual relative in-place density unless it exceeds:
   (a) 92 percent; then 92 percent will be used for the relative in-place density of that core in the QA evaluation.
   (b) 91 percent for 3/8-inch (9.5mm) mixes with plan depths of less than 0.12 foot (36 mm); then 91 percent will be used for the relative in-place density of that core in the QA evaluation.
   (c) 91 percent for any mix placed directly on a crushed aggregate surfacing; and then 91 percent will be used for the relative in-place density of that core in the QA evaluation.
6) The plant mix in the sub lot represented is considered to be not meeting density specifications. Remove free water from each core hole; place and compact new hot plant mix, not exceeding 2-inch (50 mm) lifts, to the finished surface immediately after the core is removed. If approved by the Atlantic Richfield Company Representative, fill with a commercially manufactured

quick setting non-shrink grout to the finished surface. Apply a double shot of emulsified asphalt over the core holes when the patch material has set. Mark each core as directed by the Inspector witnessing the coring.

7) The approximate mix quantity represented by each sub-lot is 600 tons (600 MT). Additional locations and tests may be required. The quantity represented by 5 tests or approximately 3,000 tons (3,000 MT) of mix constitutes a lot whenever production schedules and material continuity permit. A lot represented by 3 to 7 consecutive random sub-lots will be established when there are short production runs, significant material changes, or other unusual characteristics of the work. All costs of furnishing the cores will be considered incidental to the plant mix surfacing item and no separate measurement or payment will be made.

2. Acceptance:
   a. General: Provide the Atlantic Richfield Company Representative a copy of the original bill of lading and a copy of the certificate of compliance, with each shipment. Ensure the certificate is signed by the supplier's representative and attests that the bituminous material meets the specifications for the type and grade of material provided and that the shipping container was inspected and found free of contamination. The certificate of compliance is the basis for tentative material acceptance and use.
   b. Failures: If a shipment of bituminous material fails to meet any of the specifications the material will be rejected. The Atlantic Richfield Company Representative may accept the material at a price reduction of the cost of the bituminous material at the Atlantic Richfield Company Representative's discretion.

END OF SECTION

SECTION 32 01 14
PAVEMENT MARKINGS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. AASHTO M 247(2013) - Standard Specification for Glass Beads Used in Pavement Markings.
      b. AASHTO M 249(2012; R2016) - Standard Specification for White and Yellow Reflective Thermoplastic Striping Material (Solid Form).
   2. ASTM International (ASTM):
      a. ASTM D1652 (2011; E 2012) - Standard Test Method for Epoxy Content of Epoxy Resins.
      b. ASTM D2074 (2007; R2013) - Standard Test Methods for Total, Primary, Secondary, and Tertiary Amine Values of Fatty Amines by Alternative Indicator Method.
      c. ASTM D2240 (2015; E 2017) - Standard Test Method for Rubber Property - Durometer Hardness.
      d. ASTM D2621 (1987; R 2016) - Standard Test Method for Infrared Identification of Vehicle Solids from Solvent-Reducible Paints.
      e. ASTM D2697 (2003; R 2014) - Volume Nonvolatile Matter in Clear or Pigmented Coatings.
      f. ASTM D3335 (1985a; R 2014) - Low Concentrations of Lead, Cadmium, and Cobalt in Paint by Atomic Absorption Spectroscopy.
      g. ASTM D3718 (1985a; R 2015) - Low Concentrations of Chromium in Paint by Atomic Absorption Spectroscopy.
      h. ASTM D3924 (2016) - Standard Specification for Environment for Conditioning and Testing Paint, Varnish, Lacquer, and Related Materials.
      i. ASTM D3960 (2005; R 2013) - Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings.
      j. ASTM D4060 (2014) - Abrasion Resistance of Organic Coatings by the Taber Abraser.
      k. ASTM D4061 (2013) - Standard Test Method for Retroreflectance of Horizontal Coatings.
      l. ASTM D4280 (2012) - Extended Life Type, Nonplowable, Raised, Retroreflective Pavement Markers.
      m. ASTM D4383 (2012) - Standard Specification for Plowable, Raised Retroreflective Pavement Markers.
      n. ASTM D4505 (2012; R 2017) - Standard Specification for Preformed Retroflective Pavement Marking Tape for Extended Service Life.
      o. ASTM D4541 (2017) - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.

p. ASTM D471 (2016a) - Standard Test Method for Rubber Property - Effect of Liquids.
q. ASTM D476 (2015) - Dry Pigmentary Titanium Dioxide Pigments.
r. ASTM D522/D522M (2014) - Mandrel Bend Test of Attached Organic Coatings.
s. ASTM D638 (2014) - Standard Test Method for Tensile Properties of Plastics.
t. ASTM D6628 (2003; R 2015) - Standard Specification for Color of Pavement Marking Materials.
u. ASTM D695 (2010) - Standard Test Method for Compressive Properties of Rigid Plastics.
v. ASTM D711 (2010; R 2015) - No-Pick-Up Time of Traffic Paint.
w. ASTM D7234 (2012) - Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers.
x. ASTM D823 (2018) - Standard Practices for Producing Films of Uniform Thickness of Paint, Coatings, and Related Products on Test Panels.
y. ASTM E1347 (2006; R 2011) - Color and Color Difference Measurement by Tristimulus (Filter) Colorimetry.
z. ASTM E1710 (2011) - Standard Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer.
aa. ASTM E2177 (2011) - Standard Test Method for Measuring the Coefficient of Retroreflected Luminance (RL) of Pavement Markings in a Standard Condition of Wetness.
bb. ASTM E2302 (2003; R 2016) - Standard Test Method for Measurement of the Luminance Coefficient Under Diffuse Illumination of Pavement Marking Materials Using a Portable Reflectometer.
cc. ASTM G154 (2016) - Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.

3. International Concrete Repair Institute (ICRI):
   a. ICRI 03732 (1997) - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
4. Society Of Automotive Engineers International (SAE):
   a. SAE AMS-STD-595A (2017) - Colors used in Government Procurement.
5. U.S. Federal Highway Administration (FHWA):
   a. MUTCD (2015) - Manual on Uniform Traffic Control Devices.
6. U.S. General Services Administration (GSA):
   a. FS TT-B-1325 (Rev D; Notice 1; Notice 2 2017) – Beads (Glass Spheres) Retro-Reflective (Metric).

1.03 SUBMITTALS

A. Atlantic Richfield Company approval is required for submittals in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-03 Product Data:
      a. Surface preparation equipment list.
      b. Application equipment list.
      c. Exterior surface preparation.
      d. Safety data sheets.
      e. Reflective media for roads.
      f. Waterborne paint.
      g. Solventborne paint.
      h. Thermoplastic compound.
      i. Raised pavement markers primers and adhesives.
      j. Manufacturer's Instructions:

1) Waterborne paint.
2) Solventborne paint.
3) Thermoplastic compound.

2. SD-05 Test Reports:
   a. Reflective media for roads.
   b. Waterborne paint.
   c. Solventborne paint.
   d. High build acrylic coating (HBAC).
   e. Thermoplastic compound.
   f. Raised pavement markers primers and adhesives.
   g. Test reports.
3. SD-06 Certificates:
   a. Qualifications.
   b. Reflective media for roads.
   c. Waterborne paint.
   d. Solventborne paint.
   e. Volatile organic compound, (VOC).
   f. Thermoplastic compound.

1.04 QUALITY CONTROL

A. Regulatory Requirements: Submit certificate stating that the proposed pavement marking paint meets the Volatile Organic Compound (VOC) regulations of the local Air Pollution Control District having jurisdiction over the geographical area in which the project is located. Submit Safety Data Sheets for each product.

B. Qualifications: Submit documentation certifying that pertinent personnel are qualified for equipment operation and handling of applicable chemicals. The documentation should include experience on five projects of similar size and scope with references for all personnel.

1.05 DELIVERY AND STORAGE

A. Deliver paint materials, thermoplastic compound materials, and reflective media in original sealed containers that plainly show the designated name, specification number, batch number, color, date of manufacture, manufacturer's directions, and name of manufacturer.

B. Provide storage facilities at the job site, only in areas approved by the Atlantic Richfield Company Representative, for maintaining materials at temperatures recommended by the manufacturer. Make available paint stored at the project site or segregated at the source for sampling not less than 30 days prior to date of required approval for use to allow sufficient time for testing. Notify the Atlantic Richfield Company Representative when paint is available for sampling.

1.06 PROJECT/SITE CONDITIONS

A. Environmental Requirements:
   1. Weather Limitations for Application:
      a. Apply pavement markings to clean, dry surfaces, and unless otherwise approved, only when the air and pavement surface temperature is at least 5 degrees F above the dew point and the air and pavement temperatures are within the limits recommended by the pavement marking manufacturer. Allow pavement surfaces to dry after water has been used for cleaning or rainfall has occurred prior to striping or marking. Test the pavement surface for moisture before beginning work

each day and after cleaning. Do not commence marking until the pavement is sufficiently dry and the pavement condition has been approved by the Atlantic Richfield Company Representative. Employ the "plastic wrap method" to test the pavement for moisture as specified in paragraph TESTING FOR MOISTURE.

2. Weather Limitations for Removal of Pavement Markings on Roads and Automotive Parking Areas:
    a. Pavement surface must be free of snow, ice, or slush; with a surface temperature of at least 40 degrees F and rising at the beginning of operations, except those involving shot or sand blasting or grinding. Cease operation during thunderstorms, or during rainfall, except for water-blasting and removal of previously applied chemicals. Cease water-blasting where surface water accumulation alters the effectiveness of material removal.

B. Traffic Controls:
1. Place warning signs conforming to MUTCD near the beginning of the worksite and well ahead of the worksite for alerting approaching traffic from both directions. Place small markers along newly painted lines or freshly placed raised markers to control traffic and prevent damage to newly painted surfaces or displacement of raised pavement markers. Mark painting equipment with large warning signs indicating slow-moving painting equipment in operation.
2. When traffic must be rerouted or controlled to accomplish the work, provide necessary warning signs, flag persons, and related equipment for the safe passage of vehicles.

C. Lighting:
1. When night operations are necessary, provide all necessary lighting and equipment. Atlantic Richfield Company reserves the right to accept or reject night work on the day following night activities by the CMGC.

PART 2 - PRODUCTS

2.01 EQUIPMENT

A. Surface Preparation and Paint Removal:
1. Surface Preparation Equipment for Roads and Automotive Parking Areas:
    a. Submit a surface preparation equipment list by serial number, type, model, and manufacturer. Include descriptive data indicating area of coverage per pass, pressure adjustment range, tank and flow capacities, and safety precautions required for the equipment operation. Mobile equipment must allow for removal of markings without damaging the pavement surface or joint sealant. Maintain machines, tools, and equipment used in the performance of the work in satisfactory operating condition.
2. Water-blasting Equipment:
    a. Use mobile water-blasting equipment capable of producing a pressurized stream of water that effectively removes paint from the pavement surface without significantly damaging the pavement. Provide equipment, tools, and machinery which are safe and in good working order at all times.
3. Grinding or Scarifying Equipment:
    a. Use equipment capable of removing surface contaminates, paint build-up, or extraneous markings from the pavement surface without leaving any residue. Clean the surface by hydro-blast to remove surface contaminates and ash after a weed torch is used to remove paint.

4. Chemical Removal Equipment:
    a. Use chemical equipment capable of applying and removing chemicals and paint from the pavement surface, leaving only non-toxic biodegradable residue without scarring or other damage to the pavement or joints and joint seals.

B. Application Equipment:
1. Submit an application equipment list appropriate for the material(s) to be used. Include manufacturer's descriptive data and certification for the planned use that indicates area of coverage per pass, pressure adjustment range, tank and flow capacities, and all safety precautions required for operating and maintaining the equipment. Provide and maintain machines, tools, and equipment used in the performance of the work in satisfactory operating condition or remove them from the work site. Provide mobile and maneuverable application equipment to the extent that straight lines can be followed, and normal curves can be made in a true arc.
2. Paint Application Equipment:
    a. Hand-Operated, Push-Type Machines: Provide hand-operated push-type applicator machine of a type commonly used for application of water-based paint or two-component, chemically curing paint, thermoplastic, or preformed tape, to pavement surfaces for small marking projects, such as legends and cross-walks, automotive parking areas, or surface painted signs. Provide applicator machine equipped with the necessary tanks and spraying nozzles capable of applying paint uniformly at coverage specified. Hand operated spray guns may be used in areas where push-type machines cannot be used.
    b. Self-Propelled or Mobile-Drawn Spraying Machines: Provide self-propelled or mobile-drawn spraying machine with suitable arrangements of atomizing nozzles and controls to obtain the specified results. Provide machine having a speed during application capable of applying the stripe widths indicated at the paint coverage rate specified herein and of even uniform thickness with clear-cut edges.
    c. Road Marking: Provide equipment used for marking roads capable of placing the prescribed number of lines at a single pass as solid lines, intermittent lines, or a combination of solid and intermittent lines using a maximum of three different colors of paint as specified.
    d. Hand Application: Provide spray guns for hand application of paint in areas where the mobile paint applicator cannot be used.
3. Thermoplastic Application Equipment:
    a. Thermoplastic Material: Apply thermoplastic material with equipment that is capable of providing continuous uniformity in the dimensions and reflectorizing the marking.
        1) Furnish plastic pavement markings and legends consisting of reflectorized, prefabricated, homogeneous, thermoplastic ribbon of the specified thickness. Assure the plastic contains reflective glass spheres uniformly distributed throughout its cross section and is capable of being affixed to bituminous or portland cement concrete pavements using a liquid contact cement or pre-coated, pressure-sensitive adhesive. Furnish white and yellow meeting standard highway colors. Assure the white plastic material is non-yellowing, and the yellow plastic material is non-fading for their expected useful life.
        2) For strip line widths of 6 inches (150 mm) or less, furnish plastic pavement striping material in a single manufactured width equal to the specified width. For specified stripe line widths exceeding 6 inches (150 mm), furnish plastic pavement striping material in a single manufactured width equal to the specified width or in two or more widths totaling the specified width.
        3) Cut the plastic marking material edges clean and true. Use at least 0.09-inch (2.25 mm) thick plastic material for inlaying into new asphaltic surfaces. Use at

least 0.06-inch (1.50 mm) thick plastic material for application to existing surfaces or to hardened new surfaces.

4) Assure plastic pavement markings for inlay into new asphaltic surfaces are capable of being applied just before the final rolling of the new surface and can be rolled into place with conventional pavement rollers. For inlay applications, assure the plastic and adhesive are not damaged by pavement temperatures exceeding 175° F (79° C) or by water on roller drums.
5) Assure the plastic pavement marking material and its adhesive are tack free to provide easy handling without using a protective backing and can be repositioned on the surface before being permanently fixed in position. Pre-coated adhesive must be uniformly distributed over the entire contact surface of the plastic material.
6) Furnish plastic pavement marking material capable of molding itself to pavement contours, breaks, and other surface irregularities under traffic at normal pavement temperatures. Assure the plastic material will fuse with itself and with previously applied markings of the same composition under normal use conditions.
7) Assure pavement legends and symbols meet the applicable shapes and sizes specified by the “Manual on Uniform Traffic Control Devices” as adopted by the FHWA.
8) Assure product agents or distributors furnish the manufacturer’s specifications showing that the material furnished meets or exceeds these requirements and submit evidence of successful product use over a one-year period under similar climatic conditions. Plastic pavement marking material not meeting this use requirement will be rejected.
9) Submit a 4-inch (100 mm) by 1-foot (300 mm) sample from each lot of plastic material proposed for use on the project to the Engineer for approval. Use only approved plastic pavement marking material on the project.
    (a) Composition Requirements: Furnish pre-formed plastic pavement marking material consisting of plasticizers, pigments, and graded glass spheres combined and proportioned to meet the following requirements.
        (i) Pigments: Minimum 20 percent titanium dioxide of total pigment for white marking material; Minimum 18 percent medium chrome yellow of total pigment for yellow marking material. Use graded glass spheres that are clean, transparent. Assure the glass spheres are uniformly distributed throughout the entire material.
    (b) Physical Requirements:
        (i) Tensile Strength: Assure the plastic material has a minimum tensile strength of 40 psi (270 kPa) of cross section when tested under ASTM D638. The break resistance is based on an average of at least three (3) samples tested at a temperature of 70° – 80° F (22° – 27° C) using a jaw speed of 0.25 inches (6.25 mm) per minute.
        (ii) Plastic Pull Test: A 1”-6” (25 mm – 150 mm) sample of the plastic material must support a dead weight of 0.66 lb per 0.01 inch (.28 kg per 2.5 0 mm) of material thickness for at least 5 minutes at 70° –80° F (22°-27° C).
        (iii) Bend Test: The plastic material must be flexible so that at 80° F (27° C), a 3” by 6” (75 mm by 150 mm) sample of the material can be bent over a 1” (25 mm) diameter mandrel until the end faces are parallel and 1” (25 mm) apart without showing any fracture lines in the uppermost surface under unassisted visual inspection.
        (iv) Skid Resistance: The surface friction of the plastic cannot be less than 35 BPN when tested under ASTM E303.

(v) Reseal Test: The plastic must re-seal to itself without adhesives when tested as follows: Overlap two 1” by 3” (25 mm by 75 mm) piece face-to-face so that they form a single 1” (25 mm) by 5” (125 mm) with a 1 square inch (25 square mm) overlap in the center. Place the piece on a hard surface with a 1000-gram weight resting uniformly on the entire overlap area and maintain at 140° to 190° F (60°-88° C) for 2 hours. The actual temperature to be maintained depends on the material being tested but must be within the specified range. After cooling to room temperature, the pieces must not separate without tearing.

(vi) Reflectivity: Furnish reflective pavement marking material having reflective values not less than those listed in the table below. Reflective values are measured under Federal Specifications L-S-300C. The reflective values must be measured on a 2 by 2-1/2-foot (.6 m by .75 m) panel at 85° incidence and be expressed as average candlepower per foot (meter)-candle per 5 square feet (1.5 m^2) of material. Divergence angle of 0.2 Degrees must contain 0.20 White and 0.15 Yellow. Divergence Angle of 0.5 Degrees must contain 0.15 White and 0.10 Yellow.

b. Application Equipment:
   1) Provide application equipment capable of continuous mixing and agitation of the material, with conveying parts which prevent accumulation and clogging between the main material reservoir and the extrusion shoe or spray gun. All parts of the equipment which come into contact with the material must be easily accessible and exposed for cleaning and maintenance. All mixing and conveying parts up to and including the extrusion shoes and spray guns must maintain the material at the required temperature with heat-transfer oil or electrical-element-controlled heat.
   2) Provide application equipment constructed to ensure continuous uniformity in the dimensions of the stripe. Provide an applicator with a means for cleanly cutting off stripe ends squarely and providing a method of applying "skiplines." Provide equipment capable of applying varying widths of traffic markings.
   3) Provide mobile and maneuverable application equipment allowing straight lines to be followed and normal curves to be made in a true arc. Provide equipment used for the placement of thermoplastic pavement markings of two general types: mobile applicator and portable applicator.
   4) Equip the applicator with a pressurized or drop-on type bead dispenser capable of uniformly dispensing reflective glass spheres at controlled rates of flow. The bead dispenser must operate automatically to begin flow prior to the flow of binder to assure that the strip is fully reflectorized.

c. Mobile Application Equipment:
   1) Provide a truck-mounted, self-contained pavement marking machine that is capable of hot applying thermoplastic by either the extrusion or spray method.
      (a) Equip the unit to apply the thermoplastic marking material at temperatures according to the manufacturer's instructions, at widths varying from 3 to 12 inches, with an automatic pressurized or drop-on bead dispensing system, capable of operating continuously, and of installing a minimum of 20,000 lineal feet of longitudinal markings in an 8-hour day.
      (b) Equip the mobile unit with a melting kettle which holds a minimum of 6,000 pounds of molten thermoplastic material; capable of heating the thermoplastic composition to temperatures as recommended by the manufacturer. Use a thermostatically controlled heat transfer liquid.

Heating of the composition by direct flame is not allowed. Oil and material temperature gauges must be visible at both ends of the kettle.

(c) Equip mobile units for application of extruded markings with a minimum of two extrusion shoes; located one on each side of the truck, capable of marking simultaneous edge line and centerline stripes; each being a closed, oil-jacketed unit; holding the molten thermoplastic at a temperature as recommended by the manufacturer; and capable of extruding a line of 3 to 8 inches in width; and at a thickness of not less than 0.120 inch nor more than 0.190 inch, of generally uniform cross section.

(d) Equip mobile units for application of spray markings with a spray gun system capable of marking simultaneous edge-line and centerline stripes. Surround (jacket) the spray system with heating oil to maintain the molten thermoplastic at a temperature of 375 to 425 degrees F, capable of spraying a stripe of 3 to 12 inches in width, and in thicknesses varying from 0.060 inch to 0.098 inch, of generally uniform cross section.

(e) Equip the mobile unit with an electronic programmable line pattern control system, capable of applying skip or solid lines in any sequence, through any and all of the extrusion shoes, or the spray guns, and in programmable cycle lengths. In addition, equip the mobile unit with an automatic counting mechanism capable of recording the number of lineal feet of thermoplastic markings applied to the pavement surface with an accuracy of 0.5 percent.

d. Portable Application Equipment:

1) Provide portable hand-operated equipment, specifically designed for placing special markings such as crosswalks, stop bars, legends, arrows, and short lengths of lane, edge and centerlines; and capable of applying thermoplastic pavement markings by the extrusion method. Equip the portable applicator with all the necessary components, including a materials storage reservoir, bead dispenser, extrusion shoe, and heating accessories, capable of holding the molten thermoplastic at the temperature recommended by the manufacturer, and of extruding a line of 3 to 12 inches in width, and in thickness of not less than 0.120 inch nor more than 0.190 inch and of generally uniform cross section.

C. Reflective Media Dispenser:

1. Attach the dispenser for applying the reflective media to the [paint] [thermoplastic] dispenser and designed to operate automatically and simultaneously with the applicator through the same control mechanism. The bead applicator must be capable of adjustment and designed to provide uniform flow of reflective media over the full length and width of the stripe at the rate of coverage specified in paragraph APPLICATION.

D. Preformed Tape Application Equipment:

1. Provide and use mechanical application equipment for the placement of preformed marking tape which is a mobile pavement marking machine specifically designed for use in applying pressure-sensitive pavement marking tape of varying widths. Equip the applicator with rollers, or other suitable compaction device to provide initial adhesion of the material with the pavement surface. Use additional tools and devices as needed to properly seat the applied material as recommended by the manufacturer.

2.02 MATERIALS

A. Use [waterborne paint] [epoxy paint] [thermoplastic] [raised pavement markers] [preformed tape] for roads. [Use non-reflectorized waterborne [or solventborne] paint for automotive parking areas. Color of markings are indicated on the drawings and must conform to ASTM D6628 for roads and automotive parking areas. Provide materials conforming to the requirements specified herein.

B. Waterborne Paint:
   1. Furnish acrylic latex white and lead-free yellow waterborne pavement marking meeting the following requirements.
      a. Composition: The exact composition is at the manufacturer's discretion except that the vehicle is to be 100 percent acrylic polymer and the paint is not to contain any ingredient listed below.
         1) Lead or chromate compounds; Mercury; Lead; Chromate compounds; Chlorinated Solvents; Hydrolysable chlorine derivatives; Ethylene based glycol ethers and their acetates.
         2) Meet the following requirements:

	White	Yellow
Pigment percent Solids ASTM D3723	68 max	68 max
Total Solids percent by weight ASTM D2369	75 mx	75 mx
Titanium Dioxide, lbs/gal ASTM D4563 & 1394	1 lb min	0.15 lb min
Percent Non-Volatile vehicle of total vehicle weight ASTM2697	41 min	41 min
VOC Content, maximum EPA Method 24	150 g/L	150 g/L
pH, Min ASTM E70	9.6	9.6
Viscosity (Krebs Stormer) K.U., ASTM D562 @ 77 °F	80-95	80-95
Grind Hegman, min ASTM D1210	2	2
Deviastion in prevent weight per gallon, max	±30	±30
Daylight Reflectance[1], min. ASTM D2805	85	59.1[2]
Contrast Ratio, 15 mils wet min., ASTM D2805	0.92	0.88

            (a) The Y-Tristimulus value (luminance) is obtained using a standardized Tristimulus colorimeter using a C illuminant at a two-degree observation angle. The paint sample is drawn to a 15-mil wet film thickness over a white substrate.
            (b) Color to match the V+ color on the Hale color chart ±6 percent.
      b. Characteristics:
         1) Flexibility and Adhesion: Apply a 15-mil wet film thickness to a 3" by 5" (75 mm by 130 mm) tin panel. Dry at 77°F (25°C) for 24 hours followed by two hours at 122°F (50°C). Bend sample over a ½-inch (13 mm) mandrel. Paint to adhere firmly without showing cracking or flaking.

2) Water Resistance: Apply a 15-mil wet film thickness to a 4” by 8” (102 mm by 203 mm) glass plate. Dry at 77°F (25°C) for 72 hours. Immerse in distilled water at 77°F (25°C) for 24 hours. Air dry for two hours on a flat surface. Paint to not show blistering or adhesion loss.
3) Skinning and Lumps: Fill a pint (0.473 L) container 3/4 full of paint and seal tightly. After 72 hours, strain paint through a 100-mesh screen. No lumps or skin retained on the screen is permissible.
4) Settling: Fill a centrifuge tube with paint and revolve for two hours at 1112 Newtons (250 ft/lbs). Separation from top of vehicle to top of pigment not to exceed 13 mm (1/2-inch).
5) Skinning: Fill a 1/2-pint (0.236 L) container half full of paint and seal. Let stand for 24 hours. No skinning to be visible.
6) Bleeding: When tested under ASTM D-969, paint to not show perceptible bleeding when painted on a bituminous surface.
7) Freeze-Thaw Stability: When tested under ASTM D-2243, paint to not show coagulation or viscosity change exceeding 10 Krebs units.
8) Static Heat Stability: Pour paint into a pint (473 mL) within 0.25 inches (6.4 mm) of the top, put the lid on and seal with tape, and place the container in an oven heated to 60°C ± 1°C (140°F ± 2°F) for seven days. Equilibrate the paint at standard conditions and thoroughly mix by stirring for at least five minutes. Ensure the paint does not show signs of livering, hard settling, coagulation, lumps or course particles. Perform a consistency test meeting ASTM D-562 at 25°C (77°F). Paint viscosity to not vary 10 K.U. from the original viscosity measured at 25°C (77°F).

c. Retro-reflective Glass Beads: Use silene-coated moisture resistant glass beads.
d. Application: Follow the manufacturer’s requirements for pavement cleaning and traffic paint application or as follows, whichever is more restrictive.
1) Apply to a dry surface.
2) Clean the pavement of all loose rock, dirt, and debris immediately before applying the traffic paint.
3) Do not heat the traffic paint to exceed 110°F (43.3°C) before and during application.
4) Apply the traffic paint when the ambient temperature is 50°F (10°C) and rising. Stop application when the temperature is 50°F (10°C) and dropping and when rain or other weather adverse to the traffic paint during its drying time is imminent.
5) Apply traffic paint at 15-mils (0.38 mm) wet thickness in a single application.
6) Remove and replace all defective pavement marking damaged by weather at CMGC expense.
7) Re-paint, at CMGC expense, all striping represented by paint samples where any specified property is outside 20 percent of the specified value.
e. Reflective Glass Beads:
1) Glass beads for use in reflectorizing traffic paint markings on pavement by the drop-on method must be spherical and transparent with smooth, lustrous surfaces. The beads, as delivered, must be spherical and transparent with smooth, lustrous surfaces. The beads, as delivered, must be free from extraneous material and clumps of beads that cannot be broken up easily when applying to the stripe.
2) Imperfections: The glass beads cannot include more than 25 percent irregularly shaped particles when tested under ASTM D1155. Assure the beads are free of scratches, pits, milkiness, dark particles, and excessive air bubbles.

3) Color: The glass beads must be colorless to the extent that they do not impart a noticeable daytime hue to white pavement markings.
4) Chemical Stability: The beads must withstand refluxing in distilled water in a Soxhlet extractor for 90 hours without noticeable dulling of surface luster and not more than 2.5 percent loss in weight.
5) Index of Refraction: The glass from which the beads are made must have an index of refraction of at least 1.50 by the immersion method using tungsten light.
6) Gradation: Assure the glass beads meet the following gradation requirements when tested under the Standard Method of Test for Sieve Analysis of Glass Spheres, ASTM D1214.

Sieve No.	Total Percent Passing
20	100
30	75-95
50	15-35
100	0-5

7) Packaging and Marking: Furnish glass beads in bags containing 50 lb. (26 kg) net. Assure the shipping bags are moisture proof, paper-lined burlap bags meeting specification ICC-36-C under Interstate Commerce Commission Regulation Section 78-234. Mark each bag with the name of contents, manufacturer of beads, and net weight.
8) Certification: Submit certification from a testing laboratory approved by the Engineer certifying the beads meet these expectations.

C. Thermoplastic Compound:
1. Composition Requirements:
a. Thermoplastic compound must conform to AASHTO M 249. Formulate the binder component as an alkyd resin.
2. Primer:
a. Asphalt concrete primer: Provide thermosetting adhesive primer with a solids content of pigment reinforced synthetic rubber and synthetic plastic resin dissolved or dispersed in a volatile organic solvent for asphaltic concrete pavements. The solids content must not be less than 10 percent by weight at 70 degrees F and 60 percent relative humidity. A wet film thickness of 0.005 inch, plus or minus 0.001 inch, must dry to a tack-free condition in less than 5 minutes.
b. Portland cement concrete primer: Provide an epoxy resin primer for Portland cement concrete pavements, of the type recommended by the manufacturer of the thermoplastic composition.

D. Preformed Tape:
1. Provide adherent reflectorized strip preformed tape in accordance with ASTM D4505 Retro-reflectivity Level II, Class 1, 2 or 3, Skid Resistance Level B.

E. Raised Pavement Markers Primers and Adhesives:
1. Use either metallic or nonmetallic markers of the button or prismatic reflector type. Provide permanent color markers as specified for pavement marking, which retain the color and brightness under the action of traffic. Provide button markers with a diameter of not less than 4 inches, spaced not more than 40 feet apart on solid longitudinal lines. Make broken centerline marker spacing in segments [indicated] with gaps [of indicated] between segments. Provide button markers with rounded surfaces presenting a

smooth contour to traffic and not projecting more than 3/4 inch above level of pavement. Provide [plowable] pavement markers and adhesive epoxy conforming to [ASTM D4280] [ASTM D4383].

F. Epoxy Paint:
1. Furnish epoxy or other polymeric traffic paint in accordance with the table below. Where the NTPEP method is specified, recorded NTPEP results must be within the specifications shown. Blue, red or black paint may be used without being NTPEP tested if the base paint is the same chemical composition as a NTPEP tested paint.

Test	**Specification**	**Method**
Color (x, y, Y)	ASTM D6628	ASTM D6628 and ASTM D75875
Durability (wheel)	minimum of 8 at 24 months	NTPEP
Luminance	white: ≥30 at 12 months yellow: ≥20 at 12 months	NTPEP
Viscosity (Krebs Stormer), K.U. at 77 °F (25 °C)	80-95	ASTM D562
Density deviation	maximum of ±0.30 lbs/gallon (±35.9 g/L) from density target	ASTM D1475
Contrast ratio	0.92	MT 584
Dry no track	10 minutes maximum	NTPEP
Freeze-thaw stability	Δ10KU	ASTM D2243
Static heat stability	Δ10KU	MT 548
Bleeding ratio	0.95 minimum	ASTM D868
Skinning and lumps	Pass	MT 548
Settling	Pass	
Skinning	Pass	
NTPEP lab test verification	must match NTPEP	NTPEP and MT 548
Antimony	≤20.0 mg/Kg	MT 548
Arsenic	≤20.0 mg/Kg	
Cadmium	≤4.0 mg/Kg	
Chromium	≤5.0 mg/Kg	
Cobalt	≤20.0 mg/Kg	
Lead	≤20.0 mg/Kg	
Mercury	≤1.00 mg/Kg	
Tin	≤20.0 mg/Kg	

PART 3 - EXECUTION

3.01 EXAMINATION

A. Testing for Moisture:
1. Test the pavement surface for moisture before beginning pavement marking after each period of rainfall, fog, high humidity, or cleaning, or when the ambient temperature has

fallen below the dew point. Do not commence marking until the pavement is sufficiently dry and the pavement condition has been approved by the Atlantic Richfield Company Representative.

2. Employ the "plastic wrap method" to test the pavement for moisture as follows: Cover the pavement with a 12-inch by 12-inch section of clear plastic wrap and seal the edges with tape. After 15 minutes, examine the plastic wrap for any visible moisture accumulation inside the plastic. Do not begin marking operations until the test can be performed with no visible moisture accumulation inside the plastic wrap. Re-test surfaces when work has been stopped due to rain.

B. Surface Preparation Demonstration:
   1. Prior to surface preparation, demonstrate the proposed procedures and equipment. Prepare areas large enough to determine [cleanliness][, adhesion of remaining coating] and rate of cleaning. [Perform a demonstration removal of pavement marking in an area designated by the Atlantic Richfield Company Representative.] [Approved demonstration area establishes the standard for the remainder of the work.]

C. Test Stripe Demonstration:
   1. Prior to paint application, demonstrate test stripe application within the work area using the proposed materials and equipment. Apply separate test stripes in each of the line widths and configurations required herein using the proposed equipment. Make the test stripes long enough to determine the proper speed and operating pressures for the vehicle(s) and machinery, but not less than 50 feet long.

D. Application Rate Demonstration:
   1. During the Test Stripe Demonstration, demonstrate compliance with the application rates specified herein. Document the equipment speed and operating pressures required to meet the specified rates in each configuration of the equipment and provide a copy of the documentation to the Atlantic Richfield Company Representative prior to proceeding with the work.

E. Retroreflective Value Demonstration:
   1. After the test stripes have cured to a "no-track" condition, demonstrate compliance with the average retroreflective values specified herein. Take a minimum of ten readings on each test stripe with a Retro-reflectometer with a direct readout in millicandelas per square meter per lux (mcd/m2/lx). Perform testing in accordance with ASTM D4061, ASTM E1710, ASTM E2177, and ASTM E2302.

F. Level of Performance Demonstration:
   1. The Atlantic Richfield Company Representative will be present at the application demonstrations to observe the results obtained and to validate the operating parameters of the vehicle(s) and equipment. If accepted by the Atlantic Richfield Company Representative, the test stripe is the measure of performance required for this project. Do not proceed with the work until the demonstration results are satisfactory to the Atlantic Richfield Company Representative.

3.02 EXTERIOR SURFACE PREPARATION

A. Allow new pavement surfaces to cure for a period of not less than [30] [_____] days before application of marking materials. Thoroughly clean surfaces to be marked before application of the paint. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods as required. Remove rubber deposits, existing paint markings, residual curing

compounds, and other coatings adhering to the pavement by water blasting, approved chemical removal method, or Atlantic Richfield Company approved method.

1. For Portland cement concrete pavement, grinding, light shot blasting, or light scarification, to a resulting profile equal to ICRI 03732 CSP 2, CSP 3, and CSP 4, respectively, can be used in addition to water blasting on most pavements, to either remove existing coatings, or for surface preparation.

B. Early Painting of Rigid Pavements:
   1. Pretreat rigid pavements that require early painting with an aqueous solution containing 3 percent phosphoric acid and 2 percent zinc chloride. Apply the solution to the areas to be marked.

C. Early Painting of Asphalt Pavements:
   1. For asphalt pavement systems requiring painting application at less than 30 days, apply the paint and beads at half the normal application rate, followed by a second application at the normal rate after 30 days.

3.03 APPLICATION

A. Apply pavement markings to dry pavements only.
   1. Paint:
      a. Apply paint with approved equipment at rate of coverage specified herein. Provide guidelines and templates as necessary to control paint application. Take special precautions in marking numbers, letters, and symbols. Manually paint numbers, letters, and symbols. Sharply outline all edges of markings. The maximum drying time requirements of the paint specifications will be strictly enforced, to prevent undue softening of bitumen, and pickup, displacement, or discoloration by tires of traffic. If there is a deficiency in drying of the markings, painting operations must cease until the cause of the slow drying is determined and corrected.
         1) Roads:
            (a) Apply paint at a rate of 105 plus or minus 5 square feet per gallon. Apply beads at a rate of 7 plus or minus 0.5 pounds of glass spheres per gallon.
   2. Thermoplastic Compound:
      a. Place thermoplastic pavement markings, free from dirt or tint, upon dry pavement. The temperature must be a minimum of 40 degrees F and rising at the time of installation. Apply all centerline, skip-line, edge-line, and other longitudinal type markings with a mobile applicator. Place all special markings, crosswalks, stop bars, legends, arrows, and similar patterns with a portable applicator, using the extrusion method.
         1) Primer
   3. Reflective Media:
      a. Immediately after installation of the thermoplastic material, mechanically apply drop-on reflective glass spheres conforming to [FS TT-B-1325 Type I] [AASHTO M 247 Type 1] at the rate of one pound per 20 square feet such that the spheres are held by and imbedded in the surface of the molten material. Accomplish drop-on application of the glass spheres to ensure even distribution at the specified rate of coverage. If there is a malfunction of either thermoplastic applicator or reflective media dispenser, discontinue operations until deficiency is corrected.
   4. Raised Pavement Markers:
      a. Align prefabricated markers carefully at the spacing indicated on the drawings and permanently fix in place by means of epoxy adhesives. To ensure good bond prior to applying adhesive, thoroughly clean all areas where markers are to be set by water blasting and use of compressed air.

5. Preformed Tape:
    a. The pavement surface and ambient air temperature must be a minimum of 60 degrees F and rising. Place the preformed markings in accordance with the manufacturer's written instructions.

B. Cleanup and Waste Disposal:
    1. Keep the worksite clean and free of debris and waste from the removal and application operations. Dispose of debris as described in the CMGC's WMP.

3.04 FIELD QUALITY CONTROL

A. Sampling and Testing:
    1. As soon as the paint, thermoplastic materials, and reflective media are available for sampling, obtain by random selection from the sealed containers, four quart samples of each batch in the presence of the Atlantic Richfield Company Representative. Two quarts will be for sampling and testing by the CMGC and two quarts will be for retention by the Atlantic Richfield Company Representative. Accomplish adequate mixing prior to sampling to ensure a uniform, representative sample. A batch is defined as that quantity of material processed by the manufacturer at one time and identified by number on the label. Clearly identify samples by designated name, specification number, batch number, project contract number, intended use, and quantity involved.
    2. Test samples by an approved laboratory. If a sample fails to meet specification, replace the material in the area represented by the samples and retest the replacement material as specified above. Submit certified copies of the test reports, prior to the use of the materials at the jobsite. Include in the report of test results a listing of any specification requirements not verified by the test laboratory. At the discretion of the Atlantic Richfield Company Representative, samples provided may be tested by Atlantic Richfield Company for verification.

B. Material Inspection:
    1. Examine material at the job site to determine that it is the material referenced in the report of test results or certificate of compliance. Provide test results substantiating conformance to the specified requirements with each certificate of compliance.

C. Dimensional Tolerances:
    1. Apply all markings in the standard dimensions provide in the drawings. New markings may deviate a maximum of 10 percent larger than the standard dimension. The maximum deviation allowed when painting over an old marking is up to 20 percent larger than the standard dimensions.

D. Bond Failure Verification:
    1. Inspect newly applied markings for signs of bond failure based on visual inspection and comparison to results from Test Stripe Demonstration paragraph.

E. Reflective Media and Coating Application Verification:
    1. Use a wet film thickness gauge to measure the application of wet paint. Use a microscope or magnifying glass to evaluate the embedment of glass beads in the paint. Verify the glass bead embedment with approximately 50 percent of the individual bead spheres embedded and 50 percent of the individual bead spheres exposed.

F. Retroreflective Markings:
    1. Collect and record readings for white and yellow retroreflective markings at the rate of one reading per 1000 linear feet. The minimum acceptable average for white markings is 200 millicandelas per square meter per lux (mcd/m2/lx) (measured with Retro-

reflectometer). The minimum acceptable average for yellow markings is 175 millicandelas per square meter per lux (mcd/m2/lx). Compute readings by averaging a minimum of 10 readings taken within the area at random locations. Re-mark areas not meeting the retroreflective requirements stated above.

END OF SECTION

SECTION 32 13 13
PORTLAND CEMENT CONCRETE PAVEMENT

PART 1 - GENERAL

1.01 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
   1. ASTM International (ASTM):
      a. ASTM C-143 - Slump of Hydraulic Cement Concrete.
      b. ASTM C-231 - Air Content of Freshly Mixed Concrete.
      c. ASTM C-138 - Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
      d. ASTM C-39 - Compressive Strength of Cylindrical Concrete Specimens.
      e. ASTM C-78 - Flexural Strength of Concrete.
      f. ASTM C-150 - Standard Specification for Portland Cement.
      g. ASTM C-595 - Standard Specification for Blended Hydraulic Cements.
      h. ASTM C-157 - Standard Performance Specification for Hydraulic Cement.
      i. ASTM C-33 - Standard Specification for Concrete Aggregates.
      j. ASTM C-94 - Standard Specification for Ready-Mixed Concrete.
   2. American Association of State Highway Transportation Officials (AASHTO):
      a. AASHTO M 85 - Standard Specification for Portland Cement.
      b. AASHTO M 183 - Standard Specification for Structural Steel.
      c. AASHTO M 157 - Standard Specification for Ready-Mixed Concrete.
      d. AASHTO M 213 - Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction.
      e. AASHTO M 182 - Standard Specification for Sheet Materials for Curing Concrete.
      f. AASHTO M 148 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

1.02 DESIGN

A. This materials and construction specification is intended to be used on projects for the Pavement Design for Roads, Streets, Walks, and Open Storage Areas, Guide for the Design and Construction of Concrete Parking Lots, or Guide for Design of Jointed Concrete Pavements for Streets and Local Roads, or equivalent.

1.03 RELATED SECTIONS

A. Portland cement concrete pavement must use Section 32 01 12 – Base Course, in addition to this section.

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-01 Preconstruction Data:
      a. Concrete Mix Design:
         1) Thirty days minimum prior to concrete placement, submit a mix design, with applicable tests, for each strength and type of concrete for approval. Submit a complete list of materials including type; brand; source and amount of cement, fly ash, slag, and admixtures; and applicable reference specifications. Provide

mix proportion data using at least three different water-cement ratios for each type of mixture, which will produce a range of strength encompassing those required for each class and type of concrete required. Submittal must clearly indicate where each mix design will be used when more than one mix design is submitted. Obtain acknowledgement of approvals prior to concrete placement. Submit a new mix design for each material source change.

2. SD-03 Product Data:
   a. Curing materials.
   b. Admixtures.
   c. Dowel.
   d. Reinforcement: Submit a complete list of materials including type, brand and applicable reference specifications.
   e. Cementitious materials.
   f. Aggregate.
3. SD-05 Test Reports:
   a. Aggregate tests.
   b. Concrete slump tests.
   c. Air content tests.
   d. Flexural strength tests.
4. SD-06 Certificates:
   a. Ready-mixed concrete plant.
   b. Batch tickets.
   c. Cementitious materials.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Per ASTM C94/C94M.

1.06 QUALITY CONTROL

A. Required Information: Submit copies of laboratory test reports showing that the mix has been successfully tested to produce concrete with the properties specified and that mix will be suitable for the job conditions. The laboratory test reports must include mill test and all other test for cementitious materials, aggregates, and admixtures. Provide maximum nominal aggregate size, combined aggregate gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Submit test reports along with the concrete mix design. Sampling and testing of materials, concrete mix design, sampling and testing in the field must be performed by a commercial testing laboratory. The laboratory must be approved in writing by the Atlantic Richfield Company Representative.

B. Batch Tickets: ASTM C94/C94M. Submit mandatory batch ticket information for each load of ready-mixed concrete.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Placing During Cold Weather:
   1. Do not place concrete when the air temperature reaches 40 degrees F and is falling or is already below that point. Placement may begin when the air temperature reaches 35 degrees F and is rising, or is already above 40 degrees F. Make provisions to protect the concrete from freezing during the specified curing period. If necessary to place concrete when the temperature of the air, aggregates, or water is below 35 degrees F, placement and protection must be approved in writing. Approval will be contingent upon full conformance with the following provisions. Prepare and protect

the underlying material so that it is entirely free of frost when the concrete is deposited. Heat mixing water and aggregates as necessary to result in the temperature of the in-place concrete being between 50- and 85-degrees F. Methods and equipment for heating must be approved by Atlantic Richfield Company. Use only aggregates that are free of ice, snow, and frozen lumps before entering the mixer. Provide covering or other means as needed to maintain the concrete at a temperature of at least 50 degrees F for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period.

B. Placing During Warm Weather:
   1. The temperature of the concrete as placed must not exceed 85 degrees F except where an approved retarder is used. Cool the mixing water and aggregates as necessary to maintain a satisfactory placing temperature. The placing temperature must not exceed 95 degrees F at any time.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Portland Cement:
   1. Use Portland Cement for paving meeting AASHTO M 85, ASTM C150 Types I, II, III, and V or ASTM C-595 Type IP or ASTM C-1157 Types GU, MS, HE, and HS. The Atlantic Richfield Company Representative will specify the type of cement to be used.
      a. Air Entraining Agents:
         1) Section 03 30 00 – Cast-In-Place Concrete.
      b. Admixtures:
         1) Section 03 30 00 – Cast-In-Place Concrete.
      c. Water:
         1) Section 03 30 00 – Cast-In-Place Concrete.
      d. Fine Aggregate Concrete:
         1) Use Fine Aggregate for concrete meeting ASTM C33.
      e. Coarse Aggregate:
         1) Use Coarse Aggregate for concrete meeting ASTM C33.
      f. Reinforcing Steel:
         1) Use reinforcing steel meeting Section 03 20 00 – Concrete Reinforcing.
         2) Use dowel bars for rigid Pavement Expansion Joints or Devices meeting AASHTO M1 83 (ASTM A36). Assure dowel bars are plain and free from burring or other deformations that prevent slippage in the concrete. Paint one-half the bar length with one coat of zinc or tar paint.
      g. Sleeves:
         1) Use Metal Sleeves for dowel bars of standard manufacture that cover 2-in mm), plus or minus 1/4-inch (6-5 mm), of the dowel, having one closed end and internal stop that holds the dowel bar at least 1-inch (25 mm) from the end. Avoid collapsing the sleeve during construction.

B. Joint Fillers and Sealers:
   1. Furnish a one-piece joint filler sized to the full dept and width of the joint. If a multiple pieced joint filler is approved, fasten the abutting ends following the filler manufacturer's recommendations.
   2. Use pourable Joint sealer meeting ASTM D3406.
   3. Use two- component polyurethane or polysulfide-base sealant meeting, A.N.S.I A 116.1-1960 flow and strength requirements where specified.

4. Use either Class A (self-leveling) or Class B (non-sag) sealant for horizontal joints. Use Class B sealant for sloped or vertical joints.
5. Use preformed joint filler meeting, AASHTO M213 requirements, punched to receive the dowels shown on the plans.
6. Use preformed compression joints manufactured to the dimensions specified on the plans, from materials meeting ASTM D 2628.
7. Furnish a certification for each shipment of joints indicating that the material has been sampled, tested, and inspected under ASTM D 2628. Assure each certification furnished is signed by a manufacturer's authorized agent or independent testing agency.
8. If recommended by the manufacturer, use a manufacturer approved lubricant-adhesive to provide lubrication and bond for the joint.

C. Curing and Protective Coasting Materials:
1. Furnish materials meeting the following requirements:
   a. AASHTO M1802 (Class 3) - Burlap Cloth made from Jute of Kenaf.
   b. AASHTO M171 (ASTM C171) - Sheet Materials for Curing Concrete.
   c. AASHTO M148 - Liquid Membrane-Forming Compounds for Curing Concrete.

D. Proportioning:
1. Have a qualified independent testing laboratory, approved by Atlantic Richfield Company, determine the mix design to meet flexural or compressive strength of the pavement as specified in the Contract documents. Proportion the concrete mix under Section 03310.2.3 and have a maximum 4" (102 mm) slump (2" (51mm) slip form method).

PART 3 - EXECUTION

3.01 GENERAL

A. Obtain Atlantic Richfield Company's approval of equipment and tools used for handling, materials and performing all parts of the work. Approval applies to design, capacity, and mechanical conditions. Assure the equipment is on site ahead of the start of construction operations for Atlantic Richfield Company’s examination.

3.02 BATCHING PLANT AND EQUIPMENT

A. General:
1. The batching, plant includes bins, weighing hoppers and scales for the fine aggregate and each coarse aggregate size. Furnish a separate scale, bin, and hopper for cement if cement is used in bulk. Assure the weighing hopper is properly sealed and vented to prevent dust during operation.

B. Bins and Hoppers:
1. Provide bins with adequate separate compartments for fine aggregate and for each size of coarse aggregate in the batching plant.

C. Scales:
1. Use either beam type or springless-dial type scales for weighing, aggregates and cement. Assure the scale is accurate to within 0.5 percent throughout the range of use. When beam-type scales are used, equip the scale with a "tell-tale" dial or other device for indicating, that the required load in the weighing hopper is being approached. The device on weighing beams must clearly indicate critical position. Assure Poises are designed to be secured in any position and to prevent inadvertent change. Assure the

weigh beam and "tell-tale" device are in full view of the operator as the hopper is charged and operator has convenient access to all controls.
2. Have certified scales. Have on hand not less than ten, 50-pound (22.7 kg) weights for frequent testing of all scales.
3. Batching plants may be equipped to proportion aggregates and bulk cement using, automatic weighing devices of an approved type.
4. Obtain the Atlantic Richfield Company's approval for any deviations from the above stated batch plant and equipment requirements before concrete manufacture.

D. Stockpiled Aggregate:
1. This work is storing aggregate material for use on the project at the specified locations.
   a. Materials
      1) Assure aggregates meet the applicable requirements of ASTM C-22 AGGREGATES for the type of material required.
   b. Construction:
      1) Clear and grub the stockpile site. Assure the site is firm smooth and well drained. Place an aggregate bed to prevent contamination of the stockpiles.
      2) Build the stockpiles in maximum 4 feet (1.22 m) layers, with the preceding layer completely in place before starting, the next layer. Deposit the material to prevent coning, excluding fine aggregate approximately 90 percent finer than a No.4 sieve.
      3) Do not dump, cast, or push material over stockpile sides excluding fine aggregate specified above.
      4) Space or separate using walls, stockpiles of different aggregate types or sizes to prevent intermingling of the aggregates.
      5) Submit and obtain Atlantic Richfield Company's approval of operational plan for stockpiling any material obtained by wet pit or dredging operations.
      6) Atlantic Richfield Company may take random samples from stockpile areas where equipment has been operated. Stop operating equipment over stockpiles if tests show degradation is occurring.
      7) Remove and transport stockpiled material to prevent segregation.

E. Mixing:
1. General:
   a. Mix concrete on site, at a central plant, or wholly or partially in truck mixers. Assure each mixer has a manufacturer's plate showing the drum capacity of mixed concrete and rotation speed of the mixing drum or blades attached in a prominent place.
2. On Site Mixers:
   a. Mix concrete in an approved mixer able to combine the aggregates, cement, and water into a thoroughly mixed and uniform mass within the specified mixing period, and of discharging and distributing the mixture without segregation on the prepared grade. Assure the mixer is equipped with an approved timing device that automatically locks the discharge lever when the drum has been charged and releases at the end of the mixing period.
   b. Follow the manufacturer's recommendations for cleaning the mixer. Repair or replace the pickup and throw-over blades in the drum or drums when they are worn down 1 inch (25.4 mm) or more.
   c. Have available at the job site a copy of the manufacturer's design, showing blade dimensions and arrangement, and original blade height and depth; or place permanent marks on blades 1 inch (25.4 mm) from the new blade end. Drilled holes of 1/4-inch (6.4 mm) diameter near each end and at the mid- point of each blade are acceptable markings.

d. Truck Mixers and Truck Agitators:
   1) Assure truck mixers for mixing and hauling concrete, and truck agitators used for hauling central-mixed concrete meet Section 03 30 00 – Cast-in-Place Concrete.
e. Non-Agitator Tucks:
   1) Assure bodies of non-agitating, hauling equipment for concrete are smooth, mortar tight metal containers, capable of discharging the concrete at a controlled rate without segregation. Discharge of concrete to be from the bottom of the container. If the equipment body is tilted to discharge concrete, assure baffles retard the load.

3.03 FINISHING EQUIPMENT

A. Finishing Machine:
   1. Use a suitable finishing machine.

B. Vibrators:
   1. Vibrators may be either the surface pan type or the internal type with immersed tube or multiple spuds. Vibrators may be attached to the spreader, the finishing machine, or mounted on a separate carriage. Do not permit vibrators to come in contact with joints, load transfer devices, subgrade, or side forms. Maintain the surface vibrator frequency at 3,500 or more impulses per minute. Maintain frequency of internal types at 5,000 impulses per minute or more for tube vibrators. Maintain 7,000 impulses per minute or more for spud vibrators.
   2. Maintain a minimum frequency of 3,500 impulses per minute when spud-type internal vibrators, either hand-operated or attached to spreaders or finishing, machines, are used adjacent to forms.

C. Concrete Saw:
   1. When sawing concrete joints, use sawing equipment capable of producing the specified cut producing a straight line. Provide artificial lighting for night work to produce work of daytime quality. Assure this equipment is on the job both before and during concrete placement.

D. Forms:
   1. Use Straight Side Metal Forms having:
      a. A minimum 7/32-inch (5.6 mm) thickness.
      b. A minimum 10 feet (3.05 m) length.
      c. A depth at least equal to the prescribed edge thickness of the concrete.
      d. No horizontal joints.
      e. A base width equal to at least the depth of the forms.
   2. Use flexible or curved forms for curves of 100-foot (30.5 m) radius or less. Obtain Atlantic Richfield Company approval before using flexible or curved forms. Provide form anchors capable of withstanding, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Assure flange braces extend outward on the base at least two-thirds the height of the form.
   3. Do not use forms with battered top surfaces, bent, twisted, broken forms in the work.
   4. Do not use repaired forms until inspected and approved. Use built-up forms only where the total pavement area of any specified thickness on the project is less than 2,000 square yards (1672 m2). Assure the top form face does not vary from a true plane more than 1/8-inch in 10 feet (3.2 mm in 3.05 m), and the upstanding leg does not vary more than 1/4-inch (6.35 mm). Assure the forms are capable of locking the ends of abutting form sections together tightly providing a secure setting.

3.04 GRADE PREPARATION

A. Once the base and or subgrade is graded and compacted to the specified requirements, trim the grade to specified elevation.

B. Bring the subgrade or base course to the specified cross section when side forms are set to grade.

C. Fill and compact low areas with approved material or fill with concrete integral with the pavement.

D. Maintain the finished grade until the pavement is placed.

E. Keep the subgrade or base course uniformly moist until the concrete is placed. Do not over wet creating mud or water to pond.

3.05 SETTING FORMS

A. Base Support:
   1. Prepare the foundation under the forms so that when the form is set, it is in contact for its whole length at the specified grade. Fill and compact to grade with granular material, any grade at the form line found to be below established grade. Correct out of specification grade lines by tamping, or by cutting, as required.

B. Form Setting:
   1. Set forms in advance of concrete placing to prevent placing delays. Once forms are set to correct grade, compact the grade on the inside and outside edges of the form base. Stake forms with at least three pins for each 10- foot (3.05 m) section. Pin each side of every joint. Assure form sections are tightly locked, free from play or movement in any direction. Assure the forms do not deviate from true line in excess of 1/4-inch (6.35 mm) at any point. Correct all form settlement or springing, under the finishing, machine. Clean and oil forms before placing concrete.

C. Grade and Alignment:
   1. Check and correct all form alignment and grade elevation immediately before placing concrete.

D. Curbs and Gutters as Forms:
   1. Edges of previously placed concrete gutter section may be used as a form.

3.06 HANDLING, MEASURING, AND BATCHING MATERIALS

A. Set up the batch plant site, layout, equipment, and transporting material to assure an uninterrupted supply of material to the work. Stockpile aggregates from different sources and of different gradations to prevent co-mingling.

B. Handle aggregates from stockpiles or other sources to the batching plant to prevent segregation. Aggregates that are segregated or mixed with earth or foreign material cannot be used in the work. Stockpile or bin all aggregates produced or handled by hydraulic methods and washed aggregates for at least 12 hours before batching. Rail shipment exceeding 12 hours will be accepted as adequate binning only if the car bodies permit free drainage.

C. Separately weigh the fine and coarse aggregate into hoppers in the amounts specified in the mix. Measure cement by the sack or by weight. Use separate scales and hoppers for

weighing the cement, with a device that indicates the complete cement batch discharge into the batch box or container. One sack of bulk cement is 94 pounds (42.64 kg).

D. Measure all admixtures into the mixer within ±3% accuracy.

3.07 MIXING CONCRETE

A. Mix the concrete at the work site using a central-mix plant or truck mixers. Mixing time is measured from the time all materials, except water, are in the drum. Meet AASHTO M 157 and or ASTM C-94 requirements for ready-mix concrete mixing and delivery.

B. Operate the mixer at the manufacturer's recommended drum speed on the name plate. Remove and dispose of outside the work at Construction Management General Contractor (CMGC) expense, any concrete mixed less than the specified time. Do not exceed the mixer's nominal capacity, in cubic feet, as shown on the manufacturer's standard rating plate on the mixer. An overload up to 10 percent above the mixer's nominal capacity may be permitted if concrete tests for strength, segregation, and uniform consistency are satisfactory, and if no concrete spill occurs.

C. Re-tempering concrete by adding water or by other means is not permitted. When concrete is delivered in transit mixers or agitators, additional water may be added to the batch materials and additional mixing, time to increase the slump to meet the specified requirements, if permitted by Atlantic Richfield Company, providing the following, conditions are met:
   1. Maximum allowable water-cement ratio is not exceeded.
   2. Maximum allowable slump is not exceeded.
   3. Maximum allowable mixing and agitating, time (or drum revolutions) is not exceeded.
   4. Concrete is remixed for at least one-half the minimum required mixing time or number of revolutions.

D. Concrete not meeting these requirements will be rejected. Obtain the Atlantic Richfield Company's approval for admixtures that increase the workability or accelerate the set.

3.08 LIMITATIONS OF MIXING

A. Do not mix, place, or finish concrete when light conditions prevent meeting, the contract requirements. Obtain Atlantic Richfield Company's approval of artificial lighting

B. Discontinue concrete mix operations when the ambient temperature is 40° F (4°C) and falling. Do not resumed concrete work until the ambient temperature is 35°F (2°C) and rising.

C. When concreting work is approved during cold weather, the aggregates may be heated by either steam or dry heat before being placed in the mixer. Assure the material is uniformly heated without injuring it.

D. Maintain the mixed concrete temperature between 50°F (10°C) and 90°F (32°C) during placement in the forms.

E. Atlantic Richfield Company may direct heating the water and aggregates if the air temperature is 35°F (2°C) or less at the time of placing, concrete. Heat water and aggregate to between 70°F (21°C) and 150°F (66°C). Do not place concrete on frozen subgrade or use frozen aggregates in the concrete.

3.09 PLACING CONCRETE

A. Each placing/finishing crew must have at least one ACI Flatwork Finisher Technician level or above, on site at all times.

B. Place the concrete on the grade, handling, it as little as possible. Assure truck mixers, truck agitators, or non-agitating hauling equipment are capable of concrete discharge without segregating, the materials. Unload the concrete into an approved spreader and spread on the grade to prevent segregation. Continuously place concrete between transverse joints without the use of intermediate bulkheads. Perform necessary hand spreading, using only shovels. Do not permit workmen to walk in freshly mixed concrete with boots or shoes coated with earth or foreign substances.

C. Where concrete is to be placed adjoining a previously constructed lane of pavement and mechanical equipment will be operated upon the existing lane of pavement, assure that lane has attained 80 percent of design strength. If only finishing equipment is carried on the existing lane, paving in the adjoining lanes may be permitted.

D. Thoroughly consolidate concrete against and along the faces of all forms and along the full length and on both sides of all joint assemblies using vibrators. Do not permit vibrators to contact joint assemblies, the grade, or a side form. Do not operate vibrators more than 15 seconds in any one location.

E. Deposit concrete as close to expansion and contraction joints as possible without disturbing them. Do not dump from the discharge bucket or hopper onto a joint assembly unless the hopper is centered on the joint assembly.

F. Immediately remove any concrete spills from completed slab surfaces, using methods approved by Atlantic Richfield Company.

3.10 TESTING

A. Use ACI Grade I or equivalent certified field-testing technicians for all concrete tests.
   1. Sample, make specimens, and test concrete under the following:
      a. Slump: AASHTO T1 19(ASTM C-143).
      b. Air Content (Gravel or Stone): AASHTO T1 52 (ASTM C-23 1).
      c. Air Content (Slag or Highly Porous Aggr.): ASTM C-173.
      d. Cement Content & Unit Weight: AASHTO T121 (ASTM C-138).
      e. Strength (Compressive): AASHTO T22 (ASTM C-39).
      f. Strength (Flexural, Third Point Method) - AASITFO T97 (ASTM C-78).
      g. Making and Curing Test:
         1) Specimens in the Field - AASHTO T97 (ASTM C-78).
         2) Cure beams in the field by the method specified for the pavement.

3.11 STRIKE OFF CONCRETE AND PLACEMENT OF REINFORCEMENT

A. Place the concrete, strike it off, consolidate, and finish it to the planned cross section and elevation.

B. When placing reinforced concrete pavement in two layers, strike-off the first layer to plan depth and place the reinforcing full length its final position without further manipulation. Place the second concrete layer, strike it off, and screed. Remove and replace any bottom layer concrete that has been in place more than 30 minutes without being covered with the top layer at CMGC expense. When reinforced concrete is placed in one layer, the

reinforcement may be positioned in advance of concrete placement or it may be placed by mechanical or vibratory means in plastic concrete, after the concrete is spread.

C. Assure reinforcing steel is free from dirt, oil, paint, grease, mill scale, and loose thick rust.

3.12 JOINTS

A. Construction Joints as specified in the Contract Documents.
   1. Longitudinal Joint:
      a. Place deformed steel tie bars of specified length, size, spacing, and material as shown on the plans. Place reinforcing using approved mechanical equipment or rigidly secured by chairs or other approved supports. Assure tie bars are not painted, coated with asphalt or other material, or enclosed in tubes or sleeves. When adjacent lanes of pavement are constructed separately, use steel side forms that will form a keyway along the construction joint. Tie bars may be bent at right angles against the form of the first lane constructed and straightened into final position before the concrete of the adjacent lane is placed, or instead of bent tie bars, approved two-piece connectors may be used.
      b. Longitudinal formed joints are a groove, or cleft, extending downward from, and normal to, the pavement surface. Make these joints using an approved mechanically or manually operated device to the plan dimensions and line while the concrete is in a plastic state. Seal the groove, or cleft, with either a pre-molded strip or poured material as required.
      c. Place the longitudinal sawed joints so that their ends contact with any traverse joints.
      d. Cut longitudinal sawed joints using approved concrete saws to the plan depth, width, and line. Use guidelines or devices to assure cutting the longitudinal joint as shown on the plans. Saw the longitudinal joint before the cure period ends or shortly thereafter and before any equipment or vehicles are permitted on the pavement. Thoroughly clean the sawed area using both water and compressed air. Immediately remove from the joint all concrete pieces, aggregate and residue left from the sawing. Assure that the cut depth is uniform. Start sealing as soon as the joint is dry. Form longitudinal joints by placing a continuous strip of plastic or other inert material. Assure the joint insert material is strong, non-stretchable, 3 mil thick, 2-inch (50.8 mm) wide, incapable of bonding with the concrete and will form a weakened plane 2-inch (50.8 mm) minimum depth.
      e. Insert the joint material using a mechanical device that places the material in a continuous strip, except where intervening structures break the continuity of paving. Splices in the joint material are permitted if they can maintain the continuity of the joint material as placed. Place the joint material so that the top of the strip is not above, nor more than 1/4-inch (6.35 mm) below, the finished concrete surface. Once placed, assure the vertical axis of the joint material is within 10 degrees of a plane normal to the pavement surface. Assure final strip alignment is parallel with the pavement center line and does not vary more than 1 inch (25.4 mm) from the edge of a 12-foot (3.7 m) straightedge. The installation device must consolidate the concrete about the joint material. Once the joint material is installed, assure the concrete is free of segregation, rock pockets or voids and the finished concrete surface on each side of the joint is in the same plane.
   2. Transverse Expansion Joint:
      a. Place the expansion joint filler continuously from form to form, shaped to the subgrade and the keyway along the form. Furnish preformed joint filler in lengths equal to the pavement width or equal to one lane width. Use damaged or repaired joint filler only with Atlantic Richfield Company’s approval.

b. Ensure the expansion joint filler is held vertically. Use an approved installing bar, or other device if required to secure preformed expansion joint filler at the proper grade and alignment during concrete placing and finishing - Assure finished joints do not deviate more than 1/4-inch (6.35 mm) horizontally from a straight line. If joint fillers are assembled in section, no offsets are permitted between adjacent units. No concrete plugs are permitted anywhere within the expansion space.

3. Transverse Contraction Joints:
   a. Transverse contraction joints are weakened planes created by forming or cutting grooves in the pavement surface and, when shown on the plans, are to include load transfer assemblies.
   b. Form transverse strip contraction by installing a parting strip to be left in place.
   c. Make formed grooves by depressing an approved tool or device into the plastic concrete. Leave the tool or device in place until the concrete has attained its initial set and then remove it without disturbing the adjacent concrete, unless it is designed to remain in place.
   d. Make sawed construction joints by sawing grooves in the pavement surface of the dimensions and spacing and lines on the plans, using an approved concrete saw. Start sawing joints as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling. Saw all joints before uncontrolled shrinkage cracking occurs. When required, continue saw operations both during the day and night, regardless of weather conditions. Do not saw a planned joint when a volunteer crack develops at or near the planned joint location. Discontinue sawing when a crack develops ahead of the saw. Typically, saw all joints in sequence. Saw all contraction joints in lanes and adjacent to previously constructed lanes before uncontrolled cracking occurs. If conditions exist that make it impractical to prevent erratic cracking by early sawing, form the contraction joint groove before initial set of concrete as provided above.
   e. When directed, rout or saw random cracks and fill with joint sealer. Thoroughly clean the sawed area using water and compressed air. Immediately remove all pieces of concrete, aggregate and residue from the joint caused by sawing. Take care to maintain uniform cut depth. Seal the joint as soon as it is dry.
   f. Make sure transverse formed contraction joints comply with Section 3.12 requirements for the longitudinal formed joint.
   g. Construct transverse construction joints if there is an interruption exceeding 30 minutes in the concreting work. Do not construct a transverse joint within 5 feet (1.5 m) of an expansion joint, contraction joint, or weakened plane. If sufficient concrete has not been mixed at the time of interruption to form a slab at least 5 feet (1.5 m.) long, remove and dispose of excess concrete back to the last preceding joint as directed.

3.13 LOAD TRANSFER DEVICES

A. When used, hold dowels in position parallel to the surface and centerline of the slab by a metal device that is left in the pavement.

B. Thoroughly coat with an approved lubricant, the portion of each dowel painted with one coat of lead or tar paint, as required under Section 2.1. Furnish an approved metal dowel cap or sleeve meeting Section 2.1 requirements, for each dowel bar used with the expansion joints. Assure the caps or sleeves fit the dowel bar tightly.

C. Instead of using dowel assemblies at contraction joints, dowel bars may be placed in the full pavement thickness using an approved mechanical device.

3.14 FINAL STRIKE-OFF, CONSOLIDATION, AND FINISHING

A. Sequence:
   1. Sequence the work as follows: strike-off, consolidate, float, and remove latency, straight-edge, and final surface finish.
   2. If applying water to the surface is permitted, apply it as a fog spray using an approved spray equipment.

B. Finishing at Joints:
   1. Place the concrete adjacent to joints, under and around all load transfer devices, joint assembly units, and other features designed to extend into the pavement, free of voids or segregation. Mechanically vibrate concrete adjacent to joints meeting Section 3.10 requirements.
   2. Once the concrete has been placed and vibrated adjacent to the joints as required in Section 3.09, bring the finishing machine forward, operating it to avoid damage to or misalignment of joints. If uninterrupted operation of the finishing machine, to, over, and beyond the joints, causes segregation of concrete, damage to, or misalignment of the joints, lift the finishing machine and set it directly on top of the joint and resume the finishing. When the second screed is close enough to permit the excess mortar in front of it to flow over the joint, lift the screed and carry it over the joint. Thereafter, the finishing machine may be run over the joint without the screeds being lifted, provided there is no segregated concrete immediately between the joint and the screed or on top of the joint.

C. Machine Finishing:
   1. Vibrate all concrete pavement unless otherwise approved for small areas or for short periods of time due to equipment failure. Assure vibrators for full width vibration of concrete paving slabs meet Section 3.4 requirements. If concrete uniformity and density is not obtained using the vibratory method at joints, along forms, at structures, and throughout the pavement, furnish equipment and methods which will produce pavement meeting specifications.

D. Hand Finishing
   1. Hand finishing is permitted under the following conditions:
      a. If mechanical equipment breaks down, hand finishing concrete already deposited on the grade when the breakdown occurs is permitted.
      b. Widths or areas of irregular dimensions, where mechanical finishing equipment is impractical.
      c. As soon as concrete is placed, strike it off and screed it. Use an approved portable screed. Provide a second screed for striking off the bottom layer of concrete if reinforcement is used.
      d. Assure the screed for the surface is an approved design, sufficiently rigid to retain its shape, and constructed of metal, and at least 2 feet (.6 m) longer than the maximum width of the slab to be struck off.
      e. Obtain consolidation using a vibrator or other approved equipment.
      f. Move the screed forward on the forms with a combined longitudinal and transverse motion, always moving in the direction the work is progressing and operated to ensure that neither end is raised from the side forms during the strike off process. If necessary, repeat this until the surface is uniform in texture, true to grade and cross section, and free from porous areas.
         1) Floating: Once the concrete is struck off and consolidated, use of one of the following methods as specified or approved.
            (a) Hand Method:

(i) Use a hand-operated, longitudinal float at least 12 feet (3.7 m) long and 6 inches (152.4 mm) wide, stiffened to prevent flexing and warping. Work the float in a sawing motion, operating from foot bridges resting on the side forms and spanning and not touching the concrete. Move ahead along the pavement centerline in successive sections not exceeding one-half the length of the float. Waste all excess water or soupy material over the side forms on each pass.

(b) Mechanical Method:
(i) Obtain Atlantic Richfield Company's approval of the mechanical float before use. Adjust the float tracks to the required crown. Assure the float is adjusted to the transverse finishing machine to maintain a mortar wave ahead of the float at all times. Ensure the float passes over each pavement area at least twice. Waste all excess water or soupy material over the side forms on each pass.

(c) Alternate Mechanical Method:
(i) As an alternate to item (b) above, the CMGC may use a machine having a cutting and smoothing float, or floats, suspended from and guided by a rigid frame. This frame must be carried by 4 or more visible wheels riding on, and in constant contact with, the side forms.
(ii) If necessary, following one of the preceding float methods, long-handled floats having blades a minimum 5 feet (1.52 m) long and 6 inches (152.4 mm) wide may be used to smooth and fill in open-textured areas in the pavement. Do not use long-handled floats to float the entire pavement surface in place of, or supplementing, one of the preceding floating methods. When strike-off and consolidation are performed by hand and the pavement crown will not permit using a longitudinal float, float the surface transversely using the long-handled float. Take care to not work the pavement crown during the work.

E. Straight Edge Testing and Surface Correction:
1. Once floating is completed, excess water removed, and the concrete is still plastic, test the concrete surface for trueness with a 10-foot (3.05 m) straightedge. Furnish and use an 10-foot (3.05 m) straightedge swung from handles 3 feet (.91 m) longer than one-half the slab width. Hold the straightedge in contact with the surface in successive positions parallel to the road centerline and the go over the whole slab area, as required. Advance along the road in not to exceed one-half the straightedge length. Immediately fill any depressions with fresh mixed concrete, strike off, consolidate, and refinish. Trim high areas and refinish. Give special attention to assure that surfaces across joints meet the smoothness requirements. Continue straightedge testing and surface corrections until the entire surface meets the required grade and cross section.

F. Final Finish:
1. The final finish as specified in the Contract documents as to the type of surface texture. The following types of surface textures may be specified: Type I - Transverse Tining, Type II - Longitudinal Tining, Type III - Nylon or Artificial Grass Drag, Type IV.- Nylon or Bristle Broom, Type V - Belt Finish, and Type VI - Burlap Drag. When final, longitudinal texturing has been completed by the burlap drag, texture the plastic pavement surface to the designated texture as approved by Atlantic Richfield Company. A belt finish does not need to be preceded by a burlap drag.
a. Type I – Transverse Tining:
1) Produce the mainline finish using mechanical equipment described as follows: The transverse grooving machine must be either a vibrating roller or a comb

equipped with steel tines. The machine must be self-propelled and automatically lift the roller or tine comb at the pavement end. Obtain Atlantic Richfield Company's approval of hand grooving methods in those areas where the mechanical equipment is not practical.

2) Assure the equipment has rectangular or circular shaped spring steel tines that are spaced 1/2- to 1-inch (12.7 - 25.4 mm) center to center. Make the grooves perpendicular to the pavement center line and the transverse grooves being 0.090 to 0. 125 inches (2.3 - 3.2 nun) wide and 1/8- to 3/16-inch (3.2 - 4.8 mm) deep. Acceleration lanes, deceleration lanes, and irregular sections may be finished by methods other than mechanical, if they produce a similar transverse groove.

b. Type II – Longitudinal Loading:
   1) Produce the mainline finish using mechanical equipment meeting the following: The longitudinal grooving machine must be either a vibrating roller or a comb equipped with steel tines, be self-propelled and automatically lift the roller or tine comb at the pavement end. Obtain Atlantic Richfield Company's approval of hand grooving methods in areas where mechanical equipment cannot be used.
   2) Assure the equipment has rectangular or circular shaped spring steel tines that are spaced 1/2- to 1-inch (12.7 - 25.4 mm) center to center. Make the grooves parallel to the pavement center line and the longitudinal grooves 0.090 to 0. 125 inches (2.3 - 3.2 mm) wide and 1/8- to 3/16-inch (3.2 - 4.8 mm) deep. Operate the mechanical equipment from a bridge when the pavement is 4.9 m (16 feet) or more in width.
   3) Acceleration lanes, deceleration lanes, and irregular sections may be finished by methods other than mechanical, if they produce a similar type of longitudinal groove.
c. Type III – Nylon or Artificial Grass Drag:
   1) Produce the pavement finish using a nylon or artificial grass drag, approved by Atlantic Richfield Company. Produce a surface by pulling the drag longitudinally. For a pavement width of 16 feet (4.9 m) or more, mount the drag on a bridge that travels on the forms. Use a drag of at least 3 feet (.91 m) wide and maintain full contact the pavements full width. Maintain drags clean and free from encrusted mortar. Replace drags that cannot be cleaned with new ones.
d. Type IV – Nylon or Bristle Broom:
   1) Apply broom texturing when the water sheen has disappeared. Draw the broom from the center to the edge of the pavement with adjacent strokes overlapping. Perform the brooming so that the surface corrugations are uniform in appearance and have a minimum depth of 1/16-4nch (1.6 mm) and a maximum depth of 1/8-inch (3.2 mm). Complete brooming before the concrete surface will be tom or roughened by the work. Produce a finished surface free from rough and porous areas, irregularities and depressions resulting from poor workmanship. Mechanical brooming, in lieu of the manual brooming, is permitted if the specified results can be obtained.
e. Type V – Belt Finish (Paving with Rigid Forms):
   1) When straight edging is complete and the water sheen has disappeared, and just before the concrete becomes nonplastic,
   2) belt the surface with a two-ply, canvas belt a minimum 8 inches (203.2 mm) wide and a minimum 3 feet(.9 m) longer than the pavement width. Equip hand belts with handles to permit controlled, uniform manipulation. Work the belt with short strokes transverse to the road centerline advancing parallel to the centerline.

f. Type VI – Burlap Drag:
    1) Use a drag of seamless strip damp burlap or cotton fabric to produce a roughened surface, dragging it longitudinally along the pavement's full width. For pavement 16 feet (4.9 m) or more in width, mount the drag on a bridge that travels on the rails. Use a drag at least 3 feet (.91 m) wide, maintaining contact with the full pavement width. Maintain drags clean and free from encrusted mortar. Replace drags that cannot be cleaned with new drags.

g. Edging at Forms and Joints:
    1) After the final finish and before the concrete has taken its initial set, round the edges of the pavement along each side of each slab, and on each side of transverse expansion joints, formed joints, transverse construction joints, and emergency construction joints with an approved tool to the specified radius. Produce a radius having a smooth, dense mortar finish. Do not disturb the slab surface with the tool during the work.
    2) At all joints, remove all tool marks on the slab adjacent to the joints by brooming the surface. Do not disturb the rounding of the slab comer when brooming the surface. Completely remove all concrete on top of the joint filler.
    3) Test all joints with a straightedge before the concrete has set and correct if one side of the joint is higher than the other or if an edge is higher or lower than the adjacent slabs.
        (a) Surface Test:
            (i) As soon as the concrete has hardened to permit testing, test the pavement surface with a 10-foot (3.05 m) straightedge or other approved device. Mark and. Grind high spots exceeding 1/4-inch (6.35 mm.), but under 1/2-inch in 10 feet (12.7 mm in 3.05 m), using an approved grinding tool to an elevation where the area or spot will not show surface deviations exceeding 1/4-inch (6.35 mm) when tested with a 10- foot (3.05 m) straightedge. Use stacked head, vertical blade grinders that will provide a coefficient of friction approximately equal to that of the un-ground pavement. Keep grinding grooves parallel to the direction of travel. Where the departure from correct cross section exceeds 1/2-inch (12.7 mm)), remove and replace the pavement by hand at CMGC expense.
            (ii) Any area or section so removed cannot be less than 5 feet (1.52m) long the full lane width. When required to remove and replace a section of pavement remove and replace any remaining portion of the slab adjacent to the joints that is less than 5 feet (1 .52 m) long.

G. Curing:
1. Immediately after the finishing operations are complete and the surface cannot be marred, cover, and cure the entire surface of the newly placed concrete meeting one of the following methods. Immediately stop concrete work when insufficient cover material or lack of water would prevent obtaining the specified cure results. Do not leave the concrete exposed for more than 1/2-hour between stages of curing or during the curing period.
    a. Cotton or Burlap Mats:
        1) Cover the entire pavement surface with mats, extending least twice the pavement thickness beyond the slab edges. Assure that the entire surface and both edges of the slab are completely covered. Before placing mats, saturate the mats thoroughly with water. Place and weight the mats to remain in contact with the covered surface. Keep the mats wetted and in place for 72 hours after the concrete has been placed.

b. Waterproofed Paper:
    1) Cover the pavement top and sides entirely with waterproofed paper. Lap the units at least 18 inches (.46 m). Place and weight the paper to maintain contact with the surface. Assure the paper extends beyond the slab edges at twice the pavement thickness. If laid longitudinally, paper, not manufactured in sizes that will provide this width, must be securely sewed or cemented together with joints being sealed so that they do not open up or separate during the cure period. Maintain the covering in place for 72 hours after the concrete has been placed. Thoroughly wet the pavement surface before placing the paper.
c. Straw Curing:
    1) When using this type of curing, initially cure the pavement using burlap or cotton mats, meeting Section 2.1.3, until after final set of the concrete or, in any case, for 12 hours after the concrete is placed. Once the mats are removed, thoroughly wet and cover the surface and sides of the pavement with at least 8 inches (203.2 mm) (wetted thickness) of straw or hay. Repair or replace straw or hay covering displaced during the curing period and saturate with water for 3 days. Thoroughly wet the covering down the morning of the fourth day. Keep this cover in place until the concrete has attained the required strength. When permission is given to open the pavement to traffic, remove and dispose of the covering leaving the right-of-way in a neat and presentable condition. Do not dispose of the covering by burning on, or adjacent to, the pavement.
d. White Pigmented Impervious Membrane:
    1) Uniformly spray the entire pavement surface with white pigmented curing compound immediately after the finishing of the surface and before the set of the concrete has taken place, or if the pavement is cured initially with burlap or cotton mats, the curing compound may be applied upon removal of the mats.
    2) Do not apply the curing compound during the rainfall.
    3) Apply curing compound under pressure at 1 gallon per 150 square feet (3.79 L per 13.95 square meters) using mechanical sprayers. Use spraying equipment of the fully atomizing type equipped with a tank agitator. At the time of use, assure the compound is thoroughly mixed with the pigment uniformly dispersed throughout the vehicle. During application, continuously stir the compound using mechanical means. Hand spraying of odd widths or shapes and on concrete surfaces exposed by the removal of forms is permitted. Do not apply curing compound to the inside faces of joints to be sealed.
    4) Use curing compound producing a film that will harden within 30 minutes after application Immediately re-apply curing compound damaged from any cause within the required curing period.
    5) Upon removal of side forms, apply curing compound to the exposed slab sides.

H. White Polyethylene Sheeting:
    1. Cover entirely the top surface and sides of the pavement with polyethylene sheeting. Lap the pieces at least 18 inches (35 cm). Place and weight the sheeting so it remains in contact with the surface. Lay sheeting so it extends beyond the edges of the slab at least twice the thickness of the pavement. Maintain the covering in place for 72 hours after the concrete has been placed.

I. Curing in Cold Weather:
    1. When the average daily temperature is below 4O°F (4°C), cure by covering the pavement with at least 12 inches (304.8 mm) of loose, dry hay or straw, or equivalent

protective covering authorized by Atlantic Richfield Company. Leave covering in place for 10 days.

2. When concrete is placed and the air temperature could drop below 35 F, provide the volume of straw, hay, grass, or other blanketing material at the work site. Anytime the temperature may be expected to reach the freezing point during the day or night, spread the material over the pavement to the required depth to prevent freezing of the concrete. Maintain the covering for a minimum 10 days. Be responsible for the quality and strength of the concrete placed during cold weather and remove and replace at CMGC expense any concrete injured by freezing.

J. Removing Forms:
   1. Remove forms only after the freshly place concrete has set for 12 hours, excluding auxiliary forms used temporarily in widened areas. Carefully remove forms to prevent damage to the pavement. Once the forms are removed, cure the slab sides as specified herein. Remove and replace major honeycombed areas. The minimum area to be removed is 10 feet in length (3.05 m), the full width of the lane involved. When it is necessary to remove and replace a pavement section, any remaining portion of the slab, adjacent to the joints, less than 5 feet (1.52 m) in length is to be removed and replaced.
      a. Sealing Joints:
         1) If the joints are to be sealed, fill them with joint sealing material before the pavement is opened to traffic and as soon as practical after completion of the curing period. Just before sealing, thoroughly clean each joint of all foreign material, including membrane curing compound, assuring the joint faces are clean and surface dry when the seal is applied. Stir material for hot applied seal during heating
         2) Apply the sealing material to each joint opening meeting the plan details or as directed by Atlantic Richfield Company. Pour so that the material does not spill on the exposed concrete surfaces. Remove and clean from concrete surfaces all excess sealing material. The use of sand or similar material as a cover for the seal is not permitted. Do not place poured joint sealing material when the ambient temperature is less than 50°F (10°C), unless approved by Atlantic Richfield Company.
      b. Protection of Pavement:
         1) Protect the pavement and its appurtenances against both public and Contractor traffic. This includes supplying watchmen to direct traffic and the erection and maintenance of warning signs and lights.
         2) To protect the concrete against rain before the concrete is sufficiently hardened, have available at all times materials for the protection of the edges and surface of the unhardened concrete. Protective materials consist of standard metal forms or wood plank having a minimum nominal thickness of 2 inches (50.8 mm) and a minimum nominal width of the pavement thickness at its edge for the protection of the pavement edges, and covering material such as burlap or cotton mats, curing paper, or plastic sheeting material for the protection of the surface of the pavement. Stop paving when rain appears imminent and have all available personnel begin placing forms against the side of the pavement and cover the surface of the unhardened concrete with the protective covering.
         3) Repair or replace all damage to the pavement occurring before final acceptance at CMGC expense.

K. Concrete Pavement Slipform Method:
1. Pavement may be constructed without using fixed forms. When the slipform method is used, meet the following provisions:
   a. Grade:
      1) Once the grade or base is placed and compacted to the specified density, cut the grade and areas that will support the paving machine to the required elevation using an approved fine-grading machine. Use a self-propelled or towed fine-grading machine having the weight and power to trim the compacted material without gouging or tearing the surface. Assure the machine is equipped with cutting edges or surface shavers controlled from an independent control reference wire having an automatic control device. To avoid excessive depths of cut, the machine is to fine grade making successive passes, with each pass controlled from the independent reference line through the automatic control. Recompact to the specified density, all base disturbed by the grading operation, before placing concrete. Maintain the grading operations in advance of concrete placement. Repair damage to the grade caused by traffic before placing the concrete.
   b. Placing Concrete:
      1) Place concrete using an approved, slipform paver able to spread, consolidate, screed, and float-finish the freshly placed concrete in one complete pass to the specified line, grade, and cross section with a minimum of hand finishing. Assure the machine is equipped with vibrators, vibrating the concrete the pavements full width and depth. Vibrators must be vibrating tubes or arms working in the concrete, or a vibrating screed or pan operating on the concrete surface. Assure the sliding forms are capable of resisting displacement by the wet concrete. Use forms that trail behind the paver and prevent slumping of the concrete during the work.
      2) Assure the concrete does not exceed a slump of 2 inches (50.8 mm). Operate the slipform paver at a uniform speed. Coordinate all concrete mixing, delivering, and spreading to maintain uniform progress with minimum stopping and starting of the paving work Immediately stop vibratory and tamping when it is necessary to stop the paver. Do not apply any outside tractive force to the paver not controlled by it.
   c. Finishing:
      1) Meet the surface smoothness and texture requirements of Section 3.14.
   d. Curing:
      1) Perform curing using one of the methods in Section 3.14.
   e. Joints:
      1) Construct all joints under Section 3.12.
   f. Tolerance in Pavement Thickness
      1) The pavement thickness will be determined by measuring cores. The actual pavement thickness must be within 1/4-inch (6.35 mm) of the specified thickness.
      2) When any core is less than the plan thickness by more than the allowable deviation, additional cores will be taken from the area at minimum 10-foot (3-05 m) intervals parallel to the centerline in each direction from the affected location until, in each direction, a core is found which is not deficient by more than the allowable deviation. Atlantic Richfield Company will evaluate areas found deficient in thickness by more than the allowable deviation. Remove and replace deficient areas to the specified thickness at CMGC expense.

L. Opening to Traffic:
   1. Obtain Atlantic Richfield Company's approval to open the pavement to traffic. Pavement cannot be opened to traffic until specimen beams, meeting 3.9; Testing, have reached the design flexural strength, tested under the third-point method according to Section 3.10. If the tests are not performed, the pavement may be opened at the discretion of Atlantic Richfield Company. Clean the pavement before opening to traffic.

END OF SECTION

SECTION 32 16 19
CONCRETE CURBS, GUTTERS, AND SIDEWALKS

PART 1 - GENERAL

1.01 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. AASHTO M 182 (2005; R 2017) - Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats.
   2. ASTM International (ASTM):
      a. ASTM A615/A615M (2016) - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
      b. ASTM A1064/A1064M (2017) - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
      c. ASTM C31/C31M (2019) - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
      d. ASTM C94/C94M (2018) - Standard Specification for Ready-Mixed Concrete.
      e. ASTM C171 (2016) - Standard Specification for Sheet Materials for Curing Concrete.
      f. ASTM C172/C172M (2017) - Standard Practice for Sampling Freshly Mixed Concrete.
      g. ASTM C173/C173M (2016) - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
      h. ASTM C231/C231M (2017a) - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
      i. ASTM C309 (2011) - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
      j. ASTM C920 (2018) - Standard Specification for Elastomeric Joint Sealants.
      k. ASTM D1751 (2004; E 2013; R 2013) - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
      l. ASTM D1752 (2018) - Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
      m. ASTM D5893/D5893M (2016) - Standard Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements.

1.02 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-03 Product Data:
      a. Concrete.
   2. SD-05 Test Reports:
      a. Field quality control.

1.03 EQUIPMENT, TOOLS, AND MACHINES

A. General Requirements:
   1. Plant, equipment, machines, and tools used in the work will be subject to approval and must be maintained in a satisfactory working condition at all times. Use equipment capable of producing the required product, meeting grade controls, thickness control and smoothness requirements as specified. Discontinue using equipment that produces unsatisfactory results. Allow the Atlantic Richfield Company Representative access at all times to the plant and equipment to ensure proper operation and compliance with specifications.

B. Slip Form Equipment:
   1. Slip form paver or curb forming machines, will be approved based on trial use on the job and must be self-propelled, automatically controlled, crawler mounted, and capable of spreading, consolidating, and shaping the plastic concrete to the desired cross section in one pass.

1.04 ENVIRONMENTAL REQUIREMENTS

A. Placing During Cold Weather:
   1. Do not place concrete when the air temperature reaches 40 degrees F and is falling or is already below that point. Placement may begin when the air temperature reaches 35 degrees F and is rising, or is already above 40 degrees F. Make provisions to protect the concrete from freezing during the specified curing period. If necessary to place concrete when the temperature of the air, aggregates, or water is below 35 degrees F, placement and protection must be approved in writing. Approval will be contingent upon full conformance with the following provisions. Prepare and protect the underlying material so that it is entirely free of frost when the concrete is deposited. Heat mixing water and aggregates as necessary to result in the temperature of the in-place concrete being between 50- and 85-degrees F. Methods and equipment for heating must be approved by Atlantic Richfield Company Representative. Use only aggregates that are free of ice, snow, and frozen lumps before entering the mixer. Provide covering or other means as needed to maintain the concrete at a temperature of at least 50 degrees F for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period.

B. Placing During Warm Weather:
   1. The temperature of the concrete as placed must not exceed 85 degrees F except where an approved retarder is used. Cool the mixing water and aggregates as necessary to maintain a satisfactory placing temperature. The placing temperature must not exceed 95 degrees F at any time.

PART 2 - PRODUCTS

2.01 CONCRETE

A. Provide concrete conforming to the applicable requirements of Section 03 30 00 – Cast-In-Place Concrete and ASTM C94/C94M except as otherwise specified. Concrete must have a minimum compressive strength of 4,000 psi at 28 days. Size of aggregate must not exceed 1-1/2 inches. Submit copies of certified delivery tickets for all concrete used in the construction.

B. Air Content:
   1. See Section 03 30 00 – Cast-In-Place Concrete.

C. Slump:
   1. See Section 03 30 00 – Cast-In-Place Concrete.

D. Reinforcement Steel:
   1. Use reinforcement bars conforming to ASTM A615/A615M. Use wire mesh reinforcement conforming to ASTM A1064/A1064M.

2.02 CONCRETE CURING MATERIALS

A. Impervious Sheet Materials:
   1. Use impervious sheet materials conforming to ASTM C171, type optional, except that polyethylene film, if used, must be white opaque.

B. Burlap:
   1. Use burlap conforming to AASHTO M 182.

C. White Pigmented Membrane-Forming Curing Compound:
   1. Use white pigmented membrane-forming curing compound conforming to ASTM C309, Type 2.

2.03 CONCRETE PROTECTION MATERIALS

A. Use concrete protection materials consisting of a linseed oil mixture of equal parts, by volume, of linseed oil and either mineral spirits, naphtha, or turpentine. With Atlantic Richfield Company approval, commercially prepared linseed oil mixtures, formulated specifically for application to concrete to provide protection against the action of deicing chemicals may be used, except that emulsified mixtures are not acceptable.

2.04 JOINT FILLER STRIPS

A. Contraction Joint Filler for Curb and Gutter:
   1. Use hard-pressed fiberboard contraction joint filler for curb and gutter.

B. Expansion Joint Filler, Premolded:
   1. Unless otherwise indicated, use 1/2 inch thick premolded expansion joint filler conforming to ASTM D1751 or ASTM D1752.

2.05 JOINT SEALANTS

A. Use cold-applied joint sealant conforming to ASTM C920 or ASTM D5893/D5893M.

2.06 FORM WORK

A. Design and construct form work to ensure that the finished concrete will conform accurately to the indicated dimensions, lines, and elevations, and within the tolerances specified. Use wood or steel forms that are straight and of sufficient strength to resist springing during depositing and consolidating concrete.
   1. Wood Forms:
      a. Use forms that are surfaced plank, 2 inches nominal thickness, straight and free from warp, twist, loose knots, splits or other defects. Use forms with a nominal

length of 10 feet. Radius bends may be formed with 3/4 inch boards, laminated to the required thickness.

2. Steel Forms:
   a. Use channel-formed sections with a flat top surface and welded braces at each end and at not less than two intermediate points. Use forms with interlocking and self-aligning ends. Provide flexible forms for radius forming, corner forms, form spreaders, and fillers as needed. Use forms with a nominal length of 10 feet and that have a minimum of 3 welded stake pockets per form. Use stake pins consisting of solid steel rods with chamfered heads and pointed tips designed for use with steel forms.
3. Sidewalk Forms:
   a. Use sidewalk forms that are of a height equal to the full depth of the finished sidewalk.
4. Curb and Gutter Forms:
   a. Use curb and gutter outside forms that have a height equal to the full depth of the curb or gutter. Use rigid forms for curb returns, except that benders or thin plank forms may be used for curb or curb returns with a radius of 10 feet or more, where grade changes occur in the return, or where the central angle is such that a rigid form with a central angle of 90 degrees cannot be used. Back forms for curb returns may be made of 1-1/2 inch benders, for the full height of the curb, cleated together. In lieu of inside forms for curbs, a curb "mule" may be used for forming and finishing this surface, provided the results are approved.
5. Biodegradable Form Release Agent:
   a. Use form release agent that is colorless and biodegradable and that is composed of at least 87 percent biobased material. Provide product that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces. Provide form release agent that does not contain diesel fuel, petroleum-based lubricating oils, waxes, or kerosene.

PART 3 - EXECUTION

3.01 SUBGRADE PREPARATION

A. Construct subgrade to the specified grade and cross section prior to concrete placement.
   1. Sidewalk Subgrade:
      a. Place and compact the subgrade in accordance with Section 31 00 00 – Earthwork. Test the subgrade for grade and cross section with a template extending the full width of the sidewalk and supported between side forms.
   2. Curb and Gutter Subgrade
      a. Place and compact the subgrade in accordance with Section 31 00 00 – Earthwork and Section 32 01 12 – Base Course. Test the subgrade for grade and cross section by means of a template extending the full width of the curb and gutter. Use subgrade materials equal in bearing quality to the subgrade under the adjacent pavement.
   3. Maintenance of Subgrade:
      a. Maintain subgrade in a smooth, compacted condition in conformity with the required section and established grade until the concrete is placed. The subgrade must be in a moist condition when concrete is placed. Prepare and protect subgrade so that it is free from frost when the concrete is deposited.

3.02 FORM SETTING

A. Set forms to the indicated alignment, grade and dimensions. Hold forms rigidly in place by a minimum of 3 stakes per form placed at intervals not to exceed 4 feet. Use additional stakes and braces at corners, deep sections, and radius bends, as required. Use clamps, spreaders, and braces where required to ensure rigidity in the forms. Remove forms in a manner that will not injure the concrete. Do not use bars or heavy tools against the concrete when removing the forms. Promptly and satisfactorily repair concrete found to be defective after form removal. Clean forms and coat with form oil or biodegradable form release agent each time before concrete is placed. Wood forms may, instead, be thoroughly wetted with water before concrete is placed, except that with probable freezing temperatures, oiling is mandatory.
   1. Sidewalks:
      a. Set forms for sidewalks with the upper edge true to line and grade with an allowable tolerance of 1/8 inch in any 10-foot-long section. After forms are set, grade and alignment must be checked with a 10 foot straightedge. Sidewalks must have a transverse slope as indicated on the construction drawings. Unless otherwise indicated, construct sidewalks that are located adjacent to curbs with the low side adjacent to the curb. Do not remove side forms less than 12 hours after finishing has been completed.
   2. Curbs and Gutters:
      a. Remove forms used along the front of the curb not less than 2 hours nor more than 6 hours after the concrete has been placed. Do not remove forms used along the back of curb until the face and top of the curb have been finished, as specified for concrete finishing. Do not remove gutter forms while the concrete is sufficiently plastic to slump in any direction.

3.03 SIDEWALK CONCRETE PLACEMENT AND FINISHING

A. Formed Sidewalks:
   1. Place concrete in the forms in one layer. When consolidated and finished, the sidewalks must be of the thickness indicated. Use a strike-off guided by side forms after concrete has been placed in the forms to bring the surface to proper section to be compacted. Consolidate concrete by tamping and spading or with an approved vibrator. Finish the surface to grade with a strike off.

B. Concrete Finishing:
   1. After straight edging, when most of the water sheen has disappeared, and just before the concrete hardens, finish the surface with a wood or magnesium float or darby to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. Produce a scored surface by brooming with a fiber-bristle brush in a direction transverse to that of the traffic, followed by edging.

C. Edge and Joint Finishing:
   1. Finish all slab edges, including those at formed joints, with an edger having a radius of 1/8 inch. Edge transverse joints before brooming. Eliminate the flat surface left by the surface face of the edger with brooming. Clean and solidly fill corners and edges which have crumbled and areas which lack sufficient mortar for proper finishing with a properly proportioned mortar mixture and then finish.

D. Surface and Thickness Tolerances:
   1. Finished surfaces must not vary more than 5/16 inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch.

3.04 CURB AND GUTTER CONCRETE PLACEMENT AND FINISHING

A. Formed Curb and Gutter:
   1. Place concrete to the required section in a single lift. Consolidate concrete using approved mechanical vibrators. Curve shaped gutters must be finished with a standard curb "mule".

B. Curb and Gutter Finishing:
   1. Approved slip formed curb and gutter machines may be used in lieu of hand placement.

C. Concrete Finishing:
   1. Float and finish exposed surfaces with a smooth wood float until true to grade and section and uniform in texture. Brush floated surfaces with a fine-hair brush using longitudinal strokes. Round the edges of the gutter and top of the curb with an edging tool to a radius of 1/2 inch. Immediately after removing the front curb form, rub the face of the curb with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. Brush the front curb surface, while still wet, in the same manner as the gutter and curb top. Finish the top surface of gutter and entrance to grade with a wood float.

D. Joint Finishing:
   1. Finish curb edges at formed joints as indicated.

E. Surface and Thickness Tolerances:
   1. Finished surfaces must not vary more than 1/4 inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch.

3.05 SIDEWALK JOINTS

A. Construct sidewalk joints to divide the surface into rectangular areas. Space transverse contraction joints at a distance equal to the sidewalk width or 5 feet on centers, whichever is less, and continuous across the slab. Construct longitudinal contraction joints along the centerline of all sidewalks 10 feet or more in width. Construct transverse expansion joints at sidewalk returns and opposite expansion joints in adjoining curbs. Where the sidewalk is not in contact with the curb, install transverse expansion joints as indicated. Form expansion joints around structures and features which project through or into the sidewalk pavement, using joint filler of the type, thickness, and width indicated. Expansion joints are not required between sidewalks and curb that abut the sidewalk longitudinally.
   1. Sidewalk Contraction Joints:
      a. Form contraction joints in the fresh concrete by cutting a groove in the top portion of the slab to a depth of at least one-fourth of the sidewalk slab thickness. Unless otherwise approved or indicated, either use a jointer to cut the groove or saw a groove in the hardened concrete with a power-driven saw. Construct sawed joints by sawing a groove in the concrete with a 1/8 inch blade. Provide an ample supply of saw blades on the jobsite before concrete placement is started. Provide at least one standby sawing unit in good working order at the jobsite at all times during the sawing operations unless approved by Atlantic Richfield Company Representative.

2. Sidewalk Expansion Joints:
    a. Form expansion joints using 1/2-inch joint filler strips. Joint filler in expansion joints surrounding structures and features within the sidewalk may consist of preformed filler material conforming to ASTM D1752 or building paper. Hold joint filler in place with steel pins or other devices to prevent warping of the filler during floating and finishing. Immediately after finishing operations are completed, round joint edges using an edging tool having a radius of 1/8 inch. Remove any concrete over the joint filler. At the end of the curing period, clean the top of expansion joints and fill with cold-applied joint sealant. Use joint sealant that is gray or stone in color. Thoroughly clean the joint opening before the sealing material is placed. Do not spill sealing material on exposed surfaces of the concrete. Apply joint sealing material only when the concrete at the joint is surface dry and atmospheric and concrete temperatures are above 50 degrees F. Immediately remove any excess material on exposed surfaces of the concrete and clean the concrete surfaces.
3. Reinforcement Steel Placement:
    a. Accurately and securely fasten reinforcement steel in place with suitable supports and ties before the concrete is placed.

3.06 CURB AND GUTTER JOINTS

A. Construct curb and gutter joints at right angles to the line of curb and gutter.
    1. Contraction Joints:
        a. Construct contraction joints directly opposite contraction joints in abutting portland cement concrete pavements and spaced so that monolithic sections between curb returns will not be less than 5 feet nor greater than 15 feet in length.
            1) Construct contraction joints (except for slip forming) by means of 1/8 inch thick separators and of a section conforming to the cross section of the curb and gutter. Remove separators as soon as practicable after concrete has set sufficiently to preserve the width and shape of the joint and prior to finishing.
            2) When slip forming is used, cut the contraction joints in the top portion of the gutter/curb hardened concrete in a continuous cut across the curb and gutter, using a power-driven saw. Cut the contraction joint to a depth of at least one-fourth of the gutter/curb depth using a 1/8 inch saw blade.
    2. Expansion Joints:
        a. Form expansion joints by means of preformed expansion joint filler material cut and shaped to the cross section of curb and gutter. Construct expansion joints in curb and gutter directly opposite expansion joints of abutting portland cement concrete pavement using the same type and thickness of joints as joints in the pavement. Where curb and gutter do not abut portland cement concrete pavement, provide expansion joints at least 1/2 inch in width at intervals not less than 30 feet nor greater than 120 feet. Seal expansion joints immediately following curing of the concrete or as soon thereafter as weather conditions permit. Seal expansion joints and the top 1 inch depth of curb and gutter contraction-joints with joint sealant. Thoroughly clean the joint opening before the sealing material is placed. Do not spill sealing material on exposed surfaces of the concrete. Concrete at the joint must be surface dry and atmospheric and concrete temperatures must be above 50 degrees F at the time of application of joint sealing material. Immediately remove excess material on exposed surfaces of the concrete and clean concrete surfaces.

3.07 CURING AND PROTECTION

A. General Requirements:
   1. Protect concrete against loss of moisture and rapid temperature changes for at least 7 days from the beginning of the curing operation. Protect unhardened concrete from rain and flowing water. All equipment needed for adequate curing and protection of the concrete must be on hand and ready for use before actual concrete placement begins. Protect concrete as necessary to prevent cracking of the pavement due to temperature changes during the curing period.
      a. Mat Method:
         1) Cover the entire exposed surface with two or more layers of burlap. Overlap mats at least 6 inches. Thoroughly wet the mat with water prior to placing on concrete surface and keep the mat continuously in a saturated condition and in intimate contact with concrete for not less than 7 days.
      b. Impervious Sheeting Method:
         1) Wet the entire exposed surface with a fine spray of water and then cover with impervious sheeting material. Lay sheets directly on the concrete surface with the light-colored side up and overlapped 12 inches when a continuous sheet is not used. Use sheeting that is not less than 18-inches wider than the concrete surface to be cured. Secure sheeting using heavy wood planks or a bank of moist earth placed along edges and laps in the sheets. Satisfactorily repair or replace sheets that are torn or otherwise damaged during curing. Sheeting must remain on the concrete surface to be cured for not less than 7 days.
      c. Membrane Curing Method:
         1) Apply a uniform coating of white-pigmented membrane-curing compound to the entire exposed surface of the concrete as soon after finishing as the free water has disappeared from the finished surface. Coat formed surfaces immediately after the forms are removed and in no case longer than 1 hour after the removal of forms. Do not allow concrete surface to dry before application of the membrane. If drying has occurred, moisten the surface of the concrete with a fine spray of water and apply the curing compound as soon as the free water disappears. Apply curing compound in two coats by hand-operated pressure sprayers at a coverage of approximately 200 square feet/gallon for the total of both coats. Apply the second coat in a direction approximately at right angles to the direction of application of the first coat. The compound must form a uniform, continuous, coherent film that will not check, crack, or peel and must be free from pinholes or other imperfections. If pinholes, abrasion, or other discontinuities exist, apply an additional coat to the affected areas within 30 minutes. Respray concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied by the method and at the coverage specified above. Respray areas where the curing compound is damaged by subsequent construction operations within the curing period. Take precautions necessary to ensure that the concrete is properly cured at sawed joints, and that no curing compound enters the joints. Tightly seal the top of the joint opening and the joint groove at exposed edges before the concrete in the region of the joint is resprayed with curing compound. Use a method used for sealing the joint groove that prevents loss of moisture from the joint during the entire specified curing period. Provide approved standby facilities for curing concrete pavement at a location accessible to the jobsite for use in the event of mechanical failure of the spraying equipment or other conditions that might

prevent correct application of the membrane-curing compound at the proper time. Adequately protect concrete surfaces to which membrane-curing compounds have been applied during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from other possible damage to the continuity of the membrane.

B. Backfilling:
   1. After curing, remove debris and backfill, grade, and compact the area adjoining the concrete to conform to the surrounding area in accordance with lines and grades indicated.

C. Protection:
   1. Protect completed concrete from damage until accepted. Repair damaged concrete and clean concrete discolored during construction. Remove and reconstruct concrete that is damaged for the entire length between regularly scheduled joints. Refinishing the damaged portion will not be acceptable. Dispose of removed material as directed.

D. Protective Coating:
   1. Apply a protective coating of linseed oil mixture to the exposed-to-view concrete surface after the curing period, if concrete will be exposed to de-icing chemicals within 6 weeks after placement. Moist cure concrete to receive a protective coating.
      a. Application:
         1) Complete curing and backfilling operation prior to applying two coats of protective coating. Concrete must be surface dry and clean before each application. Spray apply at a rate of not more than 50 square yards/gallon for first application and not more than 70 square yards/gallon for second application, except that the number of applications and coverage for each application for commercially prepared mixture must be in accordance with the manufacturer's instructions. Protect coated surfaces from vehicular and pedestrian traffic until dry.
      b. Precautions:
         1) Do not heat protective coating by direct application of flame or electrical heaters and protect the coating from exposure to open flame, sparks, and fire adjacent to open containers or applicators. Do not apply material at ambient or material temperatures lower than 50 degrees F.

3.08 FIELD QUALITY CONTROL

A. Submit copies of all test reports within 24 hours of completion of the test.
   1. General Requirements:
      a. Perform the inspection and tests described and meet the specified requirements for inspection details and frequency of testing. Based upon the results of these inspections and tests, take the action and submit reports as required below, and additional tests to ensure that the requirements of these specifications are met.
   2. Concrete Testing:
      a. Strength Testing:
         1) Take concrete samples in accordance with ASTM C172/C172M not less than once a day exceeding 5 cubic yards nor less than once for every 25 cubic yards of concrete placed. Provide at least two tests for every 100 cubic yards poured. Mold cylinders in accordance with ASTM C31/C31M for strength

testing by an approved laboratory. Each strength test result must be the average of 2 test cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved. Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength.

b. Air Content:
   1) Determine air content in accordance with ASTM C173/C173M or ASTM C231/C231M. Use ASTM C231/C231M with concretes and mortars made with relatively dense natural aggregates. Make two tests for air content on randomly selected batches of each class of concrete placed during each shift. Make additional tests when excessive variation in concrete workability is reported by the placing foreman or the Government inspector. Notify the placing forman if results are out of tolerance. The placing foreman must take appropriate action to have the air content corrected at the plant. Additional tests for air content will be performed on each truckload of material until such time as the air content is within the tolerance specified.

c. Slump Test:
   1) Perform one test at point of placement for each composite sample, but not less than one test for each's pour of each type of concrete mix. Perform additional tests when excessive variation in the workability of the concrete is noted or when excessive crumbling or slumping is noted along the edges of slip-formed concrete.

3. Thickness Evaluation:
   a. Determine the anticipated thickness of the concrete prior to placement by passing a template through the formed section or by measuring the depth of opening of the extrusion template of the curb forming machine. If a slip form paver is used for sidewalk placement, construct the subgrade true to grade prior to concrete placement. The thickness will be determined by measuring each edge of the completed slab.
4. Surface Evaluation:
   a. Provide finished surfaces for each category of the completed work that are uniform in color and free of blemishes and form or tool marks.

3.09 SURFACE DEFICIENCIES AND CORRECTIONS

A. Thickness Deficiency:
   1. When measurements indicate that the completed concrete section is deficient in thickness by more than 1/4 inch the deficient section will be removed, between regularly scheduled joints, and replaced at the Construction Management General Contractors's (CMGC) expense.

B. High Areas:
   1. In areas not meeting surface smoothness and plan grade requirements, reduce high areas either by rubbing the freshly finished concrete with carborundum brick and water when the concrete is less than 36 hours old or by grinding the hardened concrete with an approved surface grinding machine after the concrete is 36 hours old or more. The area corrected by grinding the surface of the hardened concrete must not exceed 5 percent of the area of any integral slab, and the depth of grinding must not exceed 1/4 inch. Remove and replace pavement areas requiring grade or surface smoothness

corrections in excess of the limits specified. No additional payment will be made for reducing high areas.

C. Appearance:
   1. Exposed surfaces of the finished work will be inspected by the Atlantic Richfield Company Representative and deficiencies in appearance will be identified. Remove and replace areas which exhibit excessive cracking, discoloration, form marks, or tool marks or which are otherwise inconsistent with the overall appearances of the work. No additional payment will be made for replacing areas.

END OF SECTION

SECTION 32 31 00
FENCES, GATES, AND GUARDRAILS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Steel fences.
   2. Swing gates.
   3. Gate operators, including controls.

1.02 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-02 Shop Drawings:
      a. For fencing and gates:
         1) Include plans, elevations, sections, gate locations, post spacing, and mounting attachment details.
   2. SD-03 Product Data:
      a. For each type of product.
   3. SD-04 Samples:
      a. For each fence material and for each color specified:
         1) Provide Samples 12 inches in length for linear materials.
         2) Provide Samples 12 inches square for sheet or plate materials.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.
   1. Workers and Supervisors for this scope of work shall have 5 years' experience with fencing installation.
   2. Field welders shall have 5 years of welding experience.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
   1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Lightning-Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

2.02 STEEL FENCES

A. Steel Fences: Fences made from steel tubing bars and shapes.

B. Posts: Square steel tubing.
   1. Line Posts: 3 by 3 inches with 3/16-inch wall thickness.
   2. End and Corner Posts: 6 by 6 inches with 3/16-inch wall thickness.

3. Vehicular Swing Gate Posts: 10 by 10 inches with 3/16-inch wall thickness.
4. Pedestrian Swing Gate Posts: 6 by 6 inches with 3/16-inch wall thickness.

C. Post Caps: Formed from steel sheet.

D. Rails: Steel Tube Rails: Square steel tubing 3 by 1 inches with 1/8-inch wall thickness.

E. Rail Mounting Flange: Angular Steel Flange: Bar angle 3/4-inch by 3/4-inch by 1/8-inch thickness.

F. Pickets: 2-inch-square by 12 gauge steel tubes.
1. Terminate tops of pickets at top rail for flush top appearance.
2. Picket Spacing: 12 inches minimum, 16inches maximum, unless specified in details.

G. Infill: Custom design as indicated on Drawings.
1. Steel Plate: 1/4 inch thick.

H. Fasteners: Steel bolts and nuts.

I. Fabrication: Assemble fences into sections by welding pickets to rails.

J. Finish exposed welds to comply with NOMMA Guideline 1, Finish #4 - good-quality, uniform undressed weld with minimal splatter.

K. Finish for Steel Items sandblasted raw steel allowed to rust
1. Sandblast all steel to remove factory stamping & protective coatings.
2. Apply rusting agent in-field after installation.
3. Provide rusting agent formula or product for approval by Owner's Representative.

2.03 SWING GATES

A. Gate Configuration: As indicated.

B. Gate Frame Height: As indicated.

C. Gate Opening Width: As indicated.

D. Steel Frames and Bracing: Fabricate members from square steel tubing 3 by 3 inches with 3/16-inch wall thickness.

E. Frame Corner Construction: Welded.

F. Additional Rails: Provide as indicated, complying with requirements for fence rails.

G. Infill: Comply with requirements for adjacent fence.

H. Picket Size, Configuration, and Spacing: Comply with requirements for adjacent fence.

I. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 feet wide. Provide cane bolts for pairs of gates. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.
1. Material: Mild steel.

J. Hinges: BHMA A156.1, Grade 1, suitable for exterior use.

1. Function: 39 - Full surface, triple weight, antifriction bearing.
2. Material: Wrought steel, forged steel, cast steel, or malleable iron.
    a. Match material to fencing.

K. Cane Bolts: Provide for inactive leaf of pairs of gates. Fabricated from 1/2-inch diameter, round steel bars. Finish to match gates. Provide galvanized-steel pipe strikes to receive cane bolts in both open and closed positions.

L. Finish exposed welds to comply with NOMMA Guideline 1, Finish #4 - good-quality, uniform undressed weld with minimal splatter.

M. Steel Finish: Sandblasted raw steel allowed to rust
1. Sandblast all steel to remove factory stamping & protective coatings.
2. Apply rusting agent in-field after installation.
3. Provide rusting agent formula or product for approval by Owner's Representative.

2.04 STEEL AND IRON

A. Plates, Shapes, and Bars: ASTM A36/A36M.

B. Bars (Pickets): Hot-rolled, carbon steel complying with ASTM A29/A29M, Grade 1010.

C. Tubing: ASTM A500/A500M, cold-formed steel tubing.

D. Uncoated Steel Sheet: Hot-rolled steel sheet, ASTM A1011/A1011M, Structural Steel, Grade 45 or cold-rolled steel sheet, ASTM A1008/A1008M, Structural Steel, Grade 50.

2.05 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 03 30 00 – Cast-In-Place Concrete with a minimum 28-day compressive strength of 3000 psi, 3-inch slump, and 1-inch maximum aggregate size.

C. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M and specifically recommended by manufacturer for exterior applications.

2.06 STEEL FINISHES

A. Surface Preparation: Clean surfaces according to SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

B. Rusting Agent: Immediately following installation, apply non-toxic, safe for exterior use rusting agent in the field.
1. Apply rusting agent in sufficient quantities to give the raw steel a brown/red colored hue.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.

B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.
   1. Construction layout and field engineering are specified in Section 01 72 00 – Field Surveying.

3.03 FENCE INSTALLATION

A. Install fences by setting posts as indicated and field weld rails to posts.

B. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 24 inches plus 3 inches for each foot or fraction of a foot that fence height exceeds 4 feet.

C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
   1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
   2. Concrete Fill: Place concrete around posts and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
      a. Exposed Concrete: Extend 2 inches above grade. Finish and slope top surface to drain water away from post.
   3. Posts Set in Concrete: Extend post to within 6 inches of specified excavation depth, but not closer than 3 inches to bottom of concrete.
   4. Posts Set into Voids in Concrete: Form or core drill holes not less than 3/4 inch larger than outside diagonal dimension of post.
      a. Extend posts at least 5 inches into concrete.
      b. Clean holes of loose material, insert posts, and fill annular space between post and concrete with non-shrink grout, mixed and placed to comply with grout manufacturer's written instructions. Finish and slope top surface of grout to drain water away from post.
   5. Space posts uniformly between 6 feet minimum to 8 feet maximum on center.

3.04 GATE INSTALLATION

A. Install gates level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
   1. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance not less than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method according to IEEE 81.
   2. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify Architect promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.
   3. Report: Prepare test reports of grounding resistance at each test location certified by a testing agency. Include observations of weather and other phenomena that may affect test results.

3.06 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

3.07 DEMONSTRATION

A. Train Owner's personnel to adjust, operate, and maintain gates.

END OF SECTION

SECTION 32 31 19
DECORATIVE GATES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Swing gates.

1.02 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-02 Shop Drawings:
      a. For fencing and gates:
         1) Include plans, elevations, sections, gate locations, post spacing, and mounting attachment details.
   2. SD-03 Product Data:
      a. For each type of product.
   3. SD-04 Samples:
      a. For each material and for each color specified:
         1) Provide Samples 12 inches in length for linear materials.
         2) Provide Samples 12 inches square for sheet or plate materials.

1.03 QUALITY CONTROL

A. Installer Qualifications: Fabricator of products.
   1. Workers and Supervisors for this scope of work shall have 5 years' experience with fencing and gate installation.
   2. Field welders shall have 5 years of welding experience.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
   1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

A. Manufacturers and products listed in SpecAgent and Masterworks Paragraph Builder are neither recommended nor endorsed by the AIA or Deltek. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications. For definitions of terms and requirements for Contractor's product selection, see Section 01 60 00 – Product Requirements.

2.02 SWING GATES

A. Gate Configuration: As indicated.

B. Gate Frame Height: As indicated.

C. Gate Opening Width: As indicated.

D. Posts: Square steel tubing.
   1. Vehicular Swing Gate Posts: 10 by 10 inches with 3/16-inch wall thickness.

E. Post Caps: Formed from steel sheet.

F. Steel Frames and Bracing: Fabricate members from square steel tubing 3 by 3 inches with 3/16-inch wall thickness.
   1. Retain "Welded" or "assembled with corner fittings" option in "Frame Corner Construction" Paragraph below or retain both and "or" option to allow Contractor to choose. Truss rods may not be required for panels less than 5 feet (1.52 m) wide.

G. Frame Corner Construction: Welded.

H. Additional Rails: Provide as indicated.
   1. Retain one or more of first eight paragraphs below to suit Project.

I. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 feet wide. Provide cane bolts for pairs of gates. Fabricate latches with integral eye openings for padlocking, padlock accessible from both sides of gate.
   1. Material: Mild steel.
      a. Hinges in "Hinges" Paragraph below are full-surface hinges; they allow gate to swing in only one direction but do allow gate to open 180 degrees.

J. Hinges: BHMA A156.1, Grade 1, suitable for exterior use.
   1. Function: 39 - Full surface, triple weight, antifriction bearing.
   2. Material: Wrought steel, forged steel, cast steel, or malleable iron.
      a. Match material to gate.

K. Cane Bolts: Provide for inactive leaf of pairs of gates. Fabricated from 1/2-inch diameter, round steel bars. Finish to match gates. Provide galvanized-steel pipe strikes to receive cane bolts in both open and closed positions.

L. Finish exposed welds to comply with NOMMA Guideline 1, Finish #4 - good-quality, uniform undressed weld with minimal splatter.

M. Steel Finish: Sandblasted raw steel allowed to rust.
   1. Sandblast all steel to remove factory stamping & protective coatings.
   2. Apply rusting agent in-field after installation.
   3. Provide rusting agent formula or product for approval by Atlantic Richfield Company’s Representative.

2.03 STEEL AND IRON

A. Plates, Shapes, and Bars: ASTM A36/A36M.

B. Bars (Pickets): Hot-rolled, carbon steel complying with ASTM A29/A29M, Grade 1010.

C. Tubing: ASTM A500/A500M, cold-formed steel tubing.

D. Uncoated Steel Sheet: Hot-rolled steel sheet, ASTM A1011/A1011M, Structural Steel, Grade 45 or cold-rolled steel sheet, ASTM A1008/A1008M, Structural Steel, Grade 50.

2.04 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 03 30 00 – Cast-in-Place Concrete with a minimum 28-day compressive strength of 3,000 psi, 3-inch slump, and 1-inch maximum aggregate size.

2.05 STEEL FINISHES

A. Surface Preparation: Clean surfaces according to SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

B. Rusting Agent: Immediately following installation, apply non-toxic, safe for exterior use rusting agent in the field.
   1. Apply rusting agent in sufficient quantities to give the raw steel a brown/red colored hue.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that survey is specified in Section 01 73 00 – Execution or is otherwise available. Consider using sleeves to leave voids in new concrete substrates.
   1. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.
   2. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Stake locations of gates and terminal posts. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.
   1. Construction layout and field engineering are specified in Section 01 73 00 – Execution.

3.03 POST INSTALLATION

A. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth per drawings.

B. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
   1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.

C. Concrete Fill: Place concrete around posts and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
   1. Exposed Concrete: Extend 2 inches above grade. Finish and slope top surface to drain water away from post.

D. Posts Set in Concrete: Extend post to within 6 inches of specified excavation depth, but not closer than 3 inches to bottom of concrete.

3.04 GATE INSTALLATION

A. Install gates level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.05 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

3.06 DEMONSTRATION

A. Train Atlantic Richfield Company personnel to adjust, operate, and maintain gates.

END OF SECTION

SECTION 32 32 00
STONE RETAINING WALLS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Dry Stack Stone Retaining Walls.

1.02 REFERENCES

A. ASTM C 97 - Standard Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone.

1.03 SUBMITTALS

A. Submit under provisions of Section 01 33 00 – Submittal Procedures.
   1. SD-03 Product Data:
      a. Manufacturer’s name and quarry location.
   2. SD-05 Test Results:
      a. Test results as specified in this Section.

1.04 QUALITY CONTROL

A. Installer Qualifications: Firm with experience of at least five projects of similar construction and scope. Include brief description of each project and name and phone number of Atlantic Richfield Company's Representative knowledgeable in each listed project. Other verifiable experience may be accepted in lieu of the above at the discretion of the Landscape Architect.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation (as applicable).

B. Prevent excessive mud, fluid concrete, or other deleterious materials from coming in contact with and affixing to stone materials.

1.06 PROJECT CONDITIONS

A. Do not place backfill when subgrade is wet or frozen.

B. Do not place backfill during wet or freezing weather that prevents conformance with specified compaction requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Provide manufacturer’s name, quarry location, and testing data for approval by Atlantic Richfield Company’s Representative.

B. Requests for substitutions will be considered based on demonstrated conformance to material testing specification.

2.02 DRY STACK STONE

A. “Blockrock” for use in dry stack retaining walls. Ledge Metamorphic rock as quarried in the general areas South of Laurel and East of Edgar, Montana, having a beige and buff coloration.
   1. Sizes per drawings.
   2. Provide current testing data for rock, completed within 6 weeks of product delivery. Provide additional testing data upon request by Atlantic Richfield Company’s Representative. Material shall conform to the following properties, per referenced testing methods:
      a. LA Abrasion loss, crushed and sized to grading A (ASTM C 535).
         1) 15% Maximum.
      b. Specific Gravity, recommended and average of 8 rocks of varying geology (ASTM D 6473).
         1) 2.40 Min.
         2) 3% Maximum absorption.
   3. Tonnage Calculations:
      a. 1 qty. (Blockrock) symbol on the drawings = 32” height x 48” long x 30” deep = 2.46 ton per symbol on average.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Properly prepare substrates for all material

3.02 PREPARATION

A. Clean surfaces thoroughly of debris, roots, branches, and extraneous materials prior to installation.

3.03 INSTALLATION GENERAL

A. Install in accordance with drawings and specifications.

3.04 INSTALLATION - BLOCKROCK

A. Lay out wall to the lines and grades indicated on the drawings. Use the string line and stakes to mark off any straight portions and marking paint to draw out any curves.

B. Prepare a trench base that follows a string line and/or marking paint. Trench should be 6 inches wider than the stone, bedding depth per details.

C. Fill the trench with bedding layer per drawings.

D. Level the base course of stone & compact per drawings. Place first layer of stone checking for level front to back and side to side and adjust accordingly.

E. Provide drainpipe as required per the details. Route piping to daylight.

F. Stack the second course on top of the base course. Do not line up the vertical joints between the stones from one course to the other. Maintain minimum 16” offset between

joints. Select stones that fit well with those on either side. Fit stones per drawings. Shim the stones as required to eliminate wobbling with stone or concrete products.

G. Each course should be set back per drawings to allow the wall to lean back into the ground that it will be retaining. Shim the backs of the stones to eliminate wobbling.

H. Progressively backfill the wall with the drainage aggregate after each two or three courses are stacked. Prior to backfilling, lay the geo-textile fabric on the soil behind the wall, and place the drainage aggregate between the wall and the fabric. The aggregate shall be a minimum of 8 to 12 inches (203 to 305 mm) from the wall to the fabric. Compact each layer of aggregate thoroughly. Fill soil in behind the fabric as the stone is added.

3.05 PROTECTION

A. Protect installed products until completion of project.

B. Protect adjacent work areas and finish surfaces from damage during product installation.

END OF SECTION

SECTION 32 34 00
SITE BOULDERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Landscape boulders.

B. Sandstone slab.

1.02 REFERENCES

A. ASTM C 97 - Standard Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone.

1.03 SUBMITTALS

A. Submit under provisions of Section 01 33 00 – Submittal Procedures:
   1. SD-03 Product Data:
      a. Supplier’s name and quarry location.
      b. Photographs

1.04 QUALITY CONTROL

A. Installer Qualifications: Firm with experience of at least five projects of similar construction and scope. Include brief description of each project and name and phone number of Atlantic Richfield Company's Representative knowledgeable in each listed project. Other verifiable experience may be accepted in lieu of the above at the discretion of the Landscape Architect.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation (as applicable).

B. Prevent excessive mud, fluid concrete, or other deleterious materials from coming in contact with and affixing to stone materials.

1.06 PROJECT CONDITIONS

A. Do not place backfill when subgrade is wet or frozen.

B. Do not place backfill during wet or freezing weather that prevents conformance with specified compaction requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Provide manufacturer’s name, quarry location, and testing data for approval by Atlantic Richfield Company’s Representative.

B. Requests for substitutions will be considered based on demonstrated conformance to material testing specification.

2.02 LANDSCAPE BOULDERS

A. Granite Boulders:
   1. Sizes per drawings.
   2. Lichen/moss covered on greater than 25% of surface.
   3. Submit photos for approval by Atlantic Richfield Company's Representative prior to hauling rock to the site.
   4. Tonnage Calculations:
      a. 1 qty. (Granite Boulder 3') symbol on the drawings = 1.2 ton on average.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Properly prepare substrates for all material

3.02 PREPARATION

A. Clean surfaces thoroughly debris, roots, branches, and extraneous materials prior to installation.

3.03 INSTALLATION GENERAL

A. Install in accordance with drawings and specifications.

3.04 INSTALLATION – BOULDERS

A. Install boulders per plans.

B. Orient boulder faces to expose lichen covered portions to surface.

C. Boulders generally shall occupy the same bury depth as occurred in nature.

3.05 PROTECTION

A. Protect installed products until completion of project.

B. Protect adjacent work areas and finish surfaces from damage during product installation.

END OF SECTION

SECTION 32 70 00
WETLANDS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes work in existing wetlands including:
   1. Protection.
   2. Repair.
   3. Planting.
   4. Erosion control.

B. Related Sections:
   1. Section 02 37 00 – Erosion Control.
   2. Section 32 91 00 – Planting Preparation.

1.02 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-01 Preconstruction Submittals:
      a. Comply with applicable regulations.
         1) Obtain a general construction storm water CWA Section 402 (NPDES) permit for projects 1 acre or more in size. Submit copy of permit and Storm Water Pollution Prevention Plan (SWPPP).
   2. SD-03 Product Data:
      a. Plant List:
         1) Indicate type, installation size, quantity of each type. Indicate water tolerance limits for each type as applicable during establishment period and after establishment period. Include picture of each type of plant as being provided from the supplier.
   3. SD-05 Test Reports:
      a. Soil Analysis:
         1) Site-specific information on the hydraulic conductivity and permeability of the site soils shall be made through field data collection. Laboratory soil analyses shall include clay content and type of clay, percent organic matter, and mineral content.
      b. Reports for Field Quality Control:
         1) Submit test reports and inspection reports to Atlantic Richfield Company's Representative.
            (a) System inspections.
            (b) Water quality tests.
   4. SD-06 Certificates:
      a. Identify primary contact for Constructed Wetlands installation.
   5. SD-07 Closeout Submittals:
      a. Operations & Maintenance Plan.

1.03 QUALITY CONTROL

A. Construction Management General Contractor (CMGC) shall provide a supervisor on site that has at least 3 years of native wetland plant experience.

B. Installing contractor shall have a minimum of 5 years' experience installing wetland projects.
   1. Provide 3 references and projects for applicable work.

1.04 SEQUENCING AND SCHEDULING

A. Coordinate the Work with installation of associated plumbing systems specified under other sections as the Work of this Section proceeds.

1.05 OPERATIONS AND MAINTENANCE

A. Develop an Operation and Maintenance Plan:
   1. Identify the Wetlands Manager.
   2. Include procedures and schedule for operations and maintenance.
   3. Identify procedures for reporting results of Operations and Maintenance.
   4. Identify procedures for implementing corrective action as required.
   5. Update plan as necessary to reflect specific system characteristics learned during actual operation.

B. Operations: Identify procedures to accomplish the following:
   1. Provide ample opportunity for plants to contact the water and with the litter and sediment.
   2. Do not disturb natural flows of wetlands.
   3. Assure a healthy environment for microbes and a vigorous growth of vegetation.

C. Maintenance: Identify procedures to accomplish the following:
   1. Hydrology: Periodic inspection of water flow and levels. Verification that water is moving through all parts of the wetland, that buildup of debris has not blocked flow paths, and that stagnant areas have not developed.
   2. Vegetation: Inspection periodically to verify water levels are appropriate to plant age and type. Inspection periodically to verify that invasive species are not present.
   3. Herbicides: Not permitted.
      a. The control of mosquitoes with insecticides, oils, and bacterial agents such as Bti (Bacillus thuringiensis isroelensis) is not permitted.

PART 2 - PRODUCTS

2.01 WETLANDS COMPONENTS

A. Plants: Non-invasive species appropriate to wetland type and as indicated on Drawings.

B. Erosion control: As specified in Section 02 37 00 – Erosion Control and as follows:
   1. Mulch for seeding may consist of straw, chaff clover, alfalfa, peppermint, soybean hay, or wood cellulose fiber mulch.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions under which system will be installed, with Designer/Installer present, for compliance with requirements.

B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 WEEDING IN WETLANDS

A. Demo invasives and aquatic weeds in wetlands to the extents shown in the drawings and in accordance with applicable regulations.
   1. Ensure removal of roots, stems and leaves in demolition areas.
   2. Dispose of the invasive material offsite by approved methods

B. Minimize disturbance to wetland areas outside of demolition areas.

3.03 INSTALLATION

A. Perform work in wetlands accordance with the drawings and applicable regulations.

B. Planting:
   1. Planting of wetland plugs shall commence no earlier than May 1st and be completed no later than July 15th.
   2. Staged plant material shall be protected from wildlife damage.
   3. Plant material must be kept moist at all times.
   4. Prior to planting wetland plugs, the soil shall be weed free and saturated.
   5. CMGC shall submit a plan to the Atlantic Richfield Company's Representative detailing how they will control weeds during construction to ensure the wetland areas are weed free at the time of plantings.
      a. The plan shall accomplish the following:
         1) Prevent weeds in the wetlands and pond areas from going to seed.
         2) Preserving the final grading and substrate placement in the wetlands and ponds, neither compacting soil nor mixing the placed substrate layers.
         3) Not applying herbicide at a time that will result in mortality of wetland plantings.
      b. Tools available for this purpose could include:
         1) Seeding a cover crop.
         2) Mowing in areas where equipment would negatively affect the final grading.
         3) Herbicide application such a glyphosate in heavily infested areas well in advance of planting.
         4) Hand pulling in small areas where the previous methods are prohibitive.
      c. The CMGC shall provide adequate water for the plant establishment after planting.
   6. Plants assigned to each wetland shall be planted in random distribution by type in spacings noted on plan.
   7. The water level in the wetland cells shall be within one to three inches of the designed permanent water elevation at the time of planting.
   8. Provide temporary anchoring for plants as necessary.
   9. Establishment: Maintain water level as appropriate to plant types and wetlands type.

3.04 PROTECTION

A. Provide mechanical protection as needed to prevent animals from damaging newly established plants.
   1. See Drawings for more information.

3.05 WATER INTRODUCTION

A. Allow plantings to become well established before stormwater is introduced into the system.

3.06 FIELD QUALITY CONTROL

A. General: Comply with requirements of agencies having jurisdiction and as specified herein.

B. Wetland Inspection: Atlantic Richfield Company's Representative shall inspect system installation and submit reports to Atlantic Richfield Company. Notify Atlantic Richfield Company's Representative 48 hours in advance of the date and time of inspection.
   1. Provide site inspection at Substantial Completion.
   2. Provide site inspection immediately after storm event that may be severe enough to affect the system; provide inspection services for minimum 24 months after Final Completion.
   3. Provide site inspection of system seasonally, and not less than once every three months; provide inspection services for minimum 24 months after Final Completion.

3.07 GUARANTEE

A. The CMGC is responsible to provide adequate care to sustain the wetland plants from the completion of planting until substantial completion.

B. A minimum of 80% of the originally planted material shall be viable at the time of the one-year warranty inspection (one year post substantial completion).

C. Excessive plant die-off will be replaced at the expense of the CMGC.

END OF SECTION

SECTION 32 71 00
CONSTRUCTED WETLANDS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes engineering, fabricating, furnishing, and installing:
   1. Constructed wetlands for storm water treatment.
      a. Surface Flow Wetlands.
      b. Sub-Surface Flow Wetlands.

B. Related Sections:
   1. Section 32 91 00 – Planting Preparation.
   2. Division 22 – Plumbing sections.

1.02 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-01 Preconstruction Submittals:
      a. Comply with applicable regulations.
         1) Obtain a general construction storm water CWA Section 402 (NPDES) permit for projects 1 acre or more in size. Submit copy of permit and Storm Water Pollution Prevention Plan (SWPPP).
   2. SD-03 Product Data:
      a. Plant List:
         1) Indicate type, installation size, quantity of each type. Indicate water tolerance limits for each type as applicable during establishment period and after establishment period. Include picture of each type of plant as being provided from the supplier.
   3. SD-05 Test Reports:
      a. Soil Analysis:
         1) Site-specific information on the hydraulic conductivity and permeability of the site soils shall be made through field data collection. Laboratory soil analyses shall include clay content and type of clay, percent organic matter, and mineral content.
      b. Reports for Field Quality Control:
         1) Submit test reports and inspection reports to Atlantic Richfield Company's Representative.
            (a) System inspections.
            (b) Water quality tests.
   4. SD-06 Certificates:
      a. Identify primary contact for Constructed Wetlands installation.
   5. SD-07 Closeout Submittals:
      a. Operations & Maintenance Plan.

1.03 QUALITY CONTROL

A. Construction Management General Contractor (CMGC) shall provide a supervisor on site that has at least 3 years of native wetland plant experience.

B. Installing contractor shall have a minimum of 5 years' experience installing wetland projects.
   1. Provide 3 references and projects for applicable work.

1.04 SEQUENCING AND SCHEDULING

A. Coordinate the Work with installation of associated plumbing systems specified under other sections as the Work of this Section proceeds.

1.05 OPERATIONS AND MAINTENANCE

A. Develop an Operation and Maintenance Plan:
   1. Identify the Constructed Wetlands Manager.
   2. Include procedures and schedule for operations and maintenance.
   3. Identify procedures for reporting results of Operations and Maintenance.
   4. Identify procedures for implementing corrective action as required.
   5. Update plan as necessary to reflect specific system characteristics learned during actual operation.

B. Operations: Identify procedures to accomplish the following:
   1. Provide ample opportunity for contact of the water with the microbial community and with the litter and sediment.
      a. Indicate setting of water depth control structures.
      b. Indicate depth of sediment accumulation before removal is required.
      c. Indicate operating range of water levels, including acceptable ranges of fluctuation.
      d. Indicate the supplemental water source to be used to ensure adequate water levels during establishment.
   2. Assure that flows reach all parts of the wetland.
   3. Assure a healthy environment for microbes and a vigorous growth of vegetation.

C. Maintenance: Identify procedures to accomplish the following:
   1. Hydrology: Periodic inspection of water flow and levels. Verification that water is moving through all parts of the wetland, that buildup of debris has not blocked flow paths, and that stagnant areas have not developed.
      a. In Sub-Surface Flow Wetlands, verification that surface flow is not developing.
   2. Structures: Inspection of dikes, spillways, and water control structures for damage, erosion, or blockage periodically and immediately after an unusual flow event such as a severe storm, rapid ice break up, and similar events.
      a. Cleaning and maintenance of inlet and outlet structures, valving, and monitoring devices.
   3. Vegetation: Inspection periodically to verify water levels are appropriate to plant age and type. Inspection periodically to verify that invasive species are not present.
      a. Water depth may be increased during the cold months to increase retention time and to protect against freezing.
      b. Maintain vegetative cover on dikes.
   4. Herbicides: Not permitted.
      a. The control of mosquitoes with insecticides, oils, and bacterial agents such as Bti (Bacillus thuringiensis isroelensis) is not permitted.

PART 2 - PRODUCTS

2.01 WETLANDS COMPONENTS

A. Wetland Cell Structures:
   1. Dikes: Constructed of soils with adequate fine-grained material that will compact into a relatively stable and impervious embankment; high enough to contain the expected volume plus ample freeboard to accommodate occasional high flows as well as the buildup of litter and sediment over time.
      a. Slope dikes no steeper than 2:1.
      b. Protect slopes with riprap or erosion control fabric.
      c. If multiple cells are used, divider dikes may be used to separate cells and to produce the desired length-to-width ratios.
   2. Spillway: Provide an emergency spillway.

B. Liners:
   1. EPDM Sheet Materials:
      a. EPDM Sheet: Formulated from EPDM, compounded for use in hydraulic structures and formed into uniform, flexible non-reinforced sheets with material properties complying with GRI Test Method GM21 for nominal thickness indicated. Certified “Fish Friendly”
      b. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:
         1) Firestone Building Products.
         2) Carlisle Aquaguard.
            (a) Options in "Minimum Average Sheet Thickness" Subparagraph below are examples for non-reinforced and reinforced sheets according to GRI Test Method GM21.
      c. Minimum Average Sheet Thickness: 60 mils per ASTM D5199.
   2. Underlayment / Overlayment:
      a. Purpose manufactured 8 oz non-woven geotextile underlayment/overlayment fabric.
         1) Stable Polypropolene fibers, heat set and needle punched.
   3. Miscellaneous Materials:
      a. Adhesives: Provide types of adhesive primers, compounds, solvents, and tapes recommended in writing by geomembrane liner manufacturer for bonding to structures (if required), for sealing of seams in geomembrane liner, and for sealing penetrations through geomembrane liner.
      b. Penetration Assemblies: Provide manufacturer's standard factory-fabricated assemblies for sealing penetrations. Include joint sealant recommended in writing by geomembrane liner manufacturer and compatible with geomembrane liner, containment conditions, and materials.

C. Fabrication:
   1. Fabricate geomembrane liner panels from sheets in sizes as large as possible with factory-sealed seams, consistent with limitations of weight and installation procedures. Minimize field seaming.
      a. Constructed wetlands shall be sealed to avoid possible contamination of groundwater and also to prevent groundwater from infiltrating into the wetland.
      b. If the site soils contain angular stones, place sand bedding or geotextile cushions under the liner to prevent punctures.
      c. Cover the liner with 3 - 4 inches of soil to prevent the roots of the vegetation from penetrating the liner.

D. Flow Control Structures:
   1. Inlets: Per drawing details.
   2. Outlets: Per drawing details.

E. Aggregate: Aggregate used to construct the system shall be defined by their ability to pass a given sieve size as indicated on the approved Shop Drawings.
   1. Use aggregate that are suitable for use in concrete.

F. PVC Pipe: ASTM D1785 sch 40.

G. Septic Tanks: Not applicable.

H. Pumping Stations:
   1. Per Drawings.

I. Plants: Non-invasive species appropriate to wetland type and as indicated on Drawings.

J. Erosion Control: As specified in Section 31 25 00 – Erosion Control and as follows:

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions under which system will be installed, with Designer/Installer present, for compliance with requirements.

B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install wetlands system in accordance with Drawings and applicable regulations.

B. Liner Installation:
   1. Underlayment:
      a. General: Place underlayment over prepared surfaces to ensure minimum handling. Install according to Shop Drawings and in compliance with manufacturer's written instructions. Begin placing liner at Project's upwind direction and proceed downwind. Install underlayment in a relaxed condition, free from stress and with minimum wrinkles, and in full contact with subgrade. Do not bridge over voids or low areas in the subgrade. Overlap seams 6” minimum. Fit closely around inlets, outlets, and other projections through geomembrane liner. Permanently secure edges.

C. Pond Liner:
   1. General: Place geomembrane liner over prepared surfaces to ensure minimum handling. Install according to Shop Drawings and in compliance with geomembrane liner manufacturer's written instructions. Begin placing geomembrane liner at Project's upwind direction and proceed downwind. Install geomembrane liner in a relaxed condition, free from stress and with minimum wrinkles, and in full contact with subgrade. Do not bridge over voids or low areas in the subgrade. Fit closely and seal around inlets, outlets, and other projections through geomembrane liner. Permanently secure edges.
   2. Field Seams: Comply with geomembrane liner manufacturer's written instructions. Form seams by lapping edges of panels 2 to 4 inches, unless instructions require a

larger overlap. Wipe contact surfaces clean and free of dirt, dust, moisture, and other foreign materials. Use solvent-cleaning methods and grind geomembrane seam surfaces if recommended by geomembrane liner manufacturer. Proceed with seaming at required temperatures for materials and ambient conditions. Continuously bond sheet to sheet to construct single or double seams of width recommended for method of seaming used. Seal or fuse free seam edges. Inspect seams and reseal voids.

a. Adhesive Bonding: Apply bonding cement to both contact surfaces in seam area and press together immediately, or use other seaming methods as instructed by geomembrane liner manufacturer. Roll to press surfaces together, to distribute adhesive to leading edges of panels, and to remove wrinkles and fishmouths. Remove excess adhesive.

D. Overlayment:

1. General: Place overlayment over placed pond liner after all liner field seams have been completed and inspected. Place overlayment to minimize foot traffic on top of placed liner. NO equipment is allowed on top of pond liner. Install according to Shop Drawings and in compliance with manufacturer's written instructions. Begin placing liner at Project's upwind direction and proceed downwind. Install overlayment in a relaxed condition, free from stress and with minimum wrinkles, and in full contact with subgrade. Do not bridge over voids or low areas in the subgrade. Overlap seams 6” minimum. Fit closely around inlets, outlets, and other projections through geomembrane liner. Permanently secure edges.
2. Installation in Anchor Trench: Install geomembrane liner in trench according to manufacturer's written instructions. Backfill and compact to lock liner into trench.
   a. Install batten strips over geomembrane liner as indicated on Drawings.
   b. Liner Repairs: Repair tears, punctures, and other imperfections in geomembrane liner field and seams using patches of geomembrane liner material, liner-to-liner bonding materials, and bonding methods according to geomembrane liner manufacturer's written instructions. Apply bonding solvent or weld to contact surfaces of both patch and geomembrane liner, and press together immediately. Roll to remove wrinkles.
3. Field Quality Control:
   a. Retain "Testing Agency" Paragraph below to identify who shall perform tests and inspections. If retaining second option in "Testing Agency" Paragraph, retain "Field quality-control reports" Paragraph in "Informational Submittals" Article.
   b. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
   c. Revise "Nondestructive Testing" Paragraph below if manufacturer's procedures must be followed for warranty coverage, or if required for Project.
   d. Nondestructive Testing: Visually inspect seams and patches. Comply with ASTM D4437 for Air Lance Test, Vacuum Box Testing, or Ultrasonic (High Frequency) Pulse Echo Testing or with GRI Test Method GM6, as applicable to geomembrane liner and seam construction. Record locations of failed seams and patches. Individually number and date occurrences and details of leak and remedial action. Repair leaking seams and patches.
   e. Prepare test and inspection reports.

3.03 PROTECTION

A. Protect installed geomembrane liner according to manufacturer's written instructions. Repair or replace areas of geomembrane liner damaged by scuffing, punctures, traffic, rough subgrade, or other unacceptable conditions.

B. Before initial filling of pond or placement of earth cover, inspect seams and patched areas to ensure tight, continuously bonded installation. Repair damaged geomembrane liner and seams and reinspect repaired work.

C. Planting:
   1. Planting of wetland plugs shall commence no earlier than May 1st and be completed no later than July 15th.
   2. Staged plant material shall be protected from wildlife damage.
   3. Plant material must be kept moist at all times.
   4. Prior to planting wetland plugs, the soil shall be weed free and saturated.
   5. CMGC shall submit a plan to the Atlantic Richfield Company's Representative detailing how they will control weeds during construction to ensure the wetland areas are weed free at the time of plantings.
      a. The plan shall accomplish the following:
         1) Prevent weeds in the wetlands and pond areas from going to seed.
         2) Preserving the final grading and substrate placement in the wetlands and ponds, neither compacting soil nor mixing the placed substrate layers.
         3) Not applying herbicide at a time that will result in mortality of wetland plantings.
      b. Tools available for this purpose could include:
         1) Seeding a cover crop.
         2) Mowing in areas where equipment would negatively affect the final grading.
         3) Herbicide application such a glyphosate in heavily infested areas well in advance of planting.
         4) Hand pulling in small areas where the previous methods are prohibitive.
      c. The CMGC shall provide adequate water for the plant establishment after planting.
   6. Plants assigned to each cell shall be planted in random distribution by type in spacings noted on plan.
   7. The water level in the wetland cells shall be within one to three inches of the designed permanent water elevation at the time of planting.
   8. Provide temporary anchoring for plants as necessary.
   9. Establishment: Maintain water level as appropriate to plant types and wetlands type (surface flow or sub-surface flow) at all times for the duration of the initial growing season.

3.04 PROTECTION

A. Provide mechanical protection as needed to prevent animals from damaging newly established plants.
   1. See Drawings for more information.

3.05 WATER INTRODUCTION

A. Allow plantings to become well established before stormwater is introduced into the system.

B. Verify that the water supplies enough nutrients to support plant growth. If not, a solution of commercial nutrient supplement may be added with approval by Atlantic Richfield Company's Representative.

3.06 FIELD QUALITY CONTROL

A. General: Comply with requirements of agencies having jurisdiction and as specified herein.

B. Pressure Test: Perform pressure test of the pressure distribution system as occurs prior to final cover.

3.07 GUARANTEE

A. The CMGC is responsible to provide adequate care to sustain the wetland plants from the completion of planting until substantial completion.

B. A minimum of 80% of the originally planted material shall be viable at the time of the one-year warranty inspection (one year post substantial completion).

C. Excessive plant die-off will be replaced at the expense of the CMGC.

END OF SECTION

SECTION 32 80 00
IRRIGATION SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. Trenching and backfilling for all irrigation system components.
   2. Boring under driveways, walks, and curbs.
   3. Furnishing and installation of all pipe sleeves.
   4. Furnishing and installation of all exterior irrigation system components.
   5. Furnishing and installing all low voltage control wiring, including connection into controller terminal strip.
   6. Furnishing and installing irrigation system controller, excluding 120 volt wiring.

B. Trenching and backfill for irrigation system components is specified in Section 32 84 10 of this Specification.

C. Electrical Contractor shall furnish and install all 120 volt or greater wiring, including all necessary conductors, raceways and conduits, breakers, fuses, label plates and miscellaneous items required for a complete functioning installation. Construction Management General Contractor (CMGC) shall coordinate with utility provider for point of connection in location as noted on the plans.

1.02 QUALITY CONTROL

A. Qualifications of Installer: Provide at least one person who shall be present at all times during execution of this portion of the work and who shall be thoroughly familiar with the type of materials being installed and material manufacturer's recommended methods of installation and who shall direct all work performed under this section.

B. Coordination of Work: All work of this section, and the installation of all lawns and all plant materials shall be performed by CMGC.

C. Codes and Standards: In addition to complying with all pertinent codes and regulations, comply with the latest rules of the National Electrical Code and National Plumbing Code for all electrical and plumbing work and materials. Where provisions of pertinent codes and standards conflict with the requirements of this section of these Specifications, the more stringent provisions shall govern.

1.03 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:

B. SD-03 Product Data:
   1. Material List:
      a. Before any irrigation system materials are delivered to the job site, submit to the Atlantic Richfield Company's Representative a complete list of all irrigation system materials proposed to be furnished and installed.
         1) Show manufacturer's name and catalog number for each item, furnish complete catalog cuts and technical data, and furnish the manufacturer's recommendations as to method of installation.

2) Do not permit any irrigation system component to be brought onto the job site until it has been approved by Atlantic Richfield Company's Representative.

1.04 PRODUCT HANDLING

A. Protection: Use all means necessary to protect irrigation system materials before, during, and after installation and to protect the installed work and materials of all other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Atlantic Richfield Company's Representative and at no additional cost to the Atlantic Richfield Company.

1.05 UNDERGROUND OBSTRUCTIONS

A. The CMGC shall contact all utilities for locations of their installations prior to initiating work.

B. The CMGC shall preserve, intact, any underground pipes or other utilities encountered during construction. In case any such utilities or other structures are accidentally broken or damaged, the Proprietor of the underground installation shall be immediately notified, and they shall be immediately replaced in a condition at least equal to that in which they were found, all at the expense of the CMGC.

C. Use of Explosives: Use of explosives is not permitted.

PART 2 - PRODUCTS

2.01 PIPE

A. Plastic Pipe:
1. Pipe sizes shall conform to those shown on the plans. No substitutions of smaller pipe shall be allowed. Substitutions of larger pipe may be approved. All pipe rejected due to damage, defects, or non-conformance to the specifications shall be removed immediately from the site.
2. All plastic pipe shall be rigid unplasticized, PVC Class 200 conforming to ASTM D-1784 and D-2241 standard specifications for PVC plastic pipe, or as shown in drawings. The pipe shall be homogeneous throughout and free from visible cracks, holes, foreign materials, blisters, deleterious, wrinkles, and dents.
3. All pipe shall be continuously and permanently marked with the following information. Manufacturer's name or trademark, size, schedule, and type of pipe, working pressure at 73 degrees F (22.8 degrees C). and National Sanitation Foundation (N.S.F.) approval.
4. All pipe 2-1/2 inches (6.4 cm) and smaller shall be slip type joints. All pipe 3 inches (7.6 cm) and larger shall be gasket type joints. All pipe fittings to be installed for pipe 2-1/2 inches (-6.4 cm) and smaller shall be molded fittings manufactured of the same material as the pipe and shall be suitable for solvent weld or threaded connections. All pipe fittings to be installed for pipe 3 inches (7.6 cm) and larger shall be epoxy coated steel fittings with compression gaskets as manufactured by Pierce, PO Box 528, Eugene, OR 97440, (503-485-3111), or approved equal.
5. Slip fitting socket taper shall be so sized that a dry unsoftened pipe end, conforming to these special provisions, can be inserted no more than halfway into the socket. Plastic saddle and flange fittings will not be permitted. Only schedule 80 pipe or fittings may be threaded.

6. When connection is plastic to metal, plastic male adapters shall be used. The male adapters shall be hand tightened, plus one turn with a strap wrench. Joint compound shall be Teflon Tape only.

B. Sleeves:
   1. All sleeve material shall be rigid unplasticized PVC-Schedule 40 pipe. The pipe shall be homogeneous throughout and free from visible cracks, holes, foreign materials, blisters, deleterious, wrinkles, and dents.
   2. All sleeves shall be 4” or larger as required to facilitate mainlines, lateral lines and wire sizes as shown on the plans.

2.02 RISERS

A. Spray Heads:
   1. All stationary spray heads shall have risers of high-density polyethylene plastic pipe ("funny pipe") with spiral barbed ell fittings. Minimum length of "funny pipe" shall be 18 inches.

B. Rotor Pop-up Heads:
   1. All rotor heads shall have Lasco Unitized Swing Joints.

2.03 FITTINGS

A. Solvent Weld:
   1. All fittings 2-1/2” and smaller shall be schedule 40 solvent weld. Fittings shall be manufactured by Lasco, Spears, or approved equal.

B. Gasketed:
   1. All fittings 3” and larger shall be ductile iron. Fittings shall be manufactured by Harco, Sceptor, or approved equal.

2.04 MANUAL VALVES

A. Gate Valves:
   1. All manual gate valves, sizes 2 inches (5 cm) and smaller, shall be all bronze double disc wedge type with integral taper seats and with non-rising stem.
   2. All gate valves of 2-1/2 inches (6.4 cm) size or larger shall be iron body, brass trimmed, double disc wedge type with integral taper seats and with non-rising stems, 125 PSI rated. Gate valves shall function and be equal to PGL 701-A flanged, PGL 705-A threaded, or PGL 708-A gasketed.

2.05 VALVE BOXES

A. All valve boxes for valves 3 inches and larger and air release valves shall be Carson model 1419 standard with non-hinged cover or approved equal. CMGC to provide Carson model 1419E 6” extension boxes as required.

B. All valve boxes for valves smaller than 3 inches shall be Carson model 910-10” round or approved equal.

C. All manual control valves, zone shut-off valves, gate valves or globe valves unless otherwise indicated, shall be installed in valve access box of proper size as required for easy access to the valve. Standard valve box to be Carson 1419-12B with locking green cover or approved equal.

2.06 SPRINKLER HEADS

A. Sprinkler heads shall be as indicated on the plans or approved equal

B. Sprinklers shall be attached to the irrigation system per the drawings. Sprinklers to be properly set and adjusted for optimal operation.

C. CMGC shall deliver four (4) spare heads for each type used and four (4) sets of sprinkler head adjustment tools for each head type used to the Atlantic Richfield Company.

2.07 AUTOMATIC REMOTE-CONTROL VALVES

A. Automatic control valves shall be per the drawings or approved equal. Size of valves as follows: Flows up to 30 GPM to be 1-inch automatic control valve, flows from 31 GPM to 75 GPM to be 1-1/2-inch automatic control valve, flows from 76 GPM to 100 GPM to be 2-inch automatic control valve or per manufacturer's recommendations.

B. Automatic control valves to be installed as shown on the plans. CMGC shall adjust pressure regulation as necessary to provide optimal performance of the irrigation heads.

C. CMGC shall provide two (2) spare valves for each size used to the Atlantic Richfield Company.

2.08 IRRIGATION CONTROLLER

A. Controller location to be coordinated with Atlantic Richfield Company and Atlantic Richfield Company's Representative. All wires to be in conduit for a professional installation.

B. Controller model per Drawings.

2.09 CONTROL CABLE

A. All electrical control wire to match manufacturer's specifications. CMGC shall supply and install complete system per manufacturer's recommendations including electrical grounding, electrical splices and ancillary items required for a complete system.

B. Verification of wire types and installation procedures shall be checked to conform to local codes.

2.10 OTHER MATERIALS

A. Materials to be Furnished:
   1. Supply as part of this contract the following tools:
      a. Two keys for each automatic controller.

B. The above equipment shall be turned over to the Atlantic Richfield Company at the conclusion of the project. Before final inspection can occur, evidence that the Atlantic Richfield Company has received materials must be shown to the Atlantic Richfield Company's Representative.

C. All other materials, not specifically described but required for a complete and proper irrigation system installation, shall be new, first quality of their respective kinds, and subject to the approval of the Atlantic Richfield Company's Representative.

PART 3 - EXECUTION

3.01 SURFACE CONDITIONS

A. Inspection: Prior to all work of this section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence. Verify that irrigation system may be installed in strict accordance with all pertinent codes and regulations, the original design, the referenced standards, and the manufacturer's recommendations.

B. Verify that trenching may be completed in accordance with the original design and the referenced standards.

C. Discrepancies: In the event of discrepancy, immediately notify the Atlantic Richfield Company's Representative. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.02 FIELD MEASUREMENTS

A. Make all necessary measurements in the field to ensure precise fit of items in accordance with the original design.

3.03 TRENCHING/PULLING

A. General:
   1. All mainlines to be open trenched. All lateral lines can be open trenched or pulled. If CMGC intent is to pull pipe, CMGC shall submit pulling method to the Atlantic Richfield Company's Representative prior to commencement of work.
   2. Perform all trenching required for the installation of irrigation system components. Make all trenches in accordance with OSHA Requirements with sufficient width to provide free working space at both sides of the trench and around the installed item as required for gluing, joining, backfilling, and compacting while minimizing width of trenches.

B. Depth:
   1. Trench to sufficient depth to give a minimum of 18 inches of fill above the top of the pipe measured from the adjacent finished grade under driveways and sidewalks.
   2. All mainline shall have a minimum cover of 18 inches above the pipe unless as noted below. All laterals shall have a minimum cover of 12 inches above the pipe.
   3. All 6-inch mainline pipe to have a minimum of 36 inches of fill above the top of the pipe.
   4. All 4-inch mainline pipe to have a minimum of 24 inches of fill above the top of the pipe.
   5. All 3-inch and smaller mainline pipe to have a minimum of 18 inches of fill above the top of the pipe.

C. Correction of Faulty Grades:
   1. Where trench excavation is inadvertently carried below proper elevations, backfill with material approved by the Atlantic Richfield Company's Representative and then compact to provide a firm and unyielding subgrade to the approval of the Atlantic Richfield Company's Representative and at no additional cost to the Atlantic Richfield Company.

D. Trench Bracing:
   1. Properly support all trenches in strict accordance with all pertinent rules and regulations.

2. Brace, sheet, and support trench walls in such a manner that they will be safe and that the ground alongside the excavation will not slide or settle, and that all existing improvements of every kind will be fully protected from damage.
3. In the event of damage to such improvements, immediately make all repairs and replacements necessary to the approval of the Atlantic Richfield Company's Representative and at no additional cost to the Atlantic Richfield Company.
4. Arrange all bracing, sheeting and shoring so as to not place stress on any portion of the completed work until the general construction thereof has proceeded far enough to provide sufficient strength.

E. Removal of Trench Bracing:
1. Exercise care in the drawing and removal of sheeting, shoring, bracing, and timbering to prevent collapse or caving of the excavation faces being supported.

F. Grading and Stockpiling Trenched Material:
1. Control the stockpiling of trenched material in a manner to prevent water running into the excavations. Do not obstruct surface drainage but provide means whereby storm and waste waters are diverted into existing gutters, other surface drains, or temporary drains.

G. Methods:
1. All trench excavation shall be made by open cut. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading, and to prevent slides or cave-ins. All material not required for backfill or not suitable for backfill, shall be removed from the site by the CMGC. Banks of trenches shall be kept as nearly vertical as possible and shall be properly sheeted and braced as may be necessary to prevent caving.
2. Trench widths in paved streets or in areas where proximity to other structures require vertical cuts, shall not be wider than is required for proper handling, jointing and bedding of the pipe.
3. The bottom of the trenches shall be accurately graded to line and grade, and provide uniform bearing and support for each section of the pipe on undisturbed soil, at every point along its entire length. Depressions for joints shall be dug after the trench bottom has been graded, and shall be only of such length, depth and width as required for properly making the particular type joint. Care shall be taken not to excavate below the depths indicated.
4. Where rock occurs in trench excavation, the rock shall be removed to a depth of 6 inches (15.2 cm) below the established grade line, and to a width of 12 inches (30.5 cm) greater than the outside diameter of the pipe to be installed in the trench.

H. Pavement Removal:
1. Where excavation of trenches requires the removal of asphaltic pavement, the pavement shall be cut in a straight line along the edge of the excavation by use of a concrete saw or similar approved equipment to obtain straight, square and clean break; and, after backfilling and subgrade preparations are completed, hot plant mix asphaltic concrete shall be replaced and compacted.
2. Excess material, including rock, broken concrete, bituminous materials, debris or other materials not suitable for backfill, shall be removed from the site and disposed of by the CMGC.

3.04 BORING

A. Locations:
   1. Boring shall be used to route pipe, wiring, or both under concrete structures such as walks or curbs where trenching is impractical. Sleeves shall be installed in all bored holes.

B. Method:
   1. Boring shall be accomplished with a drill, auger, water jet, or any other instrument approved by the Atlantic Richfield Company's Representative capable of producing a precise hole. Boring shall not disturb overlaying structures or cause settlement and damage to those structures. CMGC shall submit boring method to the Atlantic Richfield Company's Representative for approval prior to commencement of work.

3.05 SLEEVES

A. Locations:
   1. Sleeves shall be installed wherever routing of a pipe, wiring, or both crosses a paved area or passes through a bored hole.

B. Methods:
   1. Sleeves laid in open trenches shall be uniformly and evenly supported by undisturbed soil on the trench bottom. Backfill shall conform to standards hereinafter specified.
   2. Sleeves installed in borings shall be forced through and shall have a snug fit throughout the length of the bored hole. Sleeves cracked or broken shall not be accepted.

3.06 INSTALLATION OF PIPING

A. Layout the piping system in strict accordance with the plans. Where piping is shown on the plans to be under paved areas but running parallel and adjacent to planted areas, the intention is to install the piping in the planted areas.

B. Pipe Depth:
   1. All mainlines shall be installed with 18 inches minimum cover over the pipe with the exception of the 6-inch mainline which is to have a minimum of 36 inches of cover and the 4-inch mainline which is to have a minimum of 24 inches of cover. All laterals shall be installed with 12 inches minimum cover over the pipe.

C. Line Clearance:
   1. All lines shall have a minimum clearance of 4 inches (10.2 cm) from each other, and 6 inches (15.2 cm) from lines of other trades, except through pipe sleeves. Parallel lines shall not be installed directly over one another but should be separated sufficiently to allow for repairs.

D. Inspection of Pipe and Fittings:
   1. Carefully inspect all pipe and fittings before installation, removing all dirt, scale, and burrs and reaming as required; install all pipe with all markings up for visual inspection and verification.

E. Plastic Pipe:
   1. Plastic pipe shall be installed in a manner so as to provide for expansion and contraction as recommended by the manufacturer.

2. All plastic joints shall be solvent-weld joints or slip seal joints. Only the solvent cement recommended by the pipe manufacturer shall be used. All plastic pipe and fittings shall be installed as outlined and instructed by the pipe manufacturer and it shall be the CMGC's responsibility to make arrangements with the pipe manufacturer for any, field assistance that may be necessary. The CMGC shall assume full responsibility for the correct installation.
3. Slip seal gasketed joints shall be used on all pipe 3 inches (7.6 cm) and larger.
4. All plastic to metal joints shall be made with plastic male adapters.
5. The solvent-weld joints shall be made dry.
6. The solvent-weld joints shall be allowed to set at least 24 hours before pressure is applied to the system on PVC pipe.

F. Thrust Blocks:
1. Provide concrete thrust blocks for all pipe as required by the schedule on the plans.
2. All thrust blocks shall bear directly on undisturbed earth. Center pipe in the middle of thrust block.

3.07 BACKFILL

A. Inspection:
1. The trenching shall not be backfilled until inspection has been completed and the pipe installation, including the grade, alignment and jointing has been found to be in compliance with the requirements of the plans and specifications.

B. Around and Over Pipe:
1. Select backfill material consisting of sand, fine gravel or select earth, free of large lumps or rocks larger than 3/4 inch (19 mm) shall be used in backfilling around and over the installed pipe.
2. The select material shall be obtained from the excavation material removed from the trench and shall be processed by screening, sifting, or selective sorting, so as to produce the type of backfill herein specified. The CMGC may at his option and own expense provide an acceptable imported material.
3. Backfill material shall be carefully deposited around and over the pipe in layers not more than 6 inches (15.2 cm) thick, loose measurement, unless otherwise permitted by the Atlantic Richfield Company’s Representative, wetted to optimum moisture content and uniformly compacted to at least 95 percent of the maximum density obtainable at optimum moisture content as determined by AASHTO T99 Method A or D (latest revision), until the pipe has a cover depth of at least 12 inches (30.5 cm).

C. Remainder of Trench Backfill:
1. The remaining depth of the trench shall be backfilled with excavation material removed from the trench, which shall be wetted or dried to near optimum moisture content.
2. Inclusion of a limited amount of stones and rocks will be permitted. Stones and rocks shall in no case be larger than 3/4 inch. The size and amount of rocks used in backfill shall be such that they will not interfere with proper compaction.
3. This material shall be carefully deposited in layers of a thickness suitable to the equipment selected by the CMGC for proper compaction and compacted to at least 95 percent of the maximum density as determined by AASHTO T99 Method A or D (latest revisions). The method of compaction selected by the CMGC shall not cause damage of any nature to the installed pipe.
4. The use of a water puddling of this portion of the trench backfilling may be used if the specified density can be obtained and the backfill material is suitable for this type of trench compaction.

3.08 INSTALLATION OF EQUIPMENT

A. General:
   1. All fittings, valves, etc. shall be carefully placed in the trenches as shown on the plans.
   2. All control wires shall be clearly labeled, by station using weatherproof material, both at the controller and at the valve. The inside cover of all automatic valve boxes shall also have the station number clearly painted in white.
   3. All sprinklers, having adjustable nozzles, shall be adjusted for proper and adequate distribution of the water over the coverage pattern of the sprinkler.
   4. All nozzles on stationary pop-up sprinklers or stationary spray heads shall be tightened after installation. All sprinklers having an adjusting screw, adjusting stem or adjusting friction collars shall be adjusted as required for the proper arc of coverage, radius, diameter and/or discharge.

B. Lawn Sprinkler Heads:
   1. Install lawn sprinkler heads where indicated on the plans and in strict accordance with the manufacturer's recommendations.
   2. Set heads to grade at initial install.
   3. Along walks and driveways where finished grade is established, set all heads 1/4 inch (64mm) below surface of pavement at time of installation and 1-1/2 inches (3.8 cm) from pavement. Stake all temporary risers.
   4. Set all heads to final grade where sod lawn will be installed.
   5. Upon completion of maintenance period, reset all lawn sprinkler heads flush with grade and firmly anchor with soil.

3.09 AUTOMATIC IRRIGATION CONTROLLER

A. Controllers per plans. Mount as directed by Atlantic Richfield Company’s Representative. All wires to be in conduit for a professional installation.

3.10 TESTING AND INSPECTION

A. Closing-in Uninspected Work:
   1. Do not allow or cause any of the work in this section to be covered up or enclosed until it has been inspected, tested, and approved by the Atlantic Richfield Company’s Representative. Where trenches are not closed at the end of the day CMGC shall accept all liability for any damage or injury that may result from open trenches. Provide barricades and warning tape as necessary around all open trenches.

B. Flushing:
   1. Before backfilling the mainline, and with all control valves in place, but before lateral pipes are connected, completely flush and test the mainline and repair for all leaks; flush out each section of lateral pipe before sprinkler heads are attached.

C. Testing:
   1. Make all necessary provisions for thoroughly bleeding the line of air and debris.
   2. Before testing, fill the line with water for a period of at least 24 hours.
   3. After valves have been installed, test all live water lines for leaks at a pressure of 100 psi for a period of two hours, with all couplings exposed and with all pipe sections centerloaded. CMGC shall provide deliver/documentation of system testing.
   4. Furnish all necessary testing equipment and personnel.
   5. Correct all leaks and retest until acceptance by the Atlantic Richfield Company’s Representative.

D. Final Inspection:
   1. Thoroughly clean, adjust, and balance all systems.
   2. Demonstrate the entire system to the Atlantic Richfield Company's Representative, proving that all remote control valves are properly balanced, that all heads are properly adjusted for radius and arc of coverage, and that the installed system is workable, clean, and efficient.

3.11 PAVEMENT REPLACEMENT

A. Pavement replacement shall utilize the same materials and design as the original pavement.

3.12 CLEANUP

A. Upon completion of the work, the entire site shall be cleared of all debris, and ground surfaces shall be finished to smooth, uniform slopes and shall present a neat and workmanlike appearance. Cleanup shall be considered an incidental item, and no additional payment shall be made for any cleanup item. All fences, culverts, gravel driveways or other obstructions removed or modified during construction, shall be replaced in a condition at least equal to their pre-construction condition, and shall be approved by the Atlantic Richfield Company's Representative.

3.13 INSTRUCTIONS

A. Record Drawings:
   1. Record accurately on one set of black and white prints of the site plan all installed work including both pressure and non-pressure lines.
   2. Upon completion of each increment of work, transfer all such information and dimensions to the print. The dimensions shall be recorded in a legible and workmanlike manner. Maintain as-built drawings on site at all times. Make all notes on drawing in pencil (no ball point pen). When the work has been completed, transfer all information from the field record print to a set of reproducible drawings.
   3. Dimension from two permanent points of reference (buildings, monuments, sidewalks, curbs, pavement, etc.). Locations shown on as-built drawings shall be kept day to day as the project is being installed. All dimensions noted on drawings shall be 1/8 inch (32mm) in size (minimum).
   4. Show locations and depths of the following items:
      a. Point of connection.
      b. Routing of sprinkler pressure lines.
      c. Gate valves.
      d. Sprinkler control valves.
      e. Quick coupling valves.
      f. Routing of control wires.
      g. Sprinkler heads.
      h. Other related equipment.

B. Controller Charts:
   1. As-built drawings must be approved by Atlantic Richfield Company's Representative before charts are prepared.
   2. Provide one controller chart for each controller supplied showing the area covered by automatic controller, of the maximum size controller door will allow.
   3. The chart is to be a reduced drawing of the actual as-built system. Chart shall be a photo positive with different colored shading used to show area of coverage for each station. When completed and approved, the chart shall be hermetically sealed between

two pieces of plastic. The chart shall be mounted in the controller using Velcro or equal type of semi-permanent fastening device.

4. These charts must be completed and approved prior to final acceptance of the irrigation system by the Atlantic Richfield Company.

C. Operation and Maintenance Manuals:
   1. Prepare and deliver to the Atlantic Richfield Company's Representative within ten calendar days prior to completion of construction, four individually bound copies of the operations and maintenance manual. The manual shall describe the material installed and shall be in sufficient detail to permit operating personnel to understand, operate and maintain all equipment. Spare parts lists and related manufacturer information shall be included for each equipment item installed. Each complete, bound manual shall include the following information:
      a. Index sheet stating CMGC's address and telephone number, duration of guarantee period, list of equipment with names and addresses of local manufacturer representatives.
      b. Complete operating and maintenance instructions on all major equipment.
      c. In addition to the above maintenance manuals, provide the maintenance personnel with instructions for system operation and show written evidence to the Atlantic Richfield Company at the conclusion of the project that this service has been rendered.

3.14 GUARANTEE PERIOD

A. Guarantee:
   1. The entire irrigation and water system shall be guaranteed to give satisfactory service for a period of one year from date of acceptance by the Atlantic Richfield Company.
      a. Maintain and repair any trench or boring settlement which may occur, and shall make suitable repairs to any pavements, sidewalks, or other structures which may become damaged as a result of settlement.
      b. Should any trouble develop within the time specified above due to inferior or faulty materials or workmanship, the trouble shall be corrected at no expense to the Atlantic Richfield Company.
      c. Any and all damages resulting from faulty materials or workmanship shall be repaired by the CMGC to the satisfaction of the Atlantic Richfield Company, at no cost to the Atlantic Richfield Company.

B. Guarantee Period Services:
   1. The CMGC shall winterize the system and perform spring start-up of the system during the guarantee period. These functions shall be coordinated in advance with the Atlantic Richfield Company, and the Atlantic Richfield Company's personnel shall be encouraged to participate.
   2. Upon re-energizing the system, the CMGC shall repair any leaks or breaks and shall check each head and valve, making any adjustment necessary.

END OF SECTION

SECTION 32 91 00
PLANTING PREPARATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes
   1. Furnishing all material, labor, and equipment necessary for preparation for planting of trees, shrubs, and groundcovers.

B. Installation of lawns is specified in Section 32 92 00 – Turf and Grasses and installation of plants is covered in Section 32 93 00 – Trees, Shrubs, and Groundcovers, of this Specification.

1.02 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-01 Preconstruction Submittals:
      a. The CMGC's project-specific Construction Execution Plan (CEP) shall include a Soil Preparation Plan as follows:
         1) Submit a minimum of 30 days prior to commencing soil preparation.
         2) Schedule for soil preparation.
         3) Equipment.
         4) Weed eradication methods and layout for accomplishing the Selective Clearing work:
            (a) Hand and/or Mechanized Weeding:
               (i) Show areas where weed eradication will occur by hand or mechanized means.
               (ii) Describe equipment use and method of hand or mechanized weeding.
            (b) Herbicide Application:
               (i) Show areas where herbicide will be used for weed and grass eradication.
               (ii) Describe methods of herbicide application.
               (iii) Ensure no wetland contamination results from herbicide application.
         5) Soil preparation locations, placement, incorporation and compaction techniques for the following areas:
            (a) Seeding areas outside of basin
            (b) Landscape areas outside of basin.
            (c) Seeding areas inside of basin
            (d) Landscape areas inside of basin.
            (e) Include proposed methods to protect existing desirable vegetation.
   2. SD-03 Product Data:
      a. Materials List:
         1) A complete list of proposed materials demonstrating conformance with the requirements specified. Include names and addresses of all suppliers.
      b. Fertilizers:
         1) Manufacturer's analysis.
      c. Safety Data Sheets.

3. SD-04 Samples:
    a. Soil Materials:
        1) 0.25 cu.ft. representative samples of imported topsoils and organic amendment.
4. SD-05 Test Reports:
    a. Laboratory testing documenting soil fertility and recommendations for soil additives.
    b. Imported cover soil from an off-site source shall be tested and results submitted, including source location, gradation, and moisture-density characteristics. Imported cover soil must meet the Engineered Caps/Cover Systems Material Suitability Criteria as specified in Section 31 01 20 – Growth Media (Cover Soil).
5. SD-06 Certificates.

1.03 QUALITY ASSURANCE

A. Qualification of Workmen: Provide at least one person who shall be present at all times during execution of this portion of the work and who shall be thoroughly familiar with the type of materials being installed, the best methods for their installation, and who shall direct all work performed under this section.

B. Coordination of Work: All work of this section, and the installation of all irrigation systems and all lawns shall be performed by one Contractor.

1.04 STANDARDS

A. All preparation work and materials shall meet or exceed the Specifications of federal, state, and county laws requiring inspection for plant disease and insect control.

B. Referenced Standards: This Section incorporates by reference the latest revision of the following documents. These references are a part of this Section as specified and modified in case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.
1. ASTM D1557 - Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
2. ASTM D75 - Standard Practice for Sampling Aggregates.
3. ASTM D422 - Standard Test Method for Particle-Size Analysis of Soils.
4. North American Proficiency Testing Program (NAPT).
5. USDA Textural Soil Classification.

C. Manufacturer’s Qualifications: Materials to be provided under this Section are to be the product of firms regularly engaged in the manufacture of a specified material.

1.05 PRODUCT HANDLING

A. Delivery and Storage:
1. Furnish products in manufacturer’s standard unopened containers bearing original labels showing quantity, analysis, and name of manufacturer.
2. Store products with protection from weather or other conditions that would damage or impair the effectiveness of the product.
3. Do not dump or store bulk materials near structures, utilities, walkways, and pavements, or on existing turf areas or plants.
4. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

5. Do not move or handle materials when they are wet or frozen.
6. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

1.06 MATERIAL TESTING

A. Submit samples of existing site soil, imported topsoil mix, and mulch samples to a certified soil testing laboratory for analysis and soil amendment recommendations. Three existing site soil samples will be tested at locations directed by Atlantic Richfield's Representative. Test soil components as follows:
   1. All stockpile sampling shall be per ASTM D 75 for securing samples from stockpiles. Stockpiles shall be made sufficiently in advance of testing so that pH, organic content, and carbon/nitrogen ratio have stabilized.
   2. Deliver all samples to an approved testing laboratory. Perform all tests for particle gradation, organic content, soil chemistry, and pH. Testing reports shall include the following tests and recommendations.
      a. Mechanical gradation (sieve analysis) shall be performed and compared to the USDA Textural Soil Classification System. Sieve analysis shall be in compliance with ASTM D 422 after destruction of organic matter by H2O2. To facilitate review and approval of sieve analysis, provide a computer-generated gradation curve from Laboratory.
      b. Percent of organics shall be determined by the loss on ignition of oven-dried samples.
      c. Chemical analysis shall be undertaken for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, extractable Aluminum, Lead, Zinc, Cadmium, Copper, Soluble Salts, and pH and buffer pH, and the Cation Exchange Capacity (CEC). A Conductivity Meter shall be used to measure Soluble Salts in 1:2 soil/water (v/v). Except where otherwise noted, nutrient tests shall be for available nutrients.
   3. Soil analysis shall show recommendations for soil additives to correct soil deficiencies and enhance fertility to accomplish planting work as specified.

PART 2 - PRODUCTS

2.01 TOPSOIL

A. Provide topsoil per the Consent Decree requirements. See Section 31 01 20 – Growth Media (Cover Soil).

B. See supplemental amendment requirements for tree & shrub planting in Section 31 01 30 Amendments and Section 32 93 00 – Trees, Shrubs, and Groundcovers.

PART 3 - EXECUTION

3.01 PREPARATION OF SUB-GRADE:

A. Work Outside of Protective Basin:
   1. Rip, disc, or scarify sub-grade soils to a minimum depth as follows:
      a. Landscape Planting Areas:
         1) 12 inches minimum below finished grade, unless otherwise indicated in the Plans.
      b. B&B Tree Planting Locations:
         1) Sub-grade elevation 24 inches below finished grade, unless otherwise indicated in the Plans.

B. Work Inside of Protective Basin:
    1. Stake landscape boundaries, shrub groupings and tree locations. Mark installed depths of basin liner on stakes.
    2. Maintain minimum 12 inches separation between liner and any soil preparation work.
    3. Rip, disc, or scarify sub-grade soils to optimum depth as listed below, unless depth results in violation of minimum offsets.
        a. Ideal soil preparation depths as follows:
            1) Landscape Planting Areas:
                (a) 12 inches minimum below finished grade, unless otherwise indicated in the Plans.
            2) B&B Tree Planting Locations:
                (a) Sub-grade elevation 24 inches below finished grade, unless otherwise indicated in the Plans.
    4. Notify Atlantic Richfield Company's Representative in cases where minimum offset cannot be achieved.
    5. Modify depth of preparation in accordance with minimum offset in consultation with Atlantic Richfield Company's Representative.

3.02 SOIL PREPARATION

A. For Seeded Areas:
    1. Scarify the subsoil prior to placing Topsoil.
    2. Place topsoil to depths indicated on drawings in maximum of four-inch lifts, rototilling each lift into the underlying soil before placing an additional four-inch lift, until the final grade is attained.

B. For Areas Planted with Trees and Shrubs:
    1. Scarify the subsoil prior to placing Topsoil.
    2. Add organic amendment to backfill per drawings.
    3. Hand till to thoroughly mix the organic amendment with the Topsoil.
    4. Apply mycorrhizae to tree and shrub rootballs and planting holes per Manufacturer's recommendations.

3.03 COMPACTION

A. Compact to 80 percent maximum density per ASTM D1557.

3.04 FINE GRADING

A. Perform fine grading to attain finish grades as shown on the Plans.

B. Rake out all rocks, roots, sticks and other debris larger than 2-inch diameter or sticks longer than 4 inches long. Leave surface even and readily able to accommodate plant installation.

3.05 INSPECTION

A. Scheduling:
    1. In addition to the normal progress inspections, schedule and conduct the following formal inspections, giving the Owner's Representative at least 48 hours prior notice of readiness for inspection:
        a. Inspection of prepared surfaces prior to planting.

3.06 MAINTENANCE

A. Maintain all prepared surfaces in a weed free and dust free condition through planting and seeding.

END OF SECTION

SECTION 32 92 00
TURF AND GRASSES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work in this section consists of furnishing all plant, labor, equipment, and performing all operations to finish grade topsoil, to prepare seedbeds, seeding native grass and seeding or sodding lawn areas, maintenance and protection of all planted areas.

B. All exterior areas within the seeding limits, except surfaces occupied by buildings, plant beds and paving, and areas indicated to be undisturbed shall be seeded or sodded as shown on Plans.

C. All areas disturbed by construction activities including but not limited to irrigation trenches, contractor staging areas and general disturbed areas to be seeded as specified in this section per the drawings.

1.02 RELATED WORK DESCRIBED ELSEWHERE

A. Section 32 91 00 – Planting Preparation.

B. Section 32 80 00 – Irrigation System.

C. Section 32 93 00 – Trees, Shrubs, and Groundcovers.

1.03 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-01 Preconstruction Submittals:
      a. The CMGC shall prepare a project-specific Construction Execution Plan (CEP) describing the following construction components for the Site:
         1) Revegetation and Planting.
   2. SD-03 Product Data:
      a. Complete materials list of all materials proposed to be furnished and installed under this Section.
      b. Specifications and other data required to demonstrate compliance with the specified requirements.
   3. SD-05 Test Reports:
      a. Imported cover soil from an off-site source shall be tested and results submitted, including source location, gradation, and moisture-density characteristics. Imported cover soil must meet the Engineered Caps/Cover Systems Material Suitability Criteria as specified in Section 31 01 20 – Growth Media (Cover Soil).

1.04 QUALITY CONTROL

A. Qualification of Workmen:
   1. Provide at least one person who shall be present at all times during execution of this portion of the work and who shall be thoroughly familiar with the type of materials being installed and the best methods for their installation and who shall direct all work performed under this section.

1.05 PRODUCT HANDLING

A. Protection:
   1. Upon delivery of sod to the work site use all means necessary to protect and maintain the sod before, during, and after installation and to protect the installed work and materials of all other trades.
   2. All seed shall be delivered to the job site in the original bags with tags certifying purity, germination, common and botanical name for each species, and percent weed seed. All tags shall be removed from the bags by the Atlantic Richfield Company's Representative. Untagged seed bags shall be rejected.

B. Storage:
   1. Seed, hydromulch, and hydromulch tackifier shall be kept in dry storage away from contaminants.

C. Replacements:
   1. In the event of rejection of the seed or sod, immediately make all replacements necessary to the approval of the Atlantic Richfield Company's Representative and at no additional cost to the Atlantic Richfield Company.

D. Notice to Proceed:
   1. The Construction Management General Contractor (CMGC) shall not proceed with seeding or sodding operations until the irrigation system has been tested and approved by the Atlantic Richfield Company's Representative.

E. Schedules:
   1. Install seed mixes during the specified time periods. If special conditions exist that may warrant a variance in the specified plant dates or conditions, a written request shall be submitted to the Atlantic Richfield Company's Representative stating the special conditions and proposed variance.

F. Substitutions:
   1. Request for substitutions, shall be submitted in writing prior to bid and in accordance with Section 01 25 00.

PART 2 - PRODUCTS

2.01 SEED

A. All grass seed shall be:
   1. Free from noxious weed seeds, and recleaned.
   2. Grade A recent crop seed.
   3. Treated with appropriate fungicide.
   4. Delivered to the site in sealed containers with dealer's guaranteed analysis.

2.02 FERTILIZER

A. General:
   1. All fertilizer to be commercially prepared and shall contain the following percentages by weight:
      a. 16% Nitrogen.
      b. 16% Phosphoric Acid.
      c. 16% Potash.

2. Commercial fertilizer shall be complete, uniform in composition, dry and free-flowing. The fertilizer shall be delivered to the site in the original waterproof containers, each bearing the manufacturer's statement of analysis.

B. Special Protection:
   1. If stored at the site, protect fertilizer from the elements at all times.

2.03 MULCH

A. All mulch for hydroseeding shall be North American Green GeoSkin (includes tackifier) as supplied by True North Steel, Billings, MT 59102 (406) 656-2253 or approved equal. Application rate per manufacture’s recommendations.

2.04 TOPSOIL

A. Topsoil:
   1. Provide topsoil per the Consent Decree requirements. See Section 31 01 20 – Growth Media (Cover Soil).
   2. The topsoil shall be loose, friable, and shall contain an ordinary amount of humus. It shall contain no lumps of soil, rocks larger than 1 inch (2.54 cm), or sticks, roots, and other debris. It shall be sufficiently fertile to sustain normal healthy plant growth and shall not have a pH value higher than 7.0 or lower than 5.5. The topsoil shall be delivered in an unfrozen and non-muddy condition and must meet the approval of the Atlantic Richfield Company’s Representative.

2.05 WATER

A. Water for seeding operations shall be CMGC’s responsibility.

PART 3 - EXECUTION

3.01 SURFACE CONDITIONS

A. Inspection:
   1. Prior to all work of this section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
   2. Verify that seeding or sodding may be completed in accordance with the original design and the referenced standards.

B. Discrepancies:
   1. In the event of discrepancy, immediately notify the Atlantic Richfield Company's Representative.
   2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.02 FINISH GRADING

A. Finish Grading:
   1. Grade lawn areas to finish grades, filling as needed or removing surplus dirt and floating areas to a smooth uniform grade. All lawn areas shall slope to drain. Where no grades are shown, surfaces shall have a smooth and continual grade between existing or fixed controls (such as walks, curbs, catch basins, elevations at steps or building). Roll, scarify, rake and level as necessary to obtain true even lawn surfaces. All finish

grades shall meet approval of the Atlantic Richfield Company's Representative before grass seed is sown or sod is laid.

B. Fine Grading:
   1. Upon completion of finish grading, perform all fine grading required in planting areas, using topsoil.

C. Weed Control:
   1. Prior to application of seed the seed bed shall be roughed up to a depth of 1/8 inch (32mm).
   2. Moisten the seedbed to a depth of 1 inch (2.5 cm) to promote germination of any seeds contained in the topsoil.
   3. After weeds have germinated and are growing vigorously, spray with Roundup in strict conformance with manufacturer’s specifications. Seeding shall be executed 7 days following Roundup application. Do not disturb the sterilized seedbed in any way prior to seeding.

3.03 SOWING NATIVE AND LAWN GRASS

A. Preparation:
   1. Seed bed preparation shall pertain to the preparation of the surface of the ground to receive the seed. The ground shall be hand or machine raked so as to remove all debris, clods, rocks, and other material larger than 1 inch (2.5 cm), to a depth of 4 inches (10.2 cm). Such debris, clods, rocks, and other material so removed shall be disposed of off the immediate property. Seed bed preparation shall not commence until the moisture conditions make the ground area and soil friable.
   2. If there has been a time lapse following the placement of the topsoil to allow it to become settled and compacted on the surface, the area to be planted with seed shall be thoroughly worked to a depth of 3 to 4 inches (7.6 cm to 10.2 cm) so as to provide a surface of such condition that it will allow application of the seed in compliance with these Specifications.
   3. Apply fertilizer at a rate of 5 pounds per 1,000 square feet (2.5 kg per 100 m1. Rake fertilizer lightly into top 1 inch (2.5 cm) of prepared seedbed.
   4. Seed beds should be firm prior to seeding. Seed beds should be permitted to settle or should be firmed by rolling before seedings are made.

B. Sowing:
   1. Immediately prior to the application of the seed, the soil shall be loose to a depth of at least 1 inch (2.5 cm) and free from all material as specified. If soil is too loose or dry for good handling, it should be moistened and rolled lightly.
   2. Seeding Methods:
      a. Hand Broadcast: Hand broadcast shall be used in sensitive areas where other methods may cause unnecessary disturbance or in areas where species with a small seed are being applied. CMGC must receive approval for areas of broadcast seeding by Atlantic Richfield Company’s representative if not designated on the plans. Seed should be applied at double the specified seeding rate in all areas of broadcast seeding. All broadcast seeded areas shall receive straw or hydro mulch per specifications.
      b. Drill Seeding: The seed drill shall be capable of accurately seeding native grass and forb species. Areas where drill seeding can be used must be physically accessible by a tractor and drill. The drill seeder shall have multiple seed boxes for different types and sizes of seed. Seed agitators are required to drop seed into a series of planters. The planters open a slot in the ground and plant the seeds

ensuring that each seed is effectively planted to an optimal depth. The seeder must be able to be calibrated to the rate required for each type of seed, and must be able to be pulled by a wheeled or crawler tractor. The soil surface shall not be compacted. Shallow tilling (no greater than 2" below soil surface) may be required if soil surface is compacted. All drill seeded areas shall receive straw or hydro mulch.

c. Hydroseeding: Seed placed by hydraulic methods. Seed and mulch shall be applied in separate and distinct operations except that a minimal amount of mulch may be added to the seed slurry as a visual aid during the seeding process. Mulch applied with seed shall not exceed one pound mulch for each five gallons water (25 kg mulch for each liter of water). This mulch shall be deducted from the total quantity to be applied. The application of the seed slurry shall be made with the equipment having a built-in agitation system and operating capacity sufficient to agitate, suspend and homogeneously mix a slurry containing water, seed, and mulch. The slurry shall be sprayed over the soil in a uniform coat. Wherever practical, the slurry shall be applied to the surface being treated to effectively drill the seed into the seedbed. Hydromulch application shall follow seeding as soon as practical, with consideration for minimal soil erosion through washing. All seeded areas shall be mulched before work is terminated on any day.

3. Seeding Times:
   a. Non-irrigated grass areas shall be seeded between March 1 and March 31 or between October 15 and October 31 unless otherwise directed by the Atlantic Richfield Company's Representative.
   b. Sagebrush shall be seeded between October 15 and March 1.
   c. Irrigated areas can be seeded anytime following irrigation system startup. Coordinate irrigation with Atlantic Richfield Company's Representative.
4. Seed shall be sown exercising great care that a uniform distribution of seed is obtained.
5. Mulch application shall follow seeding as soon as practical, with consideration for minimal soil erosion through washing. All seeded areas shall be mulched within 24 hours of placement.

C. Mulching:
   1. Mulch all seeded areas. Topsoil or seed which washes out for reasons attributable to the CMGC's activities or failure to take proper precautions, shall be replaced at the CMGC's expense.
   2. Hydro Mulching:
      a. Hydro mulching can be used on areas of hydroseeding, drill seeding or broadcast seeding.
      b. All structures shall be protected from hydraulic application of mulch material. Any material deposited on walks, streets, inlets, or other structures, shall be removed.
      c. Mulch shall not be applied in the presence of free surface water, but may be applied on damp ground.
      d. Apply tank mixed mulch and tackifier at a rate of 2000 pounds per acre.
      e. Tank Mix:
         1) Tank mix shall meet the manufacturer's specifications and proportions.
         2) Add tackifier and mulch to hydroseeder with machine in operation. Run hydroseeder agitator for a minimum of 2 minutes prior to applying tank mix to prepared seedbeds.
   3. Straw Mulching:
      a. Straw mulching shall be used only on areas of drill or broadcast seeding. The work consists of placing a straw mulch cover on slopes or other designated areas following seeding. Crimped straw consists of a layer of straw or hay spread or

blown over the seeded or graded soil surface. The straw is then mechanically anchored to the soil surface. The action of rolling an implement over the surface of the straw creates rows of straw that stand up. The remainder of the straw protects the soil's surface.

b. Materials:
   1) Grass Hay or Straw Mulch: Grass hay or straw mulching material shall be certified noxious weed seed free. The mulch shall have been baled dry, in bales of approximately equal weight and shall be relatively dry when applied. Materials having characteristics making them unsuitable for the purpose intended will be rejected. The Atlantic Richfield Company's representative shall approve the materials prior to installation.

c. Placing:
   1) The straw mulch shall be placed within 24 hours after the seeding or grading has been completed. Mulching operations shall not be performed during periods of high winds, which impede the proper placing of the mulch. The placing of mulch shall begin on the windward side of the areas to be covered. On gentle to moderate slopes, straw mulch can be applied by hand broadcasting to a uniform depth of 2 - 3 inches. On steep slopes, the straw should be blown onto the slope to achieve the same degree of cover. For machine application, the machine shall blow or eject mulch, by a constant air stream, that controls the amount of mulch. The machine shall cause a minimum of cutting or breakage of the mulch. Mulch containing excessive moisture, which prevents uniform feeding through the machine, shall not be used. Mulch shall be placed uniformly over the seeded areas at a rate of 4000 pounds per acre (or one 74 pound bale per 800 square feet). Approximately 10 -20 percent of the soil surface shall be visible through the mulch blanket prior to mulch tiller (punching) operation. Excessive cover, which will smother seedlings, shall be avoided. The Atlantic Richfield Company's Representative may order the placement of mulch on any area where protection is necessary to prevent erosion or encourage vegetation establishment. The mulch shall extend into existing vegetation or be stabilized on all sides to prevent wind or water damage which may start at the edges.

d. Punching:
   1) Immediately following application, the mulch shall be punched into the soil. Punching shall be accomplished using one of three methods depending on slope and equipment availability:
      (a) Hand Punching: A spade or shovel is used to punch straw into the slope until all areas have straw standing perpendicularly to the slope and embedded at least 4 inches into the slope. It shall be punched about 12 inches apart.
      (b) Roller Punching: A roller equipped with straight studs not less than 6 inches long, from 4 - 6 inches wide and approximately one inch thick shall be rolled over the slope.
      (c) Crimper Punching: Like roller punching, the crimper has a series of dull, flat disks with notched or cutout edges. The disks shall be approximately 20 inches (500 mm) in diameter, ¼ inch (6 mm) thick, spaced approximately 8 inches (200 mm) apart which force straw mulch into the soil. Crimping shall be done in two directions with the final pass across the slope. Tiller members shall be ballasted; to push mulch into the soil approximately three inches with ends exposed above the soil surface. The mulch tiller shall follow as closely as possible behind the mulcher. More than one pass of the mulch tiller may be required to assure adequate anchoring.

D. Protection: Protect all seeded areas by erecting temporary fences, barriers, signs, etc. as necessary to prevent traffic. Barriers shall remain in place for at least six (6) weeks unless other arrangements are made with the Atlantic Richfield Company's Representative.

3.04 MAINTENANCE

A. General:
   1. Maintain all native grass and lawn areas for a period of 30 days following substantial completion of the job.
   2. CMGC shall coordinate with the Atlantic Richfield Company to ensure seed establishment in disturbed areas. Overall maintenance of areas outside disturbed/seeded is not the responsibility of the CMGC.
   3. Reseeding of areas as needed is the responsibility of the CMGC.

B. Work Included:
   1. All irrigated areas shall be watered as required.
   2. All areas shall be watched closely so that they are "not permitted to dry out or to form puddles of water, or to be washed by over-application.
   3. Mow all lawn at 1- 1/2 inches (3.8 cm) with a self-bagging mower each time its height reaches 3 inches (7.6 cm). Maintain through minimum three mowings to provide an

even stand over the entire seeded area. Continue mowing all lawns at 1-1/2 inches (3.8 cm) until acceptance.

4. Mow native areas to a height of 6” per direction of Atlantic Richfield Company’s representative, for a maximum of 4 mowings throughout seed establishment.

C. Replacements:
   1. Any area that fails to produce an adequate stand of grass as determined by the Atlantic Richfield Company until Final Completion shall be reseeded by the CMGC at no additional expense to the Atlantic Richfield Company. If seeding is found to be unsatisfactory the final completion date shall be extended as required until seeding acceptance by Atlantic Richfield Company at the CMGC’s expense.
   2. Replacements required because of vandalism or other causes beyond the control of the CMGC are not part of the Contract.

D. Extension of Maintenance Period:
   1. Continue the maintenance period at no additional cost to the Atlantic Richfield Company until all previously noted deficiencies have been corrected, at which time the final inspection shall be made.

END OF SECTION

SECTION 32 93 00
TREES, SHRUBS, AND GROUNDCOVERS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. Furnishing all plants, labor, equipment, and performing all planting of trees, shrubs, and groundcovers.

B. Installation of lawns is specified in Section 32 92 00 – Turf and Grasses, of this Specification.

1.02 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-01 Preconstruction Submittals:
      a. The CMGC shall prepare a project-specific Construction Execution Plan (CEP) describing the following construction components for the Site:
         1) Revegetation and Planting.
   2. SD-03 Product Data:
      a. Plant list.
      b. Complete materials list of all materials proposed to be furnished and installed under this Section.
      c. Specifications and other data required to demonstrate compliance with the specified requirements.
   3. SD-05 Test Reports:
      a. Imported cover soil from an off-site source shall be tested and results submitted, including source location, gradation, and moisture-density characteristics. Imported cover soil must meet the Engineered Caps/Cover Systems Material Suitability Criteria as specified in Section 31 01 20 – Growth Media (Cover Soil).

1.03 QUALITY ASSURANCE

A. Qualification of Workmen:
   1. Provide at least one person who shall be present at all times during execution of this portion of the work and who shall be thoroughly familiar with the type of materials being installed, the best methods for their installation, and who shall direct all work performed under this section.

B. Coordination of Work:
   1. All work of this section, and the installation of all irrigation systems and all lawns shall be performed by one Contractor.

1.04 STANDARDS

A. All plants and planting materials shall meet or exceed the Specifications of federal, state, and county laws requiring inspection for plant disease and insect control. Quality and size shall conform with the current edition of American Standards for Nursery Stock, ANSI Z60.I, as adopted by the American Association of Nurserymen, and with the schedule shown on the plans.

B. All plants shall be true to name and one of each bundle or lot shall be tagged with the name and size of the plants in accordance with the standards of practice of the American Association of Nurserymen. In all cases, botanical names shall take precedence over common names.

PART 2 - PRODUCTS

2.01 PLANT MATERIALS

A. General: Plant materials shall mean trees, shrubs, groundcovers and plants of all descriptions, required to be furnished for the project, in accordance with the plans and specifications. All plant material must be true to name, which shall conform to Standardized Plant Names of the American Joint Committee on Horticultural Nomenclature, and shall be legibly tagged with the name and size of the material according to the general nursery practice as recommended by the American Association of Nurserymen.

B. Condition: All plants shall be first class representatives of their normal species or varieties. Unless otherwise specified, plants shall have average or normally developed branch systems and vigorous root systems. Plants shall be free from scale, disfiguring knots, sun scald injuries, abrasions of the bark, or other objectionable blemishes. Weak plants will not be accepted. Plants must show appearance of normal health and vigor in strict accordance with these Specifications. All stock shall be nursery grown.

C. Disease: All plant material shall comply with state and federal laws with respect to inspection for plant disease and infection. Any inspection certificates required by law shall accompany each shipment, invoice, or order of stock.

D. Size Variance: When planted in masses, plants shall be subject to tests that will eliminate more than twenty (20%) percent variance from uniform size and that will ensure at least fifty (50%) percent conformity to larger rather than smaller Sizes.

E. Inspection: All plant material shall be subject to approval and inspection at any place, before, during and/or after planting. Any plant material not approved by the Owner's Representative shall be immediately removed from the site. No plant material shall be accepted with loose or broken balls.

2.02 OTHER MATERIALS

A. See related specification sections.

2.03 PLANTING MIXTURE

A. Topsoil:
   1. Provide topsoil per the Consent Decree requirements. See Section 31 01 20 – Growth Media (Cover Soil).
   2. The topsoil shall be loose, friable, and shall contain an ordinary amount of humus. It shall contain no lumps of soil, rocks larger than 1 inch (2.54 cm), or sticks, roots, and other debris. It shall be sufficiently fertile to sustain normal healthy plant growth and shall not have a pH value higher than 7.0 or lower than 5.5. The topsoil shall be delivered in an unfrozen and non-muddy condition and must meet the approval of the Owner's Representative.

B. Fertilizers:
   1. Add fertilizers of the types and quantity as recommended by an accredited soils testing laboratory to bring the planting mix to optimum long-term fertility.

2. Fertilizers shall meet the general requirements of this Section and the recommendations of the testing laboratory.

C. Organic Amendment:
   1. Mix compost with topsoil at a ratio of 67% topsoil and 33% compost organic amendment by volume in the following locations:
      a. Backfill around all containerized and B&B plantings.
      b. Planting bed areas per depths noted on plans.
   2. Compost: The Compost (Organic Amendment) shall consist of 100 percent recycled organic feedstocks described as “Wood waste”, “Yard debris”, “Post consumer food waste”, “Preconsumer animal-based waste”, and/or “Preconsumer vegetative waste” that have been sorted, ground up, aerated and aged and shall be fully composted, stable and mature (non-aerobic). The composting process shall be for at least six (6) months’ time and the organic amendment shall have a uniform dark, soil-like appearance. In addition, the compost shall have the following physical characteristics:
      a. Contractor shall use only Compost that has been tested within 90 days of Submittal and meets the requirements in this Section. Compost not conforming to these requirements or taken from a source other than those tested and accepted shall not be used and shall be removed from Site immediately.
      b. Compost shall be pure composted plant waste, a well decomposed, humus-like material derived from the decomposition of grass clippings, leaves, branches, wood, food waste, and other approved organic materials.
      c. Compost shall be produced professionally at a commercial facility.
      d. Compost shall be mature with regard to its suitability for serving as a soil amendment. Maturity shall be greater than 80 percent in accordance with USCC TMECC 05.05-A.
      e. The Compost must have a moisture content that has no visible free water or dust produced when handling the material.
      f. Additional Requirements
         1) The Compost shall have a minimum organic matter content of 40 percent dry weight as determined by USCC TMECC 05.07-A.
         2) Soluble salt content shall be less than 4.0 mmhos/cm when tested in accordance with USCC TMECC 04.10.
         3) Shall be certified by the Process to Further Reduce Pathogens (PFRP) guideline for hot composting as established by the United States Environmental Protection Agency
         4) Compost shall meet the following gradation:

	Percent Passing	
Sieve Size	**Minimum**	**Maximum**
1 inch	100	
5/8 inch	85	100
1/4 inch	75	85

         5) The pH range shall be between 6.0 and 8.8 when tested in accordance with USCC TMECC 04.11-A.
         6) The material shall be certified free of all plant parasitic organisms, viable weed seeds, heavy metals, and parasitic residues. No more than 0.5 percent foreign material (plastic, concrete, ceramics, and metal) including no more than 0.1 percent film plastic, on a dry weight basis as determined by USCC TMECC 03.08-A.
         7) Stability shall be 7 mg CO2-C/g OM/day or below in accordance with the USCC TMECC 05.08-B.

D. Michorrizae:
   1. Powder form of mycorrhizae spores with water absorbing gel pellets designed for use with trees & shrubs, purpose designed to be applied to the root balls and planting holes.
   2. Apply to all B&B and container plants over 5 gallons per manufacturers recommendations.

PART 3 - EXECUTION

3.01 SURFACE CONDITIONS

A. Inspection: Prior to all work of this section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence. Verify that planting may be completed in accordance with the original design and the referenced standards.

B. Discrepancies: In the event of discrepancy, immediately notify the Owner's Representative. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.02 PLANTING TREES AND SHRUBS

A. Plant nursery stock immediately upon delivery to the site and approval by the Owner's Representative except that, if this is not feasible, heal-in all balled material with damp soil and protect from sun and wind. Regularly water all nursery stock in containers or healed in and place them in a cool area protected from sun and drying winds.

B. Contractor is required to stake the Remedy isolation liner perimeter in the field at 50' intervals adjacent to all areas of work. Stakes must note the bury elevation of the liner edge on each stake.

C. Stake tree locations based on drawing information.

D. Mark on the stakes the depths to the Remedy isolation liner.

E. Excavation of Plant Holes:
   1. Excavation shall be accomplished in such a manner as to provide a 1/2 inch (13 mm) drop from all pavements to the finished surface of beds. Excavate shrub pits to provide not less than 6 inches (15.2 cm) of planting mixture beyond the side of the container.
   2. Tree pits shall have gradually sloping sides and horizontal bottoms. Diameter of pits for all trees shall be at least three times greater than the maximum diameter of the tree ball or root system, see details.
   3. Do not operate heavy equipment within 2' vertical feet of the Remedy isolation liner. Hand dig all planting holes beyond this tolerance.
   4. Maintain minimum 12" offset between root balls and Remedy isolation liner.

F. Planting Operation:
   1. Trees and shrubs shall be supplied in sizes shown on the Landscaping Plan with all plants "Balled and Burlapped [B&B]" or containerized. During planting operations, the nursery stock shall not be exposed to the sun, drying winds, or winter freezing. Roots of evergreens shall not be exposed to the air.
   2. Planting may be executed at any time between March 1 and September 30, provided the ground is not frozen and water is available. The Contractor shall take all precautions he deems necessary against desiccation, freezing, or other potential

damage to plant materials due to weather conditions existing or that may be expected at the time of planting and during the maintenance and guarantee periods.

3. The soil in the bottom of the hole, which has been excavated to the prescribed requirements, shall be loosened to a depth of 3 inches (7.6 cm) and mixed with an equal amount of topsoil. A mound of soil shall be formed in the center of the hole to support the ball of the plant. The plant shall be placed on the mound of soil and held in a vertical position. Handle all "Balled and Burlapped" shrubs and trees by the earth ball and not by the top, exercising care not to drop or loosen the ball. After setting the shrub or tree at proper depth, untie or cut rope at trunk of plant and loosen burlap carefully without disturbing the earth ball.
4. Remove all containers and wire baskets from top 2/3 of plant root ball in a careful manner so that the root ball is not damaged.
5. The plants shall be so set, by adjusting the elevation of the mound, that after settlement the plant will stand at approximately the same depth it stood in the nursery or field, see details.
6. The plant hole shall be backfilled with native soil placed in layers around the ball. Each layer shall be carefully tamped in place in a manner to avoid injury to the ball or disturbing the position of the plant. When approximately two-thirds of the plant hole has been backfilled, the hole shall be filled with water and the soil allowed to settle around the roots. Balled and burlapped plants shall have the burlap cut away or folded back from the top of the ball before applying the water. After the water has been absorbed, the plant hole shall be filled with native soil and tamped lightly to grade. Any settlement shall be brought to grade with topsoil.
7. In the case of planting in the open on hot days, shorten the time between planting and watering.

3.03 STAKING TREES

A. All trees must be guyed and staked with materials specified in section 32 94 00 – Planting Accessories.

3.04 PRUNING

A. The brushed or broken parts of large or fleshly roots shall be cut off smooth before planting. Evergreen plants shall not be pruned except to remove dead or broken branches. Deciduous plants shall be pruned using proper pruning practices as approved by a certified arborist.

B. Trees and shrubs that have been so badly pruned as to spoil their form and usefulness shall be removed and replaced.

3.05 INSPECTION

A. Scheduling:
   1. In addition to the normal progress inspections, schedule and conduct the following formal inspections, giving the Owner’s Representative at least 48 hours prior notice of readiness for inspection:
      a. Inspection of plants in containers prior to planting.
      b. Inspection of plant locations, to verify compliance with the plans.
      c. Substantial completion inspection after completion of planting. Schedule the substantial completion inspection sufficiently in advance, and in cooperation with the Owner’s Representative so that final inspection may be conducted within 24 hours after completion of planting.

d. Final inspection at the end of the maintenance period, provided that all previous deficiencies have been corrected.

3.06 MAINTENANCE

A. General: Maintain all planting, starting with the delivery or collection of plant materials and continuing until completion of job. Maintenance shall include all watering, weeding, cultivating, spraying, and pruning necessary to keep the plant materials in a healthy growing condition and to keep the planted areas neat and attractive throughout the maintenance period. Provide all equipment and means for proper application of water. Protect all planted areas against damage, including erosion and trespassing, by providing and maintaining prior safeguards.

B. Settlement: If any tree, shrub, or plant bed settles more than 1 inch (2.54 cm) below the established grade, the plant shall be raised to the proper level and not merely covered with additional mulch.

C. Replacements: At the end of the maintenance period, all plant material shall be in a healthy growing condition. During the maintenance period, should the appearance of any plant indicate weakness and probability of dying, immediately replace the plant with a new and healthy plant of the same type and size without additional cost to the Owner.

D. Extension: Continue the maintenance period at no additional cost to the Owner until all previously noted deficiencies have been corrected at which time the final inspection shall be made. When final inspection is made and deficiencies are noted, the maintenance period will continue until such deficiencies are corrected at no additional cost to the Owner.

3.07 GUARANTEE

A. Time Frame: Guarantee all plant materials to remain healthy and in a vigorous growing condition for a period of 1 year following substantial completion. The final inspection shall be one year from the date of substantial completion.

B. Replacements: All replacements shall be the same species as originally installed.

END OF SECTION

SECTION 32 94 00
PLANTING ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Furnishing all accessories for planting of trees, shrubs, and groundcovers as specified in Section 32 93 00 – Trees, Shrubs, and Groundcovers, of this Specification.

B. Installation of turf and grasses is specified in Section 32 92 00 – Turf and Grasses, of this Specification.

1.02 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-03 Product Data:
      a. Complete materials list of all materials proposed to be furnished and installed under this Section.
      b. Specifications and other data required to demonstrate compliance with the specified requirements.

1.03 QUALITY CONTROL

A. Qualification of Workmen: Provide at least one person who shall be present at all times during execution of this portion of the work and who shall be thoroughly familiar with the type of materials being installed, the best methods for their installation, and who shall direct all work performed under this section.

B. Coordination of Work: All work of this section, and the installation of all irrigation systems and all lawns shall be performed by Construction Management General Contractor (CMGC).

PART 2 - PRODUCTS

2.01 MATERIALS

A. Staking: Stakes shall be 2 inches (5 cm) metal t-post stakes, minimum length 6 feet (.9m), with the exposed portion of the stake painted dark green or brown.

B. Guying: Guys shall be canvas or cloth straps. Staking is mandatory, see details.

C. Mulch: Mulch per details. Submit samples for approval prior to installation.

D. Weed Barrier Fabric: Weed barrier fabric shall be Typar Style 3201, as manufactured by Reemay Company or approved equal. Installed under all mulch areas unless noted otherwise in plans.

E. Bed Edging: All edging shall be 1/8 inch x 4 inches (3.2 mm x 102 mm) aluminum edging, mill finish, as manufactured by Permaloc Corporation, 13505 Barry Street, Holland, MI 49424. Telephone 1-800-356-9660 or 616-399-9600. Fax 616-399-9770. Or approved equal.

PART 3 - EXECUTION

3.01 STAKING TREES

A. All trees must be guyed with three metal t-post stakes driven into the ground outside the root ball. The stakes shall be equally spaced. The tree will be secured to the stakes by canvas or cloth straps over the first lateral branch. The straps should have a maximum of 1/2 inch (13 mm) slack. Do not have taut. Remove after one year, at time of final inspection, provided that trees are in acceptable free-standing condition. Staking is mandatory.

3.02 BED EDGING INSTALLATION:

A. Prior to all work of this section, carefully inspect installation work of other trades and, verify that all such work is complete to the point that installation of edging may properly commence.

B. In the event of discrepancy, immediately notify the Atlantic Richfield Company's Representative. Do not proceed with installation in areas of discrepancy until all such discrepancies have been resolved.

C. Install all edging where indicated on the Plans, anchoring all edging firmly in place and maintaining smooth curves and straight lines in accordance with manufacturer's recommended installation procedures. Place line stakes approximately 3.2 feet o.c. (96 cm o.c.), and plumb. Place splicer stakes in a manner so that smooth lines are maintained at all times. Kinked or waving edging, or edging not uniformly graded, shall be rejected, and replaced at no additional cost to the Atlantic Richfield Company

3.03 INSPECTION

A. Scheduling:
   1. In addition to the normal progress inspections, schedule and conduct the following formal inspections, giving the Atlantic Richfield Company's Representative at least 48 hours prior notice of readiness for inspection:
      a. Inspection of plants in containers prior to planting.
      b. Inspection of plant locations, to verify compliance with the plans.
      c. Substantial completion inspection after completion of planting. Schedule the substantial completion inspection sufficiently in advance, and in cooperation with the Atlantic Richfield Company's Representative so that final inspection may be conducted within 24 hours after completion of planting.
      d. Final inspection at the end of the maintenance period, provided that all previous deficiencies have been corrected.

3.04 MAINTENANCE

A. General: Maintain all planting accessories in new as installed condition.

B. Replacements: At the end of the maintenance period, all plant accessories shall be in the same condition as initially installed. During the maintenance period, should any accessories become damaged, replace the damaged accessories without additional cost to the Atlantic Richfield Company.

3.05 GUARANTEE

A. Time Frame: Guarantee all planting accessories for a period of 1 year following substantial completion. The final inspection shall be one year from the date of substantial completion.

B. Replacements: Replace all damaged accessories as directed by Atlantic Richfield Company's Representative without additional cost to the Atlantic Richfield Company.

END OF SECTION

SECTION 33 05 63
CONCRETE VAULTS AND CHAMBERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide precast concrete box structures in accordance with this Section and the applicable reference standards listed in Article 1.02.

B. Related Requirements:
   1. Section 05 50 00 – Metal Fabrications.

1.02 REFERENCES

A. Reference Standards:
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. AASHTO HB-17 - Standard Specifications for Highway Bridges.
      b. AASHTO T 111 - Standard Method of Test for Mineral Matter or Ash in Asphalt Materials.
   2. ASTM International (ASTM):
      a. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
      b. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
      c. ASTM A1064/1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
      d. ASTM C32 - Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale).
      e. ASTM C33/C33M - Standard Specification for Concrete Aggregates.
      f. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.
      g. ASTM C150/C150M - Standard Specification for Portland Cement.
      h. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes.
      i. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete.
      j. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
      k. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete.
      l. ASTM C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
      m. ASTM C890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.
      n. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants.
      o. ASTM D113 - Standard Test Method for Ductility of Bituminous Materials.
      p. ASTM D1227 - Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing.
      q. ASTM D217 - Standard Test Methods for Cone Penetration of Lubricating Grease.
      r. ASTM D4 - Standard Test Method for Bitumen Content.
      s. ASTM D6/D6M - Loss on Heating of Oil and Asphaltic Compounds.

t. ASTM D71 - Standard Test Method for Relative Density of Solid Pitch and Asphalt (Displacement Method).

3. Federal Specifications (FED):
   a. FED SS-S-210A - Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with the Division 01 General Requirements and Section 01 33 00 – Submittal Procedures.
   1. SD-01 Preconstruction Submittals:
      a. Design Data:
         1) Design calculations, including structural and buoyancy design calculations sealed by a professional engineer licensed in the state where the Project is located, and submitted a minimum of 2 weeks prior to scheduled manufacture.
   2. SD-02 Shop Drawings:
      a. Include details on precast concrete structure components, construction details, dimensions, reinforcement, placement, openings, and embedded components.
   3. SD-03 Product Data:
      a. Joint sealant.
      b. Manhole steps.
      c. Aluminum hatches.
      d. Anchorage hardware.
   4. SD-07: Closeout Submittals:
      a. Closeout and Maintenance Material Submittals: Per Division 01 General Requirements.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. The materials covered by this Specification are intended to be standard materials of proven ability as manufactured by reputable concerns. Materials shall be designed and constructed in accordance with Industry Practice and shall be installed in accordance with the manufacturer's recommendations. The Specifications call attention to certain features, but do not purport to cover all details entering the construction of the materials.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Products shall be shipped, stored, and handled in a manner consistent with the written recommendations of the manufacturer so as not to degrade quality, serviceability, and appearance. Any unit found to be defective, either before or after installation, shall be removed from the Project Site and replaced with a sound unit.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

PART 2 - PRODUCTS

2.01 PRECAST CONCRETE STRUCTURES

A. General:
   1. Precast structures shall have the inside dimensions as shown on the Drawings.

B. Precast Materials:
   1. Concrete:
      a. Concrete compressive strength shall be 5,000 psi after 28 days.
      b. Minimum concrete thickness shall be 6 inches.
      c. Portland cement shall be Type V conforming to ASTM C150/C150M.
      d. Fine aggregate shall consist of natural sand conforming to ASTM C33/C33M.
      e. Coarse aggregate shall consist of 1/2-inch maximum, well-graded crushed stone conforming to ASTM C33/C33M.
      f. Air entrainment admixture shall conform to ASTM C260/C260M. The air-entrained content shall be not less than 4 percent or greater than 7 percent.
      g. A super plasticizer shall be used and shall conform to ASTM C494/C494M Type F or G. Concrete shall be placed at a slump of between 5 and 8 inches.
   2. Reinforcement:
      a. Wire fabric shall conform to the requirements of ASTM A1064/1064M.
      b. Reinforcing bars shall be new billet steel, deformed, conforming to the requirements of ASTM A615/A615M, Grade 60.
      c. Minimum clear concrete cover to reinforcement shall be 1-1/2 inches.

C. Design Loads:
   1. Vehicle Loads:
      a. Except as otherwise specified, the design shall meet the requirements of AASHTO HB-17, including a HS-20 vehicle load.
      b. A lateral vehicle surcharge load of 125 psf shall be applied.
   2. Lateral Pressure:
      a. The equivalent lateral fluid pressure shall be 100 psf/lf below flood or design groundwater elevation, and 60 psf/lf above such elevation. The specified lateral vehicle surcharge load shall be added to this load.
   3. Buoyancy:
      a. The structure shall be designed with a factor of safety of 1.15 against buoyancy with an assumed flood elevation at the top of the structure. Frictional resistance in this calculation is not permitted. Where the structure is composed of successive vertical segments, the weight of the segments shall provide the same factor of safety for buoyancy, or stainless-steel mechanical connections shall be used to connect the segments together. The design shall include positive anchorage to a reinforced concrete anti-buoyancy slab of the required size.
      b. If the Engineer determines, at his sole discretion, that the pre-caster's buoyancy calculations are incorrect, the Engineer shall direct the Construction Management General Contractor (CMGC) to implement specific measures to counteract buoyancy to the Engineer's satisfaction. All costs associated with such measures shall be borne entirely by the CMGC and at no additional cost to the Atlantic Richfield Company.
   4. Water & Wastewater Structures Design Load:
      a. Except where higher loads are specified, water and wastewater structures shall be designed for the loads prescribed in ASTM C890.

5. Utility Structures Design Load:
    a. Except where higher loads are specified, utility structures shall be designed for the loads prescribed in ASTM C857.

D. Joints:
1. Concrete sections shall be provided with bell and spigot, or tongue-in-groove ends to ensure proper connection of the joints.
2. Each joint shall be sealed with a butyl rubber sealant. A compatible primer shall be applied as recommended by the manufacturer. Sealant shall be Conseal CS-102 (CS-202 when the temperature during installation is less than 30 degrees F) by Concrete Sealants, Inc., Kent Seal #2 by Hamilton Kent, Pro-Stik by Press-Seal Gasket Corporation, or approved equal, and shall be applied in accordance with the manufacturer's recommendations. Sealant properties shall be as follows:
    a. AASHTO T 111: 30 percent minimum ash content.
    b. ASTM C990
    c. ASTM D4: 50 percent minimum hydrocarbon content.
    d. ASTM D6/D6M: 2 percent maximum volatile matter.
    e. ASTM D71: Specific gravity between 1.15 - 1.50.
    f. ASTM D113: 5.0 minimum.
    g. ASTM D217: 55-100 mm at 77 degrees F.
    h. FED SS-S-210A: No deterioration, no cracking and no swelling after 30 days immersion in 5 percent solutions of HCl, H2SO4, NaOH, KOH, and H2S.

2.02 DAMPPROOFING

A. Dampproofing shall be Hydrocide 700 Mastic as made by Sonneborn, Karnak 920 Anti Hydro Mastic Emulsion, or approved equal, conforming to ASTM D 1227.

2.03 MANHOLE STEPS

A. Manhole steps shall be of steel reinforced copolymer polypropylene conforming to ASTM C478/C478M, cast-in-place or installed utilizing inserts approved by the Engineer.

B. All steps shall be 12 inches on center with abrasive step surface and safety edge, drop front design, 1-inch diameter and 16 inches wide. Metal items embedded in concrete shall be painted with a zinc chromate primer.

2.04 PIPE CONNECTIONS

A. Pre-molded elastomeric sealed joints shall be used at the joints between the pipe and precast sections. Pre-molded elastomeric sealed joints shall be A-Lok, Res-Seal, Press-Wedge II, Lock Joints Flexible Manhole Sleeve, Kor-N-Seal Joint Sleeve, or equal.

2.05 MANHOLE COVERS AND FRAMES

A. Manhole covers and frames shall be cast iron conforming to the requirements of ASTM A48/A48M, Class 30, and shall be of noiseless, non-rocking design with pick holes. The words BUTTE - SILVER BOW and the utility name shall be cast on each cover in three-inch letters.

B. Watertight Frames and Covers:
1. Watertight manhole frames and covers shall have a minimum total weight of 1,125 pounds with a clear opening of 34 inches unless otherwise indicated on the Drawings. Watertight manhole covers shall have a gasketed interior cover of watertight design,

and also contain a locking bar. Watertight manhole frames and covers shall be LeBaron Model LBW388-000 or approved equal models as manufactured by Neenah Foundry, or Campbell Foundry.

C. Standard Frames and Covers:
   1. Standard manhole covers and frames shall have a minimum total weight of 420 pounds with a clear opening of 24 inches unless otherwise indicated on the Drawings. Standard manhole frames and covers shall be LeBaron Model LB268-1, Etheridge Model M267S or approved equal.

2.06 BRICK

A. Brick shall conform to ASTM C32/C32M, and shall be new, first quality, whole, sound brick.

B. Grade MS brick shall be used for setting manhole frames.

2.07 MORTAR

A. Mortar shall be composed of one part portland cement and 2 parts sand with 20 percent hydrated lime.

B. Portland cement shall conform to ASTM C150/C150M. Sand shall conform to ASTM C144/C144M. Hydrated lime shall conform to ASTM C207/C207M.

2.08 ALUMINUM HATCHES

A. Manufacturers:
   1. Bilco Company, Halliday Products, Inc., Babcock-Davis, or equal

B. Styles, types, and sizes: per Drawings, and of single manufacturer.
   1. Type J and JD: Single leaf and double leaf, respectively, watertight, self-draining type.
      a. Door Leaf: 1/4-inch thick aluminum diamond pattern plate, reinforced with aluminum stiffeners, capable of withstanding live load of 300 pounds per square foot. Equip each door leaf with minimum 2 hinges with stainless steel pins, compression spring operators enclosed in telescopic tubes to afford easy operation.
      b. Provide automatic hold-open arm with vinyl grip handle to release cover for closing.
      c. Equip with snap lock and removable handle.
      d. Channel Frame: 1/4-inch thick aluminum with anchor flange around the perimeter. Except where connected to a drainage system per Drawings, provide extension from frame drainage coupling to drain to area below.
      e. Mechanically attach a continuous ethylene propylene diene monomer (EPDM) debris gasket to frame. Provide 1-1/2 inch drainage coupling in channel frame.
      f. Hardware: Stainless steel with factory mill finish.
      g. Bituminous coating applied to areas to be embedded in concrete.
      h. Where not connected to a drainage system per Drawings with extensions to the drainage coupling, to allow drainage to the area below.

C. Fall Protection:
   1. Equip hatch covers with fall protection grating system of fiberglass or aluminum construction and 316 stainless steel hardware, with live load capacity of 300 psf.
   2. Safety Color: Orange or yellow.

3. Provide with spring-loaded lifting handle and aluminum or stainless steel hold open arm and release handle, and automatic lock at 90-degree open position.
4. Provide capability for locking with padlock in the closed position.

2.09 ANCHORAGE HARDWARE

A. Hardware for fastening the precast structure to the anti-buoyancy slab, and to fasten precast segments together for buoyancy shall be stainless steel and as specified in Section 05 50 00 – Metal Fabrications.

2.10 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 - EXECUTION

3.01 PRECAST STRUCTURES

A. Precast structures shall be installed as shown on the Drawings. Precast sections shall be installed so that the entire structure is vertically plumb and aligned, and when not so, shall be removed and replaced. All erection holes shall be filled solid with non-shrink grout. furnish and use suitable slings, hooks, and cables for the proper handling of the sections.

3.02 APPLICATION OF DAMPPROOFING

A. Application of dampproofing shall be in accordance with the manufacturer's recommendations.

B. Application shall not be permitted in spaces exposed to inclement weather or when air temperatures are below 40 degrees F, or are expected to go below 40 degrees F within 24 hours after application.

C. Dampproofing can be applied to green or slightly damp surfaces.

D. Apply dampproofing at a rate of 4 to 6 gallons per 100 square feet. If applying 2 coats, each coat shall be 2 to 3 gallons per 100 square feet. First coat must be allowed to dry prior to the application of the second coat. Coating must be continuous and free from breaks and pinholes.

3.03 MANHOLE COVERS AND FRAMES

A. The covers and frames shall be set 1/4 inch below the finished roadway grade.

B. For temporary roadway surface, set covers 3/4 inch above temporary grade. Provide 6-inch wide, sloped bituminous concrete pavement around entire frame.

C. Voids created when raising frame to final elevation shall be filled with concrete.

3.04 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.05 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

3.06 CLEANING

A. Upon completion of all construction, and prior to final acceptance, all debris shall be removed from precast structures.

END OF SECTION

SECTION 33 11 00
WATER UTILITY DISTRIBUTION PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

B. Furnish all water main pipe and fittings meeting the Contract documents or specified as follows.

C. Furnish and install valves and fire hydrants for water mains, together with related appurtenances.

D. Construct water services, including water service piping, tapping mains, corporation stops, curb stops and related items.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. AASHTO HB-17 - Standard Specifications for Highway Bridges.
   2. American Railway Engineering and Maintenance-of-Way Association (AREMA):
      a. AREMA Eng Man - Manual for Railway Engineering.
   3. American Water Works Association (AWWA):
      a. AWWA B300 - Hypochlorites.
      b. AWWA B301 - Liquid Chlorine.
      c. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
      d. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings for Water.
      e. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service.
      f. AWWA C502 - Dry-Barrel Fire Hydrants.
      g. AWWA C504 - Standard for Rubber-Seated Butterfly Valves.
      h. AWWA C508 - Swing-Check Valves for Waterworks Service, 2 In. Through 48-In. (50-mm Through 1,200-mm) NPS.
      i. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.
      j. AWWA C512 - Air-Release, Air/Vacuum, and Combination Air Valves for Water and Wastewater Service.
      k. AWWA C515 - Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.
      l. AWWA C550 - Protective Interior Coatings for Valves and Hydrants.
      m. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances.
      n. AWWA C605 - Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings.
      o. AWWA C606 - Grooved and Shouldered Joints.
      p. AWWA C651 - Standard for Disinfecting Water Mains.
      q. AWWA C655 - Field Dechlorination.
      r. AWWA C700 - Cold-Water Meters - Displacement Type, Metal Alloy Main Case.
      s. AWWA C701 - Cold-Water Meters - Turbine Type for Customer Service.

t. AWWA C702 - Cold-Water Meters - Compound Type.
u. AWWA C703 - Cold-Water Meters - Fire Service Type.
v. AWWA C704 - Propeller-Type Meters for Waterworks Applications.
w. AWWA C706 - Direct-Reading, Remote-Registration Systems for Cold-Water Meters.
x. AWWA C707 - Encoder-Type Remote-Registration Systems for Cold-Water Meters.
y. AWWA C800 - Underground Service Line Valves and Fittings.
z. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm).
aa. AWWA C906 - Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) through 65 In., (1,575 mm) for Water Distribution and Transmission.
bb. AWWA C909 - Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 In. (100 mm) and Larger.
cc. AWWA M23 - PVC Pipe - Design and Installation.
dd. AWWA M55 - PE Pipe - Design and Installation.
ee. AWWA M6 - Water Meters - Selection, Installation, Testing, and Maintenance

4. ASME International (ASME):
   a. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
   b. ASME B1.20.3 - Dryseal Pipe Threads (Inch).
   c. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250.
   d. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
   e. ASME B16.26 - Standard for Cast Copper Alloy Fittings for Flared Copper Tubes.
   f. ASME B16.3 - Malleable Iron Threaded Fittings, Classes 150 and 300.
   g. ASME B16.4 - Standard for Gray Iron Threaded Fittings; Classes 125 and 250.
   h. ASME B18.2.2 - Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
   i. ASME B18.5.2.1M - Metric Round Head Short Square Neck Bolts.
   j. ASME B18.5.2.2M - Metric Round Head Square Neck Bolts.
5. ASTM International (ASTM):
   a. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes.
   b. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.
   c. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.
   d. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
   e. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   f. ASTM A536 - Standard Specification for Ductile Iron Castings.
   g. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts.
   h. ASTM B32 - Standard Specification for Solder Metal.
   i. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
   j. ASTM B61 - Standard Specification for Steam or Valve Bronze Castings.
   k. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
   l. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
   m. ASTM C1433 - Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers.
   n. ASTM C150/C150M - Standard Specification for Portland Cement.
   o. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.
   p. ASTM D1599 - Resistance to Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings.

q. ASTM D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
r. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120.
s. ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
t. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
u. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
v. ASTM D2774 - Underground Installation of Thermoplastic Pressure Piping.
w. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
x. ASTM D3035 - Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
y. ASTM D3139 - Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
z. ASTM D3261 - Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
aa. ASTM F1483 - Standard Specification for Oriented Poly(Vinyl Chloride), PVCO, Pressure Pipe.
bb. ASTM F1674 - Standard Test Method for Joint Restraint Products for Use with PVC Pipe.
cc. ASTM F1962 - Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings.
dd. ASTM F2164 - Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure.
ee. ASTM F2620 - Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.
ff. ASTM F402 - Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings.
gg. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
hh. ASTM F714 - Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.

6. Foundation For Cross-Connection Control And Hydraulic Research (FCCCHR):
   a. FCCCHR Manual - Manual of Cross-Connection Control.
7. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):
   a. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.
8. National Fire Protection Association (NFPA):
   a. NFPA 1961 - Standard on Fire Hose
   b. NFPA 24 - Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
9. NSF International (NSF):
   a. NSF 372 - Drinking Water System Components - Lead Content.
   b. NSF/ANSI 14 - Plastics Piping System Components and Related Materials.
   c. NSF/ANSI 61 - Drinking Water System Components - Health Effects.
10. U.S. Department of Defense (DOD):
    a. UFC 3-600-01 - Fire Protection Engineering for Facilities.
11. Underwriters Laboratories (UL):
    a. UL 246 - UL Standard for Safety Hydrants for Fire-Protection Service.
    b. UL 262 - Gate Valves for Fire-Protection Service.

c. UL 312 - UL Standard for Safety Check Valves for Fire-Protection Service.
12. Uni-Bell PVC Pipe Association (UBPPA):
    a. UBPPA UNI-PUB-08 - Tapping Guide for PVC Pressure Pipe.

1.03 DEFINITIONS

A. Water Transmission Mains:
   1. Water transmission mains include water piping having diameters greater than 14 inches, specific materials, methods of joining and any appurtenances deemed necessary for a satisfactory system.

B. Water Mains:
   1. Water mains include water piping having diameters 4 through 14 inches, specific materials, methods of joining and any appurtenances deemed necessary for a satisfactory system.

C. Water Service Lines:
   1. Water service lines include water piping from a water main to a building service at a point approximately 5 feet from building or the point indicated on the drawings, specific materials, methods of joining and any appurtenances deemed necessary for a satisfactory system.

D. Additional Definitions:
   1. For additional definitions refer to the definitions in the applicable referenced standard.

1.04 SUBMITTALS

A. Atlantic Richfield Company approval is required for submittals. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-01 Preconstruction Submittals:
      a. Connections.
   2. SD-03 Product Data:
      a. Pipe, fittings, joints and couplings.
      b. Ball and socket joint.
      c. Valves.
      d. Valve boxes.
      e. Fire hydrants.
      f. Pipe restraint.
      g. Tapping sleeves.
      h. Corporation stops.
      i. Backflow preventer
      j. Railroad crossing casing pipe.
      k. Precast concrete thrust blocks.
      l. Disinfection procedures.
   3. SD-05 Test Reports:
      a. Post-construction fusion report.
      b. Leakage test.
      c. Hydrostatic test.
   4. SD-06 Certificates:
      a. Pipe, fittings, joints, and couplings.
      b. Shop-applied lining and coating.
      c. Lining.
      d. Lining for fittings.
      e. Valves.

f. Fire hydrants.
g. Fusion Technician Qualifications.
h. Manufacturer's Instructions:
    1) PVC piping.
    2) PVCO piping.
    3) Polyethylene (PE) pipe.
    4) PVC piping for service lines.
    5) Copper pipe for service lines.

1.05 QUALITY CONTROL

A. Regulatory Requirements:
    1. Comply with NSF/ANSI 14 or NSF/ANSI 61 and NSF 372 for materials for potable water systems; comply with lead content requirements for "lead-free" plumbing as defined by the U.S. Safe Drinking Water Act effective January 2014. Provide materials bearing the seal of the National Sanitation Foundation (NSF) for potable water service.
    2. Comply with NFPA 24 for materials, installation, and testing of fire main piping and components.

B. Qualifications:
    1. Fusion Technician Qualifications:
        a. Submit a certificate from the manufacturer of the fusible pipe that shows the fusion technician is fully qualified to install fusible pipe of the types and sizes being used. Qualification must be current as of the actual date of fusion performance on the project.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Storage:
    1. Inspect materials delivered to site for damage. Unload and store with minimum handling and in accordance with manufacturer's instructions. Store materials on site in enclosures or under protective covering. Store plastic piping, jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes, fittings, valves, fire hydrants, and other accessories free of dirt and debris.

B. Handling
    1. Handle pipe, fittings, valves, fire hydrants, and other accessories in accordance with manufacturer's instructions and in a manner to ensure delivery to the trench in sound undamaged condition. Avoid injury to coatings and linings on pipe and fittings; make repairs if coatings or linings are damaged. Do not place other material, hooks, or pipe inside a pipe or fitting after the coating has been applied. Inspect the pipe for defects before installation. Carry, do not drag pipe to the trench. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare ends of the pipe. Clean the interior of pipe and accessories of foreign matter before being lowered into the trench and keep them clean during laying operations by plugging. Replace defective material without additional expense to Atlantic Richfield Company. Store rubber gaskets, not immediately installed, under cover or out of direct sunlight.

PART 2 - PRODUCTS

2.01 GENERAL

A. Furnish water main pipe and fittings as specified in the Contract Documents and meeting the material and testing requirements of this section. Furnish fittings and service line piping of the same material and design as the water main pipe unless specified otherwise. Pipe strength classifications are shown on plan drawings and/or are listed in the Contract Documents.

B. References made to ASTM, ANSI, AWWA, USASI or AASHTO designations are the latest revision at the time of call for bids.

C. Assure all water main pipe, service line pipe, fittings, and appurtenances do not contain more than a weighted average of 0.25 percent lead when used with respect to the wetted surfaces.

D. Assure all water main pipe, fittings, valves, fire hydrants, and appurtenances conform to the latest standards issued by the AWWA and ANSI/NSF, where such standards exist.

2.02 MATERIALS

A. General:
   1. Furnish the pipe specified in the contract documents meeting the materials and testing requirements as outlined in this section.
   2. Assure all pipe is clearly marked showing type, class and/or thickness. Lettering must be legible and permanent under normal handling and storage conditions.

B. Ductile Iron Pipe:
   1. Furnish meeting AWWA C151, American National Standard for Ductile Iron Pipe for Water.
      a. 3 inches to 12 inches Pressure Class 350.
      b. 14 inches to 20 inches Pressure Class 250.
      c. 24 inches Pressure Class 200.
      d. 30 inches to 64 inches Pressure Class 150.
   2. Assure the pipe interior is cement mortar lined meeting AWWA C104 requirements. Assure the outside pipe surface for underground service is bituminous coal tar base coated 1 mil thick.
   3. Fittings:
      a. Furnish fittings meeting one of the following:
         1) Class 250 fittings meeting AWWA C110, latest edition, Gray-Iron and Ductile Iron Fittings For Water And Other Liquids.
         2) Compact fittings meeting AWWA C153.
   4. Joints:
      a. Assure joints are mechanical or push-on joints meeting AWWA C111. Assure the fitting interior is cement mortar lined meeting AWWA C104. Assure the fitting exterior is bituminous tar coated 1 mil thick. Use compact fittings having a rated working pressure of 350 psi (2410 kPa) following manufacturer recommended laying lengths.
      b. Restrained joint systems and mechanical restrained joint fittings shall be installed where specifically indicated in the drawings. Restrained joints may also be allowed in applications not specifically identified in the drawings in lieu of concrete thrust blocks with Engineer approval.

1) Restrained joints shall be Flex-Ring or Lok-Ring as manufactured by AMERICAN Ductile Iron Pipe, TR Flex as manufactured by U.S. Pipe, or approved equal.
2) Restrained joints may also be internally restrained joint systems utilizing restraining gaskets as manufactured by US Pipe (Field Lok 350 Gaskets), American Pipe (Fast-Grip Gaskets), or an approved equivalent.
3) Provide mechanical restrained joint fitting constructed of ductile iron and conforming to the material and performance requirements of AWWA C153. Assure all mechanical restrained joint fittings have seals conforming to ASTM F477 and the physical testing requirements of AWWA C111. Provide mechanical restrained joint fittings coated with fusion bonded epoxy coatings meeting the requirements of AWWA C116. Install all restrained joints in full conformance with manufacturer's recommendation, and assure the assembly of fitting joints does require beveling of the plain end of a cut pipe or the use of jacks or power equipment to force the pipe end past the gasket. Furnish mechanically restrained joint fittings as manufactured by One Bolt, Inc. (OneBolt), EBAA Iron, Inc. (Mega-Lug mechanical joint restraint), or an approved equivalent.

5. Couplings:
   a. Use pipe couplings meeting one of the following:
      1) Cast type with cast iron or ductile iron sleeves and malleable or ductile iron flanges.
      2) Gray iron or ductile iron, mechanical joint solid sleeves, with a minimum 12 inch length (30 cm).
      3) Limit use of the first type to a maximum 16 inch (40 cm) diameter. Use the manufacturer's standard gasket for use in potable water systems. Use stainless steel bolts and nuts. Coating to be "manufacturer's standard".
   b. Field verify material type and size to ensure that couplings will be sized for appropriate material and size.
   c. Furnish type (1) above coupling as manufactured by Romac Industries, Dresser Piping Specialties, or an approved equivalent.

C. Polyvinyl Chloride (PVC) Pressure Pipe:
   1. Furnish PVC water main pipe meeting AWWA C900 requirements, made to ductile iron O.D.'s for "Push-On" joints. Assure pipe joints are bell and spigot having an elastomeric gasket. Use DR 25 Class 165 pipe.

D. Water Service Pipe:
   1. Use copper or polyethylene pipe in water service line construction as specified in the contract documents and meeting the following specifications.
      a. Furnish service pipe of the size or sizes specified. If not specified, match the size of existing service lines being connected to or replaced. Service lines are considered 2-inch (50 mm) size and under. Service lines over 2 inch (50 mm) size are considered as water mains and are specified under the applicable sections.
      b. Furnish and install the service pipe from the main to the property line installing a curb stop and curb box at the property line. Meet the water service installation requirements of Standard Drawing 02660-6.
      c. Copper Service Pipe:
         1) Use copper, type K, meeting Federal Specification WW-T- 799 or ASTM B88-62.
         2) Assure all new copper service pipes are continuous and free of joints from the corporation stop to the curb box unless otherwise approved by Engineer.

3) For all copper service pipe, assure corporation stops, curb stops, couplings, and all other fittings have compression connection as manufactured by Mueller (110 Compression Connection Series), Ford (Quick Joint Connection Series), A.Y. McDonald (McQuick Compression-Q Series), or an approved equivalent.

d. Polyethylene Service Pipe:
   1) Use pipe meeting AWWA Specification C901, "Polyethylene (PE) Pressure Pipe, Tubing and Fittings, 1/2 inch through 3 inch for Water" and ASTM PE3406-3408. PE pipe to be pressure tubing meeting Table 6 requirements of said specification. Use class 200 with a DR of 7 Polyethylene pipe.
   2) For all polyethylene service pipe, assure corporation stops, curb stops, couplings, and all other fittings have pressure connections designed specifically for polyethylene pipe as manufactured by Mueller (Insta-Tite Connection Series) or an approved equivalent.

E. Trenchless Piping:
1. Trenchless piping shall be conducted in accordance with Section 33 05 23 – Trenchless Utility Installation and Section 33 05 23.13 – Utility Horizontal Directional Drilling.
   a. PVC Pipe:
      1) AWWA C900 plain end meeting or exceeding ASTM D1784 cell class 12454, plastic formulated for fusing with a minimum Pressure Class 235 (DR18) with ductile iron outside diameter (DIOD).
   b. Butt Fusion:
      1) Use butt fusion jointing method for plain-end PVC pipe. Comply with AWWA C900 and AWWA C605 for butt fusion joints. No offset in alignment between adjacent pipe joints of fittings is permitted. The fusion technician must be qualified by the fusion equipment manufacturer to thermally butt-fuse the size of pipe used at the time of fusion performance. Each joint must be datalogged, recorded and submitted for review and meet the requirements of ASTM F1674.
   c. PE Pipe:
      1) Provide in accordance with AWWA C906, ASTM D3035, ASTM F1962, PE4710, with material designation code [CC2] [CC3] with a minimum Pressure Class of 200 (DR 7) with ductile iron outside diameter (DIOD).
   d. Butt Fusion Fittings:
      1) Use AWWA C906, AWWA M55, ASTM D3261 ANSI Class 250 or as necessary to provide minimum pressure rating. Use butt fusion jointing method for plain-end PE pipe. Comply with AWWA C906 and ASTM F2620 for Butt Fusion joints. No offset in alignment between adjacent pipe joints of fittings is permitted. The fusion technician must be qualified by the fusion equipment manufacturer to thermally butt-fuse the size of pipe used at the time of fusion performance. Each joint must be data-logged, recorded and submitted for review.
   e. Piping Beneath Railroad Right-of-Way:
      1) Piping passing under the right-of-way of a commercial railroad is to conform to the specifications for pipelines conveying nonflammable substances in AREMA Eng Man. Provide ductile-iron pipe in lieu of cast-iron pipe. Ductile-iron railroad crossing casing pipe is to conform to and have strength computed in accordance with ASTM A746.

2.03 VALVES

A. Gate Valves:
   1. Unless designated otherwise, valves 12 inches (30 cm) in diameter or smaller will be gate valves. Furnish iron body gate valves or resilient seat gate valves with non-rising stems with design, construction, and pressure rating meeting AWWA C509 and the following requirements.
   2. Assure stem seals are double “O” ring seals capable of replacing the seal above the stem collar with the valve under pressure in full open position.
   3. Furnish gate valves for underground installation equipped with a 2-inch (31 mm) square operating nut for key operation. All valves to open counterclockwise. Valves to be equipped with push-on joints or mechanical joints for pipe connections.
   4. Furnish resilient seat gate valves as manufactured by Mueller, Clow, American Darling, or an approved equivalent.

B. Butterfly Valves:
   1. Unless designated otherwise, all valves larger than a 12-inch (30 cm) diameter will be butterfly valves. Furnish Class 150, rubber seated, butterfly valves for water distribution systems meeting AWWA C504 requirements. Valves are to be equipped with push-on ends and lubricated screw type operators designed for underground service.
   2. Rubber valve seats to be replaceable without disassembling the valve and not interrupted by the shafting. Rubber seats may be retained on the disc edge by stainless steel clamping instead of bonding to the valve body. Assure shaft packing is the self-adjusting, permanent type.
   3. Assure underground service operators are permanently lubricated, screw type, totally enclosed and watertight constructed. Assure overload protection is incorporated in the operator allowing 450-foot pounds (610 J) input torque at full-open and full-closed positions without damaging the operator or valve. Install valves with the operating mechanism oriented on either the south or west side of the pipeline.
   4. Provide a 2 inch (50 mm) square operating nut and valve box for operating the valve. Valves to open counter clockwise. Furnish bonnet and gland bolts and nuts either fabricated from low-alloy steel for corrosion resistance or electroplated with zinc or cadmium. The hot-dip process in accordance with ASTM A153 is not acceptable.
   5. Evenly coat all exterior ferrous surfaces, except the flange faces, with black asphalt varnish in accordance with Section 5.3 of AWWA C509, or epoxy in accordance with AWWA C550. Evenly coat with epoxy all wetted ferrous surfaces in accordance with AWWA C550. Apply epoxy coating to a minimum uniform 4 mil thickness.
   6. Furnish performance certification, leakage and hydrostatic tests as specified in AWWA C504. Assure valve manufacturer has at least 5 years experience manufacturing waterworks and distribution valves.
   7. Furnish butterfly valves as manufactured by Dresser Industries (450 Valve), Allis-Chalmer (Streamseal), Henry Pratt (Groundhog), or an approved equivalent.

2.04 FIRE HYDRANTS

A. Furnish fire hydrants meeting AWWA C502; “Standard Specifications for Fire Hydrants for Ordinary Water Works Service”, and the Contract requirements.

B. Furnish hydrants with 5.25-inch (13 cm) valve openings, 6-inch (15 cm) mechanical joint, flanged or push-on inlet, one pumper connection and two, 2.5-inch (63 cm) hose connections. Assure hose nozzle threads meet ASA Specification B26 for National Standard Fire Hose Coupling Screw Threads, 7.5 threads per inch. Assure pumper nozzle size and threads match owners existing pattern. Furnish National Standard operating nut.

Furnish hydrants opening counter clockwise and having an arrow on the hydrant top designating the opening direction.

C. Furnish “Compression” type hydrants with safety flange and safety stem coupling above the ground line permitting repair without shutting off the water. Assure hydrants are of the dry top design with two or more “O” rings sealing the water from the operating mechanism. Assure the operating mechanism is automatically lubricated from a sealed, self-contained lubricating reservoir.

D. Paint the hydrant portion above the ground line meeting the owner’s standards. Furnish hydrants for 6.5 foot (2 meters) bury.

2.05 SPECIAL FITTINGS

A. Furnish special fittings meeting the Contract Documents. The Engineer will specify gasket materials for contaminated soil or special groundwater situations.

2.06 POLYETHYLENE ENCASEMENT

A. Furnish polyethylene encasement or V-Bio® enhanced polyethylene encasement in accordance with AWWA C105, “Polyethylene Encasement for Ductile Iron Pipe Systems”.

B. Optional for corrosion protection in corrosive soils - Polyethylene encasement for use with ductile iron pipe shall be V-Bio® enhanced polyethylene encasement as manufactured by Balcan Plastics Limited/First Film Extruding or Crayex Corporation.

2.07 WATER MAIN INSULATION

A. Furnish extruded polystyrene rigid foam insulation conforming to ASTM C578, Type IV, with a minimum thermal resistance (R value) of 5.0 per 1 inch of thickness at 75º Fahrenheit mean temperature. Water absorption for the insulation shall not exceed 0.10 by volume as measured by ASTM C272.

B. Materials shall be delivered in their original unopened units, stored off the ground, protected from direct sunlight with a light-colored opaque polyethylene film and ventilated to prevent excessive temperature. Damaged or deteriorated materials shall be removed from the premises.

C. Furnish extruded polystyrene rigid foam insulation as manufactured by Owens-Corning(Foamular 250), or an approved equivalent.

2.08 FLUSHING HYDRANTS

A. Furnish hidden type flushing hydrants with a dry barrel design and a 2.5-inch (63 cm) hose connection with National Standard hose threads for 6.5-foot (2 m) minimum bury.

B. Furnish flushing hydrants complete with shut-off valves with a closed-bottom body, tee head key, and an integral drain to allow hydrant post to drain after use to prevent freeze damage.

C. Furnish a meter box with a minimum width of 18 inches (50 cm) and a minimum depth of 24 inches (60 cm) and a locking lid to house the hydrant outlet.

D. Paint any portions of the flushing hydrant above the ground line to meet the Owner’s standard.

E. Furnish flushing hydrants as manufactured by The Kupferle Foundry Company (MainGuard No. 78, Underground Model) or an approved equivalent.

2.09 YARD HYDRANTS

A. Provide frost-proof sanitary yard hydrants designed for a minimum operating pressure of 100 pounds per square inch (689 kPA) and a minimum bury depth of 6.5 feet (2 m) meeting the standard of ASSE Standard 1057.

B. Furnish sanitary yard hydrants complete with backflow protection compliant with Montana standards, brass hydrant ells and tees, locking flange for padlock, and integral drain that allows hydrant barrel to drain after use to prevent freeze damage.

C. Provide a set of spare parts per each two sanitary yard hydrants installed, manufactured by the same manufacturer as the hydrants and specific to the hydrant model.

D. Furnish sanitary yard hydrants as manufactured by Woodford (Model S3 with Repair Kits RK-Y1 and RK-SHL) or an approved equivalent.

2.10 BLOWOFF HYDRANTS

A. Provide 2-inch (50 mm) diameter post type blowoff hydrants meeting all applicable parts of AWWA C502.

B. Furnish blowoff hydrants with a dry barrel design, a compression type main valve, and dual bronze drain valves.

C. Assure blowoff hydrants are rated for 150 pounds per square inch (1,034 kPa) maximum working pressure and 300 pounds per square inch (2,068 kPa) test pressure.

2.11 DISINFECTION

A. Disinfect the water mains subject to the Atlantic Richfield Company Representative's approval in accordance with AWWA C651, "Disinfecting Water Mains", and these specifications, before placing the main in service. Keep the interior of all pipe, fittings and appurtenances free from dirt, heavy and foreign particles.

2.12 ACCESSORIES

A. Pipe Restraint:
   1. Thrust Blocks:
      a. Construct reaction or thrust blocks at all tees, plugs, valves, reducers, caps and at bends deflecting 22-1/2 degrees or more. Construct thrust blocks at tapping sleeves where the outlet diameter exceeds one-half the diameter of the main being tapped. Limit using metal rods or straps for thrust restraint to those specified on the plans, or where the use of concrete thrust blocks would be impractical. Do not use metal rods or straps without the Atlantic Richfield Company Representative's approval. Construct reaction blocks from concrete having a minimum compressive strength of 2,000 pounds per square inch (14,000 kPa) at 28 days. Place blocking between undisturbed ground and the fitting to be anchored and place the blocking so that the pipe and fitting joints are accessible for repair.
   2. Joint Restraint:
      a. Provide restrained joints in accordance with NFPA 24, Chapter 10 and in accordance with ASTM F1674.

b. Provide mechanical joint restraints meeting the requirements of AWWA C110/A21.10 or metal harness fabricated by the pipe manufacturer.

B. Protective Enclosures:
1. Provide Freeze-Protection Enclosures that are insulated and designed to protect aboveground water piping, equipment, or specialties from freezing and damage.
a. Housing:
1) Reinforced and insulated [aluminum] [or] [fiberglass] construction; with anchoring devices for attaching housing to concrete base, access doors with locking devices, sized to allow access and service of the protected unit, drain openings, and thermostat controlled slab heaters.

C. Tapping Sleeves:
1. All 4-inch and larger water service taps made in public water mains shall be made using a tapping sleeve, tapping valve, and standard tapping machine.
2. Tapping Sleeves shall be the split sleeve-mechanical joint type, carbon steel, rated for not less than 200 psi working pressure, and dependent of pressure zone, and have a class 125 outlet flange. Bolts used with tapping sleeves shall be either Cor-Ten or stainless steel. Tapping sleeves shall meet the applicable requirements of AWWA Standards C104, C110, C111, and C223, latest editions and shall be similar to Smith Blair Type 622 tapping sleeves.
3. Tapping valves shall meet the applicable requirements hereinabove set forth for gate valves and shall have a Class 125 inlet flange and a mechanical joint outlet. Tapping valves shall have "O" ring seals.
4. Acceptable tapping sleeves include: Romac Model FTS420 Styles, Smith and Blair models 622 series or approved equal.

D. Sleeve-Type Mechanical Couplings:
1. Use couplings to join plain-end piping by compression of a ring gasket at each end of the adjoining pipe sections. The coupling consists of one middle ring flared or beveled at each end to provide a gasket seat; two follower rings; two resilient tapered rubber gaskets; and bolts and nuts to draw the follower rings toward each other to compress the gaskets. Provide true circular middle ring and the follower rings sections free from irregularities, flat spots, and surface defects; provide for confinement and compression of the gaskets. For [ductile iron] [and] [PVC] pipe, the middle ring is cast-iron or steel; and the follower rings are malleable or ductile iron. For ductile iron are to meet the requirements of ASTM A47/A47M and ASTM A536, respectively. Use gaskets for resistance to set after installation and to meet the requirements specified for gaskets for mechanical joint in AWWA C111/A21.11. Provide track-head type bolts ASTM A307, Grade A, with nuts, ASTM A563, Grade A; or round-head square-neck type bolts, ASME B18.5.2.1M and ASME B18.5.2.2M with hex nuts, ASME B18.2.2. Provide 5/8 inch diameter bolts. Shape bolt holes in follower rings to hold fast to the necks of the bolts used. Do not use mechanically coupled joints using a sleeve-type mechanical coupling as an optional method of jointing except where pipeline is adequately anchored to resist tension pull across the joint. Provide a tight flexible joint with mechanical couplings under reasonable conditions, such as pipe movements caused by expansion, contraction, slight settling or shifting in the ground, minor variations in trench gradients, and traffic vibrations. Match coupling strength to that of the adjoining pipeline.

E. Insulating Joints:
   1. Provide a rubber-gasketed insulating joint or dielectric coupling between pipe of dissimilar metals which will effectively prevent metal-to-metal contact between adjacent sections of piping.

F. Dielectric Fittings:
   1. Install dielectric fittings between threaded ferrous and nonferrous metallic pipe, fittings and valves, except where corporation stops join mains to prevent metal-to-metal contact of dissimilar metallic piping elements and compatible with the indicated working pressure.

G. Buried Warning And Identification Tape
   1. [Polyethylene plastic] [and] [metallic core or metallic-faced, acid- and alkali-resistant, polyethylene plastic] warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3-inch minimum width, color coded as specified below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Color and printing shall be permanent, unaffected by moisture or soil.

Warning Tape Color Codes	
Red	Electric
Yellow	Gas, Oil; Dangerous Materials
Orange	Telephone and Other Communications
Blue	Potable Water Systems
Green	Sewer Systems
White	Steam Systems
Gray	Compressed Air
Purple	Non Potable, Reclaimed Water, Irrigation and Slurry lines

      a. Warning Tape for Metallic Piping:
         1) Acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of tape shall be 0.003 inch. Tape shall have a minimum strength of 1500 psi lengthwise, and 1250 psi crosswise, with a maximum 350 percent elongation.
      b. Detectable Warning Tape for Non-Metallic Piping:
         1) Polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of the tape shall be 0.004 inch. Tape shall have a minimum strength of 1500 psi lengthwise and 1250 psi crosswise. Tape shall be manufactured with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 3 feet deep. Encase metallic element of the tape in a protective jacket or provide with other means of corrosion protection.
      c. Detection Wire For Non-Metallic Piping:
         1) Detectable buried warning tape is to have a minimum 6-inch (15cm) width and 5 mil (0.12mm) thickness and a solid aluminum core running the full length and width of the tape enclosed in a color-coded inert plastic jacket, impervious to alkalis, chemical reagents and solvents in the soil. The tape is to meet

APWA/ULCC Color Code requirements and is to have a maximum 36 INCH (90cm) imprint.

H. Water Service Line Appurtenances:
1. Corporation Stops:
a. Ground key type; lead-free bronze, ASTM B61 or ASTM B62; compatible with the working pressure of the system and solder-joint, or flared tube compression type joint. Threaded ends for inlet and outlet of corporation stops, AWWA C800; coupling nut for connection to flared copper tubing, ASME B16.26. Corporation Stops are specified below. Deviations from the list require Atlantic Richfield Company Approval before procurement.

Service Size (IN)	Type Service Pipe	Corporation Stop	Inlet/Outlet AWWA Threads	Outlet Connection
¾	Copper	Mueller B-25008N	Standard/Copper	110 Compression Connection
1	Copper			
1 ¼	Copper			
1 ½	Copper			
2	Copper/PE			
¾	Copper	McDonald 74701BQ		Q CTS Compression Connection
1	Copper			
1 ¼	Copper			
1 ½	Copper			
2	Copper/PE			

2. Curb or Service Stops:
a. Curb stops for copper water service lines shall be as specified in the table below or approved equal.

Service Size (IN)	Type Service Pipe	Curb Stop	Inlet/Outlet AWWA Threads	Outlet Connection
¾	Copper	Mueller B-25209N	Copper/Copper	110 Compression Connection
1	Copper			
1 ¼	Copper			
1 ½	Copper			
2	Copper/PE			
¾	Copper	McDonald 76100BQ		Q CTS Compression Connection
1	Copper			
1 ¼	Copper			
1 ½	Copper			
2	Copper/PE			

3. Service Clamps:
a. All 2-inch diameter or smaller water service taps made in PVC public water mains, and all taps having a diameter 1-1/4- inches through 2-inches made in any other type public water main, shall be made using an approved service saddle. Service saddles for PVC water mains shall be 304 stainless gauged steel for an outer band, two bolts, with AWWA standard thread. Service saddles for ductile iron

water mains shall be a ductile iron clamp, double bale, with AWWA standard thread.

b. Taps in public water mains for water service saddles shall be full-sized taps. The saddle and corporation stop shall be set on the water main prior to tapping, and the tap shall be made through the corporation stop using a standard tapping machine only.

c. Acceptable service saddles for PVC: Romac Model 306 series; Smith and Blair Model 372 series; or approved equal.

d. Acceptable service saddles for Ductile Iron: Romac Model 202NU series; Smith and Blair Model 313 series; or approved equal.

4. Goosenecks:

a. Manufacture goosenecks from Type K copper tubing; provide joint ends for goosenecks compatible with connecting to corporation stop and service line. Where multiple gooseneck connections are required for an individual service, connect goosenecks to the service line through a compatible lead-free brass or bronze branch connection; the total clear area of the branches to be at least equal to the clear area of the service line.

5. Curb Boxes:

a. Provide a curb box for each curb or service stop manufactured from cast iron, size capable of containing the stop where it is used. Provide a round head. Cast the word "WATER" on the lid. Factory coat the box with a heavy coat of bituminous paint.

PART 3 - EXECUTION

3.01 PREPARATION

A. Connections to Existing System:

1. Perform all connections to the existing water system in the presence of the Atlantic Richfield Company Representative.

B. Operation of Existing Valves:

1. Do not operate valves within or directly connected to the existing water system unless expressly directed to do so by the Atlantic Richfield Company Representative.

C. Earthwork:

1. Perform earthwork operations in accordance with Section 31 00 00 – Earthwork.

3.02 INSTALLATION

A. Install all materials in accordance with the applicable reference standard, manufacturer’s instructions and as indicated herein.

B. Piping:

1. General Requirements:

a. Install pipe, fittings, joints and couplings in accordance with the applicable referenced standard, the manufacturer's instructions and as specified herein.

2. Termination of Water Lines:

a. Terminate the work covered by this section at a point approximately 5 feet from the building, unless otherwise indicated.

b. Do not lay water lines in the same trench with gas lines, fuel lines, electric wiring, or any other utility. Do not install copper tubing in the same trench with ferrous piping materials. Where nonferrous metallic pipe (i.e., copper tubing) crosses any ferrous piping, provide a minimum vertical separation of 12 inches between pipes.

3. Pipe Laying and Jointing:
    a. Remove fins and burrs from pipe and fittings. Before placing in position, clean pipe, fittings, valves, and accessories, and maintain in a clean condition. Provide proper facilities for lowering sections of pipe into trenches. Under no circumstances is it permissible to drop or dump pipe, fittings, valves, or other water line material into trenches. Cut pipe cleanly, squarely, and accurately to the length established at the site and work into place without springing or forcing. Replace a pipe or fitting that does not allow sufficient space for installation of jointing material. Blocking or wedging between bells and spigots is not permitted. Lay bell-and-spigot pipe with the bell end pointing in the direction of laying. Grade the pipeline in straight lines; avoid the formation of dips and low points. Support pipe at the design elevation and grade. Secure firm, uniform support. Wood support blocking is not permitted. Lay pipe so that the full length of each section of pipe and each fitting rests solidly on the pipe bedding; excavate recesses to accommodate bells, joints, and couplings. Provide anchors and supports for fastening work into place. Make provision for expansion and contraction of pipelines. Keep trenches free of water until joints have been assembled. At the end of each workday, close open ends of pipe temporarily with wood blocks or bulkheads. Do not lay pipe when conditions of trench or weather prevent installation.
4. Buried Warning and Identification Tape:
    a. Provide buried utility lines with utility identification tape. Bury tape 12 inches below finished grade; under pavements and slabs, bury tape 6 inches below top of subgrade.
5. Tracer Wire:
    a. Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe. Attach wire to top of pipe in such manner that it will not be displaced during construction operations.
    b. All non-metallic pipe installed during the installation of water projects shall be provided with a means of detecting same once installed by means of standard location equipment.
    c. Non-Metallic Pipe Location Devices shall be an electrical conductor tracing wire, with an “underground service entry” (USE) class, 600v UL 75° C multi-stranded copper conductors, of a size of AWG 12. This tracer wire will be attached directly to the water main by the means specified on the Drawings.
6. Connections to Existing Water Lines:
    a. Make connections to existing water lines after coordination with the facility and with a minimum interruption of service on the existing line. Make connections to existing lines under pressure in accordance with the recommended procedures of the manufacturer of the pipe being tapped and as indicated, except as otherwise specified, tap concrete pipe in accordance with AWWA M9 for tapping concrete pressure pipe.
7. Sewer Manholes:
    a. No water piping is to pass through or come in contact with any part of a sewer manhole.
8. Water Piping Parallel with Sewer Piping:
    a. Where the location of the water line is not clearly defined by dimensions on the drawings, do not lay water line closer than 10 feet, horizontally, from any sewer line.
        1) Normal Conditions:
            (a) Lay water piping at least 10 feet horizontally from sewer or sewer manhole whenever possible. Measure the distance from outside edge to outside edge of pipe or outside edge of manhole. When local conditions prevent horizontal separation install water piping in a separate trench with

the bottom of the water piping at least 18 inches above the top of the sewer piping.

2) Unusual Conditions:

(a) When local conditions prevent vertical separation, construct sewer piping of AWWA compliant ductile iron water piping and perform hydrostatic sewer test, without leakage, prior to backfilling. When local conditions prevent vertical separation, test the sewer manhole in place to ensure watertight construction.

9. Water Piping Crossing Sewer Piping:

a. Provide at least 18 inches above the top (crown) of the sewer piping and the bottom (invert) of the water piping whenever possible. Measure the distance edge-to-edge. Where water lines cross under gravity sewer lines, construct sewer line of AWWA compliant ductile iron water piping with rubber-gasketed joints and no joint located within 10 feet, horizontally, of the crossing. Lay water lines which cross sewer force mains and inverted siphons at least 2 feet above these sewer lines; when joints in the sewer line are closer than 3 feet horizontally from the water line relay the sewer line to ensure no joint closer than 3 feet.

1) Normal Conditions:

(a) Provide a separation of at least 18 inches between the bottom of the water piping and the top of the sewer piping in cases where water piping crosses above sewer piping.

2) Unusual Conditions:

(a) When local conditions prevent a vertical separation described above, construct sewer piping passing over or under water piping of AWWA compliant ductile iron water piping and perform hydrostatic sewer test, without leakage, prior to backfilling. Construct sewer crossing with a minimum 20 feet length of the AWWA compliant ductile iron water piping, centered at the point of the crossing so that joints are equidistant and as far as possible from the water piping. Protect water piping passing under sewer piping by providing a vertical separation of at least 18 inches between the bottom of the sewer piping and the top of the water piping; adequate structural support for the sewer piping to prevent excessive deflection of the joints and the settling on or damage to the water piping.

10. Penetrations:

a. Provide ductile-iron or Schedule 40 steel wall sleeves for pipe passing through walls of valve pits and structures. Fill annular space between walls and sleeves with rich cement mortar. Fill annular space between pipe and sleeves with mastic.

11. Water Main Pipe:

a. Unless otherwise specified, install pipe and fittings in accordance with the paragraph GENERAL REQUIREMENTS and with the requirements of AWWA C605 for laying of pipe, joining PVC pipe to fittings and accessories, setting of fire hydrants, valves, and fittings; and with the recommendations for pipe joint assembly and appurtenance installation in AWWA M23, Chapter 7, "Installation."

1) Jointing:

(a) Make push-on joints with the elastomeric gaskets specified for this type joint, using either elastomeric-gasket bell-end pipe or elastomeric-gasket couplings. For pipe-to-pipe push-on joint connections, use only pipe with push-on joint ends having factory-made bevel; for push-on joint connections to metal fittings, valves, and other accessories, cut spigot end of pipe off square and re-bevel pipe end to a bevel approximately the same as that on ductile-iron pipe used for the same type of joint. Use a lubricant recommended by the pipe manufacturer for push-on joints. Assemble push-on joints for pipe-to-pipe joint connections in accordance

with the requirements of AWWA C605 for laying the pipe and the recommendations in AWWA M23, Chapter 7, "Installation," for pipe joint assembly. Assemble push-on joints for connection to fittings, valves, and other accessories in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories and with the requirements of AWWA C600 for joint assembly. Make compression-type joints/mechanical joints with the gaskets, glands, bolts, nuts, and internal stiffeners previously specified for this type joint; assemble in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories, with the requirements of AWWA C600 for joint assembly, and with the recommendations of Appendix A to AWWA C111/A21.11. Cut off spigot end of pipe for compression-type joint/mechanical-joint connections and do not re-bevel. Assemble joints made with sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer using internal stiffeners as previously specified for compression-type joints.

2) Joint Offset:
   (a) Construct joint offset in accordance AWWA C605. Do not exceed the minimum longitudinal bending as indicated by AWWA C605.
3) Fittings:
   (a) Install in accordance with AWWA C605.

12. Polyethylene (PE) Piping:
    a. Install PE pipes in accordance with AWWA M55 and ASTM D2774.
13. Metallic Piping for Service Lines:
    a. Install pipe and fittings in accordance with the paragraph GENERAL REQUIREMENTS and with the applicable requirements of AWWA C600 for pipe installation, unless otherwise specified.
14. Mechanical Joints:
    a. Thoroughly brush the bell and the outside of the spigot of the mechanical joint fitting with a wire brush to remove all loose rust or other foreign material just before assembly. Brush the cleaned surfaces with soapy water just before slipping the gasket over the spigot end and into the bell. Center the spigot end of the pipe or fitting in the bell before jointing is begun. Once the gasket is in place, bring the gland up toward the pipe flange evenly, maintaining approximately the same distance between the gland and the face of the flange at all points around the socket. Partially tighten the bolts, alternately around the socket, maintaining approximately equal tension until the final tension is reached. Use the following bolt torque range for the joints:

Bolt Size	**Range of Torque**
Inch	**Ft-Lb**
5/8	40-60
¾	60-90
1	70-100
1/4	90-12

    b. Apply the torque loads with torque measuring or indicating wrenches, or apply using regular socket wrenches, checked with torque wrenches. If the joint is not sealed using the maximum torque indicated above, disassemble and re assemble the joint after thorough cleaning. Do not overstress bolts to provide the seal.

15. Screwed Joints:
    a. Make screwed joints up tight with a stiff mixture of graphite and oil, inert filler and oil, or graphite compound; apply to male threads only or with PTFE Tape, for use with threaded pipe. Threads are to be full cut; do not leave more than three threads on the pipe exposed after assembling the joint.
16. Joints for Copper Tubing:
    a. Cut copper tubing with square ends; remove fins and burrs. Replace dented, gouged, or otherwise damaged tubing with undamaged tubing. Make solder joints using ASTM B32, 95-5 tin-antimony or Grade Sn96 solder. Use solder and flux containing less than 0.2 percent lead. Before making joint, clean ends of tubing and inside of fitting or coupling with wire brush or abrasive. Apply a rosin flux to the tubing end and on recess inside of fitting or coupling. Insert tubing end into fitting or coupling for the full depth of the recess and solder. For compression joints on flared tubing, insert tubing through the coupling nut and flare tubing.
17. Flanged Joints:
    a. Make flanged joints up tight, avoid undue strain on flanges, valves, fittings, and accessories.
18. Plastic Service Piping:
    a. Install pipe and fittings in accordance with the paragraph GENERAL REQUIREMENTS and with the applicable requirements of ASTM D2774 [and ASTM D2855], unless otherwise specified. Handle solvent cements used to join plastic piping in accordance with ASTM F402.
19. Jointing:
    a. Make solvent-cemented joints for PVC piping using the solvent cement previously specified for this material; assemble joints in accordance with ASTM D2855. Make plastic pipe joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.
20. Plastic Pipe Connections to Appurtenances:
    a. Connect plastic service lines to corporation stops and gate valves in accordance with the recommendations of the plastic pipe manufacturer.
21. Trenchless Piping: Refer to Section 33 05 23 – Trenchless Utility Installation for additional specifications.
    a. Butt Fusion:
        1) Fusible pipe will be fused by qualified fusion technicians, as required by manufacturer of the fusion equipment. Record and log each fusion joint by an electronic monitoring device (data logger) connected to the fusion machine. Log fusion data and create Post-Construction Fusion Report with software specifically developed for the pipe material being fused. Software must record the parameters required by the fusion equipment manufacturer and these specifications. Manual log data not logged by the data logger and be included in the Post-Construction Fusion Report. Assemble fusible PVC and PE pipe lengths in the field with butt-fused joints. Follow the manufacturer's fusion equipment procedures.
            (a) Install butt fused PE Pipe in accordance with ASTM F1962.
            (b) For butt fused PVC Pipe provide joints meeting the requirements of ASTM F1674.
            (c) Post-Construction Fusion Report: Include the following data for each fusible connection in the report:
                (i) Pipe Size and Thickness
                (ii) Machine Size
                (iii) Fusion Technician Identification
                (iv) Job Identification
                (v) Fusion Joint Number

(vi) Fusion, Heating, and Drag Pressure Settings
(vii) Heat Plate Temperature
(viii) Time Stamp
(ix) Heating and Cool Down Time of Fusion
(x) Ambient Temperature

22. Fire Protection Service Lines for Sprinkler Supplies:
    a. Connect water service lines used to supply building sprinkler systems for fire protection to the water main in accordance with NFPA 24.
23. Water Service Piping:
    a. Location:
        1) Connect water service piping to the building service where the building service has been installed. Where building service has not been installed, terminate water service lines approximately 5 feet from the building line at the points indicated; close such water service lines with plugs or caps.
    b. Water Service Line Connections to Water Mains:
        1) Connect water service lines 2 inch size to the main with a rigid connection or a corporation stop and gooseneck and install a gate valve on service line below the frostline as indicated on the Construction Drawings. Connect 2 inch water service lines to the main with a rigid connection and install a gate valve on service line below the frostline as indicated on the Construction Drawings. Connect water service lines to ductile-iron water mains in accordance with AWWA C600 for service taps. Connect water service lines to PVC water mains in accordance with UBPPA UNI-PUB-08 and the recommendations of AWWA M23, Chapter 9, "Service Connections." Connect water service lines to concrete water mains in accordance with the recommendations of AWWA M9, "Tapping Concrete Pressure Pipe." Connect water service lines to steel water mains in accordance with the recommendations of the steel water main pipe manufacturer and with the recommendations for special and valve connections and other appurtenances in AWWA M11, Chapter 13, "Supplementary Design Data and Details."

C. Railroad Right-of-Way:
    1. Install piping passing under the right-of-way of a commercial railroad in accordance with the specifications for pipelines conveying nonflammable substances in Chapter 1, Part 5, of the AREMA Eng Man. For PVC water main pipe, also install in accordance with the recommendations of AWWA M23 for installation of casings.

D. Meters:
    1. Install meters and meter boxes at the locations shown on the drawings. Center meters in the boxes to allow for reading and ease of removal or maintenance. Set top of box or vault at finished grade.

E. Cleaning Water Mains:
    1. Before chlorination, except when hypochlorite tablets are used, flush the mains thoroughly after the pressure and leakage test are completed.
    2. It is understood that such flushing removes only the lighter solids and cannot be relied upon to remove heavy material allowed to get into the main during laying. Use a minimum flushing velocity in the main of 2.5 feet per second (0.7 meters/second). If no hydrant is installed at the end of the main, provide a tap of the size to produce a velocity in the main of at least 2.5 feet per second (0.7 meters/second). Table 5 shows the rates of flow required to produce a velocity of 2.5 feet per second (0.7 meters/second) in various size pipes.

TABLE 5 REQUIRED FLOW AND OPENINGS TO FLUSH PIPELINES[1] (40 psi (276 kPa) Residual Pressure in Water Main)					
Pipe Diam. Inches (cm)	Flow Required to Produce 2.5 fps (approx.) Velocity in Main, gpm (epm)	Size of Tap (inch)(mm) 1(25) 1-1/2(38) 2(51) number of taps on pipe[2]		Hydrant Outlet Size Number in (mm)	
4 (10)	100 (380)	1		1	2-1/2 (63)
6 (15)	200 (760)	1		1	2-1/2 (63)
8 (20)	400 (1510)	2	1	1	2-1/2 (63)
10 (25)	600 (2270)	3	2	1	2-1/2 (63)
12 (30)	900 (3400)		2	2	2-1/2 (63)
16 (41)	1600 (6060)		4	2	2-1/2 (63)

[1] With a 40 psi (267 kPa) pressure in the main with the hydrant flowing to atmosphere, a 2-1/2-inch (63mm) hydrant outlet will discharge approximately 1000 gpm (3786 epm) and a 4-1/2-inch (114mm) hydrant nozzle will discharge approximately 2500 gpm (9463 epm).

[2] Number of taps on pipe based on discharge through 5 feet (1.5 meters) of galvanized iron (GI) pipe with one 90 • elbow.

3. Exercise extreme care and conduct a thorough inspection during the water main laying to prevent and detect small stones, pieces of concrete, particles of material, or other foreign material that may have entered the mains. To remove this material, flush and inspect all hydrants on the lines to assure that the entire valve operating mechanism of each hydrant is in good condition.
4. In 24-inch (61 cm) or larger diameter mains, in addition to flushing, broom-sweep the main, removing all sweepings before chlorinating the main.

F. Disinfection:
   1. General:
      a. Disinfect the water mains subject to the Atlantic Richfield Company Representative's approval in accordance with AWWA C651, "Disinfecting Water Mains", and these specifications, before placing the main in service. Keep the interior of all pipe, fittings and appurtenances free from dirt, heavy and foreign particles.
   2. Forms of Chlorine:
      a. The forms of chlorine that may be used, subject to the approval of the Atlantic Richfield Company Representative, are:
         1) Liquid chlorine containing 100 percent available chlorine under pressure in steel containers. Meet AWWA B301 requirements and use only in combination with appropriate gas-flow chlorinators and ejectors.
         2) Sodium hypochlorite in liquid form containing approximately 5 to 15 percent available chlorine. Meet AWWA B300 requirements.
         3) Calcium hypochlorite in granular form or in 5g tablets containing approximately 65 percent available chlorine by weight. Meet AWWA B300 requirements.
   3. Methods of Chlorination:
      a. Three (3) methods of chlorination may be used. The tablet method gives an average chlorine dose of approximately 25 mg./L; the continuous feed method gives a 24-hour chlorine residual of not less than 10 mg./L; and the slug method provides a three-hour exposure of not less than 50 mg./L free chlorine.

1) Tablet Method:
   (a) This method may be used if the pipes and appurtenances are kept clean and dry during construction.
   (b) During construction, place calcium hypochlorite granules at the upstream end of the first section of pipe, at the upstream end of each branch main, and at 500-foot (150 meter) intervals. Use the quantity of granules shown in Table 6.
   (c) Warning: Do not use this procedure on solvent welded plastic or on screwed joint steel pipe because of fire or explosion hazard from the reaction of the joint compounds with the calcium hypochlorite.

OUNCES OF CALCIUM HYPOCHLORITE GRANULES TO BE PLACED AT BEGINNING OF MAIN AND AT EACH 500-FOOT (150 METER) INTERVAL

Calcium Hypochlorite		
Pipe Diameter		**Granules**
Inches	**(cm)**	**oz**
4	(10)	0.5
6	(15)	1.0
8	(20)	2.0
12	(30)	4.0
16 and larger	(41)	8.0

   (d) During construction, place 5 g calcium hypochlorite tablets in each section of pipe and place one tablet in each hydrant, hydrant branch and other appurtenance. Use the number of 5 g tablets for each pipe section required to provide a minimum chlorine concentration of 25 mg/L. Attach tablets to the inside of the pipe using an adhesive such as Permatex No.1 or equal. Assure no adhesive is on the tablet except on the broad side attached to the surface of the pipe. Attach all the tablets at the inside top of the main, with approximately equal numbers of tablets at each end of a given pipe length. If the tablets are attached before the pipe section is placed in the trench, mark their position on the section so it can be readily determined that the pipe is installed with the tablets at the top.
   (e) When installation has been completed, fill the main with water at a velocity not exceeding 1 fps (0.3 mps). Take precautions to assure that air pockets are eliminated. Leave this water in the pipe for at least 24 hours. If the water temperature is less than 41° F (5°C), leave the water in the pipe for at least 48 hours. Position valves so that the chlorine solution in the main being treated will not flow into water mains in active service.

4. Continuous Feed Method:
   a. Before chlorinating, fill the main with water to eliminate air pockets and flush as specified above.
   b. Use water from the existing distribution system or other approved source of supply to flow at a constant, measured rate into the newly laid water main. At a point not more than 10 feet (3 meters) downstream from the beginning of the new main, assure water entering the new main receives chlorine fed at a minimum 25 mg/L free chlorine. To assure that this concentration is provided, measure the chlorine concentration at regular intervals.

c. During chlorine application, position valves so that the chlorine solution in the main being treated does not flow into water mains in active service. Do not stop chlorine application until the entire main is filled with chlorinated water. Retain the chlorinated water in the main for at least 24 hours, operating all valves and hydrants in the section treated to disinfect the appurtenances. At the end of the 24-hour period, the treated water in all portions of the main must have a minimum free chlorine residual of 10 mg/L free chlorine.
d. The preferred equipment for applying liquid chlorine is a solution feed vacuum operated chlorinator to mix the chlorine gas in solution water, in combination with a booster pump for injecting the chlorine gas solution water into the main to be disinfected. It is recommended that direct feed chlorinators not be used. Hypochlorite solutions may be applied to the water main with a chemical feed pump designed for feeding chlorine solutions.
e. If approved, an optional continuous feed method utilizing calcium hypochlorite granules may be used. Place the granules in the pipe sections as specified under the Tablet Method.

5. Slug Method:
a. Before chlorinating, preliminary flush the main as specified herein.
b. Use water from the existing distribution system or other approved source of supply to flow at a constant measured rate into the newly laid water main.
c. Not more than 10 feet (3 meters) downstream from the beginning of the new main, add chlorine to the water entering the new main at a constant rate that the water will have a minimum 100 mg/L free chlorine. Measure this concentration at regular intervals. Apply the chlorine continuously and for the time required to develop a solid column or “slug” of chlorinated water that will, as it moves through the main, expose all interior surfaces to 100 mg/L for at least 3 hours.
d. Measure the free chlorine residual in the slug as it moves through the main. If at any time it drops below 50 mg/L stop the flow and relocate the chlorination equipment at the head of the slug, and as flow is resumed, add chlorine to restore the free chlorine in the slug to not less than 100 mg/L.
e. As the chlorinated water flows past fittings and valves, operate related valves and hydrants to disinfect appurtenances and pipe branches.

G. Flushing:
1. After the retention period, flush the chlorinated water from the main until chlorine measurements show that the concentration in the water leaving the main is no higher than that in the system, or is acceptable for domestic use.
a. Bacteriological Tests:
1) After final flushing and before the water main is placed in service, test a sample, or samples, collected from the main(s) for turbidity and organisms. Collect at least one sample from the new main and one from each branch. Redisinfect if the initial disinfection fails to produce approved bacteriological or turbidity samples, re-flush and resample the main. If check samples show bacterial contamination, re-chlorinate the main until approved results are obtained. Where connections are made to existing piping and the connections are not disinfected along with the newly installed main, swab or spray the interior of all pipe and fittings used in making the connections with a 1 percent hypochlorite solution before installation.

H. Pipe Restraint:
1. Concrete Thrust Blocks:
a. Install concrete thrust blocks where indicated.

2. Restrained Joints:
    a. Install restrained joints in accordance with [the manufacturer's instructions] [NFPA 24] [_____] where indicated on the Construction Drawings. [For metal harness use tie rods and clamps as shown in NFPA 24.] [Provide structural welded, skip welded, clamp type harness, bell bolt harness, snap ring harness for pipe anchorage.] [Provide metal harness fabricated by the pipe manufacturer and furnished with the pipe.]

I. Valves:
1. Gate Valves:
    a. Install gate valves, AWWA C500 and UL 262, in accordance with the requirements of AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix ("Installation, Operation, and Maintenance of Gate Valves") to AWWA C500. Install gate valves, AWWA C509 or AWWA C515, in accordance with the requirements of AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix ("Installation, Operation, and Maintenance of Gate Valves") to AWWA C509 or AWWA C515. Install gate valves on PVC and PVCO water mains in accordance with the recommendations for appurtenance installation in AWWA M23, Chapter 7, "Installation." Make and assemble joints to gate valves as specified for making and assembling the same type joints between pipe and fittings.
2. Check Valves:
    a. Install check valves in accordance with the applicable requirements of AWWA C600 for valve-and-fitting installation, except as otherwise indicated Construction Drawings. Make and assemble joints to check valves as specified for making and assembling the same type joints between pipe and fittings.
3. Air Release, Air/Vacuum, and Combination Air Valves:
    a. Install pressure vacuum assemblies of type, size, and capacity indicated. Include valves and test cocks. Install according to the requirements of plumbing and health department and authorities having jurisdiction. Do not install pressure vacuum breaker assemblies in vault or other space subject to flooding.
4. Blow-off Valve Assemblies:
    a. Install blow-off valve assemblies as indicated on the drawings or in accordance with the manufacture’s recommendations. Install discharge fitting on the end of riser pipe to direct the flow of water so as to minimize damage to surrounding areas.
5. Fire Hydrants:
    a. Set all hydrants plumb with the pumper nozzle facing the street. Set the hydrant with the ground line at the location indicated by the hydrant manufacturer.
    b. Provide drainage at the hydrant base by placing clean gravel under and around it. Place gravel at least 1 foot (30 cm) on all sides from the base of the hydrant to at least 6 inches (15 cm) above the drain opening. Brace the hydrant against unexcavated earth at the trench end with concrete backing as detailed on the plans. Furnish hydrants with the specified gate valves. Install hydrants as shown on the Drawings.

3.03 FIELD QUALITY CONTROL

A. Tests:
1. Notify the Atlantic Richfield Company Representative a minimum of five days in advance of hydrostatic testing. Coordinate the proposed method for disposal of wastewater from hydrostatic testing. Perform field tests, and provide labor, equipment,

and incidentals required for testing. Provide documentation that all items of work have been constructed in accordance with the Contract documents.

a. Hydrostatic and Leakage Test:
    1) Perform hydrostatic and leakage testing in accordance with AWWA C600. Once the pipe is laid and backfilled, test for at least 2 hours, all newly laid pipe, or any valved section, to a hydrostatic pressure of at least 1.5 times the normal operating pressure at the test point or 1.25 times the normal operating pressure at the highest point along the test section.
    2) Slowly fill the pipe with water, purging all air, and apply the test pressure using a pump hooked up so that the pressure and leakage can be measured. To purge the pipe of air during the test, it is necessary to tap the pipe at its highest points if permanent air vents, water services, hydrants, etc. are not located at the high points. Use corporation stops for this purpose. Furnish the pump connections, gauges, stops, and all necessary apparatus for testing.
    3) Disassemble and reassemble all joints showing leakage after thorough cleaning. Remove and replace all cracked or defective pipes or fittings discovered in during the pressure test with sound material and repeat the test.
    4) Conduct the leakage test concurrently with the pressure test for 2 hours. Leakage is defined as the quantity of water supplied into the pipe, or any valved section thereof, necessary to maintain pressure within 5 PSI of the pressure test after the pipe has been filled with water and purged of air.
    5) The pipe installation will be rejected if the leakage exceeds that determined by the following formula:

$$L = SD(P)1/2 / 148,000$$

In which L equals the allowable leakage in gallons per hour; S is the length of pipe tested, in feet; D is the nominal diameter of the pipe, in inches; and P is the average test pressure during the leakage test, in pounds per square inch gauge.

    6) Should any test of pipe laid disclose leakage exceeding that specified above, locate and repair the defective joints until the leakage is within the specified allowance.
    7) Conduct the pressure and leakage tests with the Atlantic Richfield Company Representative present.
    8) When testing against closed metal-seated valves, an additional leakage per closed valve of 0.0078 gallon per hour per inch of nominal valve size is allowed. Repair all visible leaks regardless of the amount of leakage.
    9) Pressure test tapping sleeves after installation and before tapping.

b. Special Testing Requirements for Fire Service:
    1) Test water mains and water service lines providing fire service or water and fire service in accordance with NFPA 24. The additional water added to the system must not exceed the limits given in NFPA 24

c. Tracer Wire Continuity Test:
    1) Test tracer wire for continuity after service connections have been completed and prior to final pavement or restoration. Verify that tracer wire is locatable with electronic utility locating equipment. Repair breaks or separations and re-test for continuity.

3.04 SYSTEM STARTUP

A. Water mains and appurtenances must be completely installed, disinfected, flushed, and satisfactory bacteriological sample results received prior to permanent connections being

made to the active distribution system. Obtain approval by the Atlantic Richfield Company Representative prior to the new water piping being placed into service.

3.05 CLEANUP

A. Upon completion of the installation of water lines and appurtenances, remove all debris and surplus materials resulting from the work.

END OF SECTION

SECTION 33 30 00
SANITARY SEWERAGE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
   1. American Concrete Pipe Association (ACPA):
      a. ACPA 01-102 (2000) - Concrete Pipe Handbook.
      b. ACPA 01-103 (2000) - Concrete Pipe Installation Manual.
   2. American Railway Engineering and Maintenance-of-Way Association (AREMA):
      a. AREMA Eng Man (2017) - Manual for Railway Engineering.
   3. American Water Works Association (AWWA):
      a. AWWA C104/A21.4 (2016) - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
      b. AWWA C105/A21.5 (2010) - Polyethylene Encasement for Ductile-Iron Pipe Systems.
      c. AWWA C110/A21.10 (2012) - Ductile-Iron and Gray-Iron Fittings for Water.
      d. AWWA C111/A21.11 (2017) - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
      e. AWWA C115/A21.15 (2011) - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
      f. AWWA C151/A21.51 (2017) - Ductile-Iron Pipe, Centrifugally Cast.
      g. AWWA C153/A21.53 (2011) - Ductile-Iron Compact Fittings for Water Service.
      h. AWWA C302 (2016) - Reinforced Concrete Pressure Pipe, Noncylinder Type
      AWWA C600 (2017) - Installation of Ductile-Iron Mains and Their Appurtenances.
      i. AWWA C605 (2014) - Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings.
      j. AWWA C606 (2015) - Grooved and Shouldered Joints.
      k. AWWA C900 (2016) - Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm).
      l. AWWA M9 (2008; Errata 2013) Manual: Concrete Pressure Pipe.
   4. ASME International (ASME):
      a. ASME B1.20.1 (2013) - Pipe Threads, General Purpose (Inch)
      b. ASME B16.1 (2015) - Gray Iron Pipe Flanges and Flanged Fittings Classes 25,125, and 250.
      c. ASME B18.2.2 (2015) - Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
      d. ASME B18.5.2.1M (2006; R 2011) - Metric Round Head Short Square Neck Bolts.
      e. ASME B18.5.2.2M (1982; R 2010) - Metric Round Head Square Neck Bolts.
   5. ASTM International (ASTM):
      a. ASTM A123/A123M (2017) - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

b. ASTM A307 (2014; E 2017) - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.
c. ASTM A47/A47M (1999; R 2018; E 2018) - Standard Specification for Ferritic Malleable Iron Castings.
d. ASTM A48/A48M (2003; R 2012) - Standard Specification for Gray Iron Castings.
e. ASTM A536 (1984; R 2014) - Standard Specification for Ductile Iron Castings.
f. ASTM A563 (2015) - Standard Specification for Carbon and Alloy Steel Nuts.
g. ASTM A746 (2018) - Standard Specification for Ductile Iron Gravity Sewer Pipe.
h. ASTM C12 (2017) - Standard Practice for Installing Vitrified Clay Pipe Lines.
i. ASTM C1214 (2013) - Standard Test Method for Concrete Pipe Sewerlines by Negative Air Pressure (Vacuum) Test Method.
j. ASTM C1227 (2013) - Standard Specification for Precast Concrete Septic Tanks.
k. ASTM C124 (2011; R 2017) - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.
l. ASTM C14 (2015) - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
m. ASTM C150/C150M (2018) - Standard Specification for Portland Cement.
n. ASTM C1644 (2006; R 2017) - Standard Specification for Resilient Connectors Between Reinforced Concrete On-Site Wastewater Tanks and Pipes.
o. ASTM C260/C260M (2010a; R 2016) - Standard Specification for Air-Entraining Admixtures for Concrete.
p. ASTM C270 (2014a) - Standard Specification for Mortar for Unit Masonry.
q. ASTM C33/C33M (2018) - Standard Specification for Concrete Aggregates.
r. ASTM C361 (2016) - Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
s. ASTM C425 (2004; R 2013) - Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
t. ASTM C443 (2012; R 2017) - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
u. ASTM C478 (2018) - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections.
v. ASTM C478M (2018) - Standard Specification for Precast Reinforced Concrete Manhole Sections (Metric).
w. ASTM C700 (2013) - Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
x. ASTM C76 (2018) - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
y. ASTM C828 (2011) - Low-Pressure Air Test of Vitrified Clay Pipe Lines.
z. ASTM C923 (2008; R 2013; E 2016) - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.
aa. ASTM C94/C94M (2017a) - Standard Specification for Ready-Mixed Concrete.
bb. ASTM C969 (2017) - Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines.
cc. ASTM C972 (2000; R 2011) - Compression-Recovery of Tape Sealant.
dd. ASTM C990 (2009; R 2014) - Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants.
ee. ASTM D1784 (2011) - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
ff. ASTM D1785 (2015; E 2018) - Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120.
gg. ASTM D2241 (2015) - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

hh. ASTM D2321 (2018) - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
ii. ASTM D2412 (2011) - Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
jj. ASTM D2464 (2015) - Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
kk. ASTM D2466 (2017) - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
ll. ASTM D2467 (2015) - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
mm. ASTM D2996 (2017) - Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
nn. ASTM D2997 (2015) - Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
oo. ASTM D3034 (2016) - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
pp. ASTM D3139 (1998; R 2011) - Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
qq. ASTM D3212 (2007; R 2013) - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
rr. ASTM D3262 (2016) - "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe.
ss. ASTM D3350 (2012) - Polyethylene Plastics Pipe and Fittings Materials.
tt. ASTM D3753 (2012; E 2013) - Glass-Fiber-Reinforced Polyester Manholes and Wetwells.
uu. ASTM D3840 (2014) - "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Fittings for Nonpressure Applications.
vv. ASTM D4101 (2017) - Standard Classification System and Basis for Specification for Polypropylene Injection and Extrusion Materials.
ww. ASTM D412 (2016) - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension.
xx. ASTM D4161 (2014) - "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals.
yy. ASTM D624 (2000; R 2012) - Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
zz. ASTM F1417 (2011a) - Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low Pressure Air.
aaa. ASTM F2736 (2013; E 2014) Standard Specification for 6 to 30 in. (152 To 762 mm) Polypropylene (PP) Corrugated Single Wall Pipe and Double Wall Pipe.
bbb. ASTM F2764/F2764M (2017; E 2017) - Standard Specification for 6 to 60 in. [150 to 1500 mm] Polypropylene (PP) Corrugated Double and Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications.
ccc. ASTM F477 (2014) - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
ddd. ASTM F667/F667M (2016) - Standard Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings.
eee. ASTM F714 (2013) - Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
fff. ASTM F758 (2014) - Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage.
ggg. ASTM F794 (2003; R 2014) - Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.

hhh. ASTM F894 (2013) - Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe.
iii. ASTM F949 (2015) - Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings.

6. International Association of Plumbing and Mechanical Officials (IAPMO):
   a. IAPMO Z1000 (2013) - Prefabricated holding Tanks.
7. U.S. National Archives and Records Administration (NARA):
   a. 29 CFR 1910.27 (N0v 2016) - Scaffolds and Rope Descent Systems.
8. Uni-Bell PVC Pipe Association (UBPPA):
   a. UBPPA UNI-B-6 (1998) - Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe.

1.03 SUBMITTALS

A. Atlantic Richfield Company approval is required for submittals in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-01 Preconstruction Submittals:
      a. Contractor's license.
   2. SD-02 Shop Drawings:
      a. Installation drawings.
   3. SD-03 Product Data:
      a. Precast concrete manholes
      b. Frames, covers, and gratings.
      c. Gravity pipe.
      d. Pressure pipe.
      e. Precast concrete holding tanks.
   4. SD-05 Test Reports:
      a. Precast concrete sewer manhole test.
      b. Hydrostatic sewer test.
      c. Infiltration tests and exfiltration tests.
      d. Negative air pressure test.
      e. Low-pressure air tests.
      f. Tests for pressure lines.
      g. Deflection testing.
      h. Concrete pipe test.
   5. SD-06 Certificates:
      a. Portland cement.
      b. Gaskets.
      c. Pre-installation inspection request.
      d. Post-installation inspection.

1.04 QUALITY CONTROL

A. Installer Qualifications:
   1. Install specified materials by a licensed underground utility Contractor licensed for such work in the state where the work is to be performed. Verify installing Contractor's License is current and state certified, or state registered.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Storage:
   1. Check upon arrival; identify and segregate as to types, functions, and sizes. Store off the ground in a manner affording easy accessibility and not causing excessive rusting or coating with grease or other objectionable materials.

a. Piping:
    1) Inspect materials delivered to site for damage; store with minimum of handling. Store materials on site in enclosures or under protective coverings. Store plastic piping and jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.
b. Cement, Aggregate, and Reinforcement:
    1) As specified in Section 03 30 00 – Cast-In-Place Concrete, Section 03 20 00 – Concrete Reinforcing, and Section 31 38 00 – Granular Fill Material.

B. Handling:
1. Handle pipe, fittings, and other accessories in such manner as to ensure delivery to the trench in sound undamaged condition. Take special care not to damage linings of pipe and fittings; if lining is damaged, make satisfactory repairs. Carry, do not drag, pipe to trench. Store solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install the plastic pipe in accordance with the manufacturer's recommendation and discard those materials if the storage period exceeds the recommended shelf life. Discard solvents in use when the recommended pot life is exceeded.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Furnish sewer pipe and fittings as specified in the Contract Documents and meeting the materials and testing requirements of this Section. Furnish wye or tee branches and service line piping of the same material and design as the sewer pipe unless specified otherwise. Pipe strength classifications are shown on the plans and/or are listed in the Contract Documents.

B. References made to ASTM, ANSI or AASHTO designation are the latest revision at the time of call for bids.

C. Ensure all pipe is clearly marked with type, class and/or thickness as applicable. Ensure lettering is legible and permanent under normal conditions of handling and storage.

D. Furnish the joint type, class, thickness designation, castings, lining, marking, testing, etc. as specified.

2.02 MATERIALS

A. Provide materials conforming to the respective specifications and other requirements specified below. Submit manufacturer's product specification, standard drawings or catalog cuts.
1. Gravity Pipe:
    a. Furnish PVC pipe produced by a continuous extrusion process, employing a prime grade of un-plasticized polyvinyl chloride. Assure the grade used is highly resistant to hydrogen sulfide, sulfuric acid, gasoline, oil, detergents and other chemicals found in sewage and industrial wastes. Assure the material meets “Rigid Polyvinyl Chloride Compounds” - ASTM Designation D-1784 requirements. Assure the pipe has self-extinguishing flammability characteristics.
    b. Assure wye or tee fittings for connecting service lines are of the same material, construction and joint design as the main sewer pipe.

1) PVC Gravity Joints and Jointing Material:
   (a) Provide joints conforming to ASTM D3212. Gaskets are to conform to ASTM F477.

2. Pressure Pipe:
   a. High Density Polyethylene Pipe (HDPE):
      1) Furnish non-profile wall HDPE pipe meeting ASTM D3350, having a cell classification of PE 34-5434C. Assure dimensions and workmanship meet ASTM F714 requirements.
      2) Use wye or tee fittings for connecting service lines of the same material construction and joint design as the main sewer pipe.
      3) Heat fusion weld all field joints to meet the manufacturer's recommendations.
3. Piping Beneath Railroad Right-of-Way:
   a. Where pipeline passes under the right-of-way of a commercial railroad, piping is to conform to the specifications for pipelines conveying nonflammable substances in AREMA Eng Man, except as otherwise specified in this paragraph. For casing pipe provide ductile-iron pipe in lieu of cast-iron soil pipe. Ductile-iron pipe is to conform to and have strength computed in accordance with ASTM A746.
4. Cement Mortar:
   a. Provide cement mortar conforming to ASTM C270 and Section 03 30 00 – Cast-In-Place Concrete.
5. Portland Cement:
   a. Follow specifications provided in Section 03 42 13 – Plant-Precast Concrete Products for Below Grade Construction. Submit certificates of compliance stating the type of cement used in manufacture of holding tanks and precast manholes. Provide Portland cement conforming to ASTM C150/C150M, Type V for concrete used in tanks, vaults, and manholes and type optional for cement used in concrete cradle, concrete encasement, and thrust blocking.
6. Portland Cement Concrete:
   a. Follow specifications provided in Section 03 30 00 – Cast-In-Place Concrete.
7. Precast Concrete Manholes:
   a. Provide precast concrete manholes, risers, base sections, and tops conforming to ASTM C478 and be manufactured in accordance with Section 03 42 13 – Plant-Precast Concrete Products for Below Grade Construction; Base and first riser are to be monolithic.
      1) Frames, Covers, and Gratings for Manholes:
         (a) Submit certification on the ability of frame and cover to carry the imposed live load. Furnish frames and covers as shown on the Drawings. Furnish 2-hole type covers unless specified otherwise.
      2) Manhole Steps:
         (a) Furnish non-corrosive steps, 12-inches (30 cm) in width, of 1/2-inch (13 mm) steel rod encased with polypropylene. Assure steps withstand 400 pound (180 kg) vertical loads and 1,000 pound (450 kg) pull-out resistance.
      3) Manhole Ladders:
         (a) Provide a steel ladder where the depth of a manhole exceeds 12 feet. The ladder is not to be less than 16 inches in width, with 3/4 inch diameter rungs spaced 12 inches apart. The two stringers are to be a minimum 3/8 inch thick and 2 inches wide. Galvanize ladders and inserts after fabrication in conformance with ASTM A123/A123M.
8. Glass-Fiber-Reinforced Polyester Manholes:
   a. Glass-Fiber-Reinforced Polyester Manholes are to conform to ASTM D3753.

9. Gaskets and Connectors:
    a. Provide gaskets for joints between manhole sections conforming to ASTM C443. Resilient connectors for making joints between manhole and pipes entering manhole are to conform to ASTM C1644.
10. External Preformed Rubber Joint Seals:
    a. An external preformed rubber joint seal is an accepted method of sealing cast iron covers to precast concrete sections to prevent ground water infiltration into sewer systems. All finished and sealed manholes constructed in accordance with paragraph entitled "Manhole Construction" are to be tested for leakage in the same manner as pipelines as described in paragraph entitled "Leakage Tests." The seal is to be multi-section with a neoprene rubber top section and all lower sections made of Ethylene Propylene Diene Monomer (EPDM) rubber with a minimum thickness of 60 mils. Each unit is to consist of a top and bottom section and have mastic on the bottom of the bottom section and mastic on the top and bottom of the top section. The mastic is to be a non-hardening butyl rubber sealant and seal to the cone/top slab of the manhole/catch basin and over the lip of the casting. Extension sections are to cover up to two more adjusting rings. Properties and values are listed in the following table:

Properties, Test Methods and Minimum Values for Rubber used in Preformed Joint Seals				
Physical Properties	**Test Methods**	**EPDM**	**Neoprene**	**Butyl Mastic**
Tensile, psi	ASTM D412	1840	2195	--
Elongation, percent	ASTM D412	553	295	350
Tear Resistance, ppi	ASTM D624 (Die B)	280	160	--
Rebound, percent, 5 minutes	ASTM C972 (mod.)	--	--	11
Rebound, percent, 2 hours	ASTM C972	--	--	12

11. Check Valves:
    a. Provide iron-bodied check valves that permit free flow of sewage forward and provide a positive check against backflow. Design check valves for a minimum working pressure of 150 psi or as indicated. Directly cast the manufacturer's name, initials, or trademark and also the size of the valve, working pressure, and direction of flow on the body.
        1) Swing Check Valves:
            (a) Comply with AWWA C508. Provide with iron body, bronze mounted, and flanged ends. Provide 125-pound type flanges, complying with ASME B16.1.
12. Plug Valves:
    a. Provide cast iron valves complying with MSS SP-78 or steel plug valves in compliance with API Spec 6D.
13. Air Release Valves:
    a. Provide air release valves designed to permit release of air from an empty pipe during filling and capable of discharging accumulated air in the line while the line is in operation and under pressure. Attach valves by means of threaded pipe connections. Vent valves to the atmosphere.
        1) Manual Air Release Valves:
            (a) Consisting of a 3-inch gate valve and 3-inch ductile iron pipe and fittings. Install the valve with its line of flow in the horizontal position.

2) Automatic Air Release Valves:
   (a) Compound lever type capable of withstanding operating pressures of 150 psi, with a 1/2-inch outlet. Provide with iron body and cover of the valve and a stainless-steel float. Provide internal parts made entirely of stainless steel or bronze. Provide valve specifically adapted for use with sewage and complete with hose and blow-off valves to permit backflushing without dismantling the valve.

14. Valve Vaults:
    a. Provide and install in accordance with Section 03 42 13 – Plant-Precast Concrete Products for Below Grade Construction. Cast the word "SEWER" in the cover. Provide secure latch/lock mechanism to prevent unauthorized entry or tampering with the components within.
15. Station Enclosure:
    a. The station enclosure shall contain and enclose all valves, and associated controls and shall be constructed in accordance with Section 33 32 13 – Packaged Sewage Lift Station Wet Well Type.
16. Precast Concrete Holding Tanks:
    a. Provide precast concrete holding tanks risers, base sections, and tops conforming to ASTM C1227 and be manufactured in accordance with Section 03 42 13 – Plant-Precast Concrete Products for Below Grade Construction; base and first riser are to be monolithic.
17. Holding Tank Piping:
    a. Provide pipe and fittings specified in the construction drawings.

2.03 BURIED WARNING AND IDENTIFICATION TAPE

A. Polyethylene plastic and metallic core or metallic-faced, acid- and alkali-resistant, polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3-inch minimum width, color coded as specified below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Color and printing shall be permanent, unaffected by moisture or soil.

Warning Tape Color Codes	
Red	Electric
Yellow	Gas, Oil; Dangerous Materials
Orange	Telephone and Other Communications
Blue	Potable Water Systems
Green	Sewer Systems
White	Steam Systems
Gray	Compressed Air
Purple	Non Potable, Reclaimed Water, Irrigation and Slurry lines

1. Warning Tape for Metallic Piping:
   a. Acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of tape shall be 0.003 inch. Tape shall have a minimum strength of 1500 psi lengthwise, and 1250 psi crosswise, with a maximum 350 percent elongation.

2. Detectable Warning Tape for Non-Metallic Piping:
    a. Polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of the tape shall be 0.004 inch. Tape shall have a minimum strength of 1500 psi lengthwise and 1250 psi crosswise. Tape shall be manufactured with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 3 feet deep. Encase metallic element of the tape in a protective jacket or provide with other means of corrosion protection.
3. Detection Wire for Non-Metallic Piping:
    a. Detectable buried warning tape is to have a minimum 6-inch (15cm) width and 5 mil (0.12mm) thickness and a solid aluminum core running the full length and width of the tape enclosed in a color-coded inert plastic jacket, impervious to alkalis, chemical reagents, and solvents in the soil. The tape is to meet APWA/ULCC Color Code requirements and is to have a maximum 36-inch(90cm) imprint.

PART 3 - EXECUTION

3.01 PREPARATION

A. Prepare and install all work as indicated on the Contract Documents, Construction Drawings, and Atlantic Richfield Company Approval.

3.02 INSTALLATION:

A. Backfill after inspection by the Atlantic Richfield Company Representative. Before, during, and after installation, protect plastic pipe and fittings from any environment that would result in damage or deterioration to the material. Keep a copy of the manufacturer's instructions available at the construction site at all times and follow these instructions unless directed otherwise by the Atlantic Richfield Company Representative.

B. Connections to Existing Lines:
    1. Obtain approval from the Atlantic Richfield Company Representative before making connection to existing line. Conduct work so that there is minimum interruption of service on existing line.

C. General Requirements for Installation of Pipelines:
    1. These general requirements apply except where specific exception is made in the following paragraphs entitled "Special Requirements."
        a. Location:
            1) Terminate the work covered by this section at a point approximately 5 feet from the building, unless otherwise indicated.
            2) Horizontal and vertical separation between water and sewer mains is dictated by Montana Department of Environmental Quality and as shown on the Drawings. When these separation distances cannot be met, contact the Atlantic Richfield Company Representative for direction.

D. Sanitary Piping Installation Parallel with Water Line:
    1. Normal Conditions: Install sanitary piping or manholes at least 10 feet horizontally from a water line whenever possible. Measure the distance from edge-to-edge.
    2. Unusual Conditions: When local conditions prevent a horizontal separation of 10 feet, the sanitary piping or manhole may be laid closer to a water line provided that:
        a. The top (crown) of the sanitary piping is to be at least 18 inches below the bottom (invert) of the water main.

b. Where this vertical separation cannot be obtained, construct the sanitary piping with AWWA-approved ductile iron water pipe pressure and conduct a hydrostatic sewer test without leakage prior to backfilling.
c. The sewer manhole is to be of watertight construction and tested in place.

E. Installation of Sanitary Piping Crossing a Water Line:
1. Normal Conditions:
a. Lay sanitary sewer piping by crossing under water lines to provide a separation of at least 18 inches between the top of the sanitary piping and the bottom of the water line whenever possible.
2. Unusual Conditions:
a. When local conditions prevent a vertical separation described above, use the following construction:
b. Construct sanitary piping passing over or under water lines with AWWA-approved ductile iron water pressure piping and conduct a hydrostatic sewer test without leakage prior to backfilling.
c. Protect sanitary piping passing over water lines by providing:
1) A vertical separation of at least 18 inches between the bottom of the sanitary piping and the top of the water line.
2) Adequate structural support for the sanitary piping to prevent excessive deflection of the joints and the settling on and breaking of the water line.
3) That the length, minimum 20 feet, of the sanitary piping be centered at the point of the crossing so that joints are equidistant and as far as possible from the water line.

F. Sanitary Sewer Manholes:
1. No water piping shall pass through or come in contact with any part of a sanitary sewer manhole.

G. Earthwork:
1. Perform earthwork operations in accordance with Section 31 00 00 EARTHWORK.

H. Pipe Laying and Jointing:
1. Deliver and distribute all pipe to the site. Use tools and equipment, satisfactory to the Engineer, for the safe and convenient prosecution of the work. Load and unload pipe, fittings and accessories by lifting with hoists or skidding to avoid shock or damage. Do not drop any materials. Do not roll or skid pipe handled on skidways against pipe already on the ground.
2. In distributing the material at the site of the work, unload each piece opposite or near the place where it is to be laid in the trench. Take every precaution to prevent foreign material from entering the pipe while it is being installed. At times when pipe laying is not in progress, close the open ends of pipe using a plug or other means approved by the Engineer. Clean and remove all sand, gravel, concrete and cement grout that has entered the lines during construction.
3. Handle pipe to prevent damaging coating or lining. If any part of the coating or lining is damaged, make all repairs in a manner satisfactory to the Engineer.
4. Inspect each pipe and fitting before and after installation; replace those found defective and remove from site.
5. Provide proper facilities for lowering sections of pipe into trenches. Lay non-pressure pipe with the bell [or groove] ends in the upgrade direction.
6. Adjust spigots in bells [and tongues in grooves] to give a uniform space all around. Blocking or wedging between bells and spigots [or tongues and grooves] will not be

permitted. Replace by one of the proper dimensions, pipe or fittings that do not allow sufficient space for installation of joint material.

7. At the end of each workday, close open ends of pipe temporarily with wood blocks or bulkheads.
8. Provide batter boards not more than 25 feet apart in trenches for checking and ensuring that pipe invert elevations are as indicated. Laser beam method may be used in lieu of batter boards for the same purpose.
9. Construct branch connections by use of regular fittings or solvent cemented saddles as approved. Provide saddles for PVC pipe conforming to Table 4 of ASTM D3034.

I. Special Requirements:
   1. Installation of PVC Piping:
      a. Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the requirements of ASTM D2321 for laying and joining pipe and fittings. Make joints with the gaskets specified for joints with this piping and assemble in accordance with the requirements of ASTM D2321 for assembly of joints. Make joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.
   2. Installation of Dual Wall and Triple Wall Polypropylene:
      a. Install pipe in accordance with "General Requirements for installation of Pipelines" of this section, with the polypropylene pipe manufacturer's recommendations, and with the requirements of ASTM D2321 for laying and joining pipe and fittings. Place a minimum of 6 inches of Class 1 or Class 2 backfill over the crown of the pipe with minimum 90 percent compaction.
   3. Pipeline Installation Beneath Railroad Right-of-Way:
      a. Where pipeline passes under the right-of-way of a commercial railroad, install piping in accordance with the specifications for pipelines conveying nonflammable substances in AREMA Eng Man.

J. Concrete Work:
   1. Cast-in-place concrete is included in Section 03 30 00 Cast-In-Place Concrete. Support the pipe on a concrete cradle or encased in concrete where indicated or directed.

K. Manhole Construction:
   1. Construct base slab of cast-in-place concrete or use precast concrete base sections. Make inverts in cast-in-place concrete and precast concrete bases with a smooth-surfaced semi-circular bottom conforming to the inside contour of the adjacent sewer sections. For changes in direction of the sewer and entering branches into the manhole, make a circular curve in the manhole invert of as large a radius as manhole size will permit. For cast-in-place concrete construction, either pour bottom slabs and walls integrally or key and bond walls to bottom slab. No parging will be permitted on interior manhole walls. For precast concrete construction, make joints between manhole sections with the gaskets specified for this purpose; install in the manner specified for installing joints in concrete piping. Parging will not be required for precast concrete manholes. Perform cast-in-place concrete work in accordance with the requirements specified under paragraph entitled "Concrete Work" of this section.
   2. Joint all connections between manhole walls and base and between wall sections adjusting rings and frame making the manhole watertight. For all horizontal joints located below the established high groundwater elevation, install a preformed rubber gasket joint. The established high groundwater level is shown on the plans or noted in the Special Provisions. For all sewer pipe to manhole joints, use gasketed, flexible,

watertight connections that will accommodate differential settlement. Acceptable options for these connections to the manhole are as follows:

a. Adjacent Joints:
    1) Bell and spigot pipe joints with rubber sealing rings located within 12 inches (30 cm) of the manhole wall.
b. Compression-Type Flexible Connector:
    1) A resilient, flexible connection, cast into manhole wall, providing 10 degrees deflection.
c. Boot-Type Flexible Connector:
    1) A flexible, watertight connection consisting of a rubber gasket or boot, metal expansion ring and a metal take-up clamp. Assure the expansion ring holds the gasket in the manhole wall, with the take-up clamp holding the gasket to the pipe.
d. Options b. and c. are limited to precast manhole base inverts and other installations where the flexibility of the connection is not compromised.
e. Construct manholes meeting ASTM C478, and the rejection criteria stated therein.
f. Keep manhole construction within one manhole distant behind sewer pipeline construction.

3. Where a new manhole is constructed on an existing line, remove existing pipe as necessary to construct the manhole. Cut existing pipe so that pipe ends are approximately flush with the interior face of manhole wall, but not protruding into the manhole. Use resilient connectors as previously specified for pipe connectors to concrete manholes.
4. Install adjusting rings on each manhole to bring the manhole top elevation to match the existing or specified ground elevations. Use manhole rings with a 2-inch minimum (5 cm) and 12-inch (30 cm) maximum height. Furnish adjusting rings reinforced with the same percentage of steel as the riser and top.

L. Miscellaneous Construction and Installation:
1. Connecting to Existing Manholes:
    a. Connect pipe to existing manholes such that finish work will conform as nearly as practicable to the applicable requirements specified for new manholes, including all necessary concrete work, cutting, and shaping. Center the connection on the manhole. Holes for the new pipe are to be of sufficient diameter to allow packing cement mortar around the entire periphery of the pipe but no larger than 1.5 times the diameter of the pipe. Cut the manhole in a manner that will cause the least damage to the walls.
2. Metal Work:
    a. Perform metal work so that workmanship and finish will be equal to the best practice in modern structural shops and foundries. Form iron to shape and size with sharp lines and angles. Do shearing and punching so that clean true lines and surfaces are produced. Make castings sound and free from warp, cold shuts, and blow holes that may impair their strength or appearance. Give exposed surfaces a smooth finish with sharp well-defined lines and arises. Provide necessary rabbets, lugs, and brackets wherever necessary for fitting and support.
        1) Field Painting:
            (a) After installation, clean cast-iron frames, covers, gratings, and steps not buried in concrete to bare metal, remove mortar, rust, grease, dirt, and other deleterious materials and apply a coat of bituminous paint. Do not paint surfaces subject to abrasion.

M. Installations of Wye Branches:
   1. Install wye branches in an existing sewer using a method which does not damage the integrity of the existing sewer. Do not cut into piping for connections except when approved by the Atlantic Richfield Company Representative. When the connecting pipe cannot be adequately supported on undisturbed earth or tamped backfill, support on a concrete cradle as directed by the Atlantic Richfield Company Representative. Provide and install concrete required because of conditions resulting from faulty construction methods or negligence without any additional cost to Atlantic Richfield Company. Do not damage the existing sewer when installing wye branches in an existing sewer.

N. Installation of Valves:
   1. Prior to installation, clean valves of all foreign matter and inspect for damage and then fully open and close valves to ensure that all parts are properly operating. Install valves with the stem in the vertical position. Install valves in valve vaults as indicated on the Construction Drawings.

O. Installation of Valve Boxes:
   1. Install valve boxes over each outside gate valve, unless otherwise indicated. Center valve boxes over the valve. Carefully tamp fill around each valve box to a distance of 4 feet on all sides or to undisturbed trench face, if less than 4 feet.

P. Installation of Valve Vaults:
   1. Install valve vaults as indicated on the drawings and in Section 33 32 13 – Packaged Sewage Lift Station Wet Well Type.

Q. Drain Lines:
      a. Install drain lines where indicated. The drain line consists of a tee in the main line with a 4-inch diameter branch, a 4-inch diameter elbow, and a 4-inch gate valve.

R. Thrust Restraint:
   1. Provide thrust restraint as specified in Section 33 11 00 – Water Utility Distribution Piping. Provide plugs, caps, tees and bends deflecting 11-1/4 degrees or more, either vertically or horizontally, with thrust restraint. Securely anchor valves or provide with thrust restraints to prevent movement. Install thrust restraints made from either thrust blocks or, for ductile-iron pipes, restrained joints.
      a. Thrust Blocks:
         1) Provide concrete thrust blocking of a mix specified in Section 03 30 00 – Cast-In-Place Concrete. Place blocking between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, place the base and thrust bearing sides of thrust blocks directly against undisturbed earth. Place the side of thrust blocks not subject to thrust against forms, if applicable. Provide the area of bearing as shown or as directed. Place blocking so that the fitting joints are accessible for repair. Use steel rods and clamps, protected by galvanizing or by coating with bituminous paint, to anchor vertical down bends into gravity thrust blocks.

S. Grout:
   1. Provide grout mix for exterior joint protection on concrete pipes of 1 part portland cement, 2 parts sand, and of sufficient liquid consistency to flow into the joint recess beneath the diaper. Provide grout mix for interior joint protection of 1 part portland cement and 1 part sand. Substitute a polyurethane foam loop, impregnated with portland cement, in lieu of grout for exterior joints, if directed by Atlantic Richfield Company.

T. Bonded Joints:
   1. Where indicated, provide a thermally welded metallic bond at each joint, including joints made with flexible couplings or rubber gaskets, of ferrous-metallic piping to effect continuous conductivity.

U. Sanitary Sewer Service Lines:
   1. Construct service lines as shown on the Drawings. Plug the end of the service lines with a stopper and gasket, using a gasket of the same type used for pipe jointing. Do not grout the plugs.
   2. Mark the sanitary sewer and storm drain service line ends using a steel fence post 5 feet (1.5 m) long, buried at least 2 feet (0.6 m). Place a 2" X 2" (5cm X 5 cm) wood marker extending from the pipe invert to ground line. Wire the 2" X 2" (5cm X 5 cm) marker to the steel fence post. Paint sanitary sewer service markers green and storm drain service markers gray.

3.03 FIELD QUALITY CONTROL

A. The Atlantic Richfield Company Representative will conduct field inspections and witness field tests specified in this section. Be able to produce evidence, when required, that each item of work has been constructed in accordance with the drawings and specifications.

B. Tests:
   1. Perform field tests and provide labor, equipment, and incidentals required for testing.
   2. Make all tests after backfilling is completed, but before any surface restoration or street surfacing. Be responsible for finding and repairing all breaks and leaks revealed by the tests. Additionally, perform all tests in the presence of the Engineer, resident inspector, or the Atlantic Richfield Company's other designated representative.
      a. Light Test (Visual):
         1) After the trench has been backfilled and compacted, perform a light test between manholes to check alignment and grade for pipe displacement. Excluding curved alignments shown on the plans, the completed pipeline is to permit a true circle of light to be visible from one manhole to the next. If alignment or grade is not that specified and displacement of pipe is found, remedy all defects.
      b. Leakage Test:
         1) New sewer line will not be finally accepted until leakage tests are made assuring the Engineer that pipe laying and jointing are satisfactory.
         2) Conduct the leakage test subsequent to or concurrently with the pressure test. Place the amount of water permitted as leakage for the line in a sealed container attached to the supply side of the test pump. Apply no other source of supply to the pump or line under test. Pump the water into the line by the test pump as required to maintain the specified test pressure as described for a 2-hour period. The test will be considered a failure upon exhaustion of the supply or the inability to maintain the required pressure. PE pipe experiences diametric expansion and pressure elongation during initial testing. Consult the manufacturer prior to testing for special testing considerations. Determine allowable leakage by the following I-P formula:

            L = NDP/K Where:

            L = Allowable leakage in gallons per hour.

            N = Number of joints in length of pipeline tested.

            D = Nominal diameter of the pipe in inches.

P = Square root of the test pressure in psig.

K = 7400 for pipe materials.

3) At the conclusion of the test, measure the amount of water remaining in the container and record the results in the test report.
4) Test plastic pressure lines in accordance with the recommendations of AWWA C605.

c. Water Test:
1) Where groundwater is at least 2 feet (0.6 m) above the sewer line, make tests by sealing off the section of lines between manholes and measuring the actual flow by collecting or pumping the discharge into barrels or other approved methods. Continue tests at a minimum of 4 hours for each section tested. Allow time to soak lines and manholes in advance of performing tests.
2) When groundwater is not 2 feet (0.6 m) above the pipe, test as follows: On flat slopes where the depth over the centerline of the pipe in the lower manhole of the section being tested will be not more than 10 feet (3 m), fill the upper manhole to 2 feet (0.6 m) over the top of the pipe or 2 feet (0.6 m) above the groundwater elevation (whichever is higher), and block the lower manhole. When the above conditions cannot be met, the Engineer may order testing the line in sections between manholes. Measure the leakage by checking the water level drop in the manhole over a 4-hour period.
3) The allowable infiltration or exfiltration, including manholes, cannot exceed 200 gallons per day per mile of sewer per inch of pipe diameter (185 liters per day per kilometer of sewer per centimeter of pipe diameter). This does not exclude obvious and concentrated leaks and physical defects, such as open joints, pinched gaskets, cracked barrels or bells, etc. Make repairs on concentrated leaks, and as required to reduce infiltration or exfiltration leakage below the specified rate.
4) Manholes. When groundwater is below the bottom of the manhole, test as follows: Seal all pipe penetrations to the manhole and fill the manhole to the top of the manhole cone with water. Water may be added over a 24-hour period to compensate for losses due to evaporation and absorption. Following the 24-hour saturation period any loss of water within a 30-minute period shall be a failed test and the manhole will be rejected.

d. Air Test (Alternative):
1) As an alternate method to water testing, the CMGC may utilize low pressure air to test the sewer mains. Use the test procedure described below: Plug both ends of the pipe under test with airtight plugs and brace to prevent slippage and blowout. Furnish one plug with an inlet tap or other provision for connecting an air hose.
2) Equip the air supply hose, connected between the air compressor and the plug, with a throttling valve, an air bleed valve and a high-pressure shutoff valve for control. Equip the low-pressure side of the throttling valve with a tee for a monitoring pressure gauge, protected by a gauge cock. This cock is kept closed except when the pressure loss is being timed.
3) If the pipeline is submerged under groundwater, the back pressure, caused by the water head, is measured and added to the standard test pressures to compensate for the groundwater effect on the air test.
4) Apply air slowly to the pipeline until the pressure reaches 4.0 psig (27.6 j). Throttle the air supply to maintain the internal pressure between 4.0 and 3.5 psig (27.6 -24.1 j) for at least 2 minutes. During this time check the plugs with soap solution to detect any plug leakage.

5) When the pressure reaches exactly 3.5 psig (24.1 j), disconnect the air supply, start a stopwatch and record the time for the pressure to drop to 2.5 psig (17.2 j). The minimum time allowed for the pressure drop is computed on an air loss rate of 3.5 cfm (5.9 m3 /min) or an air loss rate of 0.0030 cubic feet per minute (cfm) per square foot (0.055 m3 /min per square meter) of inner pipe surface area under test, whichever rate yields the least time for the pressure drop. Should the time of the pressure drop between 3.5 and 2.5 psig (24.1 - 17.2 j) be less than the allowable specified time, make the necessary leakage repairs and repeat the air test.
6) For single pipe size test sections, the length limits for minimum test times obtained from “Nomograph for Air Testing Gravity Sewer Mains” are contained in the following table.

TABLE 3.1
LENGTH LIMIT FOR MINIMUM TEST TIMES

Pipe Diameter, Inches (cm)	Test Section Length, Foot (in)	
	Minimum	Maximum
4(10)	642(196)	1124(343)
6(15)	429(131)	751(229)
8(20)	322(98)	564(172)
10(25	257(78)	450(137)
12(30)	215(66)	376(115)
15(38)	172(52)	300(91)
18(46)	43(44)	1250(76)
21(53)	123(37)	215(66)
24(61)	107(33)	188(57)

7) For test sections that are shorter than the minimum lengths, new test times must be calculated. This is done by multiplying the test time from the nomograph by the actual length of the test section (in feet) and then dividing the resultant product by the minimum test section length from the preceding table.
8) For test sections exceeding the maximum lengths, either shorten the test section to an allowable length or use the water test.

e. Deflection Testing:
1) The Engineer may require deflection testing of all or any portion of a flexible pipe installation to assure the construction quality. Flexible pipe is pipe that will deflect at least 2 percent without any sign of structural distress.
2) Conduct deflection tests, when performed on PVC pipe, meeting ASTM D3034 and satisfy either of the following deflection limitations:

TABLE 3.2
DEFLECTION TESTING LIMITATIONS

Minimum Period Between Trench Backfilling & Testing	Minimum Mandrel Diameter as a Percent of Inside Pipe Diameter
7 Days	95.0
30 Days	92.5

3) Mandrels must have at least nine arms. Perform the mandrel test without mechanical pulling devices.

f. Dye Test:
   1) Perform a dye test from the projects sanitary sewer point of connection to the first downstream manhole on the next active sanitary sewer branch main. Use nontoxic non-staining sewer tracing dye. Test results are to be noted in the daily Construction Quality Control (CQC) Report as required in 01 45 10 – Contractor Quality Control.
      (a) Continue testing until it can be visually confirmed by way of the dye that the sewer connection is appropriate or until deficiencies are discovered.
      (b) During the test, monitor the storm drainage system downstream from the project, either manholes or outfalls, for any sign of cross-connection.

g. Smoke Test:
   1) Perform a smoke test on the relevant portion of the sewer system. Test results are to be noted in the daily Construction Quality Control (CQC) as required in 01 45 10 – Contractor Quality Control.
      (a) Continue testing until it can be visually confirmed that the projects sanitary sewer point of connection has not been cross connected to the storm drainage system.
      (b) During the test, monitor the storm drainage system, either manholes or outfalls, for any sign of cross-connection.

h. T.V. Camera Inspections:
   1) All sewer mains shall be inspected using a television camera before final acceptance. A sewer line is deficient and unacceptable if (1) the alignment is outside the specified limits, (2) water ponds in any section are equal to or greater than 2 times the grade tolerance specified herein under Section 221313 3.1.E.1., or (3) the pipe has visible defects such as open joints, pinched gaskets, cracked barrels or bell, or similar defects.
   2) Pay all costs incurred in any television inspection performed solely for CMGC benefit.
   3) Record all television inspections in a format acceptable to Atlantic Richfield Company. Pull the camera through the sewer at 30 feet per minute (9 meters per minute maximum). If the camera is pulled by attaching to the hose of a hydraulic sewer cleaner, assure the hose is not active during the pulling process.

C. Field Tests for Cast-In-Place Concrete:
   1. Field testing requirements are covered in Section 03 30 00 – Cast-In-Place Concrete.

D. Inspection:
   1. Check each straight run of pipeline for gross deficiencies by holding a light in a manhole; the light must show a practically full circle of light through the pipeline when viewed from the adjoining end of line.
      a. Pre-Installation Inspection:
         1) Prior to connecting the new service, perform pre-installation inspection after trenching and layout is complete. Submit pre-installation inspection request for field support at least 14 days in advance. The Installation's Utilities Field Support personnel will perform the pre-installation inspection.
      b. Post-Installation Inspection:
         1) Perform a post-installation inspection after connection has been made and before the connection is buried. Submit post-installation inspection request for field support at least 14 days in advance. The Installation's Utilities Field Support personnel will perform the post-connection inspection. During the

post-installation inspection, the CMGC will be responsible for performing a dye test, smoke test, or camera inspection.

E. Retesting:
   1. If any deficiencies are revealed during any test, correct such deficiencies, and repeat the tests until the results of the tests are within specified allowances, without additional cost to Atlantic Richfield Company.

3.04 BURIED WARNING AND IDENTIFICATION TAPE

A. Provide buried utility lines with utility identification tape. Bury tape 12 inches below finished grade; under pavements and slabs, bury tape 6 inches below top of subgrade.
   1. Buried Detection Wire:
      a. Bury detection wire directly above non-metallic piping at a distance not to exceed 12 inches above the top of pipe. The wire shall extend continuously and unbroken unless otherwise approved. The ends of the wire shall terminate inside the manholes at each end of the pipe, with a minimum of 3 feet of wire, coiled, remaining accessible in each manhole. The wire shall remain insulated over its entire length. The wire shall enter manholes between the top of the corbel and the frame and extend up through the chimney seal between the frame and the chimney seal. For force mains, the wire shall terminate in the valve pit at the pump station end of the pipe.

END OF SECTION

SECTION 33 40 00
STORM DRAINAGE UTILITIES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This work item shall consist of furnishing and installing pipe culverts and storm drainage features as shown on the Construction Drawings. This work shall include all necessary materials, labor, supervision, and equipment for installation of a complete system.

B. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. AASHTO M 190 - Standard Specification for Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches.
      b. AASHTO M 198 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
      c. AASHTO M 243 - Standard Specification for Field-Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches.
      d. AASHTO M 294 - Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm Diameter.
   2. ASTM International (ASTM):
      a. ASTM A 760/A 760M - Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains.
      b. ASTM A 798/A 798M - Standard Practice for Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications.
      c. ASTM A 807/A 807M - Standard Practice for Installing Corrugated Steel Structural Plate Pipe for Sewers and Other Applications.
      d. ASTM C 443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
      e. ASTM C 877 - External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections.
      f. ASTM D 1056 - Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
      g. ASTM D 1171 - Rubber Deterioration - Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens).
      h. ASTM D 1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3).
      i. ASTM D 2167 - Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
      j. ASTM D 3350 - Polyethylene Plastics Pipe and Fittings Materials.
      k. ASTM D 6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
      l. ASTM F 714 - Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.

m. ASTM F 894 - Polyethylene (PE) Large Diameter Profile Wall Sewer and Drainpipe.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-01 Preconstruction Submittals:
      a. The CMGC shall prepare a project-specific Construction Execution Plan (CEP) which shall include a discussion related to Stormwater Detention/Retention Conveyance System Construction.
   2. SD-03 Product Data:
      a. Products:
         1) Submit manufacturer's specifications and installation procedures. Submit all manufacturer's specifications for each type of pipe to be utilized.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Storage: Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. Keep a copy of the manufacturer's instructions available at the construction site at all times and follow these instructions unless directed otherwise by the Atlantic Richfield Company Representative. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install plastic pipe shall be stored in accordance with the manufacturer's recommendations and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.

B. Handling: Materials shall be handled in a manner that ensures delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

PART 2 - PRODUCTS

2.01 PIPE FOR CULVERTS AND STORM DRAINS

A. Furnish all storm drain piping as specified in the Contract Documents and meeting the materials and testing requirements of this Section. Furnish wye and tee branches of the same material and design as the specified storm drainpipe. Furnish the pipe sizes and strength classifications shown in the Contract documents.

B. References to ASTM, ANSI or AASHTO designation, means the latest revision at the time of call for bids.

C. Assure all pipe is clearly marked with type, class and/or thickness as applicable. Assure lettering is legible and permanent under normal handling and storage conditions.

D. Furnish the joint type, class, thickness designation, casting, lining, marking, testing, etc. as specified.
   1. PVC Pipe:
      a. Furnish PVC pipe produced by a continuous extrusion process employing a prime grade of un-plasticized polyvinyl chloride. Assure the grade used is highly resistant to hydrogen sulfide, sulfuric acid, gasoline, oil, detergents and other chemicals found in sewage and industrial wastes. Assure the material meets “Rigid Polyvinyl Chloride Compounds”, ASTM D1784 requirements. Assure the pipe has self-

extinguishing flammability characteristics. Assure the pipe meets ASTM D3034, “Standard Specifications for Polyvinyl Chloride Sewer Pipe and Fittings”, with an SDR of 35 4"-15" (10 cm - 38 cm) ASTM F679, “Standard Specification for PVC Large Diameter Plastic Gravity Sewer Pipe and Fittings: 18” – 36” (46 cm – 91 cm), or ASTM F949, “Standard Specification for PVC Corrugated (Open Profile) Sewer Pipe With a Smooth Interior and Fittings”, 12” – 36” (10 cm – 91 cm).

b. The nominal laying length is a minimum 12.5 feet (3.8 meters), 13 feet (4 meters) or 20 feet (6.1 meters) except shorter lengths are permitted adjacent to manholes, lamp holes or other appurtenances. Assure each pipe length is marked with size, SDR, “Sewer Pipe” and Code Number. Assure each pipe length has a bell providing a watertight joint when jointing the bell and spigot with a rubber ring. Make the rubber gasket joint using a rubber gasket compressed between the outer surface of the spigot and the inner surface of the bell. Assure the joint is completely sealed by the gasket providing a watertight joint under all service conditions, including expansion, contraction, settlement and pipe deformation. Assemble the rubber ring joint assembly following the manufacturer’s recommendations.

c. Furnish wye or tee fittings of the same material, construction and joint design as the main sewer pipe.

2. PE Pipe:

a. Submit the pipe manufacturer's resin certification, indicating the cell classification of PE used to manufacture the pipe, prior to installation of the pipe. The minimum cell classification for polyethylene plastic shall apply to each of the seven primary properties of the cell classification limits in accordance with ASTM D 3350.

1) Smooth Wall PE Pipe:

(a) ASTM F 714, maximum DR of 21 for pipes 3 to 24 inches in diameter and maximum DR of 26 for pipes 26 to 48 inches in diameter. Pipe shall be produced from PE certified by the resin producer as meeting the requirements of ASTM D 3350, minimum cell class 335434C.

2) Corrugated PE Pipe:

(a) AASHTO M 294, Type S or C. For slow crack growth resistance, acceptance of resins shall be determined by using the notched constant ligament-stress (NCLS) test meeting the requirements of AASHTO M 294. Pipe walls shall have the following properties:

Nominal Size (in.)	**Minimum Wall Area (square in/ft)**	**Minimum Moment of Inertia of Wall Section (in to the 4th/in)**
12	1.50	0.024
15	1.91	0.053
18	2.34	0.062
24	3.14	0.116
30	3.92	0.163
36	4.50	0.222
42	4.69	0.543
48	5.15	0.543
54	5.67	0.800
60	6.45	0.800

3) Profile Wall PE Pipe:
   (a) ASTM F 894, RSC 160, produced from PE certified by the resin producer as meeting the requirements of ASTM D 3350, minimum cell class 334433C. Pipe walls shall have the following properties:

Nominal Size (in.)	Minimum Wall Area (square in/ft)	Minimum Moment Of Inertia of Wall Section (in to the 4th/in) Cell Class 334433C	Minimum Moment Of Inertia of Wall Section (in to the 4th/in) Cell Class 335434C
18	2.96	0.052	0.038
21	4.15	0.070	0.051
24	4.66	0.081	0.059
27	5.91	0.125	0.091
30	5.91	0.125	0.091
33	6.99	0.161	0.132
36	8.08	0.202	0.165
42	7.81	0.277	0.227
48	8.82	0.338	0.277

2.02 MANHOLES

A. General:
   1. Furnish manholes constructed of precast concrete sections with frames, covers and steps meeting the requirements of the Drawings.

B. Precast Concrete Sections:
   1. Provide precast concrete manholes, risers, base sections, and tops conforming to ASTM C478 and be manufactured in accordance with Section 03 42 13 – Plant-Precast Concrete Products for Below Grade Construction; Base and first riser are to be monolithic.

C. Steps:
   1. Furnish non-corrosive type, 12 inches (30 cm) in width, of 1/2-inch (13 mm) steel rod encased with polypropylene. Assure steps withstand 400 pound (180 kg) vertical loads and 1,000 pound (450 kg) pull-out resistance.

D. Frames and Covers:
   1. Furnish frames and covers meeting the requirements of the Drawings. Furnish 2-hole type covers unless noted or specified otherwise.

E. Concrete Bases:
   1. Concrete bases may be precast or field-poured on undisturbed earth. Use concrete meeting Section 03 30 00 – Cast-In-Place Concrete.

2.03 INLETS AND CATCH BASINS

A. Furnish standard cast iron inlet frames and grates meeting the requirements of the Drawings or as specified.

2.04 MISCELLANEOUS MATERIALS

A. Joints:
   1. External Sealing Bands:
      a. Requirements for external sealing bands shall conform to ASTM C 877.
   2. Flexible Watertight, Gasketed Joints:
      a. Gaskets:
         1) When infiltration or exfiltration is a concern for pipe lines, the couplings may be required to have gaskets. The closed-cell expanded rubber gaskets shall be a continuous band approximately 7 inches wide and approximately 3/8 inch thick, meeting the requirements of ASTM D 1056, Type 2 A1, and shall have a quality retention rating of not less than 70 percent when tested for weather resistance by ozone chamber exposure, Method B of ASTM D 1171. Rubber O-ring gaskets shall be 13/16 inch in diameter for pipe diameters of 36 inches or smaller and 7/8 inch in diameter for larger pipe having 1/2 inch deep end corrugation. Rubber O-ring gaskets shall be 1-3/8 inches in diameter for pipe having 1 inch deep end corrugations. O-rings shall meet the requirements of AASHTO M 198 or ASTM C 443. Flexible plastic gaskets shall conform to requirements of AASHTO M 198, Type B.
      b. Connecting Bands:
         1) Connecting bands shall be of the type, size and sheet thickness of band, and the size of angles, bolts, rods and lugs as indicated or where not indicated as specified in the applicable standards or specifications for the pipe. Exterior rivet heads in the longitudinal seam under the connecting band shall be countersunk or the rivets shall be omitted and the seam welded.

2.05 EROSION CONTROL RIPRAP

A. Provide non-erodible rock to the dimensions indicated on the Construction Drawings in conformance with the gradations indicated in Section 31 37 00 – Riprap.

PART 3 - EXECUTION

3.01 GENERAL

A. CMGC is responsible for all material furnished. Replace all material found defective in manufacture or damaged in handling after delivery by the manufacturer at no cost to Atlantic Richfield Company. This includes furnishing all material and labor required for the replacement of installed material discovered defective before final acceptance of the work or during the guarantee period.

B. Contactor is responsible for the safe storage of material for the work until it has been incorporated in the completed project.

3.02 EXCAVATION FOR PIPE CULVERTS, STORM DRAINS, AND DRAINAGE STRUCTURES

A. Excavation of trenches, and for appurtenances and backfilling for culverts and storm drains, shall be in accordance with the applicable portions of Section 31 00 00 – Earthwork and the requirements specified below.
   1. Trenching:
      a. The width of trenches at any point below the top of the pipe shall not be greater than the outside diameter of the pipe plus 24 inches to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Sheeting and bracing, where required, shall be placed within the trench width as

specified, without any over-excavation. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures will be necessary. Cost of this redesign and increased cost of pipe or installation shall be the responsibility of the CMGC without additional cost to Atlantic Richfield Company.

2. Removal of Rock:
   a. Rock in either ledge or boulder formation shall be replaced with suitable materials to provide a compacted earth cushion having a thickness between unremoved rock and the pipe of at least 8 inches or 1/2 inch for each foot of fill over the top of the pipe, whichever is greater, but not more than three-fourths the nominal diameter of the pipe. Where bell-and-spigot pipe is used, the cushion shall be maintained under the bell as well as under the straight portion of the pipe. Rock excavation shall be as specified and defined in Section 31 00 00 EARTHWORK.
3. Removal of Unstable Material:
   a. Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the Atlantic Richfield Company Representative, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material, compacted as provided in paragraph BACKFILLING. When removal of unstable material is due to the fault or neglect of the CMGC while performing shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to Atlantic Richfield Company.

3.03 BEDDING

A. The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe as specified in Section 31 38 00 – Granular Fill Material.
   1. Corrugated Metal Pipe:
      a. Bedding for corrugated metal pipe and pipe arch shall be in accordance with ASTM A 798/A 798M. It is not required to shape the bedding to the pipe geometry. However, for pipe arches, either shape the bedding to the relatively flat bottom arc or fine grade the foundation to a shallow v-shape. Bedding for corrugated structural plate pipe shall meet requirements of ASTM A 807/A 807M.

3.04 PLACING PIPE

A. Deliver and distribute all CMGC furnished pipe. Load and unload pipe, fittings and accessories by lifting with hoists or skidding so as to avoid shock or damage. Do not drop the materials. Do not skid or roll pipe handled on skidways against pipe already on the ground.

B. In distributing the material at the work site, unload each piece opposite or near the place where it is to be laid in the trench. Keep the pipe interior and other accessories free from dirt and foreign matter at all times.

C. Handle pipe to prevent coating or lining damage. Repair or replace all coating or lining damage in a manner satisfactory to the Engineer.

D. Submit printed copies of the manufacturer's recommendations for installation procedures of the material being placed, prior to installation.

E. Each pipe shall be thoroughly examined before being laid; defective or damaged pipe shall not be used. Plastic pipe shall be protected from exposure to direct sunlight prior to laying, if necessary, to maintain adequate pipe stiffness and meet installation deflection requirements.

F. Lay and maintain all pipe to the specified lines and grades with fittings, tees and manholes at the specified locations. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Lifting lugs in vertically elongated metal pipe shall be placed in the same vertical plane as the major axis of the pipe. Pipe shall not be laid in water, and pipe shall not be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary.

G. Install wye or tee fittings in the mainline sewer for service line connections. Furnish wye or tee fittings of the same material, design and specifications as the sewer main pipe. Joint service pipe to tee branches or main line pipe other than PVC using special joint adapters manufactured specifically for jointing the two types of pipe.

H. Use tools and equipment meeting Engineer approval for the safe and convenient prosecution of the work. Carefully lower all pipe and fittings into the trench preventing damage to pipe materials and protective coatings and linings. Do not dump or drop materials into the trench.

I. Exercise care to prevent foreign material from entering the pipe as it is installed. When pipe laying is not in progress, close the open ends of pipe using a plug or other means approved by the Engineer. Remove and clean all sand, gravel, concrete and cement grout that has entered the lines during construction.

J. Install pipe within 1/2-inch (13 mm) of the specified alignment and within 1/4-inch (6 mm) of the specified grade for pipe 15-inch (38 cm) in diameter and smaller and 1/2-inch (13 mm) of specified grade for pipe larger than 15- inch (38 cm) diameter. These tolerances apply to any point along the entire pipe length.
    1. Corrugated Metal Pipe and Pipe Arch:
        a. Laying shall be with the separate sections joined firmly together, with the outside laps of circumferential joints pointing upstream, and with longitudinal laps on the sides. Part paved pipe shall be installed so that the centerline of bituminous pavement in the pipe, indicated by suitable markings on the top at each end of the pipe sections, coincides with the specified alignment of pipe. Fully paved metal pipe or pipe arch shall have a painted or otherwise applied label inside the pipe or pipe arch indicating sheet thickness of pipe or pipe arch. Any unprotected metal in the joints shall be coated with bituminous material as specified in AASHTO M 190 or AASHTO M 243. Interior coating shall be protected against damage from insertion or removal of struts or tie wires. Lifting lugs shall be used to facilitate moving pipe without damage to exterior or interior coatings. During transportation and installation, pipe or pipe arch and coupling bands shall be handled with care to preclude damage to the coating, paving or lining. Damaged coatings, pavings and linings shall be repaired in accordance with the manufacturer's recommendations prior to placing backfill. Pipe on which coating, paving or lining has been damaged to such an extent that satisfactory field repairs cannot be made shall be removed and replaced. Vertical elongation, where indicated, shall be accomplished by factory elongation. Suitable markings or properly placed lifting lugs shall be provided to ensure placement of factory elongated pipe in a vertical plane.

3.05 JOINTING

A. Corrugated Metal Pipe:
   1. Field Joints:
      a. Transverse field joints shall be designed so that the successive connection of pipe sections will form a continuous line free of appreciable irregularities in the flow line. In addition, the joints shall meet the general performance requirements described in ASTM A 798/A 798M. Suitable transverse field joints which satisfy the requirements for one or more of the joint performance categories can be obtained with the following types of connecting bands furnished with suitable band-end fastening devices: corrugated bands, bands with projections, flat bands, and bands of special design that engage factory reformed ends of corrugated pipe. The space between the pipe and connecting bands shall be kept free from dirt and grit so that corrugations fit snugly. The connecting band, while being tightened, shall be tapped with a soft-head mallet of wood, rubber or plastic, to take up slack and ensure a tight joint. The annular space between abutting sections of part paved, and fully paved pipe and pipe arch, in sizes 30 inches or larger, shall be filled with a bituminous material after jointing. Field joints for each type of corrugated metal pipe shall maintain pipe alignment during construction and prevent infiltration of fill material during the life of the installations. The type, size, and sheet thickness of the band and the size of angles or lugs and bolts shall be as indicated or where not indicated, shall be as specified in the applicable standards or specifications for the pipe.
   2. Flexible Watertight, Gasketed Joints:
      a. Installation shall be as recommended by the gasket manufacturer for use of lubricants and cements and other special installation requirements. The gasket shall be placed over one end of a section of pipe for half the width of the gasket. The other half shall be doubled over the end of the same pipe. When the adjoining section of pipe is in place, the doubled-over half of the gasket shall then be rolled over the adjoining section. Any unevenness in overlap shall be corrected so that the gasket covers the end of pipe sections equally. Connecting bands shall be centered over adjoining sections of pipe, and rods or bolts placed in position and nuts tightened. Band Tightening: The band shall be tightened evenly, even tension being kept on the rods or bolts, and the gasket; the gasket shall seat properly in the corrugations. Watertight joints shall remain uncovered for a period of time designated, and before being covered, tightness of the nuts shall be measured with a torque wrench. If the nut has tended to loosen its grip on the bolts or rods, the nut shall be retightened with a torque wrench and remain uncovered until a tight, permanent joint is assured.

3.06 INSTALLING MANHOLES

A. Construct manholes to the specified dimensions.

B. Joint all connections between manhole walls and base and between wall sections making the manhole watertight.

C. Install adjusting rings on each manhole to adjust the manhole top elevation to the existing or specified ground elevations, with the total ring height of 2-inch (5 cm) minimum and 12-inch (30 cm) maximum. Assure adjusting rings are reinforced with the same percentage of steel as the riser and top.

3.07 INSTALLING INLETS AND CATCH BASINS

A. Construct inlets and catch basins meeting the standard drawing for the type specified.

B. Construct inlet structures to the line, cross-section and dimensions specified. Furnish concrete and reinforcing steel meeting Section 03 30 00 – Cast-In-Place Concrete. Inlet structures may be precast or cast-in-place.

3.08 BACKFILLING

A. Backfilling Pipe in Trenches:
   1. After the pipe has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 6 inches in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. The fill shall be thoroughly compacted under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation equal to the midpoint (spring line) of RCP or has reached an elevation of at least 12 inches above the top of the pipe for flexible pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 12 inches. Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below. Where it is necessary, in the opinion of the Atlantic Richfield Company Representative, that sheeting or portions of bracing used be left in place, the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

B. Backfilling Pipe in Fill Sections:
   1. For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified below. The fill material shall be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 6 inches in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 12 inches above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 12 feet, whichever is less. After the backfill has reached at least 12 inches above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 12 inches. Use select granular material for this entire region of backfill for flexible pipe installations.

C. Movement of Construction Machinery:
   1. When compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert or storm drain at any stage of construction shall be at the CMGC's risk. Any damaged pipe shall be repaired or replaced.

D. Compaction:
   1. General Requirements:
      a. Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Cohesive materials include clayey and silty gravels, gravel-silt mixtures, clayey and silty sands, sand-clay mixtures, clays, silts, and very fine sands. When results of compaction tests for moisture-density relations are recorded on graphs,

cohesionless soils will show straight lines or reverse-shaped moisture-density curves, and cohesive soils will show normal moisture-density curves.

2. Minimum Density:
    a. Backfill over and around the pipe and backfill around and adjacent to drainage structures shall be compacted at the approved moisture content to the following applicable minimum density, which will be determined as specified below.
        1) For all areas of fill, the density shall be 95 percent of maximum density, up to the elevation where additional material requirements shall control.

E. Determination of Density:
    1. Testing is the responsibility of the CMGC and performed at no additional cost to Atlantic Richfield Company. Testing shall be performed by an approved commercial testing laboratory or by the CMGC subject to approval by the Atlantic Richfield Company Representative in the CMGCs Quality Control Plan. Tests shall be performed in sufficient number to ensure that specified density is being obtained. Laboratory tests for moisture-density relations shall be made in accordance with ASTM D 1557 except that mechanical tampers may be used provided the results are correlated with those obtained with the specified hand tamper. Field density tests shall be determined in accordance with ASTM D 2167 or ASTM D 6938. When ASTM D 6938 is used, the calibration curves shall be checked and adjusted, if necessary, using the sand cone method as described in paragraph Calibration of the referenced publications. ASTM D 6938 results in a wet unit weight of soil and ASTM D 6938 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D 6938. Test results shall be furnished the Atlantic Richfield Company Representative. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed.

3.09 PIPELINE TESTING

A. Post-Installation Inspection:
    1. One hundred percent of all flexible pipes shall be checked for rips, tears, joint separations, soil migration through the joint, cracks, localized bucking, bulges, settlement and alignment.
        a. Repair or replace any pipe with crack exhibiting displacement across the crack, exhibiting bulges, creases, tears, spalls, of delamination.

B. Light Test (Visual):
    1. Once the trench is backfilled, perform a light test between manholes to check alignment and grade for pipe displacement. Except for specified curved alignments, the completed pipeline must permit a true circle of light to be seen from manhole to manhole.
    2. If alignment or grade does not meet specifications, correct alignment or grade at CMGC expense.

C. Leakage Test:
    1. Unless specified, a leakage test will not be required. Obvious and concentrated leaks, such as open joints, pinched gaskets, cracked barrels or bells, are not allowed.

D. Deflection Test:
    1. The Engineer may require deflection testing of all flexible pipe installations to assure the construction quality.

2. Conduct deflection tests meeting ASTM D3034 and satisfy either of the following deflection limitations:

TABLE 1
DEFLECTION TESTING LIMITATIONS

Minimum Period Between Trench Backfilling & Testing	Minimum Mandrel Diameter as a Percent of Inside Pipe Diameter
7 Days	95.0
30 Days	92.5

3. Mandrels must have at least nine arms. Perform the mandrel test without mechanical pulling devices.

END OF SECTION

SECTION 33 46 13
FOUNDATION DRAINAGE SYSTEM

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. AASHTO M 252 (2009; R 2017) - Standard Specification for Corrugated Polyethylene Drainage Pipe.
      b. AASHTO M 294 (2017) - Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter.
   2. ASTM International (ASTM):
      a. ASTM C33/C33M (2018) - Standard Specification for Concrete Aggregates.
      b. ASTM D3034 (2016) - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
      c. ASTM D3212 (2007; R 2013) - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
      d. ASTM F667/F667M (2016) - Standard Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings.
      e. ASTM F758 (2014) - Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage.
      f. ASTM F949 (2015) - Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings.

1.03 SYSTEM DESCRIPTION

A. Extent: Furnish and install foundation drainage as a complete system as shown as shown on the Construction Drawings.

B. Outlet Connections: Foundation pipe shall be connected to the storm drainage system or terminated as shown on the Construction Drawings and specified in Section 33 40 00 – Storm Drainage Utilities.

C. Drainage Lines: Construct drainage lines of drain tile, perforated pipe, or porous pipe.

D. Outlet Lines: Construct outlet lines of closed-joint nonperforated, nonporous pipe.

1.04 SUBMITTALS

A. Atlantic Richfield Company approval is required for submittals in accordance with Section 01 33 00 – Submittal Procedures.
   1. SD-4 Samples:
      a. Materials.

2. SD-06 Certificates:
    a. Materials.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect materials placed in storage from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Do not expose plastic pipe to direct sunlight for more than 6 months from time of manufacturer to installation.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Pipe for foundation drainage system shall be of the type and size indicated. Use appropriate transitions, adapters, or joint details where pipes of different types or materials are connected. Submit two randomly selected samples of each type of pipe and fitting, prior to delivery of materials to the site, and certifications from the manufacturers attesting that materials meet specification requirements.
    1. Plastic Pipe:
        a. Plastic pipe shall contain ultraviolet inhibitor to provide protection from exposure to direct sunlight.
    2. Corrugated Polyethylene (PE) Drainage Pipe:
        a. Furnish ASTM F667/F667M heavy duty for pipe 3 to 6 inches in diameter inclusive, ASTM F667/F667M for pipe 8 to 24 inches in diameter; or AASHTO M 252 for pipe 3 to 10 inches in diameter or AASHTO M 294 for pipe 12 to 24 inches in diameter. Fittings shall be pipe manufacturer's standard type and shall conform to the indicated specification.
    3. Polyvinyl Chloride (PVC) Pipe:
        a. ASTM F758, Type PS 46, ASTM D3034, or ASTM F949 with a minimum pipe stiffness of 46 psi.
    4. Circular Perforations in Plastic Pipe:
        a. Circular holes shall be cleanly cut, not more than 5/16 inch or less than 3/16 inch in diameter and arranged in rows parallel to the longitudinal axis of the pipe. Perforations shall be approximately 3 inches apart, center-to-center, along rows. The rows shall be approximately 1-1/2 inches apart and arranged in a staggered pattern so that all perforations lie at the midpoint between perforations in adjacent rows. The rows shall be spaced over not more than 155 degrees of circumference. The spigot or tongue end of the pipe shall not be perforated for a length equal to the depth of the socket and perforations shall continue at uniform spacing over the entire length of the pipe. Manufacturer's standard perforated pipe which essentially meets these requirements may be used with prior approval of the Contracting Officer.
    5. Slotted Perforations in Plastic Pipe:
        a. Circumferential slots shall be cleanly cut so as not to restrict the inflow of water and uniformly spaced along the length and circumference of the tubing. Width of slots shall not exceed 1/8 inch or be less than 1/32 inch. The length of individual slots shall not exceed 1-1/4 inches on 3-inch diameter tubing; 10 percent of the tubing inside nominal circumference on 4- to 8-inch diameter tubing; and 2-1/2 inches on 10-inch diameter tubing. Rows of slots shall be symmetrically spaced so that they are fully contained in quadrants of the pipe. Slots shall be centered in the valleys of the corrugations of profile wall pipe. The water inlet area shall be a minimum of 0.5 square inch/linear foot of tubing. Manufacturer's standard perforated pipe which essentially meets these requirements may be used with prior approval of the Contracting Officer.

6. Fittings:
    a. Fittings shall be of compatible materials for pipe, of corresponding weight and quality, and as specified herein.
7. Cleanouts and Piping Through Walls:
    a. Cleanout pipe and fittings and piping through walls and footings shall be cast-iron soil pipe. Each cleanout shall have a brass ferrule and a cast-brass screw-jointed plug with socket or raised head for wrench.
8. Bedding and Pervious Backfill for Foundation Drains:
    a. Bedding and pervious backfill shall be in accordance with Section 31 00 00 – Earthwork and coarse aggregate conforming to Section 31 38 00 – Granular Fill Material.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Trenching and Excavation:
    1. Perform required trenching and excavation in accordance with Section 31 00 00 – Earthwork. Keep trenches dry during installation of drainage system. Changes in direction of drain lines shall be made with 1/8 bends. Use wye fittings at intersections.

B. Bedding:
    1. Place graded bedding, minimum 6 inches in depth, in the bottom of trench for its full width and length compacted as specified prior to laying of foundation drainpipe. Each section shall rest firmly upon the bedding, through the entire length, with recesses formed for bell joints. Except for recesses for bell joints, the bedding shall fully support the lower quadrant of the pipe.

C. Pipe Laying:
    1. Lay drain lines to true grades and alignment with a continuous fall in the direction of flow. Bells of pipe sections shall face upgrade. Clean interior of pipe thoroughly before being laid. Perforated pipe shall be laid with perforations facing down. Any length that has had its grade or joints disturbed shall be removed and re-laid at no additional cost to Atlantic Richfield Company. Perforated corrugated polyethylene drainage tubing and plastic piping shall be installed in accordance with manufacturer's specifications and as specified herein. Tubing and piping with physical imperfections shall not be installed.

D. Jointing:
    1. Perforated and Porous Pipes:
        a. Perforated and porous types of drainpipes shall be laid with closed joints.
    2. Nonperforated Drain Tile:
        a. Nonperforated and plain-end, drain tile shall be laid with 1/8- to 1/4-inch open joints. Open joints shall be covered or wrapped. Covered joints shall have one thickness of the cover material placed over the joint. Material shall overlap the joint not less than 4 inches on each side and cover the tile for not less than the upper half or more than the upper two-thirds of the circumference of the tile. Strips of wire cloth wrapping material3 inches wide shall be used for wrapped joints, with ends fastened together.
    3. PVC Pipe:
        a. PVC pipe joints shall be in accordance with ASTM D3034, ASTM D3212, or ASTM F949.

4. Corrugated Polyethylene:
    a. Corrugated polyethylene (PE) pipe joints shall be in accordance with ASTM F667/F667M.

E. Outlet Lines:
    1. The outlet end of drain lines connecting with an open gutter or outfall shall be finished as shown Construction Drawings.

F. Cleanouts:
    1. Provide cleanouts in locations indicated. Cleanouts in unpaved areas shall be set in 12 by 12 by 4-inch concrete blocks.

3.02 BACKFILLING

A. After joints and connections have been inspected and approved, place the specified pervious backfill material a minimum width of 6 inches on each side of the pipe or tile and 12 inches above the top of the pipe. Place the backfill preventing displacement of or injury to the pipe or tile. Place a protective covering, as specified, over the pervious backfill for the full width of the trench before regular backfill is placed. Compact backfill as specified in Section 31 00 00 – Earthwork.

END OF SECTION

SECTION 33 46 16
SUBDRAINAGE PIPING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. AASHTO M 190 (2004; R 2017) - Standard Specification for Asphalt-Coated Corrugated Metal Culvert Pipe and Pipe Arches.
      b. AASHTO M 252 (2009; R 2017) - Standard Specification for Corrugated Polyethylene Drainage Pipe.
      c. AASHTO M 288 (2017) - Standard Specification for Geosynthetic Specification for Highway Applications.
   2. ASTM International (ASTM):
      a. ASTM A123/A123M (2017) - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      b. ASTM A27/A27M (2017) - Standard Specification for Steel Castings, Carbon, for General Application.
      c. ASTM A47/A47M (1999; R 2018; E 2018) - Standard Specification for Ferritic Malleable Iron Castings.
      d. ASTM A48/A48M (2003; R 2012) - Standard Specification for Gray Iron Castings.
      e. ASTM A760/A760M (2015) - Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains.
      f. ASTM A762/A762M (2015) - Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains.
      g. ASTM A798/A798M (2017) - Standard Practice for Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications.
      h. ASTM B745/B745M (2015) - Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains.
      i. ASTM C136/C136M (2014) - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
      j. ASTM C33/C33M (2018) - Standard Specification for Concrete Aggregates
      k. ASTM C478 (2018) - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections.
      l. ASTM D2321 (2018) - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
      m. ASTM D2487 (2017) - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
      n. ASTM D3034 (2016) - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
      o. ASTM D3753 (2012; E 2013) - Glass-Fiber-Reinforced Polyester Manholes and Wetwells.

p. ASTM D4632/D4632M (2015a) - Grab Breaking Load and Elongation of Geotextiles.
q. ASTM F758 (2014) - Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage.
r. ASTM F949 (2015) - Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings.

1.03 SUBMITTALS

A. Atlantic Richfield Company approval is required for submittals in accordance with Section 01 33 00 – Submittal Procedures.
1. SD-04 Samples:
a. Geotextile.
b. Pipe and pipe fittings.
2. SD-05 Test Reports:
a. Geotextile JP-4 Fuel Resistance Test.
3. SD-06 Certificates:
a. Geotextile.
b. Pipe and pipe fittings.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Storage:
1. Inspect materials delivered to site for damage, unload, and store with minimum handling. Do not store materials directly on the ground. Keep the inside of pipes and fittings free of dirt and debris. Keep, during shipment and storage, geotextile wrapped in burlap or similar heavy-duty protective covering. Protect the geotextile from mud, soil, dust, and debris. Do not store geotextile materials in direct sunlight. Install plastic pipe within 6 months from the date of manufacture unless otherwise approved.

B. Handling:
1. Handle materials in such a manner as to ensure delivery to the trench in sound undamaged condition. Carry pipe to the trench.

PART 2 - PRODUCTS

2.01 PIPE FOR SUBDRAINS

A. General: Submit samples of pipe and pipe fittings, before starting the work. Provide type and sizes of subdrain pipe indicated. Submit certifications from the manufacturers attesting that the materials meet specification requirements. Certificates are required for drainpipe and fittings.

B. Plastic:
1. Provide plastic pipe containing ultraviolet inhibitor to provide protection from exposure to direct sunlight. Provide pipe with bell and spigot or solvent cement joints. Provide manufacturer's standard type fittings conforming to the indicated specification.
a. Polyvinyl Chloride (PVC) and Fittings:
1) ASTM D3034, ASTM F949 or ASTM F758, Type PS 46.
b. Corrugated Polyethylene (PE) and Fittings:
1) AASHTO M 252, Type S or SP as indicated.
c. Pipe Perforations:
1) Provide pipe perforations with a minimum water inlet area of 0.5 square inch per linear foot and as specified below.

(a) Circular Perforations in Plastic Pipe:
(i) Cleanly cut circular holes not more than 3/8 inch or less than 3/16 inch in diameter and arrange in rows parallel to the longitudinal axis of the pipe. Provide pipe with perforations spaced uniformly along rows. Unless otherwise recommended by the pipe manufacturer, provide pipe with rows approximately 1-1/2 inches apart and arranged in a staggered pattern so that all perforations lie at the midpoint between perforations in adjacent rows. Space the rows over not more than 155 degrees of circumference. Provide pipe that is not perforated for a length equal to the depth of the socket at the spigot or tongue end and provide perforations that continue at uniform spacing over the entire length of the pipe.

(b) Slotted Perforations in Plastic Pipe:
(i) Cleanly cut circumferential slots so as not to restrict the inflow of water and uniformly spaced along the length and circumference of the pipe. Provide pipe with slots not exceeding 1/8 inch nor less than 1/32 inch in width. Provide pipe with individual slot lengths not exceeding 10 percent of the pipe inside nominal circumference on 6- to 8-inch diameter pipe, and 2-1/2 inches on 10-inch diameter pipe. Symmetrically space rows of slots so that they are fully contained in 2 quadrants of the pipe. Center slots in the valleys of the corrugations of profile wall pipe.

C. Corrugated Steel:
1. ASTM A760/A760M, Type I or III, as indicated with a coating conforming to AASHTO M 190, Type A. Provide Class 1 perforations in Type III pipe. Pipe sheet thickness 0.064 inch.

D. Corrugated Aluminum Alloy:
1. ASTM B745/B745M, Type I or III, as indicated with a bituminous coating conforming to AASHTO M 190, Type A. Provide Class 1 perforations in Type III pipe. Pipe sheet thickness 0.064 inch.

E. Precoated Corrugated Steel:
1. ASTM A762/A762M, Type I or III, as indicated on the Construction drawings. Provide Class 1 perforations in Type III pipe.

2.02 GEOTEXTILE

A. Provide geotextiles as indicated on the drawings and Section 31 05 00 – Geotextile.

2.03 SUBDRAIN FILTER AND BEDDING MATERIAL

A. Provide filter and bedding material as specified in Section 31 38 00 – Granular Fill Material.

2.04 DRAINAGE STRUCTURES

A. Concrete:
1. Provide concrete and reinforced concrete conforming to the requirements in Section 03 30 00 – Cast-In-Place Concrete and 03 42 13 – Plant-Precast Concrete for Below Grade Construction.

B. Mortar:
   1. Provide mortar for connections to drainage structures that is composed of one part by volume of Portland cement and two parts of sand. Provide sufficient quantity of water in the mixture to produce a stiff workable mortar. Use water that is clean and free of injurious acids, alkalies, and organic impurities. Use the mortar within 30 minutes from the time the ingredients are mixed with water.

C. Glass Fiber-Reinforced Polyester (FRP):
   1. Per ASTM D3753.

D. Frames and Covers or Gratings:
   1. Except as otherwise permitted, provide frames and gratings, or frames and covers of either cast iron with tensile strength test not less than ASTM A48/A48M Class 25 or steel conforming to ASTM A27/A27M, Class 65-35. Required weight, shape, and size are indicated on the drawings. Frames and covers not subjected to vehicular traffic or storage may be of malleable iron where indicated. Provide malleable-iron frames and covers conforming to ASTM A47/A47M and of the weight, shape, and size indicated.

E. Steel Ladder:
   1. Provide a steel ladder where the depth of a manhole exceeds 12 feet. The ladder will be not less than 16 inches in width, with 3/4-inch diameter rungs spaced 12 inches apart. Provide two stringers that are a minimum 3/8 inch thick and 2 inches wide. Adequately anchor ladder to the wall by means of steel inserts spaced not more than 6 feet apart vertically and install so as to provide at least 6 inches of space between the wall and the rungs. Galvanize ladders and inserts after fabrication in conformance with ASTM A123/A123M.

2.05 TESTS, INSPECTIONS, AND VERIFICATIONS

A. Geotextile JP-4 Fuel Resistance Test:
   1. Immerse five unaged geotextile samples 4 (plus or minus 0.2) by 6 (plus or minus 0.2) inches in JP-4 fuel at room temperature for a period of 7 days. Test each sample for tensile strength and elongation in accordance with ASTM D4632/D4632M. Provide geotextile with a strength in any direction of not less than 85 percent of the strength specified in Section 31 05 00 – Geotextile.

PART 3 - EXECUTION

3.01 EXCAVATION AND BEDDING FOR SUBDRAIN SYSTEMS

A. Excavate trenches, including the removal of rock and unstable material, in accordance with Section 31 00 00 – Earthwork. Bedding material shall be placed in the trench as indicated or as required as replacement materials used in those areas where unstable materials were removed. Compaction of the bedding material shall be as specified for cohesionless material in Section 31 38 00 – Granular Fill Material.

3.02 MANHOLES AND FLUSHING AND OBSERVATION RISERS

A. Manholes:
   1. Install manholes complete with frames and covers or gratings at the locations and within the limits and sizes indicated. Construct manholes of one of the materials specified for manholes in paragraph DRAINAGE STRUCTURES. Completely fill precast concrete manhole joints so that they are smooth and free of surplus mortar or

mastic on the inside of the structure. Use either precast or cast-in-place concrete manhole bases.

B. Flushing and Observation Risers:
   1. Install flushing and observation riser pipes with frames and covers at the locations indicated. Construct risers of non-perforated [plastic] [or] [galvanized] [bituminous coated] [corrugated metal] pipe. Join riser pipes to the subdrain system as indicated.

3.03 INSTALLATION OF GEOTEXTILE AND PIPE FOR SUBDRAINS

A. Installation of Geotextile:
   1. Trench Lining and Overlaps:
      a. Grade trenches to be lined with geotextile to obtain smooth side and bottom surfaces so that the geotextile will not bridge cavities in the soil or be damaged by projecting rock. Lay the geotextile flat but not stretched on the soil and secure it with anchor pins in accordance with manufacturer's instructions. Overlap at least 12 inches, and secure with anchor pins along the overlaps.

B. Installation of Pipe for Subdrains:
   1. Pipelaying:
      a. Install pipe in accordance with the manufacturer's recommendations. Thoroughly examine each section of pipe before being laid; do not use defective or damaged pipe. Do not lay pipe when the trench conditions or weather is unsuitable for such work. Remove water from trenches by sump pumping or other approved methods. Lay the pipe to the grades and alignment as indicated. Bed the pipe to the established grade line. Center perforations on the bottom of the pipe. Lay bell-and-spigot type with the bell ends upstream. Approval of all in-place pipes by the Atlantic Richfield Company Representative is required prior to backfilling.

3.04 INSTALLATION OF FILTER MATERIAL AND BACKFILLING FOR PERFORATED SUBDRAINS

A. After perforated pipe for subdrains has been laid, inspected, and approved, place filter material around and over the pipe to the depth indicated. Place the filter material in layers not to exceed 8 inches thick. Thoroughly compact each layer using mechanical tampers or rammers.

3.05 INSTALLATION OF BEDDING AND BACKFILL FOR NON-PERFORATED SUBRAIN OUTFALL PIPE

A. Plastic Pipe:
   1. Place and compact pipe embedment for plastic pipe in accordance with ASTM D2321. Use Class IB or II embedment materials.

B. Corrugated Metal Pipe:
   1. Place and compact bedding and structural backfill for corrugated metal pipe in accordance with ASTM A798/A798M. Use structural backfill materials classified by ASTM D2487 as either GW, GM, GP-GM, GW-GM, GC, GP-GC or SW.

3.06 INSTALLATION OF AND BACKFILLING FOR BLIND OR FRENCH DRAINS

A. Place filter material as indicated and compact as specified for cohesionless materials in Section 31 00 00 – Earthwork. Extend filter material to a suitable outlet or to an outlet

through a pipeline as indicated. Place and compact overlying backfill material as specified in Section 31 00 00 – Earthwork.

END OF SECTION

SECTION 33 47 13
POND AND RESERVOIR LINERS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Construction Management General Contractor (CMGC) shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
   1. ASTM International (ASTM):
      a. ASTM D413 (1998; R 2017) - Standard Test Methods for Rubber Property - Adhesion to Flexible Substrate.
      b. ASTM D698 (2012; E 2014; E 2015) - Laboratory. Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.)).
      c. ASTM D751 (2006; R 2011) - Coated Fabrics.
      d. ASTM D4437/D4437M (2016; R 2018) - Standard Practice for Non-destructive Testing (NDT) for Determining the Integrity of Seams Used in Joining Flexible Polymeric Sheet Geomembranes.
      e. ASTM D6214/D6214M (2013) - Determining the Integrity of Field Seams Used in Joining Geomembranes by Chemical Fusion Methods.
      f. ASTM D6392 (2012; R 2018) - Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.
      g. ASTM D7002 (2016) - Standard Practice for Leak Location on Exposed Geomembranes Using the Water Puddle System.
      h. ASTM D7006 (2013) - Standard Practice for Ultrasonic Testing of Geomembranes.
      i. ASTM D7007 (2016) - Standard Practices for Electrical Methods for Locating Leaks in Geomembranes Covered with Water or Earth Materials.
      j. ASTM D7176 (2006; R 2011) - Non-Reinforced Polyvinyl Chloride (PVC) Geomembranes Used in Buried Applications.
      k. ASTM D7272 (2006; R 2018) - Standard Test Method for Determining the Integrity of Seams Used in Joining Geomembranes by Pre-manufactured Taped Methods.
      l. ASTM D7408 (2012; R 2020) – Non-Reinforced PVC (Polyvinyl Chloride) Geomembrane Seams.
      m. ASTM D7700 (2015) - Standard Guide for Selecting Test Methods for Geomembrane Seams.
   2. Geosynthetic Institute (GSI):
      a. GSI GRI GM13 (2016) - Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes.
      b. GSI GRI GM17 (2015) - Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes.
      c. GSI GRI GM18 (2015) - Test Methods, Test Properties and Testing Frequencies for Flexible Polypropylene (fPP and fPP-R) Nonreinforced and Reinforced Geomembranes.
      d. GSI GRI GM19 (2002; R 2013) - Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes.

e. GSI GRI GM21 (2016) - Test Methods, Properties and Frequencies for Ethylene Propylene Diene Terpolymer (EPDM) Nonreinforced and Scrim Reinforced Geomembranes.
f. GSI GRI GM25 (2009; R 2012) - Test Methods, Test Properties and Testing Frequency for Reinforced Linear Low Density Polyethylene (LLDPE-R) Geomembranes.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
1. SD-02 Shop Drawings:
a. Liner system.
2. SD-03 Product Data:
a. Liner, including manufacturer's instructions.
b. Seaming adhesive, including manufacturer's instructions.
c. Penetration assemblies.
d. Filter fabric.
e. Sealants, including manufacturer's instructions.
3. SD-06 Certificates:
a. Liner.
b. Filter fabric.
4. SD-07 Closeout Submittals:
a. Manufacturer's warranty.
b. Installation warranty.

1.04 DELIVERY AND STORAGE

A. Deliver liner [and filter fabric] to site in largest sizes possible to minimize field seaming. Protect from sunlight and other ultraviolet light sources during storage. Keep cements and adhesives from extreme cold or heat. Keep materials clean and dry.
1. Quality Control:
a. Required Drawings:
1) Submit drawing of liner system indicating sheet and seam layout, anchorage details, and penetration details.

1.05 WARRANTY

A. Manufacturer's Warranty:
1. Provide the Manufacturer's Warranty to the Contracting Officer. Ensure Warranty is valid for a minimum of [2] [5] [_____] years from the date of project closeout, showing the Government as warranty recipient.

B. Installation Warranty:
1. Provide the Installation Warranty to the Contracting Officer, along with final test reports. Ensure Warranty is valid for a minimum of [2] [5] [_____] years from the date of project closeout, showing the Government as warranty recipient.

PART 2 - PRODUCTS

2.01 LINER

A. High Density Polyethylene (HDPE):
1. [Smooth] [Textured] HDPE manufactured in accordance with and conforming to GSI GRI GM13, [_____] mm (mils) thick.

B. Linear Low Density Polyethylene (LLDPE):
   1. [Smooth] [Textured] LLDPE manufactured in accordance with and conforming to GSI GRI GM17, [_____] mm (mils) thick.

C. Flexible Polypropylene (fPP and fPP-R):
   1. [Unreinforced] [Reinforced] fPP manufactured in accordance with and conforming to GSI GRI GM18, [_____] mm (mils) thick.

D. Ethylene Propylene Diene Terpolymer (EPDM):
   1. [Unreinforced] [Reinforced] EPDM manufactured in accordance with and conforming to GSI GRI GM21,[1.12 mm (45 mils)][1.5 mm (60 mils)] thick.

E. Reinforced Linear Low Density Polyethylene (LLDPE-R):
   1. Reinforced LLDPE-R manufactured in accordance with and conforming to GSI GRI GM25, [_____] mm (mils) thick.

F. Polyvinyl Chloride (PVC):
   1. PVC manufactured in accordance with and conforming to ASTM D7176, [_____] mm (mils) thick.

2.02 ACCESSORIES

A. Adhesive:
   1. Provide seaming adhesive compatible with type of liner used as recommended by manufacturer.

B. Sealant:
   1. Provide sealants compatible with the type of liner used as recommended by manufacture. The use of silicone sealant is not allowed with PVC liner materials.

C. Penetrations:
   1. Provide manufacturer's standard factory fabricated penetration assemblies. Make penetration assemblies of the same base material as liner and at least 1.12 mm (45 mils) thick.

2.03 FILTER FABRIC:

A. Provide a permeable, synthetic barrier sheet resistant to mildew, chemicals in soil, stable under freeze-thaw cycles, which will not shrink or expand under wet conditions, and will not unravel or become clogged during use. Filter cloth must have a minimum tensile strength of 534 N (120 pounds). Allowable open area must not exceed [36] [_____] percent and must not be less than [4] [_____] percent. Percent open area is defined as the summation of open areas divided by total area of filter cloth. Equivalent Opening Size (EOS) must not be finer than the U.S. Standard sieve [212] micrometers [_____] (No. [70] [_____]).

PART 3 - EXECUTION

3.01 SURFACE PREPARATION

A. Soil or Granular Subgrade:
   1. Prepare subgrade in accordance with Section 31 00 00 – Earthwork. Remove vegetation, boulders and rocks larger than 20 mm (3/4 inch) in size and other sharp objects. Fill in holes, including stake holes. Inspect subgrade surface and correct defects prior to continuing construction.

B. Concrete:
   1. Provide concrete surfaces and pipe anchorages in accordance with Section 03 30 00 – Cast-In-Place Concrete. Provide smooth surfaces with no sharp projections or abrupt surface changes. Compact earth within 300 mm (12 inches) of any concrete surfaces to 100 percent maximum density, in accordance with ASTM D698.

3.02 CLEANING OF LINER SHEET

A. Clean liner sheets of dust, dirt, and other foreign matter. Carefully clean area (both mating surfaces) of seams. [Remove surface [bloom] or [cure] with solvent recommended by manufacturer.]

3.03 FILTER FABRIC INSTALLATION

A. Place synthetic fiber filter fabric on prepared subgrade. Repair damaged fabric by placing an additional layer of fabric to cover the damaged area a minimum of 900 mm (3 feet) overlap in all directions. Overlap fabric at joints a minimum of 900 mm (3 feet). [Obtain approval of filter fabric installation before placing fill. Place fill on fabric in the direction of overlaps and compact as specified in Section [31 00 00 – Earthwork][31 23 00.00 20 EXCAVATION AND FILL]]. Follow manufacturer's recommended installation procedures.

3.04 LINER INSTALLATION

A. Placement:
   1. Position liner on previously prepared surface [or filter fabric] as indicated. Unroll or unfold carefully. Avoid stretching. Allow liner to lie in a relaxed state [for a minimum of 1/2 hour] prior to seaming.

B. Seams and Laps:
   1. Provide personnel handling or applying seaming adhesive with protective clothing and other appropriate safety equipment. Apply seaming adhesive and make field seam. Make lap or seam [_____] [150 mm (6 inches)] wide. Seal lap or seam using rollers or hand pressure removing any wrinkles at that time. A plank or board may be used for back-up during sealing but remove prior to completion of installation. [For supported liners apply splicing cement to cut edges of liner and seal with a strip of unsupported liner of same material as liner.] [For supported liners apply splicing cement to cut edges (exposed scrim) of liner.]

C. Repairs:
   1. Make repairs to liner with same material as liner. Extend patch 150 mm (6 inches) in all directions from puncture. Use same method as for seams.

3.05 ANCHORAGE

A. Earth Anchorage:
   1. Make perimeter trench [a minimum of 300 mm (12 inches) wide by 300 mm (12 inches) deep] [as indicated]. After installation of liner in reservoir is complete, place liner in perimeter trench and backfill trench.

B. Anchorage to Structures:
   1. Remove curing compounds and coatings from structures in joint areas. Use bonding adhesive recommended by manufacturer to make joints. Make joint to structures [at least 300 mm (12 inches) wide.] [the width indicated. Use batten strips of stainless-steel bars to reinforce joint.]

3.06 BACKFILL OVER LINER

A. Cover installed liner with earth to depth [indicated.] [of 450 mm (18 inches).] [Cover liner within time limits specified by liner manufacturer.] Place earth on liner using rubber tired or tracked vehicles. Drive only on earth cover. Correct any damage to liner caused by covering operations.

3.07 FIELD QUALITY CONTROL

A. Tests: Use ASTM D7700 to determine appropriate test methods necessary to evaluate geomembrane seams for materials listed in this specification. [Take one destructive field seam sample per [500 meters (1640 feet)] [_____] meters (feet) of seam.] [Perform an electrical leak detection survey.]
   1. Nondestructive Testing (NDT):
      a. Nonreinforced Testing:
         1) Perform NDT in accordance with ASTM D4437/D4437M. For HDPE, LLDPE, fPP and PVC use ASTM D7006 for ultrasonic testing of materials and seams. For PVC, ASTM D7006 is only applicable to factory seam testing.
      b. Reinforced Testing:
         1) Perform NDT in accordance with ASTM D4437/D4437M.
   2. Destructive Testing:
      a. Perform destructive testing in accordance with GSI GRI GM19.
         1) Nonreinforced Testing:
            (a) For HDPE, LLDPE, and fPP perform destructive testing in accordance with ASTM D6392.
            (b) For EPDM perform destructive testing in accordance with ASTM D7272.
         2) Reinforced Testing:
            (a) For reinforced geomembranes materials listed in this specification perform destructive testing in accordance with ASTM D751, ASTM D6214/D6214M, and ASTM D6392.
   3. Adhesion to Flexible Substrate:
      a. For EPDM perform adhesion test in accordance with ASTM D413.
   4. Electrical Leak Location:
      a. For HDPE, LLDPE, fPP and PVC provide electrical leak location in accordance with ASTM D7002 and ASTM D7007.
   5. Leakage Testing:
      a. Test pond or reservoir for leakage. Determine leakage rate. Leakage rate (Q) must not exceed the lesser of 4 liters (1 gallon) per minute or the amount given by the following formula. Q (Leakage rate in gallons per minute) equals A (Area of liner in thousands of square feet) multiplied by the square root of H (Depth of liquid in feet), the product then divided by 80.

B. Inspection:
   1. Inspect completed liner for pinholes, punctures, and tears. Inspect seams and joints for unbonded areas. Repair defects as specified herein.

END OF SECTION

SECTION 33 50 23
TRENCHLESS UTILITY INSTALLATION

PART 1 - GENERAL

1.01 WORK INCLUDES:

A. Provide utility installation using microtunneling, boring, and jacking techniques at locations indicated. The Construction Management General Contractor (CMGC) is responsible for all work related to the provision of utilities installed, including assessing surface, subsurface, and environmental (seasonal) conditions.

B. The CMGC shall perform all work activities in accordance with all applicable AR-RM HSSE Management System Practices, Procedures, and Guidance.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
   1. American Petroleum Institute (API):
      a. API Spec 13A (2010; Errata 1 2014; Errata 2-3 2015) - Specification for Drilling-Fluid Materials.
      b. API Spec 5L (2018; 46th Ed; ERTA 2018) - Line Pipe.
   2. American Railway Engineering and Maintenance-of-Way Association (AREMA):
      a. AREMA Eng Man (2017) - Manual for Railway Engineering.
   3. American Society of Civil Engineers (ASCE):
      a. ASCE 27-00 (2000) - Standard Practice for Direct Design of Precast Concrete Pipe for Jacking in Trenchless Construction.
      b. ASCE 28-00 (2001) - Standard Practice for Direct Design of Precast Concrete Box Sections for Jacking in Trenchless Construction.
      c. ASCE 36-15 (2015) - Standard Design and Construction Guidelines for Microtunneling.
   4. American Water Works Association (AWWA):
      a. AWWA C200 (2012) - Steel Water Pipe - 6 In. (150 mm) and Larger.
      b. AWWA C203 (2008) - Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied.
   5. American Welding Society (AWS):
      a. AWS D1.1/D1.1M (2015; Errata 1 2015; Errata 2 2016) - Structural Welding Code – Steel.
      b. AWS D1.5M/D1.5 (2015) - Bridge Welding Code.
   6. ASTM International (ASTM):
      a. ASTM A139/A139M (2016) - Standard Specification for Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and over).
      b. ASTM A53/A53M (2018) - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      c. ASTM A716 (2018) - Standard Specification for Ductile Iron Culvert Pipe.
      d. ASTM A746 (2018) - Standard Specification for Ductile Iron Gravity Sewer Pipe.
      e. ASTM C1091 (2003a; R 2013) - Standard Test Method for Hydrostatic Infiltration Testing of Vitrified Clay Pipe Lines.
      f. ASTM C150/C150M (2018) - Standard Specification for Portland Cement.
      g. ASTM C33/C33M (2018) - Standard Specification for Concrete Aggregates.

7. U.S. Army Corps of Engineers (USACE):
    a. EM 385-1-1 (2014) - Safety and Health Requirements Manual.
8. Burlington Northern Santa Fe (BNSF):
    a. BNSF (2011) - Utility Accommodation Policy.

1.03 DEFINITIONS

A. As used herein, the terms "shaft" and "pit" are synonymous.
    1. Microtunneling:
        a. Unless otherwise specified or indicated, see ASCE 36-15 for definitions.
    2. Jacking Precast Concrete Pipe:
        a. Unless otherwise specified or indicated, see ASCE 27-00 for definitions.
    3. Jacking Precast Concrete Box Sections:
        a. Unless otherwise specified or indicated, see ASCE 28-00 for definitions.

1.04 SUBMITTALS

A. Atlantic Richfield Company approval is required for submittals in accordance with Section 01 33 00 – Submittal Procedures.
    1. SD-01 Preconstruction Submittals:
        a. Design Data:
            1) Design calculations for pipe casing.
            2) Access Shaft Construction Plan.
        b. Microtunneling Plan.
        c. Boring and Jacking Plan.
        d. Initial Survey Report of Settlement Monitoring Points.
    2. SD-03 Product Data:
        a. Pipe casing and couplings.
        b. Lubricating fluid for pipe exterior.
        c. Survey equipment for settlement monitoring.
        d. Submit manufacturer's standard drawings or catalog cuts, except submit both drawings and cuts for push-on or rubber-gasketed bell-and-spigot joints. Include information concerning gaskets with submittal for joints and couplings. Submit manufacturer’s information on the survey equipment that is to be used showing that the equipment can measure the required accuracy.
        e. Manufacturer's Instructions:
            1) Installation procedures for pipe casing and couplers.
        f. Safety Data Sheets.
    3. SD-05 Test Reports:
        a. Monitoring Survey.
    4. SD-06 Certificates:
        a. Statement of Contractor Qualifications.
    5. SD-07 Closeout Submittals:
        a. Record Drawings.
        b. Daily Work Logs of installation operations, including records of the volume of materials removed, daily progress and grout volumes used, and as-built drawings of location and alignment of casing and pipeline.

1.05 PRE-CONSTRUCTION

A. No later than 45 days prior to commencement of the work, submit the following to the Atlantic Richfield Company Representative, and the BNSF Representative, where applicable, for review and approval:
    1. Microtunneling Plan.

2. Boring and Jacking Plan.
3. Access Shaft Construction Plan.
4. Initial Survey Report of Settlement Monitoring Points.
5. Statement of Contractor Qualifications.

B. Submit a complete list of all drilling fluids, additives, and mixtures to be used along with Safety Data Sheets.

1.06 QUALITY CONTROL

A. Statement Of Contractor Qualifications:
   1. CMGCs are required to have proven and successful experience in microtunneling, boring, and jacking. The experience is the successful completion of similar projects to the tolerances indicated for the size of pipe and quantities shown on the plans, in the anticipated soil conditions indicated in the geotechnical report included in the contract documents. Submit a description of at least three such projects which include, at a minimum, a listing of the location(s), date of projects, owner with contact information, pipe type, size installed, length of installation, type, and manufacturer of equipment used, and other information relevant to the successful completion of the project.
   2. Settlement surveying shall be performed by a Montana licensed professional land surveyor. The land surveyor engaged by the CMGC and included in the Contract Price. The land surveyor shall not be directly employed by the CMGC or the tunneling Subcontractor.

B. Initial Survey Report of Settlement Monitoring Points:
   1. This report will include the horizontal coordinates, elevation, and station for each settlement monitoring point and description of the point. Include method to mark the locations on the rails. Identify which survey control points were used so that the settlement monitoring points could be re-established in the future if necessary.

C. Records:
   1. Daily Work Log:
      a. Maintain a work log of construction events and observations. Include the following information for each day's work:
         1) Hours worked.
         2) Location of boring machine face or shield by station and progress made in advancing pipe.
         3) Completed field forms, such as steering control logs, for checking line and grade of boring operation, showing achieved alignment relative to design alignment.
         4) Maximum pipe jacking pressures per drive.
         5) Ground water control operations and piezometric levels.
         6) Descriptions of soil conditions encountered.
         7) Any unusual conditions or events, including observed ground movement.
         8) Reasons for operational shutdown in event drive is halted.
         9) Survey report of railroad tracks when excavation is within 25 ft of the outermost BNSF Railroad tracks. Submit the elevations of each settlement monitoring point each day before the survey crew leaves the project site. This report shall consist of a table with one column for each settlement monitoring point and one row for each day. The CMGC's Surveyor shall fill in one row per day. This will allow BNSF's on-site representative to spot trends and errors easily.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials on site in enclosures or under protective covering. Store jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes free of dirt and debris.
   1. Handling:
      a. Handle pipe in a manner to ensure delivery to the excavation site in sound undamaged condition. Avoid damage to coatings and linings on pipe; make repairs if coatings or linings are damaged. Carry, do not drag pipe to the excavation site. Store jointing materials and rubber gaskets that are not to be installed immediately, under cover out of direct sunlight. Handle steel pipe with coal-tar enamel or coal-tar epoxy coating in accordance with the provisions for handling coal-tar enamel coated pipe in AWWA C203. Handling coal-tar epoxy coated steel is not permitted below 40 degrees F.

1.08 SAFETY

A. General:
   1. Provide procedures for safe conduct of the work in accordance with EM 385-1-1. When and where installations temporarily disrupt pedestrian use of sidewalk areas for periods exceeding two consecutive work days, provide an alternate route that meets current ADA Accessibility Standards.

B. Equipment:
   1. Utilize equipment that employs a common grounding system to prevent electrical shock in the event of underground electrical cable strike. Ensure the grounding system connects all pieces of interconnecting machinery; the drill, mud mixing system, drill power unit, drill rod trailer, operator’s booth, worker grounding mats, and any other interconnected equipment to a common ground. Utilize equipment having an "electrical strike" audible and visual warning system that notifies the system operators of an electrical strike.

C. Sheeting, Shoring and Dewatering:
   1. Provide sheeting, shoring and dewatering as specified in Section 31 00 00 – Earthwork, and as specified herein.

D. Tunnel Bore:
   1. Unprotected mining of the tunnel bore is not permitted. Fully support the tunnel face and bore at all times.

1.09 QUALITY ASSURANCE

A. Microtunneling Plan and Boring and Jacking Plan:
   1. Provide a plan prepared, signed, and sealed by a licensed Professional Engineer and include the following:
      a. Operational Layout:
         1) Layout Plan:
            (a) Provide a plan location of the operation, discussing relationship of equipment, the method of construction and details for the following:
               (i) Access pits configurations and details, including equipment layout.
               (ii) Location of intermediate jacking stations, if required.
               (iii) Casing pipe with connection details.

2) Pedestrian Access Around Site:
   (a) When and where installations disrupt pedestrian use of sidewalk areas for periods exceeding two consecutive days, provide an alternate route that meets current ADA Accessibility Standards.

b. Method and Procedures:
   1) Provide an outline of the methods and procedures, including drawings, schedule of operations, specifications, and manufacturer's catalog data for products in lieu of specifications, methods of operation for microtunneling, boring, and jacking operations, and specifically the following:
      (a) Jacking Equipment and Methods: Provide drawings of the jacking frame, jacking head, reaction blocks, jacking installation, pipe guides, procedures for lubricating exterior of pipe during jacking (if applicable), maximum force that jacking equipment can deliver.
      (b) Boring Equipment and Methods: Provide a discussion of the methods of operation, design and specifications for boring operation, steerage control, line and grade control methods, proposed procedures for removing or clearing obstructions, and a description of proposed methods for ground stabilization and minimizing over-excavation and loss of ground. Submit safety data sheets for fluids, grout, or chemical products.
      (c) Casing Annulus and Interior Space Grouting: Identify casing insulators/spacers/centralizers/tiedowns (type, number, spacing and installation instructions,) grout materials and method of placement, description of equipment used, and grout pressure employed.
      (d) Survey Alignment Control: Identify method and equipment to install pipe within specified tolerances.
      (e) Ground Stabilization: Discuss dewatering and grouting, identification of measures and methods used to stabilize face at heading (if necessary), narrative of equipment, procedure and grout mix, and identification of subcontractor who will perform any required stabilization grouting.
      (f) Excavation Support System Plan: Provide a plan and discussion of methods to be employed, including design drawings and calculations, sealed and signed by a licensed Professional Engineer.
      (g) Monitoring/Survey Plan: Develop and provide a discussion of the monitoring/survey plan to be employed to protect structures and utilities from settlement and/or heave, including the following. Incorporate into the plan any supplemental requirements specified in Part 3, paragraph entitled "Field Quality Control".
         (i) Structures Assessment: Provide a discussion of structures and utilities to be protected, and measures to be employed for preconstruction and postconstruction assessment of critical structures, namely those located within the zone of active excavation from proposed pipe centerline. Include photographs or video of existing damage to structures in the vicinity of sewer alignment in assessment reports.
         (ii) Instrumentation Monitoring Plan: Describe of instrumentation design, layout of instrumentation points, equipment installation details, manufacturer's catalog literature, and monitoring report forms.
         (iii) Railroad Tracks Settlement Monitoring Plan: Identify on a plan the location of settlement monitoring points, reference benchmarks, survey frequency and procedures, and reporting formats.
      (h) Contingency Plan: Provide a plan and discuss protection of adjacent structures, and utilities affected by adverse movements detected by instrumentation. As a minimum, include the following:

(i) Names, telephone numbers, and locations of persons responsible for implementation of contingency plans.
(ii) Materials and equipment required to implement contingency plans. Identify the location of all required materials and equipment.
(iii) Step-by-step procedure for performing work involved in implementation of the contingency plans.
(iv) Clear identification of the objectives of the contingency plans and methods to measure plan success.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. The work includes providing labor, materials, and specialized equipment for the installation of utility pipelines utilizing the boring and jacking and microtunneling methods of installation.
   1. Design Requirements:
      a. Excavations:
         1) Design excavations, including access shaft walls, considering loadings from reaction blocks, traffic loads and any surcharge loads.
            (a) Railway Crossing Criteria:
               (i) For pipe crossings under railways use Cooper E-80 locomotive loading distributions in accordance with AREMA Eng Man specifications for culverts.
      b. Design Calculations of Pipe Casing:
         1) Submit design calculations for pipe casing demonstrating that the equipment used in installing the pipe will not distort or otherwise damage the pipe. Provide calculations of maximum allowable jacking force to be used based on pipe materials to be used. The calculations are to be sealed by a licensed Professional Engineer using soil properties derived from subsurface investigations performed along the utility route.

2.02 EQUIPMENT

A. Microtunneling System:
   1. General Requirements:
      a. Utilize a continuously monitored laser guided Microtunneling Boring Machine (MTBM) system matched to the expected subsurface conditions, a hydraulic jacking system to jack the pipeline, a process to remove the slurry from the slurry water, a guidance system to provide installation accuracy to within the indicated tolerances, excavation equipment, material handling equipment, a dewatering system, and sheeting/shoring required to provide the work indicated and meet the following minimum performance requirements:
         1) Capable of providing positive face support both during excavation and during shutdown regardless of the MTBM type.
         2) Capable of handling and removing materials of high-water content from the machine head.
         3) All functions are controlled remotely from a surface control unit.
         4) Capable of controlling rotation utilizing a bidirectional drive on the cutter head or by using anti-roll fins or grippers.
         5) Capable of injecting lubricant around the exterior of the pipe being jacked.
         6) Capable of controlling heave and settlement.
         7) Minimize overcut during the operation. Do not exceed 1 inch [ ] on the radius, unless approved by the Atlantic Richfield Company Representative.

2. Control System:
    a. The main control system of the MTBM is to provide the following information to the operator, as the minimum, required for successful operation of the MTBM:
        1) Deviation of the MTBM from the required line and grade of the pipeline (normally by reference to a laser beam).
        2) Grade and roll of the MTBM.
        3) Jacking load.
        4) Torque and RPM of the cutter head.
        5) Instantaneous jacking rate and total distance jacked.
        6) Indication of steering direction.
        7) Progress of pipe advancement via CCTV at the pipe head.

B. Boring and Jacking System:
    1. Utilize a continuously monitored boring and jacking system matched to the expected subsurface conditions, a hydraulic jacking system to jack the pipeline, an auger to remove boring spoils, a guidance system to provide installation accuracy within the indicated tolerances, excavation equipment, material handling equipment, a dewatering system, and sheeting/shoring required to provide the work indicated.

C. Pipe Jacking Equipment:
    1. Provide main jacking equipment with a capacity greater than the anticipated jacking load. Provide intermediate jacking stations when the total anticipated jacking force needed to complete the installation may exceed the capacity of the main jacks or the designed maximum jacking force for the pipe. The jacking system is to supply a uniform distribution of jacking forces on the end of the pipe by use of thruster rings and cushioning material.

2.03 MATERIALS

A. Pipe Casing:
    1. Provide straight wall pipe casing of type and diameter indicated of steel pipe.
        a. Steel Pipe:
            1) Pipe:
                (a) Provide steel pipe in conformance with ASTM A139/A139M, Grade B with a minimum yield strength of 35,000 psi Weld steel pipe seamless, square cut with even lengths that complies with Articles 4.2, 4.3, and 4.4 of the API Spec 5L. Pipe shall have an inside diameter and a minimum wall thickness as indicated.
                (b) Steel casing coating shall be minimum 15 mils fusion bonded epoxy (FBE) with a minimum 30 mils abrasion resistant overlay (ARO). FBE shall be Valspar Pipeclad 2000 or approved equal, and ARO shall be Powercrete DD or approved equal.
            2) Joints:
                (a) Accomplish the connection of adjacent pieces of microtunneling steel pipe by [field buttwelding,] [internal weld sleeves,] [integral press fit connectors,] by a certified welder, in compliance with AWS D1.1/D1.1M as long as loading and installation design criteria are met.
                (b) Utilize casing pipe having beveled ends with a single V-groove for field welding. Butt weld joints using a full-penetration weld on the outside circumference of the pipe prior to jacking. The welds are to conform to the latest AWS Welding Code by a certified welder. Unless otherwise specified, inspect and test welds using a non-destructive testing method consisting of magnetic particle examination (MT), in compliance with the

AWS code. Visually inspect in compliance with AWS D1.1/D1.1M visual inspection criteria by a certified welder and by the QC manager welds on casing pipe that is sacrificial (fully grouted internally). Non-destructive testing is not required on welds on casing pipe that is sacrificial.

(c) Upon completion and inspection of joint welds, apply pipe coating to all bare steel areas as per the manufacturer's recommendations. Allow appropriate coating cure time as per manufacturer's recommendations prior to continuing jack and bore operations.

(d) The invert of the casing shall be smooth and allow for easy placement of the carrier pipe on skids. Welding methods shall assure the casing is straight.

(e) No welding will be allowed in the utility trench in areas of hydrocarbon-contaminated soil for worker safety. Where casing pipe cannot be welded in the trench or on the bank, join pipe using cast type pipe couplings appropriate to material type and size as manufactured by Romac, Dresser, or an approved equivalent.

(f) Grouting Plugs: On large pipe, (24-inch diameter or greater), provide pipe with 2-inch diameter tapped holes with threaded plugs for exterior grouting.

3) Roundness:

(a) The maximum difference between the major and minor outside diameters cannot exceed one percent of the specified nominal outside diameter or 0.25 inch, whichever is less. For pipe exceeding 48 inches in diameter, a maximum deviation of 1/2 inch is permitted provided the circumference tolerance is maintained within 1/4 inch.

4) Circumference:

(a) Ensure that the outside circumference is within plus one percent of the nominal circumference or within plus 0.50 inches, whichever is less.

5) Straightness:

(a) The maximum allowable straightness deviation in any 10-foot length cannot exceed 1/8 inch. For lengths over 10 feet, the maximum allowable deviation of the entire pipe length is computed by the following formula, but not to exceed 3/8 inch in any length exceeding 30 foot length: Maximum Allowable Deviation in inches equals (1/8) times (total length in feet) divided by 10.

6) Pipe Ends:

(a) Ensure that the end of the pipe is perpendicular to the longitudinal axis of the pipe and within 1/16 inch per foot of diameter, with a maximum allowable deviation of 1/4 inch measured with a square and straightedge across the end of the pipe.

7) End Seals:

(a) Provide rubber end seals for casing pipe to act as a barrier to debris and seepage.

(b) Furnish end seals as manufactured by APS (Model IL-S316) or approved equivalent.

B. Grout:

1. Provide cement grout for pressure grouting to fill the voids around the casing composed of Portland cement conforming to ASTM C150/C150M, Type V, and sand meeting requirements of ASTM C33/C33M for fine aggregate, sufficiently fluid to inject through the casing and fill voids, with prompt setting to control grout flow. Utilize minimum two (2) sacks of cement per cubic yard. Utilize a grout with a minimum

compressive strength of 100 psi attained within 24 hours. Admixtures are to be free of chlorides, corrosive or other material detrimental to the materials the grout contacts.

C. Lubricating Fluid (Bentonite or Polymer):
   1. Provide material for lubricating the exterior of pipe. Provide bentonite machine requirements of API Spec 13A and having the capacity of mixing with water to form a stable and homogeneous suspension. The use of water under pressure, jetting, or puddling will not be permitted to facilitate boring, pushing or jacking operations. Some boring may require water to lubricate cutter and pipe, and under such conditions, is considered dry boring.

D. Soil Materials:
   1. Backfill:
      a. Backfill material shall meet the Backfill Material Suitability Criteria defined in Section 02 11 10 – Excavation and Handling.
   2. Cover Soils:
      a. Cover soils shall meet the Engineered Caps/Cover Systems Material Suitability Criteria defined in Section 31 01 20 – Growth Media (Cover Soil).

E. Settlement Monitoring Points on Railroad Tracks:
   1. Surface settlement points located on pavement shall either be pk nails or temporary paint marks. On rails, the markings must be acceptable to BNSF. Surface settlement points located on soil shall be 2”x2” wooden hubs with a nail in the top.

2.04 INCIDENTAL MATERIALS

A. Casing Insulators/Bore Spacers:
   1. Provide casing spacers made from T-304 stainless-steel of a minimum 14-gauge thickness constructed in a 2-piece shell. Assure that the shell is lined with a ribbed polyvinyl chloride (PVC) extrusion with a retaining section that overlaps the edges of the shell and prevents slippage and that all welds and metal surfaces are chemically passive. Provide casing insulators/bore spacers 8 inches in length for pipe 12 inches and less in diameter, and 12 inches in length for pipe 14 inches and greater in diameter, having a 2-inch minimum runner width. Orient spacers to allow for grout to flow easily to completely fill the casing pipe with grout throughout its length.
   2. Assure bearing surfaces (runners) are ultra-high molecular weight polymer for abrasion resistance and a low coefficient of friction. Attach the runners to support structures (risers) at appropriate positions, as directed by manufacturer’s instructions, to properly support the carrier within the casing and to ease installations.
   3. Provide risers made of T-304 stainless steel of a minimum 10 gauge. Assure all risers over 6 inches (150 mm) in height are reinforced and MIG welded to the shell. Dimension the height of the risers and runners combined to center the carrier pipe in the casing with a top clearance of ½ inch (13 mm) minimum.

B. End Closures/Bulkheads:
   1. Provide Permanent End Closures consisting of brick and mortar (one part cement/two parts sand/water) to completely encapsulate the conduits transition into the casing. Center the closure on the casing pipe end.

PART 3 - EXECUTION

3.01 PREPARATION

A. Access Shaft and Pit Construction Plan:
   1. No later than 45 days prior to start of construction submit an Access Shaft Construction Plan. Include in the plan a discussion of the method of construction of access shafts used for microtunneling boring and jacking. Address the excavation methods, dewatering system, sheeting/shoring and bracing systems proposed for use, and any ground stabilization to be employed for the shaft work area or thrust block. Acceptable construction methods include the use of interlocked steel sheet piling or precast circular concrete segments lowered in place during excavation.
      a. Design Requirements:
         1) Construct shafts of a size commensurate with safe working practices at locations indicated. Coordinate shaft locations with the Atlantic Richfield Company Representative. With approval from the Atlantic Richfield Company Representative the CMGC may propose to relocate shafts to better suit the capabilities of the equipment/methods proposed but may not alter either the indicated pipeline alignment or structures associated with the installed pipeline, nor result in additional claims for compensation.
         2) To the extent possible, keep shaft locations clear of pavements and within a single traffic lane in order to minimize disruption to the flow of traffic. Locate support equipment, spoil piles, and materials to minimize disruption to traffic. Pits for boring, tunneling, or jacking will not be permitted within thirty (30) feet of the centerline of BNSF Railroad track; or closer to the track than the toe of fill slopes in fill sections, or toe of shoulder slopes in ditch sections when pipes are allowed on the railroad property.
         3) Support all excavations and prevent movement of the soil, pavement, utilities or structures outside of the excavation. Furnish, place, and maintain sheeting, bracing, and lining required to support the sides of all shafts and to provide adequate protection of the work, personnel, and the general public. Provide a concrete floor in the jacking access shaft. Design loads on the sides of the jacking and receiving pit walls are dependent on the construction method and flexibility of the wall systems.
         4) Consider the loading from boring or pipe jacking when preparing the design of the jacking and receiving pit supports as well as special provisions and reinforcement around the breakout location. Design the base of the pits to withstand uplift forces from the full design head of water, unless approved dewatering or other ground modification methods are employed.
         5) Construct a thrust block to transfer jacking loads into the soil. Ensure that the backstop and the proposed pipe alignment are square to each other and are designed to withstand the maximum jacking pressure to be used with a factor of safety of at least 2.5. Also, design the thrust block to minimize excessive deflections in such a manner as to avoid disturbance of adjacent structures or utilities or excessive ground movement. Begin jacking operations only after concrete thrust block or treated soil has attained the required strength.
         6) If tremie concrete sealing slabs are placed within the earth support system to prevent groundwater inflow when access shafts are dewatered, furnish and install sealing slabs of sufficient thickness to provide a minimum factor of safety of 1.2 against hydrostatic uplift in order to prevent bottom blowout when the excavation is completely dewatered.

3.02 CONSTRUCTION

A. Access Shafts:
   1. Construction Requirements:
      a. Provide ground stabilization in the work area and the thrust block as required to accomplish the work.
      b. Construct a jacking access shaft to accommodate the installation of pipe casings, equipment and piping jacking device. Install thrust blocks(s) as required and consolidate the ground (grout) where the casings exit the shaft. Provide a dry jacking work area having a stable concrete floor that drains to a recessed sump pump to handle nuisance inflow. Groundwater inflows into the jacking shaft are not to exceed 5 gallons/minute; soil inflows are not to exceed a total volume of 2 cubic feet.
      c. Construct a receiver shaft to accommodate the installation of pipe casings and the equipment used in the work. Consolidate the ground (grout) where the casings enter the shaft.
      d. Furnish, install, and maintain equipment to keep the jacking shaft free of excess water. Provide surface protection during the period of construction to ensure that surface runoff does not enter shafts. Adhere to the dewatering plan and do not affect surrounding soils or structures beyond the tolerances stated in paragraph entitled "Tolerances."
      e. Provide security fence around all access shaft areas and provide shaft cover(s) when the shaft area is not in use.
      f. Pit Backfill and Compaction: Upon completion of the pipe jacking and all tests or inspections, remove all equipment, debris, and unacceptable materials from the pits and commence backfilling operation. Complete backfilling, compaction, and pavement repairs in accordance with applicable Technical Specifications

3.03 INSTALLATION

A. Installation of Tracer Wire:
   1. Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe in accordance with the American Public Works Association Uniform Color Code. Attach wire to top of pipe in such a manner that will not be displaced during construction operations.

B. Connections to Existing Lines:
   1. Schedule connections to existing lines with the Atlantic Richfield Company Representative to cause a minimum interruption of service on the existing line.

C. Advancing the Pipe:
   1. Jack each pipe casing section forward as the excavation progresses in such a way to provide complete and adequate, ground support at all times. Utilize a bentonite slurry applied to the external surface of the pipe to reduce skin friction. Provide a jacking frame for developing a uniform distribution of jacking forces around the periphery of the pipe. Place a plywood spacer on the outer shoulder of the pipe casing joint. Design and construct the thrust reaction backstop to withstand the jacking forces. Continuously maintain a square alignment between the backstop and pipe casing and support the maximum obtainable jacking pressure with a safety factor at least 2.0. Continuously monitor the jacking pressure and rate of cutter head advancement. Exercise special care when setting the pipe guard rails in the jacking pit to ensure correctness of the alignment, grade and stability.
      a. Installation Requirements:

1) Utilize boring equipment capable of fully supporting the face of the tunnel.
2) Maintain face pressure exerted at the heading by the MTBM as required to prevent loss of ground, groundwater inflows, and settlement or heave of the ground surface by balancing soils and groundwater pressures present.
3) Dewatering for groundwater control in accordance with Section 01 35 00 – Environmental Protection.
4) Do not jack pipe casing until the concrete thrust block and tremie seal (if selected), and grouted soil zone in jacking and receiving shafts have attained the required strength.
5) Jack the pipe into place without causing damage to the coatings, joints or completed pipe section.
6) After completion of the jacking operation between jacking and receiving shafts, displace the lubricate material from between the pipe casing exterior and the surrounding ground with a cement grout. Control pressure and the amount of grout to avoid pipe damage and displacement of the pipe and soil beyond the tolerances specified in paragraph "Tolerances." Grout within 48 hours after pipe installation has been completed to prevent any surface settlement due to movement of soil material into the void space or loosened zone around the pipe casing.
7) Replace pipe casings damaged during installation.
8) Ensure that the welds of steel pipe attain the full strength of the pipe and are watertight before jacking of the pipe section. Ensure that the inner face of the internal weld seam is flush with the pipe to facilitate the installation of the carrier pipe in the pipe casing.
9) Perform all welding in accordance with requirements for shielded metal arc welding of AWS D1.5M/D1.5 for bridges and AWS D1.1/D1.1M for buildings and other structures.
10) Provide a pipeline that has a consistent diameter across assembled joints.
11) Once the tunneling process has begun, continue with that process uninterrupted until the pipe reaches the receiving shaft. Continue to push any damaged pipe until that damaged pipe section is pushed into the receiving shaft and is removed. Notify the Atlantic Richfield Company Representative immediately if any pipe is known to be or believed to be damaged.
12) If excessive voids or too large a bored hole is produced during casing or pipeline installations, or if it is necessary to abandon a bored or tunneled hole, contact Atlantic Richfield Company's Representative immediately to determine remedial action. The hole diameter resulting from bored or tunneled installations shall not exceed the outside diameter of the casing (including coating) by more than two (2) inches.

D. Carrier Pipe Installation:
1. Cleaning:
   a. Clean the inside of the casing of all foreign matter by using a pipe cleaning plug.
2. Carrier Pipe:
   a. Inspect with the Atlantic Richfield Company Representative, prior to backfilling trenches, the transition of carrier pipe within the casing to non-cased trenching.
3. Casing Insulators/Spacers:
4. Install casing insulators/spacers in accordance with approved submittals and the drawings. On center spacing is not to exceed 4 feet.
5. End Closures/Bulkheads and Grouting of Casing Pipe:
   a. Closures: Seal ends of casing with [brick and mortar][_____] Install rubber end seals for casing pipe in accordance with approved submittals and the drawings.

b. After installing, inspecting and acceptance of the carrier pipe and spacers within the casing pipe, pressure fill the annular space between the carrier pipe and the casing pipe, with cement grout specified herein. Regulate pump pressures to refusal or in accordance with the approved grouting plan. Place grout in a sequence and manner that will preclude voids or pockets of entrapped air or water. Use a refusal pressure equal to 0.5 psf per foot of overburden.

E. Ventilation:
1. Provide adequate ventilation for all tunnels and shafts, following confined space entry procedures. Include such factors as the volume required to furnish fresh air in the shafts, and the volume to remove dust that may be caused by the cutting of the face and other operations which may impact the laser guidance system. Routinely test the air in areas accessed by workers in accordance with the most current OSHA methods and standards. The current OSHA allowable gas concentrations.

F. Lighting:
1. Provide adequate lighting for the nature of the activity being conducted by workers. Separate and insulate with ground fault interrupters power and lighting circuits. Comply with requirements with regards to shatter resistance and illumination requirements.

G. Spoil Transportation:
1. Match the excavation rate with rate of spoil removal. Utilize a system capable of balancing groundwater pressures and adjustment to maintain face stability for the particular soil conditions of the project. Salvage, transport, and dispose of spoil material per Atlantic Richfield Company Direction and/or applicable Technical Specifications.

3.04 TOLERANCES

A. Tolerances:
1. Maximum allowable lateral deviation is 2 inches; maximum allowable vertical deviation is three percent (3%) of its diameter plus one-half (1/2) inch so that no loads from the roadbed, track, railroad traffic or casing pipe are transmitted to the carrier pipe. Water must be free draining between any two points at the pipe invert and reverse grades are not permitted.

3.05 FIELD QUALITY CONTROL

A. Employ the monitoring/survey plan. Maintain daily records in accordance with the paragraph titled RECORDS.
1. Instrumentation/Survey:
a. Mandatory Requirements:
1) Monitoring of the BNSF Railroad Tracks is required when excavation is within 25 ft of the railroad.
2) Include the following, as a minimum, to supplement Contractor Quality Control measures employed to monitor ground surface heave or settlement in the monitoring/survey plan:
(a) Monitor ground movements associated with the project using established survey points and make changes in the construction methods that control ground movements and prevent damage or detrimental movement to the work and adjacent structures and pavements.

(b) Record in the daily work log a summary of monitoring survey results. Clearly identify work not meeting specified requirements, out-of-tolerance results, and impacts on new or existing work from settlement or heave.
(c) Install instrumentation and perform monitoring to determine ground settlement surrounding each jacking and receiving pit.
(d) Prior to any excavation activities, perform a pre-construction survey of the areas in and surrounding excavations and along the proposed utility alignment to identify any structures, facilities, underground or above ground utilities to be protected within a radius of five times either the depth of any excavation or the depth of trenchless excavation.

b. Supplemental Requirements:
1) Prior to the start of advancing the pipe or any dewatering operation, install surface settlement markers along the trenchless excavation centerline using the following guidelines:
(a) Surface heave/settlement monitoring stations shall be established at each access shaft and along the trenchless installation alignment. Monitoring stations shall be provided starting at the face of the jacking shaft and spaced every 25 feet along the pipe centerline up and including the face of the receiving shaft, and at eight points offset 5, 10, 15, and 20 feet to the left and right of the pipe centerline (nine points total for each monitoring line).
(b) In addition to the points on the ground surface, rail settlement will also be monitored. There are two tracks with two rails each on this project (four total rails). Each rail shall have twenty-seven (27) monitoring points. The monitoring points for each rail shall include one point on the tunnel centerline and thirteen (13) points to the left and right which are offset 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, and 65 feet from the centerline of the tunnel.
(c) Locate and install settlement monitoring points so that they are not a tripping hazard.
(d) The baseline elevation at each settlement monitoring shall be surveyed. Each point shall be surveyed twice to establish a baseline elevation. At least 30 minutes must pass between the two baseline measurements. If the first two measurements do not agree, more measurements shall be taken until at least two measurements agree with each other. All track and traffic control requirements shall be followed during surveys.
(e) The baseline elevations at all points must be surveyed prior to any excavation within 25 feet of the outermost BNSF Railroad track.
2) Settlement monitoring points shall be surveyed once before any excavation within 25 feet of the outermost BNSF Railroad track, at least twice within 48 hours before tunneling for the baseline elevation, at least once every 24 hours during tunneling, and once within 48 hours after tunneling is completed, once 14-21 calendar days after tunneling is completed, and once 42 to 48 calendar days after tunneling is completed. All track control requirements must be followed.
3) Evaluate all monitoring survey data immediately to determine corrective or mitigation action should be taken using the following evaluation criteria:

TYPE OF MONITORING POINT	**LIMIT LEVEL 1**
Railroad Tracks	+/- 1/4 inch

4) If the survey readings indicate settlement or heave is greater than Limit Level 1 in the above table, provide notification to the Atlantic Richfield Company Representative immediately and increase the monitoring frequency of the instruments as directed. Proceed with advancing the pipe after providing mitigating measures to limit additional movements.
5) If the survey readings indicate settlement or heave is greater than Limit Level 1 in the above table, cease work and provide notification to the Atlantic Richfield Company Representative immediately and implement the Contingency Plan.
6) Perform all repairs and/or rebuilding of rails to their condition existing prior to settlement/lifting.

2. Field Tests:
   a. Perform field tests, and provide labor, equipment, and incidentals required for testing. Submit test results, identifying any results that do not meet specified requirements, to the Atlantic Richfield Company Representative within four days of test completion. Provide corrective action and retest pipe not meeting specified requirements. Provide corrective action as recommended by the pipe manufacturer and subject to approval by the Atlantic Richfield Company Representative.
      1) Pipe Casing:
         (a) Inspect and verify that pipe material meets the dimensional tolerances specified prior to use. Record each day's inspection results in the daily work log.
            (i) Non-Standard Pipe Lengths: Cut non-standard joint lengths from full length pipe having satisfactorily passed the hydrostatic test.
            (ii) Elevations: Prior to removal of MTBM equipment, sheeting, and backfilling of access shafts, collect invert information on pipeline installed. Confirm that the elevations meet stated tolerances.

3.06 CLEANUP AND FINAL CLOSEOUT

A. Site Cleanup:
   1. Immediately clean "blow holes" or "breakouts" of drilling fluid to the surface and fill depressions with satisfactory fill material. Dispose of all drilling fluids, soils, and separated materials in compliance with Federal, State, and local environmental regulations.

B. Drilling Fluid:
   1. Immediately upon completion of work of this section, remove all rubbish and debris from the job site. Remove all construction equipment and materials leaving the entire area involved in a neat condition equal to existing conditions prior to construction, unless indicated otherwise.

C. Record Drawings and Daily Work Logs:
   1. Submit an electronic copy and three hard copies of the record drawings to the Atlantic Richfield Company Representative within five days after completing the work. Include in the record drawings a plan, profile, and all information recorded during the progress of the work. Clearly tie the record drawings to the project's survey control. Maintain and submit upon completion final Daily Work Logs of installation operations, signed by the superintendent.

3.07 DISPOSITION OF MATERIAL

A. Dispose of waste in accordance with the CMGCs WMP and in compliance with all permits and applicable Federal, State, and local regulations at no cost to Atlantic Richfield Company. Provide the Atlantic Richfield Company Representative with records of disposal.

END OF SECTION

SECTION 40 00 00
BASIC PROCESS MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide process equipment and appurtenances in accordance with this Section and applicable reference standards listed in Article 1.02.
   2. The following Specification outlines general requirements for process equipment and appurtenances specified in Divisions 40 through 46 as well as general information and requirements, which pertains to the Drawings. Refer to the individual equipment and product Specifications in Divisions 40 through 46 for additional details.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. ANSI A13.1 - Scheme for the Identification of Piping Systems.
   2. ANSI S12.19 - Measurement of Occupational Noise Exposure.

B. ASTM International (ASTM):
   1. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   3. ASTM A 307 - Standard Specification for Carbon Steel Bolts and Studs, 60000 PSI Tensile Strength.
   4. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.

C. National Electrical Manufacturers Association (NEMA):
   1. NEMA MG 1 - Standard for Motors and Generators.
   2. NEMA MG 11 - Energy Management Guide for Selection and Use of Single Phase Motors.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-03 Product Data:
      a. Qualifications of Manufacturers.
      b. Warranties.
      c. Submittal Deviations.
      d. Drawing Modifications.
      e. Special Tools.
      f. Spare Parts.
      g. Nameplates.
      h. Equipment Tag Nameplates.

i. Field Painting of Equipment.

B. All submittals shall include but are not limited to all deviations from the Contract Documents, any and all necessary modifications to the Drawings, all special tools required for maintenance and operation, all spare parts required for normal maintenance of equipment during the manufacturer's Warranty Period, and Samples of information which will be included on equipment, instrument and tank nameplates.

C. Submit engraved equipment and tank nameplates for all equipment, (including associated instrumentation), bearing the alphanumeric tag number and the descriptive name of the equipment as it is referenced on the Drawings.

D. Submit a coordinated process system color scheme finished coating of all ferrous metallic and painted surfaces of new and existing equipment; including but not limited to pipes, valves, motors, gearboxes, supports, base plates, drive guards, enclosures and all associated appurtenances. All painting shall be in accordance with Section 09 90 00 – Painting and Coating.

E. Submittal Deviations: Provide submittals to the Engineer of all products and equipment for compliance with the Contract Documents. Submittals for Design Basis products; Named products and equipment other than the design basis; as well as Engineer Approved Equal products and equipment shall specifically outline all deviations from the Contract Documents. Submittals that do not specifically outline all deviations from the Contract Documents will be rejected.

1.05 DELIVERY, STORAGE AND HANDLING

A. Provide in accordance Division 01 General Requirements.

B. The equipment manufacturers shall coat all machined surfaces subject to corrosion with an easily removable rust preventive compound prior to shipment. Ship fabricated assemblies in the largest sections permitted by carrier Regulations. All products shall be properly labeled to ensure proper field erection. Deliver all equipment in the manufacturer's original, unopened and undamaged packages, unless mounted on the respective equipment assembles. Store and maintain all equipment in strict accordance with the manufacturer's written short term and long-term storage requirements.

C. Store all products in a manner to protect items with epoxy shop coatings from exposure to UV light, which may cause chalking of the epoxy. Length of acceptable exposure prior to providing UV protective measures shall be in accordance with the coating manufacturer's recommendations. This shall include protection from UV light after installation while awaiting covering or filling of tanks, or prior to field painting for items scheduled to be finish coated. Should damage occur, the Construction Management General Contractor (CMGC) shall immediately make all repairs and replacements necessary to the satisfaction of the Engineer at no additional cost to Atlantic Richfield Company.

1.06 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

1.07 WARRANTY

A. Special Warranty/Extended Correction Period: Per Division 00 and Division 01 and individual specification sections in Divisions 40 through 43.

PART 2 - PRODUCTS

2.01 NAMED PRODUCT AND EQUIPMENT MANUFACTURERS

A. Acceptable manufacturers may be listed in each Specification section within Divisions 40 through 43. Manufacturer's names listed in each Specification within Division 40 through 43 are intended to indicate the type and quality of materials desired. Where the words Engineer approved equal is indicated, other manufacturers of equal quality that comply fully with the Contract Documents shall be allowed.

B. The Contract Documents direct attention to certain required features of the equipment but do not purport to cover all details entering into its design and construction. Nevertheless, provide products and equipment complete in all details and ready for operation for the intended purpose.

C. The Specifications in Divisions 40 through 43 are intended to provide standard products and equipment of a recognized manufacturer meeting all the requirements of the Contract Documents. Due to differences in equipment and products of various manufacturers, provide complete and detailed submittals for the Engineer to review.

D. All equipment and products of the same type, style, and duty shall be supplied by a single manufacturer. All manufacturers named shall comply completely with the Contract Documents. The Drawings are typically based upon a single product or piece of equipment. As such, the physical installation, all services, all connections, and all appurtenances are designed around the characteristics of a single product or piece of equipment. Other named manufacturers of products and equipment as well as Engineer approved equal manufacturers will be considered.

E. However, named manufacturers' products and equipment other than the design basis, as well as Engineer approved equal manufacturers' products and equipment will differ slightly from the Contract Documents. Modifications, including but not limited to, piping, wiring, controls, foundations, other services, and structures shall be required. Coordinate these modifications with the Engineer. Any additional costs required for these modifications shall be at no additional cost to Atlantic Richfield Company or Engineer. No change in Contract time shall be granted for these modifications.

2.02 GENERAL ELECTRICAL REQUIREMENTS

A. Provide motors, with their respective pieces of equipment. Motors and controllers shall conform to and have electrical connections as described in the Contract Documents. Provide internal wiring for components of packaged equipment as an integral part of the equipment. Extended voltage range motors shall not be permitted under any circumstances.

B. Controllers and contactors shall have a maximum of 120-volt control circuits and shall have auxiliary contacts for use with the controls furnished. All electrical work shall conform to NFPA 70 standards and the Contract Documents.

2.03 ELECTRICAL CLASSIFICATIONS AND HAZARD RATINGS

A. Electrical information including but not limited to motor horsepower values, voltage, phase, cycle, hazard classification rating, and inverter duty have been listed for each respective product or piece of equipment in the respective Specification sections for ease in bidding, construction, reference, and submittal review.

B. The Contract Documents specifically outline electrical hazard classifications by area. In the case that a discrepancy between the hazard classification listed in the respective product or equipment specification section and the Contract Documents or Specifications should arise; the Drawings shall govern the electrical hazard classification of the associated equipment or product and all related appurtenances. It shall be the responsibility of the CMGC and the product and equipment manufacturers to ensure all such items furnished meet the electrical hazard classification ratings which are shown on the Drawings or as indicated in the Specifications.

2.04 ELECTRIC MOTORS - GENERAL

A. Unless otherwise specified or indicated on the Drawings, all electric motors shall conform to the requirements set forth. All electric motors shall be of sufficient capacity to operate the products and equipment under all load and operating conditions without exceeding rated nameplate current, power, or specified temperature limit.

B. When the horsepower rating is specified for a motor, the motor furnished shall meet the requirements of the output specified. In the event a horsepower rating is not specified, the motor provided shall have sufficient capacity to operate the driven products and equipment as outlined in the detailed Specifications.

C. All electric motors shall have either UL or FM approval ratings. All electric motors shall have a minimum service factor of 1.0, unless otherwise specified or indicated on the Drawings. Motors for use with variable frequency drives (VFD) shall have a minimum service factor of 1.15 and be specifically designed for inverter duty service.

2.05 ELECTRIC MOTOR DESIGN STANDARDS

A. Unless otherwise indicated, all motors shall be NEMA Design B. Motors shall have starting characteristics and ruggedness as required under the actual conditions of operation and, unless otherwise specified, shall be suitable for full-voltage starting.

B. All electric motors shall be manufactured by General Electric Co., Baldor-Reliance, Toshiba, Siemens, WEG or an Engineer approved equal product that meets all the specified requirements.

C. Unless otherwise indicated, all electric motors shall have Class F insulation with a temperature rise in accordance with NEMA Standards at a maximum ambient temperature of 40 degrees C.

D. Provide electric motors rated for explosion proof service in all electrically classified areas, Class 1 Division 1 or 2, and comply with all requirements of Class 1, Division 1, Groups C&D, as defined by the National Electrical Code, as well as all other safety codes.

E. Unless otherwise indicated, all electric motors shall be premium efficiency type. The nominal or minimum guaranteed efficiency shall be specifically printed on the motor nameplate. The values shall conform to NEMA standards for premium efficiency motors.

2.06 GENERAL DESIGN OF MOTORS

A. Electric motors shall comply with the latest NEMA Standards for Motors and Generators, unless otherwise specified or indicted on the Drawings. Motor windings shall be braced to withstand the stresses resulting from the specific method of starting. The windings shall be treated thoroughly with acceptable insulating compound suitable for protection against moisture, acidic or alkaline conditions. All motor bearings shall be of the self-lubricating

type, designed to ensure proper alignment of rotor and shaft and to prevent leakage of lubricant.

B. All bearings for open motors shall be sleeve or ball type, as specified under the respective items of mechanical products and equipment. Bearings for totally enclosed and explosion proof motors shall be ball type. Vertical motors shall be provided with thrust bearings adequate for all potential thrust forces, which could be subjected to the motors during operation.

C. Vertical electric motors of the open type shall be provided with drip hoods of acceptable shape and construction. If the drip hood is too heavy to be easily removed the drip hood shall be designed and constructed with provisions for access for testing.

2.07 WOUND ROTOR INDUCTION MOTORS

A. Wound rotor electric induction motors shall be designed for operation of the motor-driven equipment under the conditions specified in the Contract Documents. Motors shall be wound-rotor, induction type suitable for speed control by rotor resistance. The collector rings shall be constructed of hard composition metal of sufficient conductivity and ample contact surface. The rings shall be mounted accurately and securely on the shaft by means of acceptable insulating construction. The leads to the collector rings shall be fastened to and insulated from the shaft.

B. The collector rings and brushes for the wound-rotor induction motors shall be suitable for operation in atmospheres containing moisture. The brushes shall be of the electrographite type, or other suitable type, of sufficient hardness and conductivity with ample contact surfaces. Brush holders shall be provided with adjustable, spring-tension devices. Brushes shall be connected to the holders with tinned, flexible, copper-wire pigtails so arranged that no appreciable current shall be carried through the sliding contacts or springs. Brushes shall operate without noise or chattering. Rings and brushes shall be located on top of the motor and shall be easily accessible for inspection and maintenance.

2.08 SYNCHRONOUS MOTORS

A. Synchronous motors shall comply in all respects with the latest NEMA Standards for Motors and Generators, and ANSI Standard C50 for Rotating Electrical Machinery. Synchronous motors shall be designed for operation of the motor-driven equipment under the conditions dictated in the Specifications. The temperature rise shall be based on a cooling temperature not exceeding 40 degrees C and an altitude not exceeding 3,300 feet in the various parts of the motors, when operating continuously at rated voltage, frequency, and power factor, shall conform to the applicable requirements of NEMA Standards.

2.09 SINGLE PHASE MOTORS

A. Unless otherwise indicated, single-phase fractional-horsepower alternating-current motors shall be high efficiency type corresponding to the applications listed in NEMA MG 11 standards.

B. Single-phase motors requiring switching devices and auxiliary starting resistors, capacitors, or reactors shall be furnished as combination units with such auxiliaries either incorporated within the motor housings or housed in suitable enclosures mounted upon the motor frames. Each combination unit shall be mounted upon a single base and shall be provided with a single conduit box.

2.10 INVERTER DUTY MOTORS

A. Electric motors which are rated for inverter duty shall be provided for all applications where used with VFD. All motors shall be suitable for operation over the entire speed range indicated without causing motor overheating at any condition. Forced ventilation type inverter duty rated motors with a separate external continuously operating fan shall not be acceptable. Inverter duty motors installed in a Class 1, Division 1, Groups C&D hazardous, classified locations shall be identified and be specifically designed for variable speed when used in classified locations.

B. Inverter duty motors shall have Class F insulation with a Class B temperature rise and shall be motor nameplated, stamped and labeled as INVERTER DUTY RATED. All motors shall be designed with a minimum service factor of 1.0. Motors shall be wound with inverter duty wire and phase paper and shall be multi-dipped and baked in polyester, Class H varnish.

C. All inverter duty motors run by VFD shall be equipped with a grounding ring to eliminate VFD induced bearing currents. Permanent magnet direct current (DC) motors shall not require a grounding ring. The grounding ring shall eliminate all destructive electrical currents, which manifest themselves through pitting of the bearings, scoring of the shaft, and eventual bearing failure.

D. When motors are controlled by pulse-width modulation (PWM), VFD; the pulse switching causes high frequency voltage changes (dv/dt), which results in a capacitive induced shaft voltage. These voltages may cause bearing failures and substantially decrease bearing life by electrically discharging through the motor bearings to ground causing pitting and fluting failure. In accordance with NEMA MG 1 standards, the capacitive induced voltage results in peak pulses as high as 10-40 volts from the motor shaft to ground. Mitigation for all inverter duty motor bearing damage shall be provided by shaft grounding brushes, which shall divert all current around the motor bearings.

E. All motors controlled by VFD shall be equipped with a shaft grounding ring kit. The grounding ring kit shall be installed by the motor manufacturer or equipment manufacturer. Each shaft grounding ring (SGR) shall be bolted directly to the motor end bracket or installed with conductive epoxy to ensure ground connection from the grounding ring to the motor frame

F. All grounding rings of the same type, style, and duty shall be supplied by a single manufacturer. All inverter duty motor grounding rings shall be a product of the following manufacturer:
   1. AEGIS SGR Bearing Protection Ring.
   2. Engineer Approved Equal.

2.11 DRIVE COUPLINGS

A. All drive couplings shall be all metallic, flexible, and designed for both angular and parallel misalignment. Drive couplings shall be provided with guards and a means for lubrication. Close-coupled connections shall have machined shouldered joints for the motor and pump motor support. High torque couplings shall be all metal gear couplings with external grease fittings. A service factor of 1.50 shall be used based on the motor nameplate rating.

B. Drive couplings for mixers, which differ from the above referenced coupling types, shall be of metallic construction. Couplings shall be standard integral parts of mixer manufacturer's equipment.

2.12 BELT DRIVES

A. All v-belt drives shall be provided with front removable guards.

B. Removing of the guards shall not require disturbing of the sheaves. All belt drive assemblies shall be designed for upsizing and downsizing the sheaving. All belt drives shall be designed for a minimum 1.5 service factor, unless otherwise indicated.

C. Variable-speed transmission in belt drive systems shall consist of a self-contained drive, totally enclosed variable speed motor, a housing on which the motor is mounted and which encloses an adjustable, heavy-duty v-belt drive between two variable-pitch pulleys and the output shaft.

2.13 SCR CONTROLLERS

A. All silicon controlled rectifier (SCR) controllers shall be completely solid state assemblies consisting of an electronic switching amplifier, silicon controlled full wave rectifier, and associated circuitry. Bridge and gate trigger circuitry shall employ printed circuit boards. Provide all required power transformers. All SCR units shall be heavy-duty type suitable for handling the full current rating of the motors and brief acceleration currents. The assembly shall be mounted on a heat sink but insulated there from.

B. Power supply to the SCR controllers shall be 115-volt, single phase, and 60 hertz. Each unit shall be factory wired and tested with all leads brought out to terminal strips to facilitate connections to the motors and local control stations. Each SCR controller shall be designed and constructed with functionality including, but not limited to the following:
   1. Full wave rectification.
   2. Power cube containing all power semi-conductors in a single component.
   3. Annature contactor with auxiliary normally open and normally closed contacts.
   4. Circuit breaker to provide overload protection.
   5. Surge suppressers to protect semi-conductors from line surges and transient voltages.
   6. Adjustable current limit.
   7. Adjustable iR compensation.
   8. Voltage level and current capacities shall meet the requirements of the connected equipment.

2.14 GEAR REDUCTION UNITS

A. Gears of gear reduction units shall be manufactured of alloys treated for hardness and rated for severe service duty. All gear reduction units on equipment shall be selected for a minimum Class II service, as classified by the American Gear Manufacturers Association (AGMA).

B. Unless otherwise specified, the complete reduction unit shall be fully enclosed in a heavy cast-iron or fabricated steel housing with gears running in oil. All bearings shall be anti-friction type.

C. The actual and rated horsepower, torque, overhang capacity, or bearing capacity of each reduction unit shall be not less than the horsepower rating of the drive motor, nor less than that which will be encountered under full load or under the most severe loading conditions of the equipment.

D. Unless otherwise specified, all gear reduction units shall be helical or spiral bevel helical combinations. Planetary gear units and worm gear type units shall be used only where

specified. Class of service shall be Class II or heavier, as determined by the manufacturer or as directed by the Engineer.

E. The equipment manufacturer shall provide the Engineer with complete, detailed, information, catalog data, design features, loading capacities, and mechanical efficiency ratings for every gear reduction unit incorporated in the Work.

2.15 LUBRICATION FITTINGS

A. All lubrication fittings shall be readily accessible from the outside of all equipment, without the need to remove covers, plates, housings, or guards, or without creating falling hazards by unusual elevations. All lubrication fittings shall be button head type. All lubrication fittings shall be mounted together wherever possible.

B. Pressure grease lubricated fittings shall be Zerk Hydraulic type or Alemite type. Housings of grease-lubricated bearings shall be automatically exhausted to the atmosphere to prevent over-greasing.

C. All oil drains shall be piped to a location outside of equipment frames for ease of draining. Provide a 316 stainless steel ball valve for positive shutoff. All drain piping shall be 316 stainless steel tubing.

2.16 SPECIAL TOOLS

A. Each manufacturer shall provide one set of all special tools required to completely assemble, disassemble, or maintain their respective pieces of equipment or systems. Special tools shall refer to oversized or specially dimensioned tools, special attachments or fixtures, or any similar items.

2.17 SPARE PARTS

A. For each piece of equipment furnished, provide spare parts, as specified in the respective Specification sections of Division 40 through 43. All spare parts shall be delivered at the same time as the equipment. Properly store and safeguard such spare parts until completion of the Work, at which time they shall be delivered to Atlantic Richfield Company. All spare parts shall be appropriately labeled and shall be properly packaged for long-term storage.

2.18 EQUIPMENT DRIVE GUARDS

A. All equipment driven by open shafts, belts, chains, or gears shall be provided with metallic or rigid fiberglass OSHA approved guards enclosing the drive mechanism. Guards shall be securely installed but shall be easily removable with quick open latches. Guards shall be constructed of 2-part epoxy coated sheet steel, epoxy coated steel woven wire, or expanded metal set in a frame of epoxy coated steel members, unless otherwise specified or indicated on the Drawings.

B. All guards shall be secured in position by stainless steel braces or straps, which shall permit easy removal for servicing the respective equipment. All guards shall conform in all respects to all applicable safety codes, OSHA standards, and local Regulations.

2.19 NAMEPLATES

A. Each piece of equipment shall be provided with a 304 stainless steel nameplate, securely fastened in place with 316 stainless steel hardware. All nameplates shall be clearly and

permanently inscribed with the manufacturer's name, model or type designation, serial number, principal rated capacities, electrical or other power characteristics, and similar information as appropriate.

B. An enlarged paper copy of all nameplate data on equipment and motors shall be provided in the submittals as well as the Operation and Maintenance Manuals.

2.20 EQUIPMENT TAG NAMEPLATES

A. Each item of equipment, including all instrumentation, shall have an engraved nameplate bearing the alphanumeric tag number and the descriptive name of the equipment as it is referenced on the Drawings. The nameplate shall be securely affixed in a conspicuous place as approved and directed by the Engineer and Atlantic Richfield Company. The CMGC shall coordinate the final tag numbers and descriptive names with the Engineer prior to ordering. The CMGC shall install all equipment tag nameplates in a location as directed by the Engineer and Atlantic Richfield Company.

B. All nameplates shall be resistant to abrasion, heat, and chemicals. Each nameplate shall be manufactured from stain resistant multi-layered acrylic specifically designed for both indoor and outdoor applications. Each nameplate shall be a minimum of 1/16 inch thick, 3-ply, scratch resistant, low glare satin phenolic finish. All nameplates shall conform to Mil Spec LP-387A Type N.D.P. LP 509. The nameplates shall be manufactured of a rigid thermoset material which is electrically non-conductive lamicoid. Provide contrasting background (black) and lettering (white) colors as selected by the Engineer and Atlantic Richfield Company.

2.21 FASTENERS AND HARDWARE

A. Provide all necessary fasteners and hardware including but not limited to bolts, anchor bolts, nuts, washers, lock washers, locking nuts, plates, bolt sleeves as required by the Work in the Contract Documents. All anchor bolts shall have suitable washers, lock washers and, where required, the nuts shall be hexagonal.

B. All fasteners and hardware shall be a minimum of 304-grade stainless steel unless otherwise specified or shown on the Drawings. All fasteners and hardware utilized in submerged applications shall be 316-grade stainless steel. All fasteners and hardware in areas including, but not limited to, splitter structures, valve vaults and wet wells shall be 316-grade stainless steel.

C. Expansion bolts shall have stainless steel composition elements of the required number of units and size. All threads shall be clean cut and shall conform to ANSI B 1.1 for Unified Inch Screw Threads (UN and UNR Thread Form).

D. All fasteners and hardware specified to be galvanized, shall be zinc coated, after being threaded, by the hot-dip process in conformity with the latest revisions of ASTM A 123/A 123M or ASTM A 153/A 153M standards. Galvanized fasteners and hardware shall only be utilized where specified or indicated in the Contract Documents. Galvanized fasteners and hardware are not considered equal to stainless steel.

E. All anchor bolts and expansion bolts shall be set accurately. If anchor bolts are set before the finished concrete has been placed, they shall be carefully held in suitable templates of Engineer approved design. Where indicated on the Drawings, specified, or as required, anchor bolts shall be provided with square plates at least 4 inches by 4 inches by 3/8 inches or shall have square heads and washers and be set in the concrete forms with suitable pipe sleeves, or both. If anchor or expansion bolts are set after the concrete has

been placed, all necessary drilling and grouting or caulking shall be provided by the CMGC, and care shall be taken not to damage the structure or finish by cracking, chipping, spalling, or otherwise during the installation.

F. All fasteners and hardware shall be suitable size for the intended purpose, with direct input from the equipment or product manufacturer. In no case shall anchor bolts have a diameter less than 3/8 inches.

2.22 OILS AND LUBRICANTS

A. Prior to startup and testing, the CMGC shall ensure all motor driven equipment and appurtenances are provided with the appropriate oils and lubricants. The respective equipment manufacturer's shall provide detailed instructions for proper lubrication and oil filling of all products. The use of special or proprietary oils and lubricants shall not be acceptable under any circumstances. All oils and lubricants shall be readily available from a local source within the United States to ensure ease of maintenance for Atlantic Richfield Company. Provide oils and lubricants of types and grades as recommended by the respective equipment manufacturers for startup, testing, and initial operation of equipment.

2.23 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 - EXECUTION

3.01 INSPECTION

A. The CMGC shall carefully inspect receiving structures and anchor supports for defects in workmanship prior to arrival of all equipment. Carefully inspect all equipment for any damage in shipping, defects in workmanship and materials, and tightness of all fastening hardware.

B. The CMGC shall examine all equipment upon delivery for structural soundness, correctness of setting, alignment, and relative arrangement of various parts, adequacy, and correctness of packing, sealing, and lubricants.

C. Prior to startup and testing, the CMGC shall ensure all motor driven equipment and appurtenances are furnished with the appropriate oils and lubricants. Provide all oils and lubricants in strict accordance with the recommendations of the respective equipment manufacturer.

3.02 FIELD PAINTING OF EQUIPMENT

A. All field painting shall be provided by the CMGC. All ferrous metallic and painted surfaces of new or existing equipment; including but not limited to pipes, valves, motors, gearboxes, supports, base plates, drive guards, enclosures, and all associated appurtenances shall be provided with a corrosion resistant field applied finished coating system with a coordinated process system color scheme.

B. For retrofit Projects, the color scheme shall match the existing designations for each process system. In all cases, new or retrofit, the color for each process system shall be as directed by the Engineer. Field applied coatings shall be in accordance with Section 09 90 00 – Painting and Coating. Stainless steel, brass, bronze, plastic, and galvanized surfaces shall not be painted unless specifically indicated or directed by the Engineer.

3.03 FACTORY PAINTING

A. The manufacturer's standard factory painting systems shall be provided, unless otherwise specified or indicated on the Drawings. The manufacturer shall provide a certification that the factory painting system applied for equipment located indoors shall withstand 125 hours in a salt-spray fog test. Equipment located outdoors shall withstand 500 hours in a salt-spray fog test. Salt-spray fog test shall be in accordance with ASTM B 117 standards.

B. Immediately after completion of the testing, the paint shall show no signs of blistering, wrinkling, cracking, or loss of adhesion. The paint shall show no signs of rust creepage beyond 0.125 inches on either side of the scratch mark.

C. The film thickness of the factory painting system applied on the equipment shall not be less than the film thickness used on the test specimen. All manufacturers' standard factory painting systems shall be designed for the maximum surface temperatures expected to occur on each respective piece of equipment.

3.04 FACTORY PAINTING OF METALLIC SURFACES

A. Clean, pre-treat, prime and paint all metal surfaces. Stainless steel, aluminum, brass, bronze, copper, and plastic surfaces shall not be painted unless specifically indicated in the Contract Documents. Apply all coatings to clean dry surfaces. Clean all surfaces to remove dust, dirt, rust, oil and grease prior to application of paint. Surfaces subject to temperatures in excess of 120 degrees F shall be cleaned to bare metal prior to painting.

B. Where more than one coat of paint is required, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat shall be the manufacturer's standard unless otherwise specified or indicated on the Drawings.

C. All metallic surfaces which are designed to experience temperatures less than 120 degrees F shall receive one coat of epoxy pretreatment primer applied to a minimum dry film thickness of 0.3 mils, one coat of epoxy primer applied to a minimum dry film thickness of 1.0 mils; and two coats of epoxy applied to a minimum dry film thickness of 1.0 mils per coat.

D. All metallic surfaces which are designed to experience temperatures between 120 and 400 degrees F shall receive two coats of 400 degrees F heat-resisting epoxy applied to a total minimum thickness of 2.0 mils.

E. All metallic surfaces which are designed to experience temperatures greater than 400 degrees F shall receive two coats of 1,000 degrees F heat-resisting epoxy paint applied to a total minimum dry film thickness of 2.0 mils.

3.05 INSTALLATION

A. The CMGC shall install all equipment in accordance with the manufacturer's requirements. Do not install any equipment until all defects or inadequacies in receiving structures have been corrected to meet the design as noted in the Contract Documents. Erect and lubricate all products and equipment in strict accordance with the manufacturer's instructions. Installation shall include providing all oils and grease required for proper operation.

B. All equipment mechanisms shall withstand all stresses that may occur during fabrication, erection, intermittent or continuous operation. The CMGC shall furnish and install all supports as indicated on the Drawings, and as required by the equipment manufacturer.

C. Thoroughly clean all equipment and appurtenant piping to remove all dirt, grease, mill scale, tools, dust, and other foreign matter. The CMGC shall touch up all factory finishes to the satisfaction of the Engineer.

3.06 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.07 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.08 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 40 05 13
PROCESS PIPE AND FITTINGS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Provide all labor, materials, equipment, incidentals, and appurtenances required for process pipe and fittings in accordance with this Section and applicable reference standards listed in Article 1.03.
2. The following sections reference the process piping and specification reference numbers shown in the piping tag symbols on the Drawings. Pipes without pipe tag symbols are specified elsewhere. The piping included in this Specification may or may not all be required for the Work. Provide all pipe that is specified, indicated on the Drawings and/or is required to complete the work indicated in the Contract Documents.
3. Furnish, install, test and make ready for operation all process pipe and fittings of the type(s) and size(s) required as shown on the Drawings and as specified herein. Provide all related appurtenances, including but not limited to attachments, foundations, anchors, supports, couplings, restraints and all related accessories to provide complete operational piping systems as shown on the Drawings and as specified herein.
4. Unless otherwise indicated, all fittings and appurtenances shall be of the same type and grade of materials as the connecting pipe. All products provided under this section shall conform to current AWWA and ANSI specifications as appropriate to the type of pipe specified.
5. Process pipe shall be defined as "Interior", "Above Grade Exterior Piping”, and "Below Grade Exterior Piping". Process piping shall include but is not limited to stormwater recirculation, city/town water, vent, and air piping systems as shown on the Drawings and as specified herein. The following sections reference the process pipe type and specification reference number shown in the piping tag symbols in the Contract Documents.
6. Furnish one set of all special tools required to completely assemble, disassemble, or maintain the process piping and appurtenances. Special tools shall refer to oversized or specially dimensioned tools, special attachments or fixtures, or any similar items.

1.02 RELATED REQUIREMENTS

A. Section 09 90 00 – Painting and Coating.

1.03 REFERENCES

A. Reference Standards:
1. ASME International (ASME):
   a. ASME A13.1 - Scheme for the Identification of Piping Systems.
   b. ASME B1.1 - Unified Inch Screw Threads (UN and UNR Thread Form).
   c. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
   d. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250.
   e. ASME B16.3 - Malleable Iron Threaded Fittings Classes 150 and 300.
   f. ASME B16.9 - Factory-Made Wrought Buttwelding Fittings.
   g. ASME B16.15 - Cast Bronze Threaded Fittings Classes 125 and 250.

h. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
i. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
j. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
k. ASME B16.26 - Standard for Cast Copper Alloy Fittings for Flared Copper Tubes.
l. ASME B31.1 - Power Piping.
m. ASME B31.9 - Building Services Piping.

2. ASTM International (ASTM):
   a. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   b. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   c. ASTM A 181/A 181M - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
   d. ASTM A 193/A 193M - Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
   e. ASTM A 197/A 197M - Standard Specification for Cupola Malleable Iron.
   f. ASTM A 234/A 234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
   g. ASTM A 240/A 240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.
   h. ASTM A 269/A 269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
   i. ASTM A 276/A 276 M - Standard Specification for Stainless Steel Bars and Shapes.
   j. ASTM A 307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.
   k. ASTM A 312/A 312M - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
   l. ASTM A 351/A 351 M - Standard Specifications for Castings, Austenitic, for Pressure-Containing Parts.
   m. ASTM A 380/A 380M - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   n. ASTM A 403/A 403M - Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
   o. ASTM A 449 - Standard Specification for Hex Cap Screw, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use.
   p. ASTM A 463/A 463M - Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process.
   q. ASTM A 479/A 479M - Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels.
   r. ASTM A 530/A 530M - Standard Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe.
   s. ASTM A 536 - Standard Specification for Ductile Iron Castings.
   t. ASTM A 632 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing (Small-Diameter) for General Service.
   u. ASTM A 733 - Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples.
   v. ASTM A 774/A 774M - Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
   w. ASTM A 778/A 778M - Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
   x. ASTM B 117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.

y. ASTM B 61 - Standard Specification for Steam or Valve Bronze Castings.
z. ASTM B 62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
aa. ASTM B 88 - Standard Specification for Seamless Copper Water Tube
bb. ASTM C 150/C 150M - Standard Specification for Portland Cement.
cc. ASTM D 1238 - Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.
dd. ASTM D 1248 - Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
ee. ASTM D 1598 - Standard Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure.
ff. ASTM D 1599 - Standard Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings.
gg. ASTM D 1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
hh. ASTM D 1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
ii. ASTM D 2000 - Standard Classification System for Rubber Products in Automotive Applications.
jj. ASTM D 2239 - Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
kk. ASTM D 2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
ll. ASTM D 2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
mm. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials.
nn. ASTM F 1476 - Standard for Performance of Gasketed Mechanical Couplings in Piping Applications.
oo. ASTM F 402 - Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings.
pp. ASTM F 439 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
qq. ASTM F 441/F 441M - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
rr. ASTM F 493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
ss. ASTM F 593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
tt. ASTM F 594 - Standard Specification for Stainless Steel Nuts.

3. American Water Works Association (AWWA):
   a. AWWA C104/A21.4 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
   b. ANSI/AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings, 3 in through 48 in (76 mm through 1219 mm), for Water.
   c. ANSI/AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   d. AWWA C115/A21.15 - Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges.
   e. AWWA C150/A21.50 - Thickness Design of Ductile-Iron Pipe.
   f. AWWA C606 - Grooved and Shouldered Joints.
   g. AWWA M 11 - Steel Water Pipe: A Guide for Design and Installation.

4. International Organization for Standardization (ISO):
    a. ISO 228-1 - Pipe Threads Where Pressure-Tight Joints Are Not Made on the Threads - Part 1: Dimensions, Tolerances and Designation.
5. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):
    a. MSS SP-58 - Standard for Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
    b. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
    c. MSS SP-69 - Standard for Pipe Hangers and Supports - Selection and Application.
6. NSF International (NSF):
    a. NSF 372 - Drinking Water System Components – Lead Content.
    b. NSF 61 - Drinking water System Components – Health Effects.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
    1. SD-02 Shop Drawings:
        a. Shop Drawings for each type of process pipe shall be identified with the applicable style or series designation. Shop drawings shall show layout and dimensions of equipment, major components, key alignment locations and locations of bolt holes. Drawings shall show critical field dimensions identified by the Manufacturer.
        b. Shop Drawings shall show layouts and dimensions of the piping, including actual pipe lengths, diameters, fittings and appurtenances.
    2. SD-03 Product Data:
        a. Submit sufficient product data to verify compliance with the specifications and to illustrate the construction and assembly of the products. Include compliance of materials and components with applicable standards. Product data shall include manufacturer's descriptive data, technical literature, performance charts, catalog cuts, and installation instructions.
    3. SD-05 Test Reports:
        a. Submit field test reports for each section of piping tested for pressure and leakage.
    4. SD-06 Certificates:
        a. Prior to shipment of pipe, submit a certified affidavit of compliance from the pipe manufacturer stating that the pipe, fittings, gaskets, linings and exterior coatings for this Project have been manufactured and tested in accordance with applicable WWA, ASTM and other standards as well as the requirements specified herein.

1.06 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. All welding shall be conducted under qualified welding procedures. All welders and operators shall be certified in accordance with the latest applicable AWS and ANSI codes for shop and Project Site welding of piping work. Furnish written proof of certifications upon request from the Engineer.

C. All piping systems, components, and appurtenances in contact with potable water including potable water during any stage of treatment or conditioning shall be certified to meet the requirements of NSF 372 and NSF 61 for water service.

D. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components. All castings used for fittings and couplings shall be date stamped for quality control and traceability.

1.07 DELIVERY, STORAGE AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. All equipment delivered and placed in storage shall be provided with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants in accordance with the Manufacturer's written instructions.

C. Finished surfaces of all exposed openings shall be protected by caps, wooden blanks or other suitable cover to prevent foreign material and debris from entering the equipment.

D. Off-load equipment at the installation site using equipment of sufficient size and design to prevent damage to the equipment. Immediately after off-loading, inspect all equipment for shipping damage or missing parts. Any damage or discrepancy shall be noted in a written claim with the shipper prior to accepting delivery. Validate all serial numbers and parts lists with the shipping documentation. Notify the Manufacturer of any unacceptable conditions with the shipper. Pipe which has been rejected after delivery shall be specifically marked for non-use and shall be removed from the Project Site at no additional cost to Atlantic Richfield Company. The acceptance of manufacturer's pipe samples prior to shipment shall not guarantee acceptance of all subsequent piping delivered to the job Site.

E. Where necessary to store outside, enclose with durable, waterproof wrapping. Store rubber products under cover out of direct sunlight. Do not store materials directly on the ground.

F. Plastic pipe shall be packed, packaged, and marked in accordance with ASTM D 3892 standards. A Material Safety Data Sheet (MSDS) in conformance with 29 CFR 1910 Section 1200(g) shall accompany each chemical product delivered for use in pipe installations. At a minimum, this includes all solvents, solvent cements, glues and other materials that may contain hazardous compounds. Handling of chemicals for piping installation shall be in accordance with ASTM F 402.

1.08 STACKING & UNLOADING

A. Unload all piping in strict accordance with the manufacturer's recommendations. Take care not to damage the pipe during unloading. Utilize padding on all hooks, slings, and pipe tongs used for unloading to prevent damage to the piping including exterior coating and interior lining. Damage to the interior lining of piping shall render it unfit for use. Dropping of pipe during unloading is not acceptable. Care shall be taken to not skid piping against stationary piping during unloading or stacking.

B. All piping shall be stacked in accordance within the limits recommended by its manufacturer. The piping shall be supported off the ground through the use on timbers, rails, or concrete as recommended by the piping manufacturer.

C. Avoid contact between stainless steel piping and ferrous surfaces or materials, which may lead to rusting of particles embedded in the walls of stainless steel piping. All stainless steel piping shall be stored on supports constructed of non-ferrous metal materials. All tools for stainless steel piping installation shall be specifically designated for use on stainless steel piping to ensure no contamination from ferrous metals occurs. All piping storage and fabrication supports shall be constructed from non-ferrous metal, stainless steel, or provided with a rubber lining.

1.09 WARRANTY

A. Provide in accordance with Division 01 General Requirements.

1.10 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

PART 2 - PRODUCTS

2.01 COPPER PIPE, TUBING & FITTINGS - TYPE (CU/1)

A. All interior copper piping and tubing for potable water, protected water, process fluids, compressed air, vacuum, inert gas, plant water, general use, and other pressurized service shall conform to ASTM B 88, Type L, Hard Temper. Pipe sizes and end connections shall be as shown on the Drawings or as specified. Provide all necessary end connections and appurtenances as required to connect to the end uses.

B. Press Fittings:
   1. Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer.
   2. Press fittings shall be designed to assure leakage of liquids and/or gases from inside the system past the sealing element of an un-pressed connection. The function of this feature is to provide easy identification of connections which have not been pressed prior to putting the system into operation.
   3. Press fittings shall be of the same Type and Temper of copper as the connecting pipe.

C. Flanged Joints:
   1. Where copper piping is connected to equipment the end connection shall be flanged. Flanges and flanged fittings shall be faced and drilled Class 125/150 in accordance with ASME B16.26 standards. For tie-in to existing flanges, field check existing flanges for non-standard bolt-hole configurations. Provide adaptors and fittings to assure new pipes and flanges mate properly. All flanged joints shall be in alignment with the holes mating with the centerline of the piping.
   2. All bolts for flanged connections shall be lubricated with a graphite and oil mixture prior to tightening. All bolts shall be tightened with proper tools to avoid overstressing the piping, bolts, and sealing gaskets beyond the proper designed limits.
   3. Alloy bolts ASTM A 193/A 193M, Grade B7 shall be tightened to obtain a stress of 45,000 psi. Carbon steel bolts ASTM A 307, Grade B shall be tightened to obtain a stress of 15,000 psi based on the root thread area. All flange bolts shall be of sufficient length so as to allow a minimum of 2 full threads to extend beyond the fastening nut. Provide dielectric isolation between dissimilar metals.

D. Threaded Joints:
   1. Threaded joints shall be made with an Engineer approved joint compound applied to the male thread only. The use of caulking on the threaded joint shall not be acceptable. All threaded connections shall be in accordance with ASME B1.20.1 standards. The threaded connections shall be full thread, true taper type, machined accurately to gauge. Size reductions shall be through the use of reducing fittings. All plugs shall be steel or brass with a square head design. Bushings and close nipples shall not be acceptable.

E. Solder & Flux:
   1. Solder and flux shall conform to ASTM B 32 standards. The solder alloy shall be 95 percent tin and 5 percent antimony on all pressure piping and potable water piping. No lead-bearing solder shall be permitted under any circumstances. All soldering shall conform to ASTM B 813 standards. Silver solder with 45 percent brazing silver alloy shall be utilized.
   2. All tubing shall be square cut with reamed ends to prevent improperly sized ends or burrs prior to soldering. Prior to soldering all surfaces shall be cleaned to a bright metal finish and be free of dirt, grease, or other foreign materials prior to fluxing and soldering. All cleaning shall be conducted using an emery cloth, sandpaper, or steel wool.
   3. Both the outside and inside ends of the pipe to be soldered shall be cleaned to a length of at least 3/4 inches greater than the depth of the fitting. All joints shall be assembled using non-corrosive flux. Acid solder or flux shall not be permitted under any circumstances. Any cracks, holes, areas of incomplete penetration, or other related defective connections shall not be acceptable. Peening of defects is not permitted under any circumstances.
   4. All soldered joints shall be heated uniformly to the solder melting point to allow a complete draw of the solder into the connecting joint. All excess solder shall be completely removed with a cloth brush. A fillet shall be left around the end of the fitting. All connections shall be required to have full penetration of solder throughout the entire connection joint. The cooling of soldered joints via quenching is not permitted.

F. Brazing:
   1. All flux shall be applied in strict accordance with the recommendations of the brazing manufacturer. Flux is required when joining copper tubing to cast bronze fittings. Flux is not required when joining copper tubing to wrought copper fittings. Parts to be joined shall be heated 1 inch from the edge of the fitting. Once the flux has become transparent, the heating of the fitting at the base of the cup shall commence. The torch flame shall move continuously throughout the process.
   2. Brazing materials shall be applied where the tubing enters the socket or fitting. Direct flames shall not be applied to the brazing material. Capillary action from the heated joint shall draw the brazing material into the joint. A properly made joint shall show a visible fillet completely around the pipe joint. No additional filler shall be added once a fillet has been formed.
   3. All flux material shall be removed once the brazing material has solidified. All fittings shall be allowed to cool naturally without the aid of separate quenching. Any cracks, holes, areas of incomplete penetration, or other related defective connections is not acceptable. Peening of defects is not permitted under any circumstances.

G. Grooved Joint Couplings and Fittings:
   1. Grooved end copper fittings shall be ASME B16.22 wrought copper or ASME B16.18 cast bronze, manufactured to copper tube dimensions. Flaring of tube or fitting ends to accommodate alternate sized couplings shall not be permitted.
      a. Unless otherwise specified or shown on the Drawings, all grooved end fittings for Type (CU/1) copper pipe of the same type, style, and duty shall be a product of the following manufacturer:
         1) Victaulic – Copper Connection.
         2) Engineer approved equal.
   2. Grooved joint couplings and associated fittings shall be ASTM A 536, Grade 65-45-12 ductile iron, manufactured to copper tube dimensions. Couplings shall have two housing segments. Coupling gaskets shall be pressure responsive elastomer, center-leg type with pipe stop to ensure proper groove engagement, alignment, and pipe

insertion depth. Fitting gaskets shall be {Poly Vinylidene Fluoride (PVDF) and Nitrile}. The coupling system shall be rated to 300 psi (2065 kPa) with Type K or L Copper Tubing.

a. Unless otherwise specified or shown on the Drawings, all grooved joint couplings for Type (CU/1) copper pipe of the same type, style, and duty shall be a product of the following manufacturer:
   1) Victaulic - Style 607.
   2) Engineer approved equal.

H. Copper Tubing:
1. All seamless copper alloy tubing shall conform to ASTM B 88M standards, alloy C12200, Type L, with an O60 annealed temper. Copper tubing shall only be used where specified or specifically indicated on the Drawings.

I. Copper Joints:
1. If the joint type is not specified elsewhere, use soldered joints or joining as directed by the Engineer. Dielectric fittings or isolation joints and materials shall be provided between all dissimilar metals.
2. Unions shall be installed to allow for ease of disassembly for any future piping alterations or repairs. All unions shall be installed as shown on the Drawings and as directed by the Engineer. Unions shall also be installed in in long piping runs, equipment bypasses, connections to equipment, pumps, tanks and between shutoff valves.
3. Unions or flanges for servicing and disconnect are not required in installations using grooved joint couplings.

J. Copper Fittings – General:
1. All component castings of flanges and fittings shall be copper alloy and shall conform to ASTM B 61 or ASTM B 62 standards. Solder joint fittings shall conform to ASME B16.22 and ASME B16.18 standards. Fittings for flared copper tube shall conform to ASME B16.26 standards. Cast bronze threaded fittings shall conform to ASME B16.15 standards and shall be threaded in accordance with ASME B1.20.1 standards. Tubing compression fittings shall be forged brass alloy C37700, conforming to ASTM B 124/B 124M standards.
2. Flared fittings shall not be used without prior written approval from the Engineer.
3. Fittings shall match the type and grade of the connecting piping.

K. Bolting for Copper Piping:
1. All bolting materials shall meet the requirements of ASME B31.1 standards. Bolts shall be provided with washers of the same material as the bolts. Provide flange bolt isolators for all dissimilar metals.

L. Pipe Bending:
1. All bending of copper piping shall be in accordance with the recommendations of the pipe manufacturer. All bends shall be free from damage including, but not limited to, holes, cracks, or buckles.

2.02 DUCTILE IRON PIPE & FITTINGS - TYPE (DI/1)

A. All Type (DI/1) ductile iron piping shall be Class 52 flanged pipe and fittings per AWWA C150/A21.50, AWWA C115/A21.15, and AWWA C110/A21.10 standards. Flanges shall conform to the drilling and facing of ASME B16.1/ANSI Class 125/150 unless otherwise noted or as required to connect to valves, tanks, equipment, and other appurtenances.

B. The minimum class thickness for flanged pipe shall be Class 52 for sizes up through 54 inches. All flanged pipe joints shall be assembled using gaskets. All pipes shall be provided and installed in standard lengths whenever possible.

C. All Type (DI/1) ductile iron pipe of the same type, style, and duty shall be supplied by a product of the following manufacturer:
   1. U.S. Pipe & Foundry Company Inc.
   2. American Cast Iron Pipe Company.
   3. Clow Water System Company.
   4. Engineer approved equal.

D. Flanges & Connectors:
   1. All ductile iron flanges shall conform to ANSI/AWWA C115/A21.15 and be flat faced type unless otherwise specified or indicated on the Drawings. All ductile iron fittings shall conform to ANSI/AWWA C110/A21.10 standards and be pressure rated for 250 psi. As a minimum, all fittings shall be rated equally to the connecting piping.
   2. Unless otherwise specified or indicated on the Drawings, all ductile iron piping and fittings shall utilize ANSI standard flanged connections.
   3. The use of alternative joining methods, including but not limited to couplings, and flanged adaptors shall be acceptable where specifically indicated and as approved by the Engineer. Rigid grooved connections with rigid connectors shall be acceptable where specified or indicated on the Drawings or as approved by the Engineer.

E. Interior Linings:
   1. Unless otherwise specified or shown on the Drawings, all type (DI/1) ductile iron piping shall be provided with a cement-mortar lining. The cement-mortar lined piping shall conform to AWWA C104/A21.4 standards. The cement used shall be Type II and be in accordance with ASTM C 150.
   2. Ductile iron piping used for high temperature applications such as air piping shall be unlined.

F. Exterior Coatings:
   1. An exterior coating shall be provided for all ductile iron pipe, fittings, and flanges. Unless otherwise specified or noted on the Drawings, the prime coat shall be factory applied. The top coat (finished coat) shall be field applied as approved by the Engineer. The top coat shall match the color coding for the material to be handled by the pipe. All field finish painting shall be in accordance with Section 09 90 00 – Painting and Coating.
   2. Unless approved in writing by the Engineer the finished coat shall be applied prior to assembly of the pipe in moist areas. Stainless steel flange hardware shall not be painted with epoxy paint.
   3. Submerged piping shall not require a urethane finish.
   4. The pipe shall not be coated at pipe and fitting ends to allow for Engineer approved installation of joint connections in the field. The pipe manufacturer shall provide all necessary coating materials for application at factory supplied uncoated piping locations. All field applied coatings shall be a product of the same manufacturer as the factory prime coating to ensure compatibility. All flange bearing surfaces shall be left uncoated.
   5. Field repair of damaged pipe coatings shall receive prior written approval by the Engineer. If the Engineer deems the coating damage to be beyond repair, all damaged piping shall be replaced at no additional cost to Atlantic Richfield Company or the Engineer.

G. Flange Hardware:
   1. All nuts, bolts, washers and other flange or coupling fastening hardware shall be 304 stainless steel for interior and above grade exterior installations. Provide 304 stainless steel flange hardware for submerged, below grade, and in tank installations. Threads shall be coated with mineral oil or other anti-seize compound. Bolts shall be square headed machine bolts with hexagonal nuts in accordance with ANSI B18.2 standards. All threads shall conform to ANSI B1.1 standards. The bolts shall be of an adequate length such that they protrude through the nut following tightening. The bolt protrusion shall not exceed 1/2 inch.

H. Pipe Markings:
   1. All ductile iron pipe and fittings as specified in this section shall be permanently marked with the manufacturer, date of manufacture, size, type, class, wall thickness, and standard produced to (ASTM, AWWA, ANSI).

I. Non-Standard Fittings:
   1. Fittings with non-standard dimensions shall only be allowed with prior written approval of the Engineer. Unless approved in writing by the Engineer, all non-standard fittings shall meet the Specification requirements for standard fittings and be of the same thickness and diameter. Laterals or reducing elbows not meeting the requirements of ANSI A21.10 standards shall meet the requirements of ANSI B16.1, Class 125.

J. Joint Bracing:
   1. Provide joint bracing as shown on the Drawings and as required to prevent piping from being pulled apart when under pressure. If used, all bridles and tie rods shall be a minimum of 3/4 inches in diameter except when they replace flange bolts of a smaller size. If replacing flange bolts of a smaller size, the bridles shall be fitted with a nut on each side of the pair of flanges.
   2. All pipe which requires joint bracing shall be provided with Engineer approved lugs and hooks cast integrally for use with pipe clamps, tie rods, or bridles. All pipe clamps, tie rods, and bridles shall be provided with the same coating as the piping system for interior applications except that stainless steel hardware shall not be painted.

2.03 DUCTILE IRON PIPE AND FITTINGS - TYPE (DI/2)

A. All Type (DI/2) ductile iron piping shall be of Class 350 mechanical joint pipe and fittings for buried applications as per AWWA C151/A21.51 standards. Pipe shall be supplied in standard lengths whenever possible. The pipe thickness design shall be in accordance with AWWA C150/A21.50 standards, except provide a minimum of Class 350 for all piping 12 inches and smaller. Provide a minimum Class 350 for piping from 14 inches to 24 inches and provide a minimum of Class 250 for piping larger than 24 inches.

B. All Type (DI/2) ductile iron pipe of the same type, style, and duty shall be supplied by a single manufacturer. All Class 350 ductile iron process piping shall be a product of the following manufacturer:
   1. U.S. Pipe & Foundry Company Inc.
   2. American Cast Iron Pipe Company.
   3. Engineer approved equal.

C. Mechanical Joint Fittings:
   1. Mechanical joint compact body fittings shall be ductile iron class 350 and shall be produced in strict accordance with AWWA C153/A21.53 and AWWA C111/A21.11 standards. All pipe and fittings shall be provided with a cement and mortar lining in accordance with AWWA C104/A21.4 standards for sizes 3 inches through 12 inches.

Pipe and fittings 14 inches through 24 inches shall be a manufacturer's standard and produced to AWWA C153/A21.53 standards. Mechanical joint fittings shall be Underwriters Laboratories (UL) listed and rated at 350 psi.

D. Restrained Joint Fittings:
   1. All joints shall be rated for pressure service. Joints shall be restrained rubber-gasket mechanical joints and fittings conforming to AWWA C111/A21.11 standards. All gaskets shall be as specified. All restrained type joints shall be locked type and be produced by the pipe and fitting manufacturer. The joints shall utilize restraint independent of the joint gasket.
   2. All restrained mechanical joints shall be in accordance with Specification 40 05 14 – Process Pipe Couplings and Connectors, Type C14 Couplings.

E. Standard mechanical joint glands shall be ductile iron per ASTM A 536 standards, Grade 65-45-12.

F. Mechanical Joint Hardware:
   1. Mechanical joint nuts and tee-head bolts shall be from Corten Steel Company and shall meet or exceed the requirements of AWWA C111/A21.11, 11-7.5 and ANSI A-21.22 for high strength, low alloy steel, having the following composition: a maximum of 0.20 percent carbon, 1.25 percent manganese, 0.50 percent sulfur, 0.25 percent nickel, 0.20 percent copper with a minimum combined of 1.25 percent of nickel, copper and chromium. The mechanical joint nuts and tee-head bolts shall have minimum yield strength of 45,000 psi and an elongation in 2-inch increments of 20 percent.

G. Interior Linings:
   1. Unless otherwise specified or shown on the Drawings, all type (DI/2) ductile iron piping shall be provided with a cement-mortar lining. The cement-mortar lined piping shall conform to AWWA C104/A21.4 standards. The cement used shall be Type II and be in accordance with ASTM C 150.
   2. Ductile iron piping used for high temperature applications such as air piping shall be unlined.

H. Exterior Coatings:
   1. Pipe shall have an exterior bituminous coating.

2.04 PVC PIPE & FITTINGS - TYPE (PVC/1)

A. All type polyvinyl chloride (PVC) pipe and fittings shall be socket welded Schedule 80 PVC pipe. The pipe shall conform to ASTM D 1785 standards, PS 21-70, PVC 1120. Pipe material shall be Type I, Grade I, compound cell classified 12454-B per ASTM D 1784 standards. The PVC compound shall be gray in color. The pipe marking shall indicate the pressure rating in psi for water at 73 degrees F, per ASTM D 1785 standards, as well as the manufacturing date code. Schedule 80 fittings shall comply with ASTM D 2467 standards.

B. Flange dimensions shall conform to ASME B16.1, Class 125 standards unless otherwise indicated or required for connection to pumps, tanks, equipment, and appurtenances. Unions shall utilize Viton O-Rings or a material compatible with the process fluid. The pipe shall have a minimum hydrostatic design stress of 2,000 psi at 73 degrees F.

C. Pipe, fittings, and solvent cement for use with potable water shall be certified by National Sanitation Foundation (NSF) Standard No. 14 and the seal shall be included on the pipe.

D. All Type (PVC/1) of the same type, style, and duty shall be supplied by a single manufacturer. All Type PVC/1 piping shall be a product of the following manufacturer:
   1. CertainTeed Corporation.
   2. J-M Manufacturing Company, Inc.
   3. Harvel Plastics, Inc.
   4. Engineer approved equal.

E. PVC Cement:
   1. All cement for socket welded connections shall be low volatile organic compound (VOC) emission, heavy bodied, medium setting, high strength solvent cement.
   2. When bonding sodium hypochlorite piping, sodium hydroxide piping or any other acid piping system, the cement shall be specially formulated for the chemical application. The PVC cement shall conform to ASTM F 402, ASTM D 2564 and ASTM F 493 standards; All Schedule 80 PVC piping solvent cement for acid and chemical piping systems shall be a product of the following manufacturer:
      a. IPS Corporation - Series 724.
      b. Engineer approved equal.

F. Flanged Joints:
   1. All flanges shall be single piece and be suitable for solvent cementing to the pipe. Two-piece sleeve flanges are not acceptable.
   2. All bolts, nuts, washers, and other fastening devices shall be designed for use in corrosive service environments. All fastening devices shall be 304 stainless steel and conform to ASTM F 593 and ASTM F 594 standards. All nuts and bolts shall be installed with an anti-seize compound of molybdenum disulfide base.

2.05 STAINLESS STEEL PIPE & FITTINGS - TYPE (SS/1)

A. All Type SS/1 piping shall be flanged or welded, Type 304L, Schedule 10S with dimensions conforming to ASME B36.19M and ASTM A 778 standards.

B. Only where specifically noted, specified, or indicated on the Drawings; pipe shall be austenitic type intended for general corrosive or high-pressure service in accordance with the requirements of ASTM A 312/A 312M standards.

C. All stainless steel piping shall be fabricated from stainless steel sheet conforming to ASTM A 778 standards. The carbon content of all 304L stainless steel shall be no greater than 0.03 percent.

D. All pipe shall be finished to No. 1 or better.

E. All pipe tolerances for length, inside diameter, outside diameter, and straightness shall conform to ASTM A 530/A 530M standards.

F. All pipe shall be die-formed or rolled true to dimension and round. Ends of pipe and fittings shall be perpendicular to the longitudinal access. All interior welds shall be smooth and even. The internal bead shall not exceed 1/16 of an inch in height. Any longitudinal seams on fittings and pipe shall be welded by the tungsten or metallic gas methods.

G. All Type SS/1 piping of the same type, style, and duty shall be supplied by a single manufacturer. All stainless steel piping shall be a product of the following manufacturer:
   1. Douglas Brothers.
   2. Felker Brothers Corporation.
   3. Engineer approved equal.

H. Stainless Steel Joints:
   1. Stainless steel piping shall be joined by welded fittings, flanges, or rigid roll groove joints with rigid 316 stainless steel connectors.
   2. Rigid roll grooved joints shall utilize Type C06 couplings in accordance with Section 40 05 14 – Process Pipe Couplings & Connectors. Flexible roll grooved joints shall utilize Type C04 couplings in accordance with Section 40 05 14 – Process Pipe Couplings & Connectors.
   3. Plain end Schedule 10S pipe with pressure sealed (press type) joints and fittings may be used on applicable piping systems 2 inches and smaller.
   4. Dielectric fittings or isolation joints shall be provided between all dissimilar metals. Fittings shall be smooth curve type, same schedule, and same size as the pipe they are connected to. Fittings shall conform to ASTM A 774/A 774M and ANSI B16.9 standards.
   5. Unless otherwise indicated, connections at valves, strainers, and equipment shall be flanged.

I. Fittings:
   1. Unless otherwise indicated, all reducers shall be straight tapered, cone type. Eccentric reducers shall be provided as indicated on the Drawings. All tees, crosses, laterals, and wyes shall be shop fabricated from stainless steel pipe.
   2. All long radius elbows up to 24 inches in diameter shall be manufactured so the centerline to end of elbow dimension is equal to 1.5 times the nominal pipe size.
   3. Unless otherwise specified or indicated on the Drawings, all elbows and associated fittings shall be smooth curved radial type. Mitered elbows and fittings shall be acceptable for larger diameter piping (24 inches and larger).
   4. Substitutions of mitered fittings for radial fittings shall only be as approved in writing by the Engineer. A minimum of 5 miter sections shall be provided for 90 degree bends. A minimum of 3 mitered sections shall be provided for 45 and 60 degree bends. A minimum of 2 mitered sections shall be provided for 30 degree and smaller bends.
   5. Pressure sealed (press type) fittings shall be precision, cold drawn, stainless steel with elastomer O-rings for working pressures up to 500 psig. Unless otherwise specified or shown on the Drawings, all pressure sealed fittings for Type (SS/1) stainless steel pipe of the same type, style, and duty shall be a product of the following manufacturer:
      a. Victaulic – Vic-Press.
      b. Engineer approved Equal.

J. Grooved Joint Couplings and Fittings:
   1. Grooved joint couplings shall have two ASTM A536, Grade 65-45-12 ductile iron or ASTM A351, Grade CF8M stainless steel housing segments.
      a. Rigid type couplings shall have a housing key that engages with the bottom of the groove. Unless otherwise specified or shown on the Drawings, all rigid type grooved end couplings for Type (SS/1) stainless steel pipe of the same type, style, and duty shall be a product of the following manufacturer.
         1) Victaulic – Series 89.
         2) Engineer approved equal.
      b. Flexible type couplings shall be used in locations where vibration attenuation and stress relief are required. Unless otherwise specified or shown on the Drawings, all flexible type grooved end couplings for Type (SS/1) stainless steel pipe of the same type, style, and duty shall be a product of the following manufacturer:
         1) Victaulic – Series 77.
         2) Engineer approved equal.
      c. Grooved joint fittings shall be ASTM A403 wrought stainless steel or factory-fabricated from ASTM A312 stainless steel pipe.

K. Welding:
   1. All welding shall be conducted using filler wire of extra low carbon (ELC) grade. The cross section of all welds shall be equal to or greater than the piping thickness. All butt welds shall have full penetration to the interior surface of the joint and pipe. Provide gas shielding or solar flux on the interior and exterior of the pipe or fitting joint.
   2. All welds shall provide a smooth and even finished surface. All welds shall have a bead height of 1/16 inches. All angle face rings shall be welded on all sides of the pipe and fitting. All welding for angle face rings shall be continuous.
   3. Remove all excess slag, spatter, and weld deposits by grinding. All welds on surfaces to be sealed with gaskets shall be ground to a smooth level surface. Repair all welding defects, including but not limited to, crevices, pin holes, cracks, undercuts, or concavity at no additional cost to Atlantic Richfield Company or the Engineer.
   4. All piping with wall thicknesses up to 0.125 inches shall be welded with the tungsten inert gas (TIG) process. All piping with heavier walls shall be properly beveled and have a root pass with the TIG process. Additional welding passes shall be provided with the TIG, metal inert gas (MIG), or metallic arc processes.

L. Stainless Steel Welded Fittings:
   1. All welding fittings shall be butt-welded. Butt welds shall have 100 percent penetration to the interior or backside of the weld joint. All fittings shall be forged austenitic stainless steel in accordance with ASTM A 774/A 774M standards. The grade shall match the connecting pipe and conform to ASME B16.9 and ASME B16.28 standards.
   2. Only where specifically noted, specified, or indicated on the Drawings; provide fittings to match the connecting piping in accordance with ASTM A 403/A 403M standards.
   3. All shop welding of fabrications shall be done according to the procedures and by welders certified per ASME Section IX. Welds shall be by an inert gas shielding process using only extra low carbon filler metals. Welds shall have a bead height of no more than 1/16 of an inch. Cross-sectional thickness of welds shall be equal or greater than that of the parent metal.

M. Stainless Steel Flanges:
   1. Flanges shall be used on stainless steel piping where shown on the Drawings, and where approved by the Engineer. Flanges shall be provided at the connection to valves, equipment, couplings, and other appurtenances.
   2. The internal diameter bores of flanges and flanged fittings shall be the same as that of the connecting pipe. The flanges shall be slip-on type rolled angle face rings with stainless steel backing flanges. Flanges and flanged fittings shall be the same grade as the pipe and be drilled to ASME B16.5 standards.
   3. For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations. Assure the new pipe and flange mate properly to the existing pipe.
   4. Flanges for pipe larger than 4 inches shall have stub ends, angle type stub ends, or angle rings of the type of stainless steel as the pipeline welded to the pipe end.
   5. Bolts, washers, nuts, and other hardware for flange bolting shall be of a material as specified below.

N. Backing Flanges:
   1. Unless otherwise specifically noted, specified or indicated on the Drawings, all backing flanges shall be 304 stainless steel. All backing flanges shall be drilled to ASME B16.5 Class 125/150 or as required match to the respective connecting equipment or appurtenance. The angle face ring thickness shall be equal to or greater than the wall of the pipe or fitting to the sides of the pipe or fitting. The angle leg shall not create interferences with the flange bolt holes.

2. Only where specifically noted, specified or indicated on the Drawings, provide ductile iron backing flanges in accordance with ASTM A-536-80 standards. All ductile iron back-up flanges shall be shop primed and field finished painted in accordance with Section 09 90 00 – Painting & Coating. Where the pipe stub is to pass through a sleeve during installation, a split-type back up flange shall be used.
3. Cast austenitic stainless steel backing flanges shall conform to ASTM A 351/A 351M and/or ASTM A 240 standards and shall be drilled to ASME B16.5 Class 125/150 or as required to match to the connecting equipment or appurtenances.
4. All backing flanges shall have minimum thicknesses in accordance with the following:

Pipe Size (Inches)	Flange Thickness (Inches)
2 to 8	1/2
10 to 1	5/8
18 to 2	3/4
24 to 3	1
36 to 6	1-1/4

O. Pipe Ends & Couplings:
1. Unless otherwise specified or indicated on the Drawings, all stainless steel piping and fittings shall utilize welded or ANSI standard flanged. Unless otherwise specified or indicated on the Drawings, the use of alternative joining methods, including but not limited to couplings and flanged adaptors, is not acceptable without prior written approval from the Engineer.
2. The use of rigid shouldered end connections shall be acceptable where specified or indicated on the Drawings and as approved by the Engineer.
3. All connections to valves, process equipment and appurtenances shall be flanged. Replacement of flanged joints with shop butt welds or continuous pipe runs shall be acceptable with prior written approval of the Engineer. The manufacturer shall specifically indicate all connection types and locations as part of Shop Drawing submittals.
4. All pipe ends shall be prepared for couplings or other type ends where required by transport and handling limitations, where required by the support layout requirements, and where noted on the Drawings.
5. Grooving and built-up ends for stainless steel piping shall be of the coupling manufacturers standard type. The Construction Management General Contractor (CMGC) shall be responsible for ensuring sufficient rigidity of joints. All normal pipe joints including but not limited to: at valves, pumps, equipment, and other related appurtenances, shall be flanged drilling per ANSI B 16.1, Class 125/150.
6. Schedule 5S and 10S pipe shall be grooved using a manufacturer-provided grooving tool equipped with RX roll sets, specifically designed for stainless steel pipe.
7. Split-sleeve couplings shall be a bolted, split-sleeve type. Housing shall be ASTM A240 Type 316/316L stainless steel and elastomers shall conform to ASTM D2000. Restraint rings, if required for joint restraint, shall be ASTM A276, 316L stainless steel.
    a. Unless otherwise specified or shown on the Drawings, all split-sleeve type couplings for Type (SS/1) stainless steel pipe of the same type, style, and duty shall be a product of the following manufacturer:
        1) Victaulic – Style 230S non-restrained flexible (ExE); 231S non-restrained expansion (FxE); and 232S flexible with joint restraint (FxF).
        2) Engineer approved equal.

P. Pipe Markings:
   1. All stainless steel piping shall be marked with the gauge and type of stainless steel and with the initials of the inspector marked on the inside of each piece, at each end.

Q. Finishing:
   1. All stainless steel pipe and fittings shall be fully submerged and pickled at the point of manufacture. After removal from the pickling bath, all piping shall be scrubbed and washed until all discoloration is removed in accordance with ASTM A 380 standards.
   2. The pickling bath shall be a minimum 25 percent solution of nitric and hydrofluoric acids at 125 degrees F. All stainless steel piping, fittings, and related appurtenances shall be fully immersed for a minimum of 20 minutes. All stainless steel shall be clean water rinsed after removal from the acid pickle.
   3. During fabrication and installation care shall be taken to avoid contact of stainless steel pipe with structural steel, chain, wire ropes, steel tools, and any other carbon steel products. The contamination of stainless steel by carbon steel may lead to marks due to rusting of imbedded steel. Provide repair and/or replacement of all contaminated stainless steel pipe, fittings, and appurtenances.

2.06 STAINLESS STEEL PIPE & FITTINGS - TYPE (SS/2)

A. All Type SS/2 stainless steel piping shall be Schedule 40, Type 304L, with National Pipe Thread Taper (NPT) threaded connections. All Type SS/2 stainless steel pipe and fittings shall be used for sample piping, instrument piping and gauge connections 2 inches and smaller in diameter as specified or as shown on the Drawings.

B. The piping shall meet ASTM A 312/A 312M, ASTM A 733, ASME B1.20.1, and ANSI B1.20.1 standards. All stainless steel piping shall be fabricated from stainless steel sheet conforming to ASTM A 778 standards. All pipe shall be finished to No. 1 or better.

C. Threaded fittings shall be austenitic stainless steel, Grade 304L, in accordance with ASTM A 182/A 182M ASME B16.11 standards. All fittings shall be threaded in accordance with ASME B1.20.1 standards. PTFE pipe-thread tape conforming to ASTM D 3308 standards shall be used for lubricant and sealant.

D. All Type (SS/2) piping of the same type, style, and duty shall be supplied by a single manufacturer. All stainless steel piping shall be a product of the following manufacturer:
   1. Felker Brothers Corporation.
   2. Douglas Brothers.
   3. Engineer approved equal.

2.07 HIGH DENSITY POLYETHYLENE PRESSURE PIPE – TYPE (PE/4)

A. Type (PE/4) high density polyethylene pressure piping to be DR-11, PE 3408 pipe with iron pipe size (IPS) outside diameter as indicated on Drawings. Pipe and fittings to conform to AWWA C906. Provide transition couplings, mechanical joint adaptors and stiffeners as required, as indicated on Drawings, as specified and as recommended by pipe manufacturers. Provide butt fusion or electro-fusion welded connections and molded fittings for Type (PE/4) piping.

B. Provide solid end caps for terminations as specified or as indicated on Drawings. Stiffeners, appurtenances and joint hardware to be 304 stainless steel.

C. Transition couplings from HDPE to other piping materials to be pre-assembled couplings, acceptable level of quality: equivalent to Poly-Cam, Inc.

2.08 NON-WOVEN FILTER FABRIC

A. Provide non-woven filter fabric in accordance with Section 31 05 00 - Geotextile.

2.09 DETECTABLE UNDERGROUND MARKING TAPE

A. Provide 4-inch wide detectable underground metallic marking tape for buried utilities including but not limited to force main pressure piping. Provide detectable marking tape as follows:
   1. Pressure Piping Systems - Force Mains - Detectable tape shall be brown and shall read "Caution - Buried Force Main Below".
   2. Underground marking tape shall be detectable marking tape, with a minimum 5.0 mil overall thickness. Tape shall be manufactured using a 0.8 mil clear virgin polypropylene film, reverse printed and laminated to a 0.35 mil solid aluminum foil core, and then laminated to a 3.75 mil clear virgin polyethylene film. Tape shall be printed using a diagonally striped design for maximum visibility and meet the APWA Color-Code standard for identification of buried utilities.

2.10 GASKETS

A. All gaskets shall conform to ANSI/AWWA C111/A21.11. Gaskets shall be provided by the pipe manufacturer unless otherwise noted. Unless otherwise noted, all gaskets 12 inches in diameter or less shall be a minimum of 1/8 inches thick. All gaskets larger than 12 inches in diameter shall be a minimum of 3/32 inches thick.

B. Gaskets shall have a smooth finish, be designed for use in plastic, metal or plastic-lined metal piping systems as applicable and be compatible with the associated process fluid. Gaskets for use in potable water service shall have an NSF 61 listing. Gaskets for low pressure air piping shall be suitable for use at temperatures to 250 degrees F.

C. Gaskets for use on flanged piping shall be low torque, flat ring type, full face to ANSI B16.5 dimensions for 125/150-pound flanges and rated for a minimum pressure of 150 psi. Gaskets shall have two concentric, convex, molded rings between the center hole and bolt hole circle. For flanged CPVC piping, when the mating flange has a raised face an additional filler gasket shall be provided between the outer diameter of the raised face and outer diameter of the flange to protect the flange from bolting moments.

D. Gaskets for use on mechanical joint and push-on joint piping shall meet or exceed the minimum requirements of AWWA C111/A21.11 for styrene-butadiene rubber (SBR) gaskets. Gaskets for use on bell and spigot joint FRP piping shall be EPDM.

E. Gaskets for use with grooved end joints shall be pressure responsive elastomer. Gaskets for carbon steel grooved end piping shall be EHP and suitable for water service to 250 deg F.

F. If for a specific application a pipe or valve manufacturer recommends a different type of gasket than that specified, the CMGC shall submit to the Engineer the gasket information for review and approval.

G. Provide gaskets constructed of the following materials for process fluids and chemical piping systems as shown on the Drawings:
   1. Stormwater Recirculation (Interior and Below Grade Exterior): EPDM.

H. All gaskets of the same type and material shall be provided by a single Manufacturer. All gaskets shall be a product of the following Manufacturer:
   1. Asahi America, Inc.
   2. Allstate Gasket & Packing, Inc.
   3. Metro Industries, Inc.
   4. Engineer approved equal.

2.11 UNIONS

A. When joining pipe segments, provide unions where called for on the Drawings and as specified. Provide additional unions to allow for disassembly of piping segments. Provide unions at pumps, equipment and valves to allow for removal without disassembly of the piping systems.

B. Unions or flanges for servicing and disconnect are not required in installations using grooved joint couplings.

2.12 PIPE AND FITTINGS COATINGS

A. An exterior coating shall be provided for all ferrous metallic pipe, fittings, and flanges. The prime coat shall be factory applied. The finish coat shall be field applied. The finish coat may be factory applied for all submerged piping applications. The finish coating color shall match existing color coding for retrofit or upgrade Projects. For new Projects and systems, the color coding shall be as directed by the Engineer.

B. The color coding shall be unique color for each fluid carried. Fluid designations are provided on the Drawings. The Engineer and Atlantic Richfield Company shall determine colors for each application.

C. Unless otherwise indicated, all ferrous metallic pipe shall be field finish painted. Refer to Section 09 90 00 – Paint and Coatings as well as the piping manufacturer's recommendations for coating types and requirements. Coat ferrous metallic pipes, fittings, hangers and supports using the same paint system. Stainless steel pipe, stainless steel pipe supports, stainless steel hardware and appurtenances shall not be painted. All ferrous metallic pipe in submerged applications does not require a urethane finish. The finished coating shall be a product of the same manufacturer as the prime coat to ensure compatibility.

D. Confirm the final color-coding with Atlantic Richfield Company and the Engineer prior to any application.

2.13 ATTACHMENT HARDWARE

A. Unless otherwise indicated, all attachment hardware, including but not limited to nuts, bolts, washers and all related fastening devices shall be 304 stainless steel. Threads shall be coated with mineral oil or another anti-seize compound prior to installation. Hardware for submerged applications shall be 304 stainless steel.

2.14 PIPE LABELS

A. All piping shall be labeled on 2 sides at maximum 15-foot intervals. A flow direction arrow shall follow the label legend and be of the same color. The labels shall meet or exceed ASME A13.1 and ANSI standards. The legend letters shall be capitalized and be black or white, depending on the background color. The labels shall be self-adhesive vinyl type. The labels shall be suitable for a pipe temperature range of minus 40 degrees F to 175 degrees F. Clip on or zip tied labels are not acceptable.

B. The pipes shall be labeled according to the fluid carried. The labels shall match the fluid designations as shown on the Drawings. Provide a detailed submittal, which shall include each pipe label for each of the respective fluid designations for review by the Engineer. Pipe labels shall be installed on the exterior of all piping insulation and jacket.

C. The piping labels shall spell out the entire fluid designation, not the abbreviation. Confirm the naming convention with the Engineer and Atlantic Richfield Company prior to ordering the labels. Color coding of labels shall be as approved by the Engineer.

D. All pipe labels of the same type, style, and duty shall be supplied by a single manufacturer. All pipe labels shall be a product of the following manufacturer:
   1. MSI Marking Services, Inc.
   2. Brimar Industries, Inc.
   3. Engineer approved equal.

2.15 THRUST BLOCKS

A. Provide concrete thrust blocks at pressure pipe fittings as specified, as indicated on Drawings and as directed by Engineer. Thrust blocks shall be 3,000 psi (minimum) compressive strength concrete. Cast-in-place concrete thrust blocks shall be ready mixed concrete from a concrete truck. Pre-cast concrete thrust blocks shall also be acceptable. Refer to Drawings for additional details and requirements.

2.16 RIGID INSULATION

A. Provide rigid insulation as specified, as indicated on Drawings or as directed by the Engineer. Insulation shall be rigid, cellular polystyrene thermal insulation with closed cells and integral high-density skin, formed by the expansion of polystyrene base resin in an extrusion process to comply with ASTM C 578. Insulation shall have a minimum compressive strength of 25 psi. Insulation shall conform to the following properties:
   1. Thermal Resistance: 5.0 ft2-h-0F/Btu, per ASTM C 518 & ASTM C 177.
   2. Compressive Strength: 25 psi (minimum), per ASTM D 1621.
   3. Water Absorption: 0.3% by volume, per ASTM C 272.
   4. Water Vapor Permeance: 0.8 perms, per ASTM E 96.
   5. Maximum Use Temperature: 165 degrees F.
   6. Coefficient of Linear Expansion: 3.5x10-5 in/in-0F, per ASTM C 203.
   7. Insulation Type: V, per ASTM C 578.
   8. Thickness: 2-inch, unless otherwise specified or indicated on Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION - GENERAL

A. Piping systems shall be fabricated and installed in accordance with ASME B31.1 standards. Install each run of piping with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance or replacement of valves and equipment. Reduce sizes, where indicated on the Drawings, by use of reducing fittings. Align piping accurately at connections, within 1/16-inch misalignment tolerances.

B. Locate piping runs, except as indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown, or, if not otherwise indicated, run piping in the shortest route which does not obstruct usable space or block access for servicing the building and its equipment. Hold piping close to walls, overhead construction, columns, and other structural and permanent-enclosure elements of buildings.

C. Horizontal piping shall pitch uniformly 1 inch in 40 feet and drain to a minimum number of low points. All low points shall be provided with a minimum 3/4-inch tapped Type SS/2 drain pipe, 304 stainless steel isolation ball valve (Type V26), and 304 stainless steel or aluminum hose connection.

D. Provide Type PVC/1 drain piping and a (Type V20) PVC ball valve for drain connections off of PVC piping. Drain connections may or may not be shown on the Drawings. Confirm the final location of all drain connections with the Engineer and Atlantic Richfield Company prior to installation. Provide larger drain connections as required and as directed by the Engineer and Atlantic Richfield Company.

E. Provide unions in piping as shown on the Drawings and as specified herein. Unions shall be provided in locations, including but not limited to the following: equipment, pumps, tanks, valves, long piping runs, piping bypasses around equipment, or any other location as directed by the Engineer or Atlantic Richfield Company. Unions shall be located to allow for piping disassembly, alterations, and repairs.

F. Provide all field routing and coordination of process piping routing as required to accommodate all necessary coordination with other Work of the Contract, including, but not limited to heating, ventilating, and air-conditioning (HVAC), electrical, structural, architectural, plumbing, and civil work.

G. Unless otherwise indicated, provide concrete thrust blocks at all pipe fittings and changes in direction or alignment. For clarity, thrust blocks may or may not be shown at every bend, fitting, or directional change. Thrust blocks which have not been shown shall not relieve the CMGC of the responsibility for providing and installing them.

3.02 COPPER PIPE & TUBING INSTALLATION - TYPE (CU/1)

A. All threaded connections shall conform to ANSI B2 and ASME B1.20.1 standards. All threaded connections shall be true, accurate, and of full thread. All threaded plugs shall be brass with a square head. All threaded joints shall be made with a joint compound approved by the piping manufacturer. The joint compound shall be applied to the male thread only. Caulking of threaded joints is not acceptable. All reductions and expansions in piping diameters shall be through the use of reducers and expansion fittings. Bushings or close nipples are not acceptable.

B. Soldering:
   1. Unless otherwise indicated all joints for copper pipe 2 inches and smaller shall be soldered. Prior to soldering, all surfaces shall be thoroughly cleaned and polished, and free from dirt, grease, grime or other foreign materials before fluxing and soldering. The cleaning shall be performed by using an emery cloth, sandpaper, or steel wool. Clean the outside end of the copper tubing for a length of a least 1/2 inch greater than the depth of the fitting. The inside of the fittings shall be cleaned in a similar manner. Apply non-corrosive flux and assemble the joint. Insert ends of tubes into fittings to the full depth of the sockets. Acid solder and acid flux are not acceptable.
   2. The copper piping and tubing surfaces to be joined shall be heated up slowly and uniformly. The surface being soldered shall be heated to the melting point of the solder. Apply heating to draw the solder completely into the joint. Form continuous solder beads around the entire circumferences of the joints. Once solder is plasticized, remove all excess with a brush or other suitable cleaning device. Excess solder shall be removed from the interior and exterior of the piping. Provide a fillet around the end of all fittings and joints. Allow soldered joints to cool slowly in the air. The use of water for quenching is not acceptable. Provide full penetration of solder within all joints.

C. All cutting of copper tubing shall be square. The ends of all-cut piping shall be reamed or filed to remove burrs. The use of piping with out-of-round ends is not acceptable. Any type of defects, including but not limited to, cracks, holes, and incomplete solder penetration is not acceptable. Peening for the closing of defects is not acceptable under any circumstances.

D. Utilize heating torches of sufficient size based on the size of the piping to be joined. Utilize combination torches with ring burners or multiple tips for heating of copper fittings 1-3/4 inches and larger.

E. Brazing:
   1. All joints for interior copper pipe larger than 2 inches shall be brazed. Apply all flux in strict accordance with the recommendations of the manufacturer of brazing filler material. Apply flux to the outside of fittings and avoid allowing the flux to enter the inside of the tubing. Apply heat to the brazed sections of piping beginning 1 inch from the edge of each fitting.
   2. Once the flux becomes transparent, heat the fitting at the base of the cup. All heating shall be conducted while continuously moving the torch flame. Continuously maintain heating along the joint between the fitting and tubing connection axis.
   3. Apply the brazing material at the joint where the tubing enters the socket of a fitting. Heat the joint to melt the brazing material. Do not apply the torch flame directly on the brazing material. A properly assembled joint shall consist of a fillet of filler being visible around the complete circumference of the joint. Once a complete fillet is visible, stop adding filler metal. Remove any excess flux residue.
   4. Allow all joints to cool slowly via the surrounding air. The use of water for quenching is not acceptable. Any type of defects, including but not limited to, cracks, holes, and incomplete filler material penetration is not acceptable. Peening for the closing of defects is not acceptable under any circumstances.

F. Flanges:
   1. Install flanged connections as required as shown on the Drawings and as approved by the Engineer. Install all flange faces in perfect alignment. The flange holes shall straddle the vertical center line of the piping.
   2. Flange bolts shall be alloy steel, ASTM A 193/A 193M Grade B7, or commercial grade carbon steel, ASTM A 307, Grade B. Alloy steel bolts shall be tightened to obtain a stress of 45,000 psi and carbon steel bolts shall be tightened to obtain approximately 15,000 psi of stress. The stress shall be based on the root area of the bolt thread. Provide flange bolt isolators for dissimilar metals.
   3. Lubricate all bolts over the entire thread length with a heavy graphite and oil mixture prior to tightening. Tighten bolts with proper wrenches. Secure flanges with uniform pressure on the bolts and gaskets. Flanged joints with flange dishing and over-compression of the gaskets due to overstressing of the bolts is not acceptable. Utilize bolts of adequate length to allow for a minimum of 2 full thread lengths to extend beyond the fastening nut.

3.03 DUCTILE IRON PIPE INSTALLATION - TYPE (DI/1)

A. Install Type DI/1 ductile iron piping and fittings true to alignment. Provide rigid pipe supports and anchorage. All pipe shall be thoroughly cleaned prior to laying and shall be kept clean throughout the duration of the Work. Provide all fittings for field routing of piping in addition to those shown on the Drawings to provide for a complete and operational piping system. Provide additional flanges as directed by the Engineer where piping interferes with existing facilities. All ductile iron piping and fittings shall be installed in accordance with requirements of AWWA C600 standards.

B. The support spacing shall be in strict accordance with the recommendations of the piping manufacturer. The installation and piping support system shall not allow deflection of piping greater than 50 percent of the maximum deflection as recommended by the piping manufacturer. Each section of piping and fittings must be cleaned, free of dirt, debris and other foreign material prior to installation. All cleaning shall be in accordance with the recommendations of the piping manufacturer.

C. Pipe Cutting:
   1. Pipe cutting shall be as approved by the Engineer. Any damage to the interior pipe linings shall be repaired to the satisfaction of the Engineer before installation. If approved by the Engineer, cutting shall be conducted using a saw with blades specifically designed for cutting iron pipe. All cuts shall be at right angles to the axis of the piping. The cuts shall leave smooth edges. Damages to interior pipe linings caused by cutting of pipe shall be repaired to the satisfaction of the Engineer and Atlantic Richfield Company.
   2. Seal the ends of all cut pipe in accordance with the recommendations of the pipe manufacturer.
   3. Field cutting and threading of ductile iron pipe is not acceptable under any circumstances. All pipe shall be pre-cut and threaded for flanges at the factory of origin.

D. Joints & Connections:
   1. Connect piping to equipment in accordance with the instructions of the equipment manufacturer. When manufacturer's indicate that equipment shall not support dead loads from piping, the CMGC shall submit, in writing, that the piping installation does not transfer loading from the piping to the equipment, and that all the manufacturer's requirements have been met. Install piping so as not to impart any strain or loading on the connected equipment
   2. All bolts for flanged joints shall be tightened evenly. All bolts shall conform to the size of the flange and well as all ANSI standards. Flanged joints shall be made using gaskets, bolts, and bolt studs with a nut on each end. Utilize studs with nuts where the flange is tapped.
   3. Provide tapped pipe connections as shown on the Drawings and as directed by the Engineer. All piping shall be drilled and tapped perpendicular to the longitudinal access of the pipe. All taps shall be designed to seal watertight. The pipe taps shall be of sufficient strength to prevent blowouts in pressurized applications. Follow the manufacturer's instructions when tapping into fittings. All pipe taps shall be in accordance with ANSI A21.51 standards.

3.04 DUCTILE IRON PIPE INSTALLATION - (TYPE DI/2)

A. Install Type DI/2 ductile iron piping and fittings true to alignment. All pipe shall be thoroughly cleaned prior to laying and shall be kept clean throughout the duration of the Work. Piping shall conform to the lines and grades indicated in the Contract Documents. All ductile iron piping and fittings shall be installed in accordance with the requirements of AWWA C600, unless otherwise specified or indicated on the Drawings.

B. A firm, even bearing shall be constructed by digging bell holes at each joint and by tamping screened gravel at the sides of the pipe up to mid-diameter. Provide fill at least 1 foot over the top of the pipe in accordance with the details shown on the Drawings. Blocking is not permitted. All defective pipe shall be removed even after it has been laid. The pipe shall be replaced with a sound, non-defective pipe in a satisfactory manner, by the CMGC, at no additional cost to Atlantic Richfield Company or the Engineer.

C. All pipe shall be sound and clean prior to laying. When laying is not in progress, including lunch breaks, the open ends of piping shall be closed by watertight plugs or other Engineer approved means. Proper alignment shall be preserved in laying. Deflection of joints shall not exceed that recommended by the pipe manufacturer. All fittings shall be provided, for crossing utilities, which may be encountered upon opening the trench. Solid sleeve couplings may only be utilized where indicated on the Drawings, or with written approval of the Engineer.

D. Pipe Laying:
   1. All Type DI/2 ductile iron pipe shall be installed in accordance with the trench detail as shown on the Drawings.

E. Pipe Cutting:
   1. When cutting of pipe is required, the cutting shall be done by a machine, leaving a smooth cut at right angles with the axis of the pipe. Cut ends of pipe shall be joined with a bell and shall be beveled to conform to the manufactured spigot end. Cement lining shall be undamaged. Field cut ends shall be sealed with an Engineer approved epoxy, in accordance with the pipe manufacturer's instructions. Cutting of restrained joint pipe is not acceptable unless approved in writing by the Engineer. If approved, cutting shall be at specific locations, and the CMGC shall provide all restrainer glands or field adaptable restrained joints.

F. Mechanical Joints – Type DI/2:
   1. Mechanical joints shall be assembled in accordance with Appendix A of AWWA C111/A21.11 and the pipe manufacturer's instructions. Thoroughly clean and lubricate the joint surfaces and rubber gaskets with soapy water before assembly. Bolts shall be tightened to the specified torques. Under no conditions shall extension wrenches or pipe over handle of ordinary ratchet wrenches be used to secure greater leverage. Bolts in mechanical or restrained joints shall be tightened evenly and alternately.

3.05 PVC PIPE INSTALLATION - TYPE (PVC/1)

A. Install Type PVC/1 pressure piping in strict accordance with the manufacturer's instructions as well as specified herein. When cutting of piping is required, all burrs, chips, filings, and other associated defects shall be removed from both the pipe inside diameter and outside diameter before joining. Cutting of piping shall be with a hand saw or pipe cutter with blades. The use of pipe cutters with rollers is not acceptable. All cut pipe ends shall be beveled approximately 1/16 inch back from the edge of the pipe, at an angle of 10 to 15 degrees. All cutting of PVC piping shall be in strict accordance with the recommendations of the piping manufacturer.

B. Solvent Welding:
   1. All joints for plastic pipe shall be solvent welded except where flanged joints are required. All pipe and fittings to be socket welded shall be clean of all loose dirt and moisture from the inside and outside diameter of the pipe end and the inside diameter of the fitting. Do not socket weld wet piping surfaces.
   2. The solvent cement shall be a grade specifically recommended by the piping manufacturer for the size and schedule of the pipe as well as the process fluid carried. Solvent cements for acidic chemicals shall be in accordance with that previously specified. Prior to solvent welding, all fittings and couplings shall be exposed to the installation atmosphere for at least 1 hour to the same temperature conditions as the pipe, in order to assure proper thermal balance between the piping and associated fitting.

3. Apply low VOC solvent cement to the pipe in accordance with the manufacturer's recommendations. A minimum of 2 coats shall be applied when recommended by the pipe, fitting, or solvent cement manufacturer. All piping system joints shall use a primer and finished solvent cement coating prior to assembly. Apply the solvent cement to the socket while keeping both the surface and applicator wet and in motion for approximately 5 to 15 seconds. Take care not to add excess solvent cement. Joints shall not be cramped.
4. The atmospheric and weather conditions affect the solvent welding procedure. In cold weather, sufficient time shall be allowed for proper penetration of the solvent cement. Joining of PVC pipe and fittings shall not be conducted in atmospheric conditions below 40 degrees F, above 90 degrees F, or when exposed to direct sunlight. Allow for a minimum of 48 hours of drying time before moving the socket welded joint or subjecting any internal or external pressure or force.
5. When solvent welding piping to valves or other appurtenances, take specific care not to allow solvent cement to enter the valve. Solvent cement shall not be allowed to run free from joints. All valves shall be solvent welded in strict accordance with the recommendations of the valve manufacturer.
6. All solvent welded joints shall remain undisturbed for a minimum of 48 hours to allow for the development of complete strength.

C. Flanged Joints:
1. When connecting Type PVC/1 piping to metallic piping, assemble the metallic piping first. Flanged connections shall be used to connect all PVC piping to metallic piping unless otherwise specified or shown on the Drawings. Tighten all bolts evenly to prevent warping and dishing of the PVC flange. A wrench may be used to provide a tight seal between the flanges and gaskets. All joints shall conform to the piping manufacturer's recommendations.

3.06 INSTALLATION OF BURIED PIPE

A. Install plant process piping in accordance with the manufacturer's recommendations and the details as shown on Drawings. Installation of HDPE pressure pipe Type (PE/4) to conform to the Plastic Pipe Institute (PPI) Handbook of PE Pipe and the manufacturer's recommendations. Thermal butt fusion or electro-fusion methods are acceptable provided CMGC has submitted evidence of training by a manufacturer's representative.

B. Lay pipe to line and grade shown on Drawings. Do not allow positive-negative grade discontinuities. Line and grade may be adjusted by Engineer as required by field conditions.

C. Flush piping and remove debris. Flushing method used to be approved by Engineer. Gravity flushing is not acceptable. Provide labor, water, pumps and related appurtenances for pipe flushing.

D. Lay pipe in dry conditions. Do not use installed pipe to remove water from work area.

E. Install warning tape continuously from structures to the end of each process pipe. At ends of rolls and repairs, splice tape with 3-foot overlap connected with tape. Provide Atlantic Richfield Company with one full roll for future repairs. Extend to grade at each access manhole and at pump stations.

F. Provide thrust protection via concrete thrust blocks at all bends in force main pressure piping systems in accordance with Drawings.

3.07 INSULATION

A. Provide rigid insulation as shown on Drawings or directed by Engineer.

3.08 INSTALLATION OF SLEEVES AND SEALS

A. Install pipe sleeves of types as indicated on the Drawings where piping passes through walls, floors, ceilings, and roofs. Do not install sleeves through structural members of Work, except as detailed on the Drawings, or as approved by the Engineer. Install sleeves accurately centered on pipe runs. Size sleeves so that piping and insulation will have free movement in the sleeve, including allowance for thermal expansion; but not less than 2 pipe sizes larger than the piping run. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface, except floor sleeves. Extend floor sleeves 4 inches above the level floor finish, and 4 inches above floor finishes sloped to drain. Provide temporary support of sleeves and provide temporary closure to prevent concrete and other materials from entering sleeves.

B. Sleeve Seals shall be installed in accordance with the following:
   1. Mechanical Seals: Loosely assemble rubber links around the pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Tighten bolts until links have expanded to form a watertight seal.
   2. Wall Pipe: Install wall pipe where indicated on Drawings. Joints shall be as indicated for connection to adjacent piping.

3.09 CLEANING

A. Thoroughly clean the interior and exterior of all piping prior to testing. Provide removal of all dirt, dust, oil, grease and other foreign materials from the piping. Exercise care while cleaning piping to avoid damage to linings and coatings. Clean all piping in strict accordance with the recommendation of the piping manufacturer.

B. Flush out piping systems, except odor control piping, with clean water prior to proceeding with the required tests. Inspect each run of piping for completion of joints, supports, accessory items, and appurtenances prior to testing.

3.10 PIPE TESTING - GENERAL

A. Test all piping in the presence of the Engineer and the plumbing or building inspector if required by the State of the Project location or by Atlantic Richfield Company. All testing shall be in accordance with the requirements of the local and state plumbing codes and the appropriate sections of these Specifications. All testing shall be conducted at no additional cost to Atlantic Richfield Company or the Engineer. Provide all labor, equipment, materials, taps, water, gauges, pumps, and appurtenances to conduct all piping tests.

B. When requested by the Engineer or local plumbing inspector, building gravity drains shall be tested prior to backfilling or concealing. All other piping may be tested after backfilling. Any deficiencies found during testing shall be repaired and retested at no additional cost to the Engineer or Atlantic Richfield Company. Provide lawful disposal of all waste after the testing.

C. Test all piping systems before insulation is installed. Remove all control devices before testing. Test each natural section of each piping system independently but do not use piping system valves to isolate sections where the test pressure exceeds the valve pressure rating. Test each section with water or other fluids as directed by the Engineer and Atlantic Richfield Company. Pressurize the pipe to the specified level for the required time period.

3.11 HYDROSTATIC PRESSURE TESTING

A. All liquid service pipe and fittings shall be pressure tested using water to the test pressures specified or as directed by the Engineer. All pipe and fittings shall be pressure tested with water at the maximum service temperature specified or as directed by the Engineer. Test pressures for designations and systems not listed shall be as directed by the Engineer prior to testing. All testing shall be in accordance with the procedures of ASME B31.1 standards.

B. Provide water or other test fluid as directed by the Engineer, of sufficient capacity to deliver the required test pressure specified. Provide all valves on the suction and discharge side of the pump as well as a strainer on the inlet side of the pump to prevent foreign matter from entering the system. Provide pressure gauges capable of reading 50 percent higher than the specified test pressure. The pressure gauges shall be located at the pump discharge and any other place as directed by the Engineer. Provide a pressure relief valve set at a pressure 20 to 25 percent above the specified test pressure. Provide heaters, if required, to heat the test water to the specified test temperature.

C. Preparation For Testing:
   1. Coordinate the testing fluid to be used with the Engineer and Atlantic Richfield Company. When the fluid test temperature is not ambient, the CMGC shall consult the Engineer for the appropriate test temperature. All testing equipment shall be compatible with the piping and test fluid. Provide vents at all high points of the system if not already installed. Provide drains in locations where venting or draining devices do not exist.
   2. Remove all discs, pistons, and balls from check valves if they prohibit testing of the piping system. Ensure all valves and appurtenances are fully open within the section of piping to be tested. Remove all control instruments and alarms prior to testing. Block off or remove all pressure relief valves prior to testing and temporarily close all external openings of the piping section to be tested. All closures shall be specifically designed for the test pressure. All joints in the piping section to be tested shall be left exposed for examination and inspection during the test period. Pipe insulation shall not be installed prior to conducting pipe testing.
   3. Provide temporary supports for vapor or gas piping to support the weight of the test fluid if the vapor or gas piping is directed to be hydrostatically tested.
   4. Provide temporary support, restraint or isolation for all expansion joints.

D. Hydrostatic Test:
   1. Slowly fill the piping system, expelling entrapped air from all high points. The fill rate shall be controlled so that the fluid velocity within the pipe system is less than 2 feet per second. Once the filling process has been completed the piping system shall be brought up to the specified test temperature, if required or directed by the Engineer. The pressure shall be held at 20 percent less than the test pressure until the temperature has been stabilized. Once the temperature has stabilized, raise the pressure to the test level as specified or as directed by the Engineer.
   2. The pipe system shall be slowly brought up to the test pressure. Take care not to create shock, surge, or water hammer in the pipe system.
   3. For pressure piping, test each piping system at 150 percent of the design operating pressure, but not less than 25 psig test pressure, whichever is greater. Pressure piping shall be defined as piping systems in which the process fluid does not flow via gravity. The minimum test pressure for all gravity piping shall be 10 psig. Provide the Engineer and Atlantic Richfield Company with a minimum 24-hour notice prior to the testing. Tests which are not witnessed by Engineer are not acceptable. In the absence of specified test pressures, the CMGC shall consult the Engineer for determining the test pressure for each system. The required test period shall be a minimum of 2 hours.

4. The test duration time limit shall not begin until the full pressure specified or indicated by the Engineer has been reached and the system has been stabilized to within plus or minus 5 percent of the test temperature. The system temperature shall be maintained to within plus or minus 5 percent of the specified or Engineer indicated value for the entire duration of the test. The test pressure shall be maintained at plus or minus 5 psi of the specified or Engineer indicated test pressure for the entire duration of the test.
5. The pressure test shall be monitored by a recording type pressure gauge. When temperature and pressure control is required, the CMGC shall use a combination temperature and pressure recording gauge. Record the entire test process. The records shall include, but are not limited to, the date of testing, piping section tested, test pressure, testing equipment, testing results, test fluid, test temperature, and signatures of the Engineer, CMGC, and Atlantic Richfield Company.

E. Inspection of Testing:
1. Observe each test section for leakage during the test period. The hydrostatic test shall be deemed acceptable if no visible leaks are detected and the pipe system pressure can be maintained within plus or minus 1 percent but no more than 5 psi of the specified value.
2. Upon completion of the test, the pressure shall be slowly removed by opening a valve or other pressure-relieving device at a location remote to the location of the pressure and temperature monitoring equipment. The pressure shall be reduced to approximately 20 percent of the specified or Engineer indicated test pressure. Stabilize the system pressure at that point while the entire system is inspected for leaks, cracks, or other piping system defects. If any defects are found, the CMGC shall alleviate all pressure in the piping system, drain the test fluid, correct all defects, and retest the piping system.
3. Repair all piping system sections which fail the hydrostatic pressure piping test, by disassembly and re-installation using new materials to the extent required to overcome leakage or pressure drop. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods. Repair and retest all defective piping sections at no additional cost to Atlantic Richfield Company or the Engineer. Drain and dispose of all fluids from the piping systems after testing and repair Work has been completed.

3.12 PNEUMATIC PRESSURE TESTING

A. All low-pressure air service pipe and fittings shall be pneumatically pressure tested using air to the test pressures specified or as directed by the Engineer. All pipe and fittings shall be pressure tested with air at the maximum service temperature specified or as directed by the Engineer. Test pressures for designations and systems not listed shall be as approved by the Engineer prior to testing. All testing shall be in accordance with the procedures of ASME B31.1 standards.

B. Preparation For Testing:
1. Coordinate the testing pressure with the Engineer. When the air test temperature is not ambient, the CMGC shall consult the Engineer for the appropriate test temperature. All testing equipment shall be compatible with the piping. Provide vents at all high points of the system if not already installed.
2. Remove all discs, pistons and balls from check valves if they prohibit testing of the piping system. Ensure all valves and appurtenances are fully open within the section of piping to be tested. Remove all control instruments and alarms prior to testing. Block off or remove all pressure relief valves prior to testing and temporarily close all external openings of the piping section to be tested. All closures shall be specifically designed for the test pressure. All joints in the piping section to be tested shall be left exposed for examination and inspection during the test period. Insulation shall not be installed

prior to conducting tests. Provide a soapy water solution and test all fittings, joints, couplings and valves for air leakage.

3. Personnel not directly involved in pneumatic pressure testing of piping shall be evacuated from the area. The maximum length of piping to be tested at 1 time shall be 400 feet. Examine all connections prior to testing to ensure proper fit and tightness. Determine the pressure rating for all connected devices and appurtenances to ensure they are rated for the required test pressure. Isolate all equipment and appurtenances, which may be damaged by testing. Plug all test, drain, and vent ports, which are not required for the test. If the section of pipe being tested is isolated from other sections by in-line valves, ensure that the portion not being tested is open to the atmosphere. Protect expansion joints against system pressures by suitable movement-limiting devices.

C. Pneumatic Pressure Test:
   1. Slowly fill the piping system. Each piping system shall be brought up to the specified test temperature. The pressure shall be held at 20 percent less than the required test pressure until the temperature has been stabilized. Once the temperature has stabilized, raise the pressure to the test level as specified or as directed by the Engineer.
   2. Test each piping system at 150 percent of the design operating pressure, but not less than 25 psi test pressure, whichever is greater. Provide the Engineer and Atlantic Richfield Company with a minimum of 24-hour notice prior to the testing. Tests which are not witnessed by Engineer are not acceptable. In the absence of specified test pressures, the CMGC shall consult the Engineer for determining the test pressure for each system. The required test period shall be 2 hours.
   3. The test duration time limit shall not begin until the full pressure specified or indicated by the Engineer has been reached and the system has been stabilized to within plus or minus 5 percent of the test temperature. The system temperature shall be maintained to within plus or minus 5 percent of the specified or Engineer indicated value for the entire duration of the test. The test pressure shall be maintained at plus or minus 0.5 psi of the specified or Engineer indicated test pressure for the entire duration of the test.
   4. The pressure test shall be monitored by a recording type pressure gauge. When temperature and pressure control is required, use a combination temperature and pressure recording gauge. Record the entire test process. The records shall include, but are not limited to, the date of testing, piping section tested, test pressure, testing equipment, testing results, test temperature, and signatures of the Engineer, CMGC, and Atlantic Richfield Company.

D. Inspection:
   1. Observe each test section for leakage during the test period. Once the test segment has been pressurized to the specified levels, the source of pressurization shall be isolated and all piping, connections shall be tested for leaks by swabbing with standard high film soap solution conforming to MIL-L-25567 standards, while also observing for the formation of air bubbles. Each pneumatic pressure test shall be deemed acceptable if no visible leaks (air bubbles) are detected and the pipe system pressure can be maintained to within plus or minus 1/2 percent but no more than 0.5 psi of the specified value.
   2. Upon completion of the test, the pressure shall be slowly removed by opening a valve or other pressure-relieving device at a location remote to the location of the pressure/temperature monitoring equipment. If any defects are found, the CMGC shall alleviate all pressure in the piping system, correct all defects, and retest the piping system.

3. Repair all piping system sections which fail the pneumatic pressure-piping test, by disassembly and re-installation, using new materials to the extent required to overcome leakage or pressure drop. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods. The CMGC shall be responsible for repairing and retesting all defective piping sections at no additional cost to Atlantic Richfield Company or the Engineer.

3.13 WATER SYSTEM OPERATIONAL TESTING

A. Upon completion of flushing and prior to disinfection procedures, subject the plumbing/water systems to operating tests to demonstrate satisfactory installation, connections, adjustments, functional and operational efficiency. Such operating tests shall cover a period of not less than 2 hours for each system and shall include the following information in a report with conclusion as to the operation of the system:
   1. Time, date, and duration of test.
   2. Water pressures at the most remote and the highest fixtures.
   3. Operation of each valve, hydrant, or faucet.
   4. Pump suction and discharge pressures.
   5. Operation of each floor drain by flooding with water.
   6. Operation of each vacuum breaker and backflow preventer.
   7. Complete operation of each water pressure booster system, including pump start pressure and stop pressure.

B. The report of the test shall be submitted in quadruplicate. The CMGC shall furnish instruments, equipment, and personnel required for the tests. The CMGC shall also provide all the necessary water, electricity, fuel, and related appurtenances for testing.

END OF SECTION

SECTION 40 05 14
PROCESS PIPE COUPLINGS AND CONNECTORS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide process pipe couplings and connectors in accordance with this Section and applicable reference standards listed in Article 1.02.
   2. The following sections reference the process coupling type and specification reference numbers shown in the coupling tag symbols on the Contract Drawings. Couplings without coupling tag symbols are specified elsewhere. The couplings and connectors included in this specification section may or may not all be required for the work of the Contract. Provide all couplings that are specified, indicated on the Drawings and/or are required to complete the work indicated in the Contract Documents.
   3. Furnish, install, test, and make ready for operation all process pipe couplings and connectors of the type(s) and size(s) required and as shown on the Drawings and as specified herein. The items include but may not be limited to sleeve type couplings, split type couplings, flanged adaptors, expansion joints, harnessing and restraints, quick connect couplings, unions, dielectric connectors, and restrained mechanical joint couplings. The couplings, connectors, and appurtenances shall be of sizes and connection types as shown on the Drawings and as specified herein.
   4. Furnish one set of all special tools required to completely assemble, disassemble, or maintain the couplings and connectors. Special tools shall refer to oversized or specially dimensioned tools, special attachments or fixtures, or any similar items.

1.02 REFERENCES

A. Reference Standards:
   1. ASTM International (ASTM):
      a. ASTM A 108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
      b. ASTM A 126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      c. ASTM A 183 - Standard Specification for Carbon Steel Track Bolts and Nuts.
      d. ASTM A 197/A 197M - Standard Specification for Cupola Malleable Iron.
      e. ASTM A 307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
      f. ASTM A 325M - Standard Specification for Structural Bolts, Steel, Heat Treated, 830 mpa Minimum Tensile Strength (Metric).
      g. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.
      h. ASTM A 48/A 48M - Standard Specification for Gray Iron Castings.
      i. ASTM A 512 - Standard Specification for Cold-Drawn Buttweld Carbon Steel Mechanical Tubing.
      j. ASTM A 513 - Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing.
      k. ASTM A 536 - Standard Specification for Ductile Iron Castings.
      l. ASTM A 564/A 564M - Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.

m. ASTM A 575 - Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
n. ASTM A 632 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing (Small-Diameter) for General Service.
o. ASTM B 584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
p. ASTM B 62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
q. ASTM B 633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
r. ASTM B 88 - Standard Specification for Seamless Copper Water Tube.
s. ASTM B 806 - Standard Specification for Copper Alloy Permanent Mold Castings for General Applications.
t. ASTM D 2774 - Underground Installation of Thermoplastic Pressure Piping.
u. ASTM F 1476 - Standard for Performance of Gasketed Mechanical Couplings in Piping Applications.

2. American Water Works Association (AWWA):
a. AWWA C110/A21.10 - Ductile Iron and Gray-Iron Fittings for Water.
b. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
c. AWWA C153/A21.53 - Ductile Iron Compact Fittings for Water Service.
d. AWWA C207 - Standard for Steel Pipe Flanges for Waterworks Service-Sizes 100 mm through 3600 mm 4 in. through 144 in.
e. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
f. AWWA C606 - Grooved and Shouldered Joints.
g. AWWA M11 Manual - Steel Pipe: A Guide for Design and Installation.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
1. SD-02 Shop Drawings:
a. Shop drawings for each coupling or connector shall be identified with the applicable style or series designation. Shop drawings shall show layout and dimensions of equipment, major components, key alignment locations and locations of bolt holes. Drawings shall show critical field dimensions identified by the Manufacturer.
2. SD-03 Product Data:
a. Submit sufficient product data to verify compliance with the specifications and to illustrate the construction and assembly of the products. Include compliance of materials and components with applicable standards. Product data shall include manufacturer's descriptive data, technical literature, performance charts, catalog cuts, and installation instructions.
b. Product data for all bellows type expansion joints shall include gauge of corrugated element, maximum test pressure force to compress joint, bellows spring rate, shear force and end moment due to calculated traverse only. Complete cycle life test results for the maximum diameter coupling to be installed shall also be included.

3. SD-07 Closeout Submittals:
    a. Per Division 01 General Requirements.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. All welding shall be conducted under qualified welding procedures. All welders and operators shall be certified in accordance with the latest applicable AWS and ANSI codes for shop and Project Site welding of piping work. Furnish written proof of certifications upon request from the Engineer.

C. All piping systems, components, and appurtenances in contact with potable water, including potable water during any stage of treatment or conditioning, shall be certified to meet the requirements of ANSI/NSF 61 for water service.

D. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components. All castings used for fittings and couplings shall be date stamped for quality control and traceability.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. All equipment delivered and placed in storage shall be provided with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants in accordance with the Manufacturer's written instructions.

C. Finished surfaces of all exposed openings shall be protected by wooden blanks or other suitable cover to prevent foreign material and debris from entering the equipment.

D. Off-load equipment at the installation site using equipment of sufficient size and design to prevent damage to the equipment. Immediately after off-loading, inspect all equipment for shipping damage or missing parts. Any damage or discrepancy shall be noted in a written claim with the shipper prior to accepting delivery. Validate all serial numbers and parts lists with the shipping documentation. Notify the Manufacturer of any unacceptable conditions with the shipper.

E. Where necessary to store outside, elevate above grade and enclose with durable, waterproof wrapping. Store rubber products under cover out of direct sunlight. Do not store materials directly on the ground.

1.07 WARRANTY

A. Provide in accordance with Division 01 General Requirements.

1.08 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

PART 2 - PRODUCTS

2.01 GENERAL

A. All couplings and connectors shall be of sizes shown on the Drawings or as specified. Provide couplings which are sized to match the connecting piping outside diameters. Where piping outside diameters differ, provide transition type couplings.

B. B. All couplings and connectors shall have the manufacturer, size, flow directional arrows (if applicable), working pressure for which they were designed and referenced standards, cast in raised letters or permanently marked on the equipment. Unless otherwise specified or indicated on the Drawings, all couplings and connectors shall have a minimum pressure rating of 150 psi or be of the same working pressure as the pipes they connect, whichever is greater.

C. C. The reference of a manufacturer's name and model number in this Specification has been provided for the purpose of establishing the standard of quality or general configuration desired and shall not be considered as proprietary.

D. D. Unless otherwise specified or indicated on the Drawings, all piping shall be connected using standard flanged, mechanical joint, push-on joint, threaded, welded, or solvent cement welded connections. Couplings and connectors shall be used where specified or indicated on the Drawings.

E. E. The use of couplings in place of standard piping connections shall not be acceptable unless approved by the Engineer in writing.

2.02 SLEEVE TYPE COUPLINGS - TYPE C01

A. Provide sleeve type couplings to join all plain end pipes and exterior below grade transitions in piping materials as shown on the Drawings, and as specified and outlined in AWWA C 201 standards. In cases where the outside diameters of the piping segments to be connected differ, provide reduction/expansion sleeve type couplings.

B. Unless otherwise indicated, sleeve type couplings shall also be provided for all exterior below grade piping runs prior to entering and exiting buildings or structures. The couplings shall be installed prior to the building or structure wall penetration to allow for differential settlement of the piping and structure. All sleeve type couplings shall conform to the provisions of AWWA C 219 standards. All sleeve type couplings shall be rated for use with the same operational pressure as the connecting pipes.

C. Unless otherwise indicated, all sleeve type couplings for low pressure air service shall be 304 stainless steel with 316 stainless steel followers.

D. All coupling lugs shall be in accordance with ASTM A 36/A 36M standards. All washers shall be in accordance with ASTM A 325M standards. All couplings shall be fitted with plastic plugs to protect the bolt holes.

E. Fasteners & Hardware:
   1. All bolts shall be installed such that a minimum of 1/4 inch of the bolt projects beyond the surface of the nut. All hexagonal nuts shall be in accordance with ANSI B18.2 standards. Hexagonal nuts shall have threads in accordance with ANSI B1.1 standards. All bolts shall be in accordance with ASTM A 307 and ANSI B1.1 standards. All bolts shall be square or hexagonal head type. Bolts shall be threaded over the full

length. All bolt ends shall be rounded or chamfered. Bolts shall be coarse thread fit type.
2. Provide 304 stainless steel hardware for all sleeve type couplings.

F. Middle Ring:
1. Middle Ring (Sleeve) shall be ductile iron per ASTM A 536, Grade 65-45-12 for pipe sizes 12-inches and smaller. Provide fabricated steel middle ring for couplings larger than 24-inches.
2. The pipe stop within the inner surface of the middle ring of couplings shall be omitted as required to permit removal of valves, flow meters, equipment, and appurtenances. All other couplings shall be provided with pipe stops.
3. The middle ring of each sleeve type coupling shall have a thickness at least equal to that of the connecting piping on which the coupling is to be used.
4. All sleeve type couplings shall be a minimum of 10 inches long for pipe 30 inches and larger. All sleeve type couplings shall be a minimum of 7 inches long for pipe under 30 inches in diameter.
5. Couplings which are designed to be self-restrained are not required to meet the minimum middle ring length requirements specified.

G. Joint Harnesses:
1. When specified or when shown on the Drawings, anchor sleeve-coupled joints with harness bolts. Weld all harness lugs to steel pipe. All harnesses shall be in accordance with AWWA M11 standards. All harnesses shall be provided with a minimum of two 5/8-inch diameter bolts.
2. All joint harness bolts shall be of sufficient length. Provide harness lugs and install them such that the coupling can be slipped in one direction to clear the joint. Provide harnesses of sufficient number and strength to withstand the test pressure of the piping being connected. Test pressures shall be as indicated by the Engineer or as specified in Section 40 05 13.
3. Provide 304 stainless steel harnesses for stainless steel piping systems.

H. Finishing:
1. All ferrous metallic surfaces of couplings shall be provided with a standard liquid epoxy coating. All stainless steel, plastic, brass or bronze parts shall not be painted.

I. Manufacturer:
1. All sleeve type couplings of the same type, style, and duty shall be supplied by a single manufacturer. All sleeve type couplings shall be a product of the following manufacturer:
   a. Romac Industries, Inc. – Style 501 (small diameter) or Style 400 (large diameter).
   b. Dresser Piping Specialties.
   c. Smith-Blair, Inc.
   d. Engineer approved equal.

2.03 FLEXIBLE SLEEVE TYPE COUPLINGS - TYPE C02

A. Provide flexible sleeve type couplings to join all plain end pipes and transitions in piping materials as shown on the Drawings and as specified. In cases where the outside diameters of the piping segments to be connected differ, provide concentric or eccentric (flat bottom) reduction/expansion flexible sleeve type couplings.

B. Flexible sleeve type couplings shall also be provided for all exterior below grade piping runs prior to entering and exiting buildings or structures. The couplings shall be installed prior to

the building or structure wall penetration to allow for differential settlement of the piping and structure.

C. All sleeve type couplings shall be rated for use with the same operational pressure as the connecting pipes. The couplings shall also conform to applicable portions of ASTM A 564/A 564M, ASTM C 443, ASTM C 425 and ASTM D 1869 standards.

D. Provide couplings with a 300 series stainless steel shear ring for all below grade installation applications.

E. The couplings shall be designed for a maximum operating temperature of 140 degrees F (non-consistent) and a minimum operating temperature of minus 30 degrees F.

F. Each coupling shall include two 316 stainless steel band clamps. Each clamp shall be an interlocked housing and band design which strengthens under tension to ensure a positive seal. The bands shall include additional slots to accommodate a greater dimensional range.

G. Coupling Sleeve (Gasket):
   1. The coupling sleeve shall be constructed of polyvinyl chloride (PVC) to allow for flexibility and chemical resistance. The PVC sleeve shall also be resistant to ultraviolet rays, fungus growth and sewer gases.
   2. All flexible sleeve type couplings shall also be designed in accordance with ASTM D 5926, ASTM C 1173 and CSA B602 standards. All coupling sleeves shall be designed and constructed in accordance with the following criteria:
      a. Hardness (Shore A): 65 plus or minus 5.
      b. Tensile Strength: 1,000 psi (minimum).
      c. Elongation at Rupture: 250 percent (minimum).
      d. Tear Strength: 150 pounds/inch (minimum).
      e. Brittleness Temperature: Minus 40 degrees F.

H. Coupling Shear Rings:
   1. For buried applications provide couplings with shear rings which are designed for resistance to heavy earth loads and shear forces to provide improved pipe alignment. The shear ring shall be a minimum of 0.12 inches thick 300 series stainless steel. The width of the shear ring shall be manufactured according to coupling width and the length shall be manufactured according to coupling diameter. Each shear ring shall have clamps spot welded in place at the factory.

I. Manufacturer:
   1. All flexible sleeve type couplings of the same type, style, and duty shall be supplied by a single manufacturer. All flexible sleeve type couplings shall be a product of the following manufacturer:
      a. Fernco, Inc.
      b. Mission Rubber Company, LLC.
      c. Engineer approved equal.

2.04 SPLIT TYPE COUPLINGS – GENERAL

A. Provide split type couplings for connection of grooved or shouldered end pipe. All split type couplings shall be cast in 2 segments for steel and ductile iron pipe through 48 inches. Couplings for other pipe materials shall be cast in 2 segments for pipe sizes 3/4 inch through 14 inches; 4 segments for pipe sizes 15 inches through 24 inches; and 6 segments for pipe sizes over 24 inches.

B. The couplings shall be designed to engage grooved or shouldered pipe ends while encasing an elastomeric gasket to create a seal between the connected pipe segments.

C. Split type couplings shall be utilized as directed by the Engineer for piping with thin wall thicknesses. The use of split type couplings shall prevent weakening of the piping due to compression.

D. Split Coupling Housing:
   1. The coupling housing shall be constructed of ductile iron conforming to ASTM A 536 standards, grade 65-45-12. The housing shall be provided with alkyd phenolic primer coating for corrosion resistance.
   2. Provide ASTM A 351 Grade CF8M or 304 stainless steel split coupling housings for use with stainless steel pipe.

E. Split Coupling Hardware:
   1. Only when specified or specifically indicated on the Drawings, provide all couplings with galvanized carbon steel bolts and nuts, conforming to ASTM A 449 and A 183 standards.
   2. Unless otherwise specified or indicated on the Drawings, all couplings shall be provided with Type 316 stainless steel, Grade B-8M, Class 2, bolts, nuts, and washers with galling-resistant coating.

F. Piping Wall Thickness:
   1. The standards of AWWA C606 as well as the respective coupling manufacturers require a minimum thickness of pipe walls for use of various split type couplings. Provide piping with the minimum wall thicknesses required (unless a greater thickness is specified or required in the individual pipe Specifications) for use with split type couplings.
   2. In the event that the minimum pipe wall thicknesses do not meet the coupling manufacturer or AWWA C606 standards for the minimum requirements for grooving, then a shouldered end treatment with couplings as specified or as shown on the Drawings shall be utilized.

G. Split Couplings – Ductile Iron Piping:
   1. All ductile iron pipe for use with split-type coupling joints shall be designed with radius grooved ends and conform to AWWA C606 standards. All ductile iron pipe shall have grooved ends to provide either a rigid joint or flexible joint as shown on the Drawings or as specified.
   2. When not specified or shown on the Drawings, provide rigid grooved couplings unless otherwise approved by the Engineer. Flexible joint grooving and couplings shall permit expansion, contraction, and angular deflection of the piping.
   3. All rigid joint grooving and couplings shall allow no angular or linear movement or deflection. The minimum pipe wall thickness for grooved pipe shall be as specified by the coupling manufacturer.

H. Split Couplings – Steel & Stainless Steel Piping:
   1. Grooved couplings for steel and stainless steel piping shall have roll grooving, machine-grooving, or ring collars fully welded to the pipe or fitting.
   2. Schedule 5S and 10S stainless steel pipe shall be grooved using a manufacturer-provided grooving tool equipped with RX roll sets, specifically designed for stainless steel pipe.

2.05 FLEXIBLE SPLIT RING GROOVED END COUPLINGS - TYPE C03

A. Provide Flexible Split Ring Grooved End Couplings in accordance with the General Criteria previously specified.

B. Unless otherwise specified or shown on the Drawings, all flexible split ring grooved end type couplings of the same type, style, and duty shall be a product of the following manufacturer:
   1. Victaulic - Style 77 or 177 (steel pipe), 77S or 77 DX (stainless steel pipe).
   2. Engineer approved equal.

2.06 FLEXIBLE SPLIT RING SHOULDERED END COUPLINGS - TYPE C04

A. Provide Flexible Split Ring Shouldered End Couplings in accordance with the General Criteria previously specified.

B. Unless otherwise specified or shown on the Drawings, all flexible split ring shouldered end type couplings of the same type, style, and duty shall be supplied by a single manufacturer. All flexible split ring shouldered end type couplings shall be a product of the following manufacturer:
   1. Victaulic - Style 44 with Vic-Ring.
   2. Engineer approved equal.

2.07 RIGID SPLIT RING GROOVED END COUPLINGS - TYPE C05

A. Provide Rigid Split Ring Grooved End Couplings in accordance with the General Criteria previously specified.

B. Unless otherwise specified or indicated on the Drawings, provide rigid split ring grooved end couplings on ductile iron pipe less than 36 inches.

C. Pipe wall thickness shall meet all requirements of AWWA C606. If not specifically specified or indicated on the Drawings.

D. Unless otherwise indicated, the use of rigid split ring grooved end couplings shall only be used with written permission from the Engineer. If approved, all couplings used in place of flanges shall utilize rigid grooved pipe connections.

E. Unless otherwise specified or shown on the Drawings, all rigid split ring grooved end type couplings for ductile iron piping, of the same type, style, and duty shall be supplied by a single manufacturer. All rigid split ring grooved end type couplings shall be a product of the following manufacturer:
   1. Victaulic - Style 31.
   2. Engineer approved equal.

F. Unless otherwise specified or shown on the Drawings, all rigid split ring grooved end type couplings for manufactured steel, high pressure applications and other associated standard groove piping of the same type, style, and duty shall be supplied by a single manufacturer. All rigid split ring grooved end type couplings shall be a product of the following manufacturer:
   1. Victaulic - Style 07 or 107N (steel pipe), 89 or 489 (stainless steel pipe).
   2. Engineer approved equal.

2.08 RIGID SPLIT RING SHOULDERED END COUPLINGS - TYPE C06

A. Provide rigid split ring shouldered end couplings as specified and as shown on the Drawings and in accordance with the General Criteria previously specified.

B. Utilize rigid split ring shouldered end couplings on all ductile iron pipe over 16 inches or ductile iron pipe without sufficient wall thickness as outlined in AWWA C606 standards.

C. Provide rigid split ring shouldered end couplings on all manufactured steel pipe or thin walled stainless steel pipe. Unless otherwise specified or shown on the Drawings, the coupling shall be of the same materials of construction as the piping being connected.

D. Provide stainless steel couplings for use with stainless steel piping.

E. Unless otherwise specified or shown on the Drawings, all rigid split ring shouldered end type couplings for manufactured steel, ductile iron, stainless steel and other associated thin walled piping, of the same type, style, and duty shall be supplied by a single manufacturer. All rigid split ring shouldered end type couplings shall be a product of the following manufacturer:
   1. Victaulic - Style 44 with Vic-Ring, 89 or 489 (stainless steel pipe).
   2. Engineer approved equal.

2.09 SLEEVE TYPE FLANGED ADAPTORS - TYPE C07

A. Provide exposed sleeve type flanged adaptors for joining plain end piping at fittings, valves, equipment, flow meters, and other appurtenances as required, specified, as shown on the Drawings or as directed by the Engineer.

B. All flanged adapters shall conform in size and bolt hole placement to ANSI standards for steel and cast iron flanges 125/150 pound unless otherwise required for connections. The flanged adaptors shall be rated for a minimum pressure of 150 psi.

C. The body and end ring shall be in accordance with AISI C1012 or ASME SA36 standards. The body and flange shall be designed in accordance with ASTM A 513, ASTM A 635, or ASME SA675 GR60 standards. Provide ductile iron bodies in accordance with ASTM A 536 standards, Grade 65-45-12 for piping 16-inches and smaller and provide fabricated steel bodies for piping larger than 16-inches.

D. All bolts, nuts and washers as well as flange hardware shall be 304 stainless steel in accordance with AWWA C111/A21.11 standards.

E. Provide 316 stainless steel anchor (lock) pins, rated for 175 psi minimum.

F. All flanged adaptors for use in potable water service shall be ANSI/NSF 61 listed.

G. All ferrous metal surfaces of flanged adaptors shall be provided with a corrosion resistant epoxy finish. Stainless steel components shall not be painted. Provide liquid epoxy per AWWA C210 coating for interior and exterior of couplings.

H. Unless otherwise specified or shown on the Drawings, all exposed sleeve type flanged adaptors, of the same type, style, and duty shall be supplied by a single manufacturer. All exposed sleeve type flanged adaptors shall be a product of the following manufacturer:
   1. Romac Industries, Inc. – Style FCA 501 or Style FC 400 per pipe size.
   2. Dresser, Inc. - Style 128.

3. Smith-Blair, Inc. - Style 912.
4. Engineer approved equal.

2.10 EXPANSION JOINTS (LIQUID SERVICE) - TYPE C11

A. Provide single arch flexible connectors of the expansion/vibration type for connection to pumps and equipment as specified and as shown on the Drawings. Expansion joints for liquid stormwater service shall be filled arch type to prevent sediment build up. Guides shall be provided for each expansion joint.

B. All expansion joints shall be designed for the axial movements required for the specified application along with the maximum axial force required to compress the joint. The joints shall prevent axial, lateral and rotational movement and vibration from being transmitted to the piping and equipment. All expansion joints shall be designed for the test pressure of the connecting piping where installed as outlined in Section 40 05 13 or as directed by the Engineer.

C. Materials of Construction:
   1. Expansion joints shall be manufactured of EPDM surrounded by high grade woven cotton or suitable synthetic fiber and individual solid steel ring reinforcement. All soft rubber fillers shall be integrally cured into the arches to provide a smooth flow path to prevent settling of material, grit, or sludge into the arch. The rubber used shall be specifically designed for service with wastewater or sludge. The expansion joints shall include a 3-ply abrasion resistant liner.

D. Joints:
   1. Unless otherwise specified or shown on the Drawings, all joints shall match the connecting piping size. The expansion joints shall be designed for the working pressure and fluid service of the connecting piping. All joints shall have full faced fabric reinforced flanges integral with the flexible connector body.

E. Backing Rings:
   1. Unless otherwise indicated, provide Type 304 stainless steel back-up rings for each joint. Unless otherwise specified or shown on the Drawings, all rings shall be designed for mating with ANSI standards for steel and cast iron flanges, 125/150 pound.

F. Control Rods:
   1. All expansion joints used for vibration isolation/expansion service shall be provided with control harness (rod) assemblies. All control harness assemblies shall consist of a minimum of 2 drilled plates, stretcher bolts, and rubber washers backed by metal washers. The stretcher bolts/control rods shall prevent over-elongation of the joint. Extra nuts shall be provided on the stretcher bolts/control rods on the inside of the plate to prevent over compression. All nuts, bolts, fasteners and plates shall be 304 stainless steel.

G. Manufacturer:
   1. Unless otherwise specified or shown on the Drawings, all expansion joints for liquid service, of the same type, style, and duty shall be supplied by a single manufacturer. The manufacturer of the expansion joints shall be a member of the Rubber Expansion Joint Division of the Fluid Sealing Association. All liquid service expansion joints shall be a product of the following manufacturer:
      a. General Rubber Corporation - Style 1100.
      b. Mercer Rubber Company - Series 450.

c. Red Valve Company, Inc. - Type J-1 or T-205 (Chemical Service).

2.11 QUICK CONNECT COUPLINGS - TYPE C13

A. Provide quick connect couplings as specified and as shown on the Drawings.

B. Couplings shall match the connecting pipe size shown on the Drawings. The quick connect couplings shall be cam and groove type with a male/female adapter as required. All quick connect couplings shall conform to A-A-59326 and (MIL-C-27487) standards.

C. All couplings for water service which are connected to metallic piping shall have a body constructed of 304 stainless steel or aluminum with 304 stainless steel or aluminum handles and pull rings.

D. All seals shall be EPDM.

E. The male adapter shall connect to the pipe via a 125/150 pound flange connection.

F. All couplings connected to PVC as well as all couplings for chemical delivery or chemical service applications shall have a body constructed of polypropylene. The polypropylene shall be acid-resistant and glass-reinforced. Handles and pull rings for polypropylene couplings shall be brass.

G. The quick connect coupling shall be designed to receive a female/male coupler without requiring threading, bolting, or special tools. The connection shall remain tight and leak-proof under pressures up to 100 psi. Each quick connect coupling shall be furnished with a dust cap complete with a stainless steel security chain. Provide all adaptors and appurtenances as required to provide a complete and working system.

H. Unless otherwise specified or shown on the Drawings, all quick connect couplings, of the same type, style, and duty shall be supplied by a single manufacturer. All quick connect coupling systems shall be a product of the following manufacturer:
   1. OPW Engineered Systems – Kamlok Series.
   2. Flow Security Systems, Inc. - Snaplock Series.
   3. Banjo Corporation.
   4. Engineer approved equal.

2.12 RESTRAINED MECHANICAL JOINT COUPLINGS - TYPE C14

A. Provide restrained mechanical joint couplings where indicated on the Drawings or as specified. Restrained mechanical joint couplings shall only be utilized with written permission of the Engineer when not specified or indicated on the Drawings. Restrained mechanical joint couplings shall not be considered as equivalent to concrete thrust blocks.

B. All restrained mechanical joint couplings shall be listed by UL, as meeting their standard (UL 6M46), latest revision. Restrained mechanical joint couplings shall also comply with Factory Mutual Research Corporation's (FMRC) approvals.

C. Retainer & Follower Glands:
   1. Mechanical joint retainer glands shall be incorporated in the design of the follower gland and shall include a restraining ring that, when actuated by a wedging action of the gland, imparts a restraining force against the pipe that increases as the pressure increases. The restraining ring shall grip the full pipe circumference.

2. Coupling devices that restrain by a method of point loading on the pipe are not acceptable.

D. Materials of Construction:
   1. Glands and restraining rings shall be manufactured of ductile iron meeting ASTM A 536 standards, Grade 65-45-12. Restraining rings shall also be heat treated to a minimum hardness of Rockwell 40. The restrained mechanical joint couplings shall meet the latest revisions of ANSI A21.10, AWWA C111/A21.11, and AWWA C153/A21.53 standards. The restraint ring shall be actuated solely by the tee-head bolts.
   2. Provide a 2-part fusion bonded epoxy coating on all ferrous metallic surfaces of couplings.
   3. The restrained mechanical joint couplings shall have a working pressure of at least 350 psi with a minimum safety factor of 2:1.

E. Manufacturer:
   1. Unless otherwise specified or shown on the Drawings, all restrained mechanical joint couplings, of the same type, style, and duty shall be supplied by a single manufacturer. All restrained mechanical joint coupling systems shall be a product of the following manufacturer:
      a. Romac Industries, Inc. – RomaGrip.
      b. EBAA Iron – MegaLug.
      c. Engineer approved equal.

2.13 DUCTILE IRON LINEAR EXPANSION JOINTS – TYPE C15

A. Expansion joints shall be installed in the locations indicated on the Drawings and shall be manufactured of ductile iron conforming to the material properties of ANSI/AWWA C153/A21.53. All expansion joints shall be capable of expanding or contracting to the amounts shown on the Drawings or as indicated in the Specifications.

B. Separation beyond the maximum extension of the expansion joint shall be prevented without the use of external tie rods. Each expansion joint shall be pressure tested against its own restraint to a minimum of 350 psi for joint which are less than 24 inch and 250 psi for joints which are larger than 24 inches. Joint restraint shall be provided with each connection to the expansion joint.

C. All internal surfaces (wetted parts) shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213. Exterior surfaces shall be coated with a minimum of 6 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C116/A21.16. Each ductile iron expansion joint shall be designed in accordance with the following criteria:
   1. Size: 3 inch through 36 inch – match to piping size shown on Drawings
   2. Body: Ductile Iron, per ASTM A 536
   3. End Connections: Flanged, mechanical joint, or combination flanged/mechanical joint as required for piping connections or as indicated on the Drawings.
   4. Linear Expansion: 4 inches (minimum)

D. All coupling seals shall conform to the applicable requirements of ANSI/AWWA C111/A21.11. Flange outlets shall conform to the dimensional requirements of ANSI/AWWA C110/A21.10 (class 150) with the addition of an O-ring gasket to ensure a watertight seal. Mechanical joint end connections conform to the dimensional requirements of either ANSI/AWWA C111/A21.11 or ANSI/AWWA C153/A21.53 depending on size.

E. Unless otherwise specified or shown on the Drawings, all linear expansion joints, of the same type, style, and duty shall be supplied by a single manufacturer. All linear expansion joint systems shall be a product of the following manufacturer:
   1. EBAA Iron – Ex-Tend.
   2. Engineer approved equal.

2.14 HDPE TO PVC PIPE ADAPTORS – TYPE C17

A. Provide HDPE (PE/4) pipe transition fittings to PVC materials as indicated on the Drawings. Transition fitting shall be designed to handle the pressure rating of the HDPE pipe with a 2:1 safety factor at 73 degrees Fahrenheit with a minimum 50-year design life.

B. The transition fitting shall be constructed out of PVC material, Epoxy coated Carbon Steel, and high-density polyethylene (HDPE) 3408 pipe. The PVC and HDPE materials are joined together by hydraulically pressing the HDPE pipe into the Epoxy coated carbon steel coupling. The coupling portion of the transition fitting shall be machined with a multi-level barb system that provides a leak free radial compressed joint. The high-density polyethylene and PVC portions of the transition fitting shall be cut to a specific length and pressed into the coupling.

C. Transition joint shall meet or exceed the requirements of ASTM D2513 Category 3 and AWWA C906-99.

D. Epoxy coating (IF 194T Red Iron Oxide) shall be fusion bonded to the metal. Approvals shall include NSF 61, FDA 175.300, AWWA C116-01, C213-01, UL 262 and FM 1120/1130.

E. Stainless Steel Outside Ring & Inserts: 304 stainless steel tubing (ASTM A249 or ASTM A269) or ERW pipe (ASTM SA-312)

F. Provide pipe segments in accordance with the following:
   1. SDR 35 PVC (PVC/5): ASTM D3034 in sizes 4 through 15 inch.
   2. HDPE (PE/4): 3408 high density polyethylene pipe (cell class 345454c) that classified according to ASTM D 3350
   3. Schedule 40, 80, SDR 21 & SDR 26 PVC: ASTM D1785, material used in the manufacture of pipe shall be rigid Polyvinyl Chloride (PVC) compound, Type 1 Grade I, with a Cell Classification of 12454 as defined in ASTM D1784.

G. Manufacturer: Poly-Cam, Inc. or Engineer approved equal.
   1. Series 730 – PVC IPS Sch. 40 (PVC/7) and 80 (PVC/1).
   2. Series 731 – PVC SDR 35 (PVC/5).
   3. Series 732 – PVC DIPS (PVC/6).
   4. Series 737 – PVC to HDPE with inside diameter-controlled fitting.

2.15 HDPE THREADED TRANSITIONS – TYPE C18

A. Provide HDPE (PE/4) pipe transition fittings with threaded connections to materials as indicated on the Drawings. Transition fitting shall be designed to handle the pressure rating of the HDPE pipe with a 2:1 safety factor at 73 degrees Fahrenheit with a minimum 50-year design life.

B. All National Pipe Threads shall be made to ANSI/ASME B1.20-1983 R 1992.

C. End Connections: MNPT or FNPT as indicated on the Drawings or as required to connect to piping.

D. Stainless Steel Inserts: ASTM 2513 Category 1.

E. Threaded Transition shall be manufactured of Type 304 stainless steel and incorporated with the transition manufactured of HDPE (cell class 345454C) or pipe quality Copolymer material. (PE3408, PE3608 and PE4710). All pipe shall meet ASTM 3035 and ASTM 714, NSF 61 for potable water applications.

F. Provide epoxy coating for ferrous metallic connectors which is fusion bonded to the metal. Coating shall have approvals in accordance with NSF 61, FDA 175.300, AWWA C116-01, C213-01, UL 262 and FM 1120/1130.

G. C954 grade Aluminum Bronze (Lead Free material) shall comply with ASTM B505/B505M and B271. Material shall comply with NSF 61 for potable water applications and California AB1953, SB1334 and SB1935.

H. High Density Polyethylene Pipe: Pipe conforming to ASTM D-3350 with minimum cell classification values of 345464C (PE 3408), PE445574C (PE 4710), and shall conform to ASTM F714.
   1. Density: No less than 0.955 gms/ccm as referenced in ASTM D1505, with melt index no greater than 0.15 gms/10 minutes when tested in accordance with ASTM D 1238.
   2. Tensile Strength at Yield: 3,200 to less than 3,500 psi as referenced in ASTM D638, and ESCR-Environmental Stress Crack Resistance shall be in excess of 5,000 hours with zero failures when tested in accordance with ASTM D 1693-Condition C.
   3. All pipe shall meet ASTM 3035.

I. Manufacturer: Poly-Cam, Inc. or Engineer approved equal.
   1. Series 710HD – Heavy Duty Transition with Male NPT.
   2. Series 712 – Transition with Female NPT.

2.16 HARNESSING AND RESTRAINTS

A. Provide all harnessing as specified, as shown on the Drawings, and as required for couplings and adaptors. Unless otherwise specified or noted, the size and material for tie rods, clamps, plates and hex nuts shall be as shown on the Drawings. When not specifically specified or shown on the Drawings all harnessing and restraints shall be sized per AWWA M11 standards.

B. All restrained joints, such as welded, or locking mechanical joints shall be of the type specified with the individual type of pipe. If not specified, restrained (locking) mechanical joint pipe shall be of the manufacturer's standard design utilizing a locking device (ring or ears) integrally cast with the pipe. The Construction Management General Contractor (CMGC) shall be responsible for all anchorage and restraint for piping installations.

C. Unless otherwise specified or shown on the Drawings, all harnessing and restraint systems, of the same type, style, and duty shall be supplied by a single manufacturer. All manufacturers, named or otherwise, shall comply with the Contract Documents. All harnessing and restraint systems shall be a product of the following manufacturer:
   1. Dresser, Inc. - Style 440.
   2. Engineer approved equal.

2.17 UNIONS

A. Provide unions as specified and as shown on the Drawings. In addition to that shown on the Drawings, provide unions at all locations including but not limited to the following: equipment, pumps, tanks, valves, long piping runs, piping bypasses around equipment, or any other location as directed by the Engineer or Atlantic Richfield Company. Unions shall be located to allow for ease of piping disassembly, alterations, or repairs.

B. All unions shall be brass or bronze for joining nonferrous metallic pipe. Provide malleable brass, bronze-seated iron, or steel unions for joining ferrous metallic pipe. Provide PVC unions for joining plastic and non-metallic pipe.

C. Unions or flanges for servicing and disconnect are not required in installations using grooved joint couplings.

2.18 DIELECTRIC CONNECTORS

A. Provide dielectric piping connectors, fittings, and insulators as specified, as shown on the Drawings or as directed by the Engineer. Dielectric pipe connectors and unions shall be used to prevent galvanic action wherever valves or piping of dissimilar metals connect. In addition, provide dielectric connectors whenever copper, brass, or bronze piping is required to be connected to cast iron or steel piping.

B. Provide dielectric flange unions for all connections 2-1/2 inches and larger. All cast iron flanges shall meet ASTM A 126 standards. The copper solder end shall meet ASTM B 62 standards and the pipe thread shall meet ASME B2.1 standards. Dielectric flange unions shall be rated for at least 175 psi at 210 degrees F.

C. Dielectric unions used for piping connections 2 inches and smaller shall be designed to accommodate the end connections of the 2 connecting pipe segments. Steel union nuts shall be in accordance with ASTM A 575 standards. Steel or ductile iron connection ends shall have accurately machined taper tapped pipe threads in accordance with ASME B2.1 standards. Copper connection ends shall be solder joint which meets the requirements of ASTM B 88 standards. All dielectric unions for piping connections 2 inches and smaller shall be rated for at least 250 psi at 210 degrees F.

D. Dielectric fittings and unions shall be manufactured of one or more of the following materials. The materials shall be in accordance with the associated reference standards and criteria:
   1. Gray iron - ASTM A 48/A 48M.
   2. Malleable iron parts - ASTM A 197/A 197M.
   3. Steel parts - ASTM A 108.
   4. Brass parts - ASTM B 16.
   5. Bronze parts - ASTM B 584.
   6. Zinc parts - ASTM B 633.
   7. Stainless steel - ASTM A 632.
   8. Copper/silicon castings – ASTM B 806.

E. Unless otherwise specified or shown on the Drawings, all dielectric unions, of the same type, style, and duty shall be supplied by a single manufacturer. All dielectric union systems shall be a product of the following manufacturer:
   1. Watts, Inc. – Series 3000.
   2. Wilkins, a Zurn Company.
   3. G&L Fittings, Inc.

4. Victaulic – Style 647.
5. Engineer approved equal.

F. Provide all flange-insulating kits for dielectric connections. One insulator shall be provided for each bolt of the flange connection. Insulated sleeve couplings shall be similar to Type C01 sleeve couplings previously specified and flange adaptors shall be similar to Type C07 as previously specified.

G. Unless otherwise specified or shown on the Drawings, all flange-insulating kits, of the same type, style, and duty shall be supplied by a single manufacturer. All flange insulating systems shall be a product of the following manufacturer:
1. Watts, Inc.
2. Wilkins, a Zurn Company.
3. Engineer approved equal.

2.19 GASKETS

A. Gaskets shall be compatible with the associated process fluid. Coupling gasket material shall match the piping system gasket material. Refer to Section 40 05 13 – Process Pipe and Fittings for gasket materials to be used for each application. Gaskets for use in potable water service shall have an NSF 61 listing. All EPDM gaskets shall be rated for a temperature range of minus 30 degrees F to plus 230 degrees F.

B. Gaskets for use with split type couplings that are suitable for installation without field disassembly shall be center-leg with pipe stop to ensure proper groove engagement, alignment, and pipe insertion depth. Gaskets for use with ductile iron pipe split couplings shall be halogenated butyl.

C. Sealing gaskets for use with Type C15 couplings shall be constructed of EPDM meeting ANSI/NSF 61.

D. If a different type of gasket than that specified for a specific application is recommended by the manufacturer, the gasket information shall be submitted to the Engineer for review and approval.

PART 3 - EXECUTION

3.01 INSTALLATION OF SLEEVE TYPE COUPLINGS

A. All sleeve type couplings shall be installed in strict accordance with the recommendations of the coupling manufacturer. The CMGC shall thoroughly clean all pipe connecting ends prior to installation of sleeve couplings. The pipe ends shall be cleaned a minimum of 8 to 12 inches from the ends of the piping prior to installation. Provide clean soapy water for use as a gasket lubricant.

B. Install the follower ring then the gasket over each pipe end to a distance of approximately 6 inches from the end of the pipe. Place the middle ring over the center of the joint. Insert the pipe length into the middle ring the full and proper distance. The gaskets and followers shall then be pressed evenly into the middle ring flares.

C. Insert all bolts. All bolts shall be finger tightened prior to the use of tools. Progressively tighten diametrically opposite nuts uniformly around the adapter. Once the nuts can no longer be finger tightened use a torque wrench of the appropriate size and torque for the bolts. Utilize the wrench to progressively and uniformly tighten all bolts.

D. The torque applied shall be in accordance with the recommendations of the coupling manufacturer. The correct torque as indicated by a torque wrench shall not exceed 75 foot-pounds for 5/8 inch bolts and 90 foot-pounds for 3/4 inch bolts.

E. Insert and tighten all tapered threaded lock pins. All bolts shall be finger tightened prior to use of tools. Progressively tighten diametrically opposite nuts uniformly around the adapter. Once the nuts can no longer be finger tightened use a torque wrench of the appropriate size and torque for the bolts. Utilize the wrench to progressively and uniformly tighten all bolts.

F. Provide and install harnessing or flange clamp assemblies where shown on the Drawings, as specified or as directed by the Engineer. Harnessing or flange clamp assemblies shall be provided to prevent sleeve couplings from being pulled apart under pressure. It is the CMGC's responsibility for locating, providing and installing all restraints. Harnessing, flange clamp assemblies, or tie rods shall be provided on all pressurized lines.

3.02 INSTALLATION OF SPLIT TYPE COUPLINGS

A. Install all split type couplings in strict accordance with the recommendations of the coupling manufacturer. Where applicable, the CMGC shall refer to specified procedures for the installation of sleeve type couplings. The shoulders of the connecting pipes as well as all other associated portions of the assembly shall be thoroughly cleaned prior to assembly. Slip the gasket over the pipe end. The ends of the pipes and outside of the gaskets shall be moderately coated with petroleum jelly, cup grease, soft soap, or graphite paste to provide lubrication for installation. Once the other pipe has been brought to the correct position, the gasket shall be centered properly over the pipe ends with the lips against the pipes. Then install the housing sections of the coupling.

B. Ensure that the joints are fully extended after the rings are in place. Do not tighten the bolts prior to assuring that the joints are fully extended. Insert all bolts and tighten nuts progressively and uniformly until the housing sections are in tight contact. Do not over-tighten such that excessive bolt tension or strain is applied on the connecting piping. Tighten all fasteners to the torque rating as recommended by the coupling manufacturer.

3.03 INSTALLATION OF EXPANSION JOINTS

A. Align all piping systems prior to installation of expansion fittings. The alignment shall be provided by fitting a rigid pipe spool in place of the expansion joint. Prior to testing of the piping system, the pipe spool shall be replaced with the specified expansion or flexible fitting.

B. In addition to the locations noted on the Drawings, expansion fittings and anchors shall be located and spaced as specified by the Expansion Joint Manufacturer's Association (EJMA). The CMGC shall not install any expansion joints or flexible connectors during times of temperature extremes or in a fully compressed or fully expanded condition. Install all expansion joints in strict accordance with the manufacturer's recommendations.

3.04 TESTING

A. All couplings and connectors specified in this section shall be hydrostatically pressure tested with the associated piping as specified in Section 40 05 13 – Process Pipe and Fittings or as directed by the Engineer.

3.05 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.06 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.07 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 40 05 15
PROCESS PIPE SUPPORTS

PART 1 - GENERAL

1.01 SUMMARY

A. Provide all labor, materials, equipment, incidentals, hardware and appurtenances to install a complete system of pipe hangers, pipe supports, concrete inserts, anchor bolts and related appurtenances for supporting non-buried piping as shown on the Drawings and as specified herein. All pipe hanger and support systems shall be designed and constructed to resist the seismic forces as specified herein or as indicated on the Drawings.

B. The pipe supports described in this section are also applicable to plumbing and HVAC systems.

1.02 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-03 Product Data:
      a. For each product type specified.
   2. SD-05 Test Reports:
      a. Testing reports as specified in this Section.

PART 2 - PRODUCTS

2.01 PIPING SUPPORTS - GENERAL

A. The products specified are intended to support the various types of process piping systems shown on the Drawings. The Construction Management General Contractor (CMGC) shall be responsible for developing the final details associated with the specific installation conditions. The details include, but are not limited to, piping system temperatures and pressures associated with each application.

B. The CMGC may propose minor adjustments to the piping arrangements to simplify the supports and to adjust the layout of process piping systems. An example of an adjustment shall be a minor change to a pipe centerline elevation so that a single trapeze support may be used for a process piping system.

C. Unless otherwise indicated, process piping hangers and supports shall be a manufacturer's standard product. All products specified or otherwise shall conform to the requirements of MSS SP-58 and MSS SP-69 standards. Any reference to specific catalog or figure numbers from a specific manufacturer shall be for establishing the type, design, and quality of a piping support product. Any references contained in this Specification section shall not be considered as proprietary.

D. All piping supports and hangers of the same type, style, and duty shall be supplied by a single manufacturer. All process piping supports and hangers shall be a product of the following manufacturer:
   1. Gulf States Hangers & Supports Manufacturers, Inc.
   2. Anvil International, Inc.
   3. Carpenter & Paterson, Inc.
   4. Eaton B-Line (Formerly Cooper B-Line).

5. PHD Manufacturing, Inc.
6. Unistrut Corporation (For Pipe Support Framework).
7. Globe Strut (For Pipe Support Framework).
8. Power-Strut (For Pipe Support Framework).
9. MP Husky (For Pipe Support Framework).
10. Engineer approved equal.

2.02 PIPING FORCES

A. Provide rigid support of all piping systems. Provide supports to prevent significant stresses in the material, valves, fittings and other connected pipe appurtenances. All supports and anchors shall be designed to secure the pipe in the intended position and alignment.

B. All supports and anchors shall be designed to accommodate thermal expansion and contraction.

C. Pipe supports and anchor design shall specifically account for internal flow forces, all probable external forces from equipment connection, human contact, and all seismic forces. Provide structural steel members to brace any piping system from excessive dislocation. All pipe fittings and appurtenances connected to equipment shall be supported in a manner to prevent any strain from being imposed on the equipment or piping systems. All pipe supports shall be installed such that they do not induce point loadings on the piping. All supports shall distribute pipe loads evenly along the pipe circumference.

D. All piping hangers, supports and appurtenances shall be adequate to maintain the supported load in proper position under all operating conditions. The minimum working factor of safety for all supporting equipment, except for springs, shall be 1/5 the ultimate tensile strength of the material, assuming a minimum 10 feet of water filled pipe being supported.

2.03 DISSIMILAR METALS

A. All stainless steel piping shall be isolated from all ferrous metals including galvanized steel. Provide a neoprene sheet or stainless steel protection shields to prevent direct contact when installed.

B. Copper piping shall be protected from galvanic corrosion from contact with ferrous metals. Provide corrosion protection by wrapping the copper pipe with 1/16-inch thick neoprene, sheet metal and a galvanized protection shield with isolators. Copper plated or polyvinyl chloride (PVC) coated hangers and supports may also be used to provide dielectric isolation.

2.04 NON-METALLIC PIPING

A. Uninsulated non-metallic piping, including, but not limited to Type (PVC/1), Type (PVC/2), Type (PVC/3), Type (PVC/4), Type (PVC/5), Type (PVC/6), Type (PE/1), Type (PE/2), Type (PE/3), and Type (PE/4) shall be protected from local stress concentrations at each support point. Protection from local stresses shall be provided by PVC coated steel or 304 stainless steel protection shields.

B. Pipes which are bottom supported for 180 degrees shall be provided with arc shields. Pipes which are supported for 360 degrees shall be provided with protection shields for the entire exterior pipe circumference. Protection shields shall have an 18-gauge minimum thickness. Protection shields shall be a minimum of 12 inches in length. Securely fasten

each protection shield to the pipe with 304 stainless steel straps not less than 1/2 inches in width.

2.05 INSULATED PIPE

A. Insulated piping shall be provided with a rigid insulating saddle at each pipe support location. Provide protection shields at each support location.

2.06 VERTICAL PIPING

A. Whenever possible, support vertical piping using floor supports rather than wall supports. Concrete supports, base elbows, and base tees shall be used when possible and as shown on the Drawings.

B. Support vertical piping by pipe collars, clamps, brackets, or wall rests. Spacing as indicated under “Support Spacing” in this Specification.

C. All vertical pipes passing through pipe sleeves shall be secured using a pipe collar.

2.07 MATERIALS OF CONSTRUCTION

A. All piping support systems shall be constructed of the following materials based on location unless otherwise specified or indicated on the Drawings:
   1. All submerged piping: 316 stainless steel.
   2. All outdoor piping: 316 stainless steel.
   3. All interior in-basin, in-channel, as well as piping in access vaults (located above the maximum water level): 304 stainless steel.
   4. All interior building piping: 304 stainless steel.

B. All pipe clamps on plastic pipe shall be provided with a plastic coating or neoprene isolator.

C. All supports for copper pipe shall be copper plated or shall have a minimum 1/16-inch plastic coating.

D. All fasteners and related hardware for supports, including, but not limited to nuts, bolts, anchors, and washers shall be 316 stainless steel regardless of location.

E. All stainless steel components shall be passivated after fabrication.

2.08 HORIZONTAL PIPING HANGERS AND SUPPORTS

A. Unless otherwise specified or indicated on the Drawings, provide factory fabricated horizontal piping hangers and supports conforming to MSS SP-58 standards. Horizontal piping supports and hangers shall be one of the following MSS types listed below.
   1. The specific type of support shall be selected by the CMGC to suit the horizontal piping system layout in accordance with MSS SP-69 standards as well as the piping manufacturer's published support requirements. Whenever possible, use only one type of support system by one manufacturer for each piping service. Select the size of hangers and supports to exactly fit the nominal pipe outside diameter for bare piping, and to exactly fit around piping insulation with a saddle or shield for all insulated piping.
   2. Type 5 - Pipe Hangers, Type 12 - Pipe Clamps, and Type 26 - Pipe Clips shall not be used. Type 3 - Three Bolt Pipe Clamps shall not be used on insulated piping systems. Type 24 - U-Bolts shall only be used in conjunction with other supports types including trapeze hanger systems or fabricated frames.

2.09 SINGLE PIPE CLEVIS HANGERS

A. Whenever possible, single process piping runs shall be supported by single pipe adjustable clevis type hangers (MSS Type 1), suspended by hanger rods from structural steel members, concrete ceilings, or the bottom of trapeze hangers. The clevis type hanger shall be specifically designed for the process piping type being supported as follows
   1. Adjustable Clevis Hangers:
      a. Anvil International, Inc. - Figure No. 260.
      b. Carpenter & Paterson, Inc. - Figure No. 100.
      c. PHD Manufacturing, Inc. - Figure No. 425.
      d. Engineer approved equal.
   2. Adjustable Clevis Hangers (Insulated Pipe):
      a. Anvil International, Inc. - Figure No. 300.
      b. Carpenter & Paterson, Inc. - Figure No. 100EL.
      c. PHD Manufacturing, Inc. - Figure No. 430.
      d. Engineer approved equal.
   3. Adjustable Clevis Hangers (Cast Iron or Ductile Iron Pipe):
      a. Anvil International, Inc. - Figure No. 590.
      b. Carpenter & Paterson, Inc. - Figure No. 100DI.
      c. PHD Manufacturing, Inc. - Figure No. 420.
      d. Engineer approved equal.

2.10 PIPE CLAMPS

A. Single process piping runs supported by pipe clamps, (MSS Type 4), shall be in accordance with the following:
   1. Anvil International, Inc. - Figure No. 212.
   2. Carpenter & Paterson, Inc. - Figure No. 175.
   3. PHD Manufacturing, Inc. - Figure No. 520/521.
   4. Engineer approved equal.

2.11 PIPE SADDLE SUPPORTS

A. Single process piping runs supported by pipe saddle supports, (MSS Type 36), shall be in accordance with the following:
   1. Anvil International, Inc. - Figure No. 258.
   2. PHD Manufacturing, Inc. - Figure No. 880.
   3. Engineer approved equal.

B. Provide pipe base supports and cast floor flanges for all pipe saddle supports. Refer to the details on the Drawings for additional requirements.

2.12 PIPE STANCHION SADDLES

A. Single process piping runs supported by pipe stanchion saddles, (MSS Type 37), shall be in accordance with the following:
   1. Anvil International, Inc. - Figure No. 259.
   2. Carpenter & Paterson, Inc. - Figure No. 125.
   3. PHD Manufacturing, Inc. - Figure No. 882.
   4. Engineer approved equal.

B. Provide pipe base supports and floor flanges for all pipe stanchion saddles. Refer to the details on the Drawings for additional requirements.

2.13 EXTENDED VERTICAL PIPING CLAMPS

A. Except as otherwise indicated, provide factory-fabricated extended vertical piping clamps. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping. Provide larger diameter clamps to accommodate insulated piping and shields. Provide vertical piping two-bolt extended riser clamps in accordance with the following:
   1. Anvil International, Inc. - Figure No. 100.
   2. Carpenter & Paterson, Inc. - Figure No. 267.
   3. PHD Manufacturing, Inc. - Figure No. 545.
   4. Engineer approved equal.

2.14 OFFSET PIPE CLAMPS

A. Except as otherwise indicated, provide factory fabricated offset vertical piping clamps. Provide vertical piping 2 bolt offset riser clamps in accordance with the following:
   1. Anvil International, Inc. - Figure No. 103.
   2. Carpenter & Paterson, Inc. - Figure No. 179.
   3. PHD Manufacturing, Inc. - Figure No. 535.
   4. Engineer approved equal.

2.15 PIPE RISER CLAMPS

A. Pipe riser clamps (MSS Type 8) shall be used to support vertical piping runs extending through floor slabs. Insulation shall be provided for the entire diameter of insulated pipes prior to installing riser clamps. Insulation shall not be damaged by clamp installation. Provide pipe riser clamps in accordance with the following:
   1. Anvil International, Inc. - Figure No. 261.
   2. Carpenter & Paterson, Inc. - Figure No. 126.
   3. PHD Manufacturing, Inc. - Figure No. 550, 551, or 553.
   4. Engineer approved equal.

2.16 WALL PIPE SUPPORTS

A. Where pipe runs are near supports, including, but not limited to walls, beams, and columns, and are also located an excessive distance from ceilings or the underside of beams, welded stainless steel wall pipe supports shall be used for hanging pipe. In cases where single pipes rest on top of bracket pipe supports, all attachments shall meet requirements as specified under multiple pipe hangers. Provide structural wall pipe supports in accordance with the following:

B. Light duty applications (MSS Type 31) shall be defined as small diameter piping less than 2 inches nominal pipe size.
   1. PHD Manufacturing, Inc. - Figure No. 850.
   2. Carpenter & Paterson, Inc. - Figure No. 69.
   3. Engineer approved equal.

C. Medium duty applications (MSS Type 32) shall be defined as 3 inch through 6 inch PVC or stainless steel piping.
   1. PHD Manufacturing, Inc. - Figure No. 855.
   2. Carpenter & Paterson, Inc. - Figure No. 84.
   3. Engineer approved equal.

D. Heavy duty applications (MSS Type 33) shall be used for all Type DI/1 & Type CS/1 piping and all piping materials larger than 6 inch nominal pipe size.

1. PHD Manufacturing, Inc. - Figure No. 860.
2. Carpenter & Paterson, Inc. - Figure No. 139.
3. Engineer approved equal.

E. Where applicable and approved by the Engineer, the use of C-channels with stainless steel brackets and pipe clamps shall be provided. All members shall be securely fastened to walls, columns, or other Engineer approved structural members. Attachment shall utilize double expansion shields or other methods as approved by the Engineer. Additional wall bearing plates shall be provided where required.

2.17 MULTIPLE PIPE HANGERS

A. Suspended multiple pipes, running parallel in the same horizontal plane, which are adjacent to each other shall be suspended by trapeze type hangers or wall brackets. Trapeze hangers shall consist of stainless steel or aluminum structural channels supported from stainless steel threaded rods.

B. Provide all other necessary accessories, including, but not limited to rods, concrete inserts, C-clamps, beam clamps, welded beam attachments, and expansion shields, as required and as specified for a complete piping support system.

C. Unless otherwise specified or indicated on the Drawings, pipe anchors used for attaching pipe to trapeze or multiple pipe wall brackets shall be anchor or pipe chairs.

D. All chair U-bolts shall be tightened to allow freedom of movement for normal expansion and contraction of piping runs except where pipe shall be anchored to control direction of movement or act as a thrust anchor.

2.18 HANGER ROD ATTACHMENTS & BEAM CLAMPS

A. Hanger rod attachments shall be machine threaded. The strength of the rod shall be based on its root diameter. Threaded rods shall not be formed or bent in the field.

B. Hanger rods shall be attached to concrete structures using concrete inserts. Beam clamps, C-clamps, or welded beam attachments shall be used for attaching hanger rods to structural steel members.

C. Where required and as approved by the Engineer, expansion or epoxy anchors shall be used for attaching to concrete structures.

D. Provide a bituminous coating for all iron or steel in direct contact with concrete.

E. Both locknuts and retaining devices shall be furnished by the piping support manufacturer.

F. Field fabricated clamp bodies and retaining devices are not acceptable. Side beam or channel clamps (MSS Type 20) shall be provided with an added iron heel plate or adaptor. Whenever possible utilize center beam clamps (MSS Type 21).

2.19 HORIZONTAL SMALL DIAMETER PIPE SUPPORTS

A. Horizontal piping runs less than 3 inches in diameter shall be held in position by supports fabricated from 304 stainless steel or aluminum C-channels, welded post bases and pipe clamps.

B. To assure adequate support, fabricate supports using two vertical members and post bases connected by a horizontal member of sufficient load capacity to support the piping run.

Wherever possible, supports shall be anchored to nearby walls or other structural members to provide horizontal rigidity. More than 1 pipe may be supported from a common fabricated support as approved by the Engineer.

2.20 SMALL DIAMETER PLASTIC PIPE SUPPORT

A. Provide all pipe supports for closely spaced vertical plastic piping systems 3 inches and smaller to provide a rigid support system. The interval of vertical support spacing shall be as required by the pipe manufacturer, but in no case, shall the vertical spacing interval exceed 6 feet between supports. The support system shall consist of a framework suitably anchored to floors, ceilings, roofs or other Engineer approved structural members.

B. Vertical and horizontal supporting members shall be 304 stainless steel or aluminum U-shaped channels. The assemblies shall be furnished complete with all nuts, bolts and fittings for a complete assembly including end caps for all support members.

C. Vertical piping shall be secured to the horizontal members by pipe clamps or pipe straps.

D. The design of each individual framing system for small diameter plastic pipe support systems shall be the responsibility of the CMGC. Shop Drawings, shall be submitted and shall show all details of the installation, including dimensions and types of supports. In all instances the completed frame shall be adequately braced to provide a complete rigid structure when all the piping has been attached.

E. Size all supports for proper support as well as to provide compatibility with the associated piping material. Use only 1 type by 1 manufacturer for each piping service.

2.21 CUSTOM FABRICATED PIPE SUPPORTS

A. Whenever possible utilize standard piping supports and appurtenances. If standard supports are not suitable for an application, provide custom fabricated structural shapes, concrete, and anchor hardware for support of process piping systems.

B. All custom fabricated supports and hardware shall be of approved materials of construction like items previously specified, and shall meet all applicable requirements of this specification section.

C. Submit complete design details of the pipe support system and system components. Do not install custom fabricated pipe supports without the written approval of the Engineer.

2.22 THIN-WALLED PIPE SUPPORTS

A. Supports for thin walled pipe shall be provided per the requirements of this Specification, and shall include saddle bracing to avoid damaging the pipe at the point of contact with the associated support.

2.23 CONCRETE INSERTS

A. Provide inserts (MSS Type 18) to allow a connection point for hanger rods in concrete. Inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for (MSS Type 18) inserts. Provide a bituminous coating for all metallic inserts in direct contact with concrete. All concrete inserts shall be in accordance with the following:
   1. Anvil International, Inc. - Figure No. 282.
   2. Carpenter & Paterson, Inc. - Figure No. 650.
   3. PHD Manufacturing, Inc. - Figure No. 951.

4. Engineer approved equal.

2.24 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 - EXECUTION

3.01 GENERAL

A. Hangers, supports, and guides shown on the Drawings are for coordination purposes and represent recommendations based on assumed pipe routing. Provide routing and installation of all hangers, supports and guides for complete piping systems.

B. Proceed with the installation of piping and supports only after any building structural work has been completed and all new concrete has reached its specified design strength in accordance with the requirements of Division 03.

C. The installation of pipe support systems shall in no way interfere with the operation of monorails, access hatches, building systems, overhead doors, etc. The installed systems shall not interfere with maintenance and operational access to equipment.

D. All pipe supports shall be designed with liberal strength and stiffness to support the respective pipes under the maximum combination of peak loading conditions including pipe weight, liquid weight, liquid movement and pressure forces, thermal expansion and contraction, vibrations and all probable externally applied forces, including seismic forces. Prior to installation, all pipe support systems shall be approved by the Engineer.

E. Design and adjust pipe support systems to allow for drainage of pipe.

3.02 SEISMIC CONDITIONS

A. Design process piping supports in accordance with the stricter of the following:
   1. The seismic criteria indicated in the Contract Documents, or
   2. The highest seismic hazard class or level possible within the State in which the Project resides.

B. Provide seismic restraints for all piping systems, including, but not limited to free standing, suspended or wall mounted piping. Use the restraints defined in the SMACNA Seismic Restraints Manual when the seismic criteria, and size of piping, are within the limits of the SMACNA Manual. Provide members of material of equal strength to those in the standards where materials other than carbon steel are specified.

3.03 SUPPORT LOCATIONS

A. Support piping such that piping live and dead loading, and stresses from movement, will not be transmitted to connected equipment, valves, tanks, couplings, and any other appurtenances that are not designed to support piping loads. Equipment shall not be used to support piping.

B. Support piping immediately adjacent to each change of direction and where installation of inline equipment produces concentrated loads. Provide support at offsets in piping as necessary to prevent deflection of the pipe axis due to expansion or pressure forces, except where right angle bends are utilized to compensate for expansion.

C. Provide independent support on either side of each valve and in-line instrument. Support shall permit removal and replacement of valve or instrument without affecting support of adjacent piping. Support of valves by connected piping is not acceptable. All electric and hydraulic valve actuators shall be independently supported.

D. Couplings: Support all couplings shown on the Drawings and as specified for connection to tanks, pumps, equipment, and appurtenances. All such couplings shall be rigidly supported, to prevent transfer of force to the equipment. Fixed or restraining supports shall not be installed between a flexible coupling and the connected piece of equipment/appurtenance. The supports shall be located at the end opposite the tank, pump, equipment, and appurtenance.

3.04 SUPPORT SPACING, GENERAL

A. Distance between pipe supports shall be the minimum of pipe manufacturer requirements, location requirements defined above, and spacing defined below.

B. Space supports so that the sag of the pipe (if any) is within the limits of the piping manufacturer. The support design and layout shall minimize bending stresses on the supported piping from concentrated loads between supports. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for the smallest pipe size or install intermediate supports for smaller diameter pipe.

3.05 SUPPORT SPACING, METALLIC PIPING

A. Minimum Spacing for Rigid Metallic Piping (including cast iron, ductile iron, steel and stainless steel) shall be per the following table:

Pipe Size (Inches)	Maximum Span (feet)
1½ inches & smaller	5 feet
2 inches to 4 inches	10 feet
5 inches to 8 inches	15 feet
10 inches & larger	20 feet

3.06 SUPPORT SPACING, PLASIC PIPING

A. Provide continuous support for plastic piping (including PVC and HDPE) whenever possible. Continuous support shall consist of ladder type cable trays.

B. All ladder type cable trays shall be constructed of PVC coated aluminum, aluminum or stainless steel. The ladder rung spacing shall be a maximum of l2 inches. The tray width shall be a minimum of 6 inches for single piping runs and l2 inches for double piping runs.

C. Secure plastic pipes to ladder trays by clamps or fasteners. The spacing between clamps and fasteners shall not be greater than 10 feet.

D. Minimum Spacing for Rigid Plastic Piping (including PVC and HDPE) shall be per the following table:

Pipe Size (Inches)	Maximum Span (feet)
1½ inches & smaller	4.5 feet
2 inches to 4 inches	6 feet

5 inches to 8 inches	9 feet
10 inches & larger	10 feet

3.07 INSTALLATION

A. Install hangers, supports, clamps, and attachments to support piping properly from building structures in accordance with MSS SP-69.

B. Attach pipe supports to concrete walls, columns, structural steel, and other Engineer approved support members. The pipe support system shall not impose loads on the supporting structures in excess of the loads for which the supporting structure was designed.

C. Do not support piping from existing precast concrete tees, metal stairs, ladders, concrete columns or concrete beams or walkways unless specifically directed or authorized in writing by the Engineer. Do not use wire or perforated metal to support piping. Do not support piping from other piping.

D. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

E. Torque all Top Beam C-Clamps (MSS Type 19), C-Clamps (MSS Type 23), and any other hardware with specific torque requirements in in accordance with MSS SP-69 standards and manufacturer requirements.

F. Except as otherwise permitted, make provisions for vertical adjustment of all hangers after installation.

G. Where temporary supports are used, provide sufficiently rigid support to prevent shifting or distortion of pipe.

H. Apply anti-seize compound to all nuts, bolts, and other associated fasteners. Supports installed without the approved anti-seize compound shall be dismantled and correctly installed, at no additional cost to Atlantic Richfield Company or the Engineer.

3.08 CONCRETE INSERTS

A. Install concrete inserts on forms before concrete is placed. Before setting these items, all Drawings and figures shall be checked which have a direct bearing on the pipe location. Responsibility for the proper location of pipe supports shall be the responsibility of the installing Contractor. Continuous metal inserts shall be embedded flush with the concrete surface. Provide a bituminous coating for all metallic concrete inserts in contact with concrete.

3.09 FINISHING

A. All sharp edges and corners within 7 feet of the floor or walking surfaces shall be ground down and/or protected with plastic protective covers.

B. All ferrous metal surfaces shall be finished in accordance with Section 09 90 00 – Paint and Coatings. Stainless steel, galvanized steel, plastic, brass, bronze, copper and fiber-reinforced plastic (FRP) components shall not be painted unless otherwise indicated in the Contract Documents.

3.10 TESTING

A. All pipe support systems shall be tested for compliance with this Specification and referenced standards. After installation, each pipe support system shall be tested in conjunction with the respective piping pressure tests as specified in Section 40 05 13 – Process Pipe and Fittings. If any part of the pipe support system proves to be defective or inadequate, it shall be repaired and/or augmented to the satisfaction of the Engineer, at no additional cost to the Atlantic Richfield Company or the Engineer.

3.11 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.12 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.13 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 40 05 17
PROCESS PIPE SLEEVES AND SEALS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide all labor, materials, equipment, incidentals, and appurtenances required for pipe penetration assemblies as indicated on the Drawings, in accordance with this Section and applicable reference standards listed in Article 1.02.
   2. Refer to the Drawings for additional details and requirements for each penetration configuration.
   3. Furnish one set of all special tools required to completely assemble, disassemble, or maintain the pipe sleeves and seals. Special tools shall refer to oversized or specially dimensioned tools, special attachments or fixtures, or any similar items.

1.02 REFERENCES

A. Reference Standards:
   1. American Water Works Association (AWWA):
      a. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings.
      b. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
      c. AWWA C115/A21.15 - Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges.
      d. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast, for Water.
      e. AWWA C153/A21.53 - Ductile-Iron Compact Fittings.
   2. ASTM International (ASTM):
      a. ASTM D 297 - Standard Test Methods for Rubber Products - Chemical Analysis.
      b. ASTM D 2000 - Standard Classification System for Rubber Products in Automotive Applications.
      c. ASTM D 395 - Standard Test Methods for Rubber Property - Compression Set.
      d. ASTM D 412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension.
      e. ASTM F 593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
      f. ASTM F 594 - Standard Specification for Stainless Steel Nuts.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-03 Product Data:
      a. Product data shall include manufacturer's descriptive data, technical literature, performance charts, catalog cuts, and installation instructions. Provide literature, installation instructions, and where applicable, fire ratings and certified test results of the various components on all sleeves and seals.
   2. SD-07 Closeout Submittals:
      a. Per Division 01 General Requirements.

1.05 QUALIFICATIONS OF MANUFACTURER

A. Materials and equipment shall be the standard products of a manufacturer regularly engaged in the production of such products and shall essentially duplicate items that have been in satisfactory use in identical applications in other wastewater treatment facilities. The manufacturer shall have a minimum of 5 years of documented experience in the design and production of pipe sleeves and seals of all types, and not less than 5 years of experience in the production of equal or larger sized models or designs of the exact products as specified.

1.06 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

1.07 WARRANTY

A. Provide in accordance with Division 01 General Requirements.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Materials delivered and placed in storage shall be stored with protection from the weather, excessive humidity variation, excessive temperature variation, dirt, dust and/or other contaminants. Proper protection and care of materials before, during, and after installation shall be the Construction Management General Contractor’s (CMGC) responsibility. Any materials found to be damaged shall be replaced at the CMGC's expense. Materials shall be stored with protection from puncture, dirt, grease, moisture, mechanical abrasions, excessive heat, ultraviolet (UV) radiation, or other damage. All couplings and connectors shall be handled and stored in accordance with the Manufacturer's recommendations.

C. Surfaces such as flange faces shall be protected from damage during shipment. Inspect the materials delivered to the Site for damage. Store rubber products under cover out of direct sunlight. Do not store materials directly on the ground. Keep the inside of couplings and connectors free of dirt and debris.

1.09 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

PART 2 - PRODUCTS

2.01 PIPE SLEEVES

A. Provide pipe wall sleeves and seal penetrations as indicated or required to complete the Work. Unless otherwise specified or indicated on the Drawings, all pipe sleeves 24 inches and smaller shall be constructed of high-density polyethylene (HDPE). The use of ferrous metallic sleeves is not acceptable. All pipe sleeves larger than 24 inches shall be constructed of 304L stainless steel. Pipe sleeves of all sizes and materials shall include a 2 inch (minimum) circumferential water stop welded or integrally molded to the exterior of the sleeve at its midpoint. The sleeve length shall be specifically coordinated with the respective thickness of the penetrated structural wall, floor or ceiling. Unless otherwise indicated, ends of sleeves shall be flush with the wall or ceiling and extend a minimum of 4 inches above finished floors. Refer to the piping penetration details on the Drawings for additional information and requirements. Pipe sleeves which penetrate masonry block walls do not require an integral water stop.

B. Pipe sleeves which are to be sealed with mechanical seals shall be sized in accordance with the recommendations of the seal manufacturer.

C. Sleeves to be sealed by caulking or sleeves for insulated piping shall be sized, constructed and installed as specified or as indicated on the Drawings. Unless otherwise indicated, all pipe sleeves which penetrate fire rated walls, floors or ceilings shall be 304L stainless steel, regardless of size.

D. All pipe sleeves shall be supplied by a single manufacturer. All wall pipe sleeves shall be a product of the following manufacturers:
   1. Pipeline Seal & Insulator, Inc.
   2. Advance Products & Systems, Inc. - Infinity Series.
   3. Engineer approved equal.

2.02 WALL CASTINGS (WALL PIPE)

A. Provide wall castings (wall pipe) as specified or indicated on the Drawings. All wall castings shall be constructed of ductile iron conforming to AWWA C151/A21.51 standards, Class 53, with a diameter to match the connecting piping system. Ductile iron wall castings shall be grade 60-42-10. All wall castings shall have minimum physical properties in accordance with the following:
   1. Minimum Tensile Strength: 60,000 psi.
   2. Minimum Yield Strength: 42,000 psi.
   3. Minimum Elongation: 10 percent.

B. Flanges and mechanical joint bells shall be drilled and tapped for studs where flush with the wall. Castings shall be provided with a 2-inch minimum circumferential flange/water stop integrally cast with or welded to the pipe. All welded flanges/water stops shall include a continuous 360-degree fillet weld on both sides of the collar over the entire circumference of the wall pipe. The pipe collar shall be designed for use as both a thrust collar and a water stop mechanism.

C. Unless otherwise noted, all cast flanges shall be in accordance with AWWA C110/A21.10, AWWA C153/A21.53 and AWWA C115/A21.15 standards. All mechanical joints shall be in accordance with AWWA C111/A21.11 standards. Fabricated mechanical joint bells shall be in accordance with applicable portions of AWWA C153/A21.53 standards. Flanges shall be designed for a 125-pound drilling pattern.

D. Ductile iron wall sleeves may be provided with AWWA C606 compliant grooved ends in applicable piping systems as approved by the Engineer. The sleeves shall be complete with flexible radius grooves for installation with Victaulic Style 31 couplings or Engineer-approved equal.

E. For castings set flush with walls, locate the flange/water stop at the center of the overall length of the casting. For castings which extend through the wall, locate the flange/water stop within the middle third of the wall. All ductile iron wall castings shall be provided with a 2-part epoxy prime and finished coating system in accordance with Section 09 90 00. As an alternative to epoxy coating, provide a bituminous coating on all surfaces of wall castings which are in contact with concrete.

F. Stainless steel wall pipes shall be provided for all stainless steel piping systems to match the connecting piping. All stainless steel wall pipes shall be Schedule 10S, Type 304L stainless steel with a 2 inch minimum circumferential flange/water stop integrally cast with or welded to the pipe. All stainless steel wall pipes shall be in accordance with the

requirements of Types SS/1 piping as noted in Section 40 05 13 – Process Pipe and Fittings.

1. Schedule 10S stainless steel wall sleeves may be provided with grooved ends in applicable piping systems as approved by the Engineer. The sleeves shall be suitable for installation with Victaulic Style 489 couplings or Engineer-approved equal.

G. All ductile iron wall castings shall be supplied by a single manufacturer. All wall castings shall be a product of the following manufacturers:
   1. American Cast Iron Pipe Company.
   2. Clow Water Systems Company.
   3. Engineer approved equal.

2.03 MECHANICAL PIPE SEALS

A. Unless otherwise specified or indicated on the Drawings, all core drilled or sleeved wall, floor and ceiling penetrations shall be provided with a modular, mechanical type, sealing system. The sealing system shall consist of inter-locking synthetic rubber links shaped to continuously fill the annular space between the pipe and the cored opening or pipe sleeve. The elastomeric element shall be sized and selected in accordance with the manufacturer's recommendations and sizing guidelines. Coloration shall be throughout the elastomer as indicated below for the respective seal materials to allow for positive field identification. Each link shall have a permanent identification of the size and manufacturer's name molded into it. Each seal shall be rated by the manufacturer for positive sealing at a minimum pressure of 40 feet of water or 20 psig. All mechanical pipe seals shall have the following properties.
   1. For General Service Applications, utilize ethylene propylene diene monomer (M-class) rubber (EPDM) seals per ASTM D 2000 standards. Color shall be black. Pressure plates shall be constructed of reinforced nylon polymer or composite material. Seals shall be rated for a temperature range of minus 40 to 250 degrees F. The minimum EPDM durometer hardness (Shore A) shall be 50 plus or minus 5.
   2. For Thin Wall Pipe Applications utilize EPDM seals per ASTM D 2000 standards. Color shall be blue. Pressure plates shall be constructed of reinforced nylon polymer or composite material. Seals shall be rated for a temperature range of minus 40 to 250 degrees F. The minimum EPDM durometer hardness (Shore A) shall be 40 plus or minus 5. Examples of thin walled pipe applications include but are not limited to the following:
      a. Copper Tubing (Type CU/1):
   3. For Fire Rated or High Temperature penetration applications utilize silicone or rubber seal elements. All seals shall meet or exceed the fire rating requirements of the wall, floor or ceiling which is penetrated. Provide a double seal for all fire rated penetrations. Color shall be gray or red. All seals shall be rated for a temperature range of at least minus 67 to 400 degrees F. Pressure plates shall be constructed of corrosion resistant zinc plated steel. All fire rated seals shall be factory mutual (FM) approved for the rating of the constructed element being penetrated. Refer to the Drawings for the fire ratings of each respective area.

B. Provide mechanical seals with wall sleeves for new construction where specified or as indicated on the Drawings. Provide seals for cored openings for existing construction where pipe penetrations pass through a sound concrete wall. When a pipe penetration into a tank or other vessel is below the high-water level, provide 2 mechanical seals, 1 flush with the inside wall and 1 flush with the outside wall. Mechanical seal hardware shall be oriented towards the wall side which allows for future access. Refer to the Drawings for additional details and requirements.

C. All mechanical pipe seals shall be supplied by a single manufacturer. All pipe seals shall be a product of the following manufacturers:
   1. Pipeline Seal & Insulator, Inc. - Link-Seal.
   2. Advance Products & Systems, Inc. – Innerlynx.
   3. Engineer approved equal.

2.04 MECHANICAL PIPE SEAL PROPERTIES

A. All EPDM mechanical pipe seals shall be designed and constructed in accordance with the following minimum physical and chemical properties:
   1. Tensile Strength: 1,450 psi per ASTM D 412.
   2. Elongation at Break: 400 percent per ASTM D 412.
   3. Compression Set: 15 percent after 22 hours at 150 degrees F per ASTM D 395.
   4. Specific Gravity: 1.10 per ASTM D 297.

B. All silicone mechanical pipe seals shall be designed and constructed in accordance with the following minimum physical and chemical properties:
   1. Tensile Strength: 860 psi per ASTM D 412.
   2. Elongation at Break: 250 percent per ASTM D 412.
   3. Compression Set: 38 percent after 22 hours at 150 degrees F per ASTM D 395.
   4. Specific Gravity: 1.30 per ASTM D 297.

C. All Nitrile (NBR/Buna-N) mechanical pipe seals shall be designed and constructed in accordance with the following minimum physical and chemical properties:
   1. Tensile Strength: 1,200 psi per ASTM D 412.
   2. Elongation at Break: 300 percent per ASTM D 412.
   3. Compression Set: 45 percent after 22 hours at 150 degrees F per ASTM D 395.
   4. Specific Gravity: 1.15 per ASTM D 297.

2.05 SEALING OF FLAMMABLE PIPE

A. Unless otherwise indicated, all pipe sleeves which penetrate fire rated walls, floors or ceilings shall be 304L stainless steel regardless of size. In cases where small diameter flammable plastic pipes penetrate fire rated construction, provide an intumescent pipe wrap with a rating which meets or exceeds the fire resistance requirements of the area. Examples of flammable plastic pipes include but are not limited to polyvinyl chloride (PVC), unplasticized polyvinyl chloride (UPVC), acrylonitrile-butadiene-styrene (ABS), polypropylene, and polyethylene. All intumescent pipe wrap shall be water resistant as well as halogen and plasticizer free. Provide a minimum fire expansion rate of 40:1.

B. In cases where larger diameter flammable plastic pipes penetrate fire rated construction, provide an intumescent pipe collar with a rating which meets or exceeds the fire resistance requirements of the area. The collar shall be surface mounted for existing construction. Provide centrally cast flush fitted collars for new construction.

C. Pipe collars shall be epoxy coated steel and contain high-performance intumescent material. On exposure to heat from a fire, the pipe collars shall rapidly expand inwards to squeeze the collapsing flammable pipe until the aperture is completely sealed. For horizontal installations the collar may be surface mounted or recessed depending upon the construction installation requirements. Install a collar on 1 or both sides of walls, floors, or ceilings according to the direction of risk. Provide fire rated insulation, caulk, putty, mortar, pillows and hardware to provide a complete installation.

D. All fire rated sealing systems shall be supplied by a single manufacturer. All fire rated pipe collars, wraps and related appurtenances shall be a product of the following manufacturers:

1. 3M Fire Protection Products.
2. Hilti Corporation.
3. RectorSeal Corporation - Bio Fireshield.
4. Engineer approved equal.

2.06 HARDWARE

A. All process pipe sleeve and seal hardware, including mechanical seal hardware shall be 316 stainless steel in accordance with ASTM F 593 and ASTM F 594 standards. The minimum hardware tensile strength shall be 60,000 psi. Provide dielectric insulation or isolation between ferrous metal surfaces and stainless steel hardware.

2.07 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Install pipe sleeves, seals and wall castings of the types and configurations as indicated on the Drawings. Provide sleeves, seals and wall castings where piping passes through walls, floors, ceilings, and roofs. Do not install sleeves through structural members of Work, except as detailed on the Drawings, or as approved by the Engineer. Install all sleeves and castings accurately centered on pipe runs. Size wall sleeves so that piping and insulation (if any) will have free movement in the sleeve, including allowance for thermal expansion, but not less than 2 pipe sizes larger than the piping run.

B. Provide and install sleeves and wall castings with a length equal to thickness of the construction being penetrated. Unless otherwise specified or indicated on the Drawings, all wall sleeves and castings shall be finished flush to the wall construction being penetrated. Unless otherwise indicated, floor sleeves shall be extended a minimum of 4 inches above the finished floor in process areas. Provide temporary supports of sleeves and provide temporary closure to prevent concrete and other materials from entering sleeves during construction.

3.02 MECHANICAL PIPE SEAL INSTALLATION

A. Center the pipe in the cored or sleeved opening. Provide temporary support for the pipe on both ends. Loosen the rear pressure plate with nut just enough so mechanical links move freely. Connect both ends of belt around the pipe. Check to be sure all bolt heads are facing the installer. Extra slack or sag is normal. Do not remove links if extra slack exists. On smaller diameter pipe, links may require stretching. Slide belt assembly into annular space. For larger size belts, start inserting the mechanical seal assembly at the 6 o'clock position and work both sides up toward the 12 o'clock position in the annular space.

B. Using a hand socket or offset wrench only, start at 12 o' clock. Do not tighten any bolt more than 4 turns at a time. Continue in a clockwise manner until links have been uniformly compressed. Approximately 2 or 3 rotations are typical. Make 2 or 3 more passes at 4 turns per bolt maximum, tightening all bolts clockwise until all sealing elements bulge around all pressure plates. If the mechanical seals include type 316 stainless steel bolts, hand wrench tighten only without use of power tools to prevent galling.

3.03 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.04 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.05 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 40 05 23
PROCESS VALVES AND STRAINERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide all labor, materials, equipment, incidentals, and appurtenances required for process valves and strainers in accordance with this Section and applicable reference standards listed in Article 1.02.
   2. The following sections reference the process valve type and specification reference numbers shown in the valve tag symbols on the Contract Drawings. The valves and strainers included in this specification section may or may not all be required for the work of the Contract. Provide all valves that are specified, indicated on the Drawings and/or are required to complete the work indicated in the Contract Documents.
   3. Furnish, install, test and make ready for operation all process valves and strainers of the type(s) and size(s) required and as shown on the Drawings and as specified herein. Provide all related valve accessories including but not limited to hand wheels, chain wheels, extension stems, stem guides, operating wrenches, floor stands, and valve tags. The valves, strainers, and appurtenances shall be of sizes and connection types as shown on the Drawings and as specified herein.
   4. Provide chain wheel actuators for all valves which are located with a center line elevation which is 6'-0" or greater above the operating floor level. Some chain wheel actuators have been omitted from the Drawings for clarity.
   5. Provide gear operated hand wheel actuators for all valves which are located adjacent to walls or structural supporting members to allow unobstructed actuation.
   6. Furnish one set of all special tools required to completely assemble, disassemble, or maintain the valves and strainers. Special tools shall refer to oversized or specially dimensioned tools, special attachments or fixtures, or any similar items.

1.02 REFERENCES

A. Reference Standards:
   1. American National Standards Institute (ANSI):
      a. ANSI B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
      b. ANSI B16.104 - Control Valve Seat Leaking.
   2. American Society of Mechanical Engineers (ASME):
      a. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24ASME B16.10 Face-to-Face and End-to-End Dimensions of Valves.
      b. ASME Section IV - Rules for the Construction of Heating Boilers.
   3. ASSE International (ASSE):
      a. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers.
   4. ASTM International (ASTM):
      a. ASTM A 126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      b. ASTM A 216/A 216M - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.

c. ASTM A 240/A 240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
d. ASTM A 276/A 276M - Standard Specification for Stainless Steel Bars and Shapes.
e. ASTM A 351/A 351M - Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
f. ASTM A 436 - Standard Specification for Austenitic Gray Iron Castings.
g. ASTM A 48/A 48M - Standard Specification for Gray Iron Castings.
h. ASTM A 536 - Standard Specification for Ductile Iron Castings.
i. ASTM B 584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
j. ASTM B 16/B 16M - Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines.
k. ASTM B 30 - Standard Specification for Copper Alloys in Ingot Form.
l. ASTM B 36/B 36M - Standard Specification for Brass Plate, Sheet, Strip, and Rolled Bar.
m. ASTM B 61 - Standard Specification for Steam or Valve Bronze Castings.
n. ASTM B 62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
o. ASTM B 124/B 124M - Standard Specification for Copper and Copper Alloy Forging Rod, Bar, and Shapes.
p. ASTM B 138/B 138M - Standard Specification for Manganese Bronze Rod, Bar, and Shapes.
q. ASTM B 150/B 150M - Standard Specification for Aluminum Bronze Rod, Bar, and Shapes.
r. ASTM B 505/B 505M - Standard Specification for Copper Alloy Continuous Castings.
s. ASTM D 1599 - Standard Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings.
t. ASTM D 2000 - Standard Classification System for Rubber Products in Automotive Applications.
u. ASTM D 3222 - Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
v. ASTM D 4024 - Standard Specification for Machine Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Flanges.
w. ASTM D 429 - Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates.
x. ASTM D 1056 - Standard Specification for Flexible Cellular Materials – Sponge or Expanded Rubber.
y. ASTM D 1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
z. ASTM F 593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
aa. ASTM F 1476 - Standard for Performance of Gasketed Mechanical Couplings in Piping Applications.
bb. ASTM F 1970 - Standard Specification for Special Engineered Fittings, Appurtenances or Valves for Use in Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Systems.

5. American Water Works Association (AWWA):
   a. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service.
   b. AWWA C504 - Rubber-Seated Butterfly Valves.

c. AWWA C508 - Swing-Check Valves for Waterworks Service, 2 In. (50 mm) Through 24 In. (600 mm) NPS.
d. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.
e. AWWA C511- Reduced-Pressure Principle Backflow-Prevention Assembly.
f. AWWA C512 - Air Release, Air/Vacuum, and Combination Air Valves for Waterwork and Wastewater Service.
g. AWWA C515 - Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.
h. AWWA C517 - Resilient-Seated Cast-Iron Eccentric Plug Valves.
i. AWWA C550 - Protective Interior Coatings for Valves and Hydrants.
j. AWWA C606 - Grooved and Shouldered Joints.
k. AWWA D102 - Coating Steel Water-Storage Tanks.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
1. SD-02 Shop Drawings:
a. Shop drawings for each valve or strainer shall be identified with the applicable style or series designation. Shop Drawings shall show layout and dimensions of equipment, major components, key alignment locations and locations of bolt holes. Drawings shall show all critical field dimensions identified by the Manufacturer.
2. SD-03 Product Data:
a. Submit sufficient product data to verify compliance with the specifications and to illustrate the construction and assembly of the products. Include compliance of materials and components with applicable standards. Product data shall include manufacturer's descriptive data, technical literature, performance charts, catalog cuts, and installation instructions. The type, thickness, application procedure, and test for coatings, and non-metallic and metallic linings shall also be included.
3. SD-05 Test Reports:
a. Submit test reports for each valve tested for pressure and leakage.
b. Submit test reports for each backflow preventer tested.
4. SD-07 Closeout Submittals:
a. Per Division 01 General Requirements.

1.05 QUALIFICATIONS OF MANUFACTURER

A. Materials and equipment shall be the standard products of a Manufacturer regularly engaged in the production of such products and shall essentially duplicate items that have been in satisfactory use in identical applications in other wastewater treatment facilities. The Manufacturer shall have a minimum of five (5) years of documented experience in the design and production of process valves or strainers of "all types", and not less than five (5) years of experience in the production of equal or larger sized models of the exact equipment as specified herein.

B. The Manufacturer shall provide a list of at least five (5) similar installations, including contact names and phone numbers. Equipment shall be supported by a service organization that is, in the opinion of the Engineer, reasonably convenient to the site to ensure parts and service can be acquired in a timely fashion.

1.06 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. All valves and strainers of the same type shall be the product of a single Manufacturer. Unless otherwise indicated, floor stands, associated adapters, extension stems, extension stem brackets, chain wheels and all associated appurtenances shall be provided by the valve Manufacturer.

C. All valves and strainers shall be suitable for the services specified and intended. The pressure ratings and materials specified represent minimum acceptable standards for valves and strainers. All valves and strainers shall have a pressure rating no less than that required for the system in which they are installed.

D. All piping systems, components, and appurtenances in contact with potable water, including potable water during any stage of treatment or conditioning, shall be certified to meet the requirements of ANSI/NSF 61 for water service.

E. All grooved valves shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components. All castings used for valve shall be date stamped for quality control and traceability.

1.07 DELIVERY, STORAGE & HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. All equipment delivered and placed in storage shall be provided with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants in accordance with the Manufacturer's written instructions.

C. Finished surfaces of all exposed openings shall be protected by wooden blanks or other suitable cover to prevent foreign material and debris from entering the equipment.

D. Off-load equipment at the installation site using equipment of sufficient size and design to prevent damage to the equipment. Immediately after off-loading, inspect all equipment for shipping damage or missing parts. Any damage or discrepancy shall be noted in a written claim with the shipper prior to accepting delivery. Validate all serial numbers and parts lists with the shipping documentation. Notify the Manufacturer of any unacceptable conditions with the shipper.

E. Where necessary to store outside, elevate above grade and enclose with durable, waterproof wrapping. Store rubber products under cover out of direct sunlight. Do not store materials directly on the ground.

1.08 WARRANTY

A. Provide in accordance with Division 01 General Requirements.

1.09 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

PART 2 - PRODUCTS

2.01 PROCESS VALVES - GENERAL

A. The use of a Manufacturer's and/or identification catalog number in the following sections shall be for the purpose of establishing a standard of quality and/or the valve configuration/assembly desired for the application specified or shown on the Drawings. The reference to specific product catalog, model, or figure numbers shall not be considered as "Proprietary".

B. Valve sizes shall be equal to line sizes as shown on the Drawings, unless otherwise indicated. Provide all necessary reducers and/or expansion fittings for connection of valves to pipelines that are not of equal size. All flanged valves shall conform to ANSI B16.1 standards unless otherwise noted. Grooved end valves shall be of the same manufacturer as the adjoining couplings, with ends compliant to AWWA C606.

C. Valves and strainers shall include all required operator(s), actuator(s), handwheel(s), chain wheel(s), extension stem(s), floor stand(s), floor box(es) worm and gear operator(s), operating nut(s), chain(s), wrenches, and all other appurtenances required for a properly installed and operational valve assembly as shown on the Drawings and as specified herein. The installation shall form a complete workable system as shown on the Drawings.

D. Cast marking(s) shall be provided on all valves and strainers. The marking(s) shall include size, working pressure, a cast arrow to indicate direction of flow, name of Manufacturer, and year of Manufacture. The marking shall be located on an appropriate part of the valve in a clearly visible location. All valves and strainers shall be suitable for the intended service shown on the Drawings and specified herein. Renewable parts shall not be of a lower quality than those specified and provided with the initially specified and installed valve or strainer assembly.

E. All valves shall open by turning/rotating the valve actuator Counterclockwise ("Left"), unless otherwise specified or shown on the Drawings. Provide all special adaptors to ensure compatibility between valves, appurtenances, and adjacent piping.

2.02 PVC BALL VALVE - TYPE V20

A. Provide PVC ball valves suitable for use as shown on the Drawings and as specified herein. The valves shall be industrial type manufactured to ASTM F 1970 standards. All PVC ball valves shall be constructed from PVC Type I, per ASTM D 1784 standards, Cell Classification 12454. All O-rings shall be compatible with the pumped fluid as specified and as recommended by the valve manufacturer. All valves shall have a stem with double O-ring seals. All valve handles shall be polypropylene with a built-in lockout mechanism. All valve union nuts shall have Buttress threads. All valve components shall be replaceable without removing the valve from the piping line.

B. For potable water applications, all valves shall be certified by NSF International for use in potable water service. All 1/2 inch through 4 inch valves shall be pressure rated to 235 psi, all 6 inch and 8 inch Venturied and all flanged valves shall be pressure rated to 150 psi for water at 73 degrees F.

C. Provide stem extensions where required and as shown on the Drawings. The stem extension shall be a single-piece, two-piece, or single-piece panel-mount extension of PVC with outer housing 100% sealed and either of free standing or supported design. The valve shall not require any special tools. All PVC ball valves shall be in accordance with the following criteria:
   1. Size: 1/2 Inch to 8 Inch - Match to piping size as shown on the Drawings.

2. End Connections: True union.
3. Valve Body, Ball, Carrier, End Connector & Stem: PVC.
4. Valve Seat: EPDM.
5. Gaskets, Seals, & O-Rings: PTFE, EPDM.
6. Maximum Line Pressure: 235 psi.
7. Valve Operator: Lever.

D. All PVC ball valves of the same type, style and duty shall be supplied by a single Manufacturer. All PVC ball valves shall be a product of the following Manufacturer:
   1. Asahi/America Inc.
   2. Spears Manufacturing Company.
   3. Hayward Industrial Products Inc.
   4. Engineer approved equal.

2.03 STAINLESS STEEL BALL VALVE - TYPE V26

A. All stainless steel ball valves shall be non-lubricated with a blow-out proof stem design. All valves shall have a full floating ball. The valve seats and seals shall be easily accessible and replaceable. All stainless steel ball valves shall be designed and constructed in accordance with the following criteria:
   1. Size: 1/4 Inch to 3 Inch - Match to Piping Size as Shown on Drawings.
   2. End Connections: Threaded NPT or flanged connections as indicated on the Drawings and as required for connection to piping and appurtenances. Press fitting end connections will also be allowed with approval from the Engineer.
   3. Body & Trim: 304 Stainless Steel per ASTM A 276/A 276M.
   4. Ball & Stem/Shaft: 304 Stainless Steel per ASTM A 276/A 276M.
   5. Seats & Seals: PTFE.
   6. Maximum Operating Pressure: 150 psi.
   7. Valve Type: Full port.
   8. Valve Body Type: Two piece.
   9. Valve Operator: Lever - 304 stainless steel.
   10. Lever Hand Grip: Vinyl.

B. An easily visible, permanent indicator located conspicuously on the top of the valve shall be provided to determine the position of the ball within the valve in the "Open" or "Closed" position.

C. All stainless steel ball valves of the same type, style, and duty shall be supplied by a single Manufacturer. All stainless steel ball valves shall be a product of the following Manufacturer:
   1. Apollo by Conbraco Industries Inc.
   2. Neles Jamesbury Company.
   3. Watts Regulator Company.
   4. Hammond Valve Company.
   5. Victaulic – Series P569.
   6. Engineer approved equal.

2.04 PLUG VALVE - TYPE V40

A. All plug valves shall be manufactured in accordance with AWWA C517 standards. All valves shall have a body with integral flanges, faced and drilled per ASME B16.5 Class 125. All plug valves shall be non-lubricated, eccentric, quarter turn, with resilient faced plugs. Valves shall be furnished with a 1/8-inch welded seat overlay of not less than 90% pure nickel. Seat area shall be raised and the raised surface shall be completely covered

with a weld to insure that the plug face only contacts nickel. Screwed-in seats shall not be acceptable. The valve shall be provided with adjustable limit stops for both opening and closing. A clearly marked position indicator shall also be provided.

B. The plug shall have a cylindrical seating surface eccentrically offset from the center of the plug shaft. The interference between the plug face and body seat, with the plug in the closed position, shall be externally adjustable in the field with the valve in the line under pressure. The valve plug shall be resilient faced with Nitrile (Buna-N) and be suitable for use with wastewater. Valves shall have sleeve type metal bearings and shall be sintered, oil impregnated, and permanently lubricated. Valve shaft seals shall be multiple V-ring type and shall be externally adjustable and re-packable without removing the bonnet or actuator from the valve under pressure. All metallic plug valves for water/wastewater service shall be designed and constructed in accordance with the following criteria:
   1. Size: 3 Inch to 72 Inch - Match to Piping Size as Shown on Drawings.
   2. End Connections: Flanged, ANSI Class 125/150.
   3. Body Type: Minimum 100% nominal full port area. Smaller port areas will not be acceptable for this project.
   4. Body & Cover: Ductile iron per ASTM A 536, (Epoxy Coated).
   5. Seat: Welded nickel.
   6. Plug: Ductile iron per ASTM A 536.
   7. Plug Facing: Nitrile (Buna-N).
   8. Valve Operator (Valves 6 Inches & Smaller): Lever, for 2-inch square operating nut.
   9. Valve Operator (Valves Larger than 6 Inches): Gear operated hand wheel.
   10. Bolts, Nuts, Washers: 316 stainless steel.

C. Provide gear operated hand wheels for all valves located adjacent to walls or structural members regardless of size to allow for unobstructed actuation. Provide gear operated hand wheels where specifically indicated on the Drawings regardless of valve size.

D. Provide chain wheel actuators for all valves with a centerline elevation of 6’-0” or greater above the operating floor elevation.

E. Valves utilizing O-ring seals or non-adjustable packing shall not be acceptable. Valves shall provide drip-tight bidirectional shutoff at the rated pressures. The plug shall have a cylindrical seating surface eccentrically offset from the center of the plug shaft. The interface between the plug face and body seat, with the plug in the closed position, shall be externally adjustable in the field with the valve in the line under pressure. For "Sludge Service", plug valves shall permit pigging of the piping with line-size pigs.

F. The valve plug shall be removable without the need to take the valve out of the line. The valve plug shall be one piece for valves up to 14 inches and a maximum of two (2) pieces for larger valves.

G. Valves in horizontal liquid lines shall have plugs that travel from open above the flow to closed on the upstream end of the valve. Valves in vertical liquid lines shall have plugs that close up. Valves shall be tagged or marked by the Manufacturer to indicate the proper mounting position. All gearing shall be enclosed in semi-steel housing and be suitable for running in a lubricant with seals provided on shafts to prevent entry of dirt and water into the actuator. The actuator shaft and the quadrant shall be supported on permanently lubricated bronze bearings. Actuators shall clearly indicate valve position and an adjustable stop shall be provided to set closing torque and to provide seat adjustment to compensate for change in pressure differential or flow direction change. The actuator shall be capable of holding the valve in a single position without slip or vibration.

H. Plug valves up to 12 inches shall be rated at 200 psi water working pressure. Plug valves larger than 12 inches shall be rated at 150 psi water working pressure. Seat tightness at rated pressure shall be in accordance with AWWA C504 standards. The valves shall be certified by the Manufacturer as allowing zero (0) leakage for a period of at least 1/2 hour with the specified pressure applied in either direction. If requested, a valve seat leakage test shall be conducted & witnessed by the Engineer to prove compliance of the valve with this section.

I. All three-way plug valves shall be designed in accordance with the previously specified criteria and performance requirements for "two way" plug valves. All three-way plug valves shall be designed for installation in either horizontal or vertical piping. Each valve shall be designed for flow in any direction. Each valve shall be designed for positive shut-off of the "feed port" as well as the two "discharge ports". Provide tight shut-off of bi-directional flow in either direction.

J. All plug valves of the same type, style, and duty shall be supplied by a single Manufacturer. All metallic plug valves shall be a product of the following Manufacturer:
   1. DeZurik Water Controls.
   2. Henry Pratt Company.
   3. Clow Valve Company.
   4. Engineer approved equal.

2.05 PVC SWING CHECK VALVE - TYPE V61

A. All PVC Swing Check Valves shall be of Thermoplastic PVC construction. PVC shall conform to ASTM D 1784 standards, Cell Classification 12454-A. All valves shall be designed as a maintenance free seal unit construction with a resilient seat and weighted disc. All valves shall have an external flow arrow direction designation. All valves shall be certified by NSF International for use in potable water service. All valves shall be suitable for installation in both the horizontal and vertical planes. The swing check valves shall also be designed and constructed in accordance with the following criteria:
   1. Size: Match to piping size as shown on Drawings.
   2. End Connection: True union.
   3. Valve Body: PVC, per ASTM D 1784 Cell Classification 12454-A.
   4. Valve Seat: Viton.
   5. Seal: Viton.
   6. Maximum Inlet Pressure: 150 psi.
   7. Maximum Backpressure: 75 psi (Closed).

B. The valve shall be constructed so that the disc and body seat may be easily removed and replaced without the need for removing the valve from the line. The valves shall be fitted with an external counter weight to assist the disc in closing faster. The position of the weight shall be adjustable to limit the force required to open the disc.

C. All PVC swing check valves of the same type, style, and duty shall be supplied by a single Manufacturer. All PVC swing check valves shall be a product of the following Manufacturer:
   1. Asahi/America Inc.
   2. Spears Manufacturing Company.
   3. Hayward Industrial Products Inc.
   4. Engineer approved equal.

2.06 METALLIC FLAP STYLE SWING CHECK VALVE - TYPE V63

A. Provide rubber flap type swing check valves suitable for use with wastewater containing grit. Valve sizes shall be equal to line sizes as shown on the Drawings, unless otherwise

noted. The valve Manufacturer shall state in writing that valve is suitable for intended service. The valve shall be designed constructed and tested in accordance with AWWA C508 standards.

B. The body and cover design shall be of a long pattern (not wafer) with integrally cast-on end flanges. The valve body shall be full flow equal to nominal pipe diameter at all points through the valve. The seating surface shall be approximately 45 degrees from the long axis of the valve to minimize disc travel. The top access port shall be full size, allowing the removal of the disc without removing the valve from the line. The access cover shall be shaped to provide flushing action over the disc for operation in lines containing high solids content and/or grit.

C. All valves shall be hydrostatically tested and seat tested to demonstrate zero leakage by the valve Manufacturer. The flex portion of the disc shall be warranted for a minimum of twenty-five years. The valve disc shall be cycled 1,000,000 times in accordance with ANSI/AWWA C508 standards and show no signs of wear, cracking or distortion of the disc or seat and shall remain drip tight at both high and low pressures. Test results shall be independently certified. A copy of independent standard certification shall be provided to the Engineer upon request. The valves shall be designed and constructed in accordance with the following criteria:
   1. Size: 2 Inches to 24 Inches - Match to piping size as shown on Drawings.
   2. End Connections: Flanged, per ANSI B16.1 125/150.
   3. Body & Cover: Ductile iron, per ASTM A 536 Gr 65-45-12.
   4. Flap/Disc: Nitrile (NBR/Buna-N), per ASTM D 2000.
   5. Hardware (Bolts, Nuts, Washers): 316 stainless steel.
   6. Pressure Rating: 175 psi.

D. An external screw-type, back-flow device shall be provided to create back-flow through the check valve, to allow for pump priming, or to allow for back-flushing of a clogged pump. Nitrile (NBR/Buna-N) seals shall be used to seal the stainless steel stem in a bronze bushing. The backflow device shall be rising-stem type to indicate position. A stainless steel T-handle shall be provided for ease of operation.

E. Valve exterior shall be painted Universal Metal Primer for high resistance to corrosion. The seat and internal body shall be fully coated with a two-part thermosetting epoxy suitable for use in both potable water and wastewater applications. The interior and exterior coatings shall meet all applicable ANSI/NSF 61 standards.

F. The disc shall be one piece construction with an integral O-ring type sealing surface and an internal steel and/or nylon reinforcing. Non-slamming closing shall be incorporated by providing for a short (approximately 35 degrees) travel length of the disc. The flow area shall be equal to the nominal pipe inside diameter throughout the valve.

G. All metallic flap style check valves of the same type, style, and duty shall be supplied by a single Manufacturer. All metallic flap style check valves shall be a product of the following Manufacturer:
   1. APCO a DeZurik Company - Series 100.
   2. Henry Pratt Company - RD Series.
   3. Val-Matic Valve & Manufacturing Company - Series #500.
   4. Engineer approved equal.

2.07 DUCK BILL CHECK VALVE - TYPE V69

A. Duck bill check valves shall be all rubber flow operated type. The port area shall be "straight" or "contoured" down to a duckbill to allow passage of flow in one direction while

preventing reverse flow. The flexible duckbill sleeve shall be one-piece rubber construction with nylon reinforcement. The duckbill shall be offset so that the bottom line of the valve is flat, keeping the invert of the pipe parallel with the invert of the valve. The top of the valve shall rise to form the duckbill shape. The bill portion shall be thinner and more flexible than the valve body and formed into a curve of 180°. The valve shall be designed and manufactured in accordance with the following criteria:

1. Size: 1/2 Inch to 84 Inch - Match to piping size as shown on Drawings.
2. End Connections: Flanged ANSI B16.1 & ANSI B16.5, Class 125/150.
3. Elastomer (Wastewater): Nitrile (NBR/Buna-N).
4. Maximum Flow: Refer to Pump Schedule for specific pipeline.
5. Maximum Line Pressure: See Pump Schedule for specific pipeline.
6. Maximum Back Pressure: See Drawings.
7. Minimum Flow: See Pump Schedule for specific pipeline.
8. Minimum Line Pressure: See Pump Schedule for specific pipeline.
9. Minimum Back Pressure: See Drawings.
10. Hardware: 316 stainless steel.
11. Backing Rings: 316 stainless steel.

B. The valve Manufacturer shall have available flow test data from an accredited hydraulics laboratory to confirm pressure drop data. The company name, plant location, valve size and serial number shall be bonded to the check valve.

C. When line pressure inside the valve exceeds the backpressure outside the valve, the line pressure shall force the bill of the valve open, allowing flow to pass. When backpressure exceeds the line pressure, the bill of the valve shall be forced closed preventing backflow.

D. All duck bill check valves of the same type, style, and duty shall be supplied by a single Manufacturer. All duck bill check valves shall be a product of the following Manufacturer:
   1. Tideflex Technologies Division of Red Valve Company.
   2. CLA-VAL Company.
   3. Engineer approved equal.

2.08 GASKETS

A. Gaskets shall be compatible with the associated process fluid. Coupling gasket material shall match the piping system gasket material. Refer to Section 40 05 13 – Process Pipe and Fittings for gasket materials to be used for each application. Gaskets for use in potable water service shall have an NSF 61 listing. All EPDM gaskets shall be rated for a temperature range of minus 30 degrees F to plus 230 degrees F.

B. If a different type of gasket than that specified for a specific application is recommended by the manufacturer, the gasket information shall be submitted to the Engineer for review and approval.

2.09 SPARE PARTS

A. Concurrent with delivery and installation of the specified valves, spare parts for each different item of material and equipment specified that is recommended by the Manufacturer to be replaced any time up to three (3) years of service shall be provided. For each type and size of valve, the following extra materials shall be provided: lubricator, lubricant (with appropriate temperature rating), lubricator/isolating valve; galvanized operating wrench, 4 feet long, for T-handled operators; galvanized operating key for cross handled valves.

B. Extra materials shall include two (2) of the following spare parts for each type and size of valve: gaskets; O-ring seals; diaphragms (molded); all elastomer parts; stem packing; seat rings and seat ring pulling tool.

2.10 VALVE ACTUATORS & OPERATORS

A. Unless otherwise specified or shown on the Drawings, all valves shall be manually actuated. All valves shall have an operating hand wheel or a handle/lever mounted on the operator. Valves with operating nuts shall be non-rising stem design with an AWWA 2 inch square operating nut. Provide at least six (6) two (2) foot long steel operating bars for all operating nuts. All valves shall be provided with hand wheel actuators on all manually actuated valves larger than six (6) inches in size unless otherwise specified or shown on the Drawings.

B. The valve Manufacturer shall supply and factory mount all actuators; including any type of manual or powered actuators. The valves and actuators shall be shipped as a single unit. All valve actuators shall be sized to operate the associated valve for the full range of pressures and velocities. Position indicators shall be provided for interior NRS valves.

C. The force in a manual operator shall not exceed 40 pounds of rim-pull under any operating condition, including initial breakaway. The operator shall be equipped with gear reduction when force exceeds 40 pounds of rim-pull. All manual operators shall be self-locking type or shall be equipped with a self-locking device. The actuators shall be capable of moving the valves from a fully open to a fully closed position and a fully closed position to a fully open position. The actuator shall be capable of holding the valve at any position in between the fully open and fully closed positions. A position indicator shall be supplied on quarter-turn valves. Each operating device shall have the word "OPEN" permanently cast as well as an arrow indicating the direction of operation.

2.11 CHAINWHEEL OPERATORS

A. Unless otherwise specified or shown on the Drawings, chain wheel actuators shall be provided for all valves when the valve center line is located six (6) feet or greater above the operating floor. All chain wheel actuators shall be provided complete with chain guides. The operator chain shall loop within a minimum of four (4) feet from the operating floor level. Provide 316 stainless steel "L" type tie-back anchors shall be to allow for chain attachment. All chain shall be weldless single loop lock type.

B. All chain wheel actuators and chain guides shall be specifically sized for the diameter of the valve hand wheel. All chain wheel actuators shall be designed to allow for field adjustment and detachment. All chain wheel actuators shall be designed and constructed in accordance with the following criteria:
   1. Size: Match to valve hand wheel diameter.
   2. Chain Wheel: Cast iron or ductile iron - epoxy coated.
   3. Chain Guide: Malleable iron.
   4. Attachment Hardware: 316 stainless steel.
   5. Chain: 304 stainless steel.
   6. Chain: Spark-resistant brass (explosion proof environments only).

C. The chain wheel rim shall contain a groove into which the chain guide attaches. The groove shall be an integral part of the casting. All ferrous metallic surfaces of the chain wheel actuators shall be provided with a two-part epoxy paint coating. The coating color system shall be matched to the valve piping system color coding. All chain wheel actuators which are located in Class 1, Division 1 & 2 "Explosion Proof" electrical hazard areas shall be equipped with a spark-resistant brass chain.

D. All chain wheel actuators of the same type, style, and duty shall be supplied by a single Manufacturer. Where applicable, chain wheel actuators shall be provided by the Manufacturer of the valve being served. The chain wheel actuators shall be a product of the following Manufacturer:
   1. M&H Valve Company.
   2. Kennedy Valve Company.
   3. Babbitt Steam Specialty Company.
   4. Engineer approved equal.

2.12 GEAR OPERATORS

A. Unless otherwise specified or shown on the Drawings, all valves larger than eight (8) inches shall be provided with gear operators. All manually operated valves with a rim pull greater than 40 ft-lbs shall also be provided with gear operators. Worm and gear operators shall be a one-piece design with worm-gears of bronze or machine cut steel material. Worm shall be hardened alloy steel with the thread ground and polished. Traveling nut type operators shall have threaded steel reach rods with an internally threaded bronze or ductile iron nut.

B. The output shaft shall be perpendicular to the valve shaft and be provided with a removable hand wheel. Unless otherwise noted or specified all gear actuators shall conform to AWWA C504 standards. All butterfly valve actuators shall provide proof of certification. All gear actuators shall be removable from the valve without removing the valve from the line or dismantling the valve.

C. All gear operators shall indicate the valve position and have adjustable stops. The maximum hand wheel size shall be 24 inches in diameter. All position indicators shall be of the embossed, stamped, engraved, etched, or raised types.

D. Unless otherwise specified or shown on the Drawings, all gear operated valves three (3) inches & larger shall be provided with position indication at the point of operation. Valves smaller than three (3) inches shall have position indication on the respective hand wheel's or lever actuators.

2.13 EXTENSION STEMS & STEM GUIDES

A. Where the depth of the valve is such that its centerline is more than 12 inches below grade or operator level, an operator extension stem shall be furnished with a two (2) inch operating nut to bring the operating nut to a point six (6) inches below the surface of the ground and/or box cover. The operating nut shall be located in a floor box.

B. Extension stems shall be two (2) inch 304 stainless steel. Provide support brackets for spans greater than five (5) feet. All extension stems and/or operating nuts shall be provided with universal joints and pin couplings when longer than ten (10) feet. All stem adaptors shall be provided. All extension stems and operating nuts shall have a rating of at least five (5) times the maximum operating torque.

C. All stem guides shall be high strength stainless steel. The stem guides shall be adjustable wall bracket type. The guide shall be provided with bronze bushings where the extension stem passes through. The maximum spacing shall be ten (10) feet. All stem guides shall be designed and constructed in accordance with the following:
   1. Bracket: 304L stainless steel.
   2. Guide: 304L stainless steel.
   3. Bushing: Brass CDA 360.
   4. Bolts & Nuts: 316 stainless steel.
   5. Operator: 2-inch square nut or hand wheel as shown on Drawings.

D. All stem guides & extension stems of the same type, style, and duty shall be supplied by a single Manufacturer. Where applicable, stem guides and extension stems shall be provided by the Manufacturer of the valve being served. The stem guides and extension stems shall be a product of the following Manufacturer:
   1. Clow Valve Company.
   2. Penn-Troy Manufacturing, Inc.
   3. M&H Valve Company.
   4. Kennedy Valve Company.
   5. Engineer approved equal.

2.14 VALVE BOXES (OUTDOOR SUB-GRADE VALVES)

A. Each exterior valve shall be provided with a valve box. Valve boxes shall be cast iron, adjustable, telescoping, heavy-pattern type. They shall be designed and constructed to prevent the direct transmission of traffic loads to the pipe or valve.

B. Cast-iron valve boxes shall have minimum metal thickness of 3/16 inch. All boxes shall be extension type with slide-type adjustment and a flared base. The bell end of the valve box shall be sufficiently large enough to fit over the stuffing box of the respective valve.

C. The boxes shall be adjustable through at least six (6) inches vertically without reduction of lap between sections to less than four (4) inches. The length shall be as necessary to suit the finish grade elevation.

D. The inside diameter of the box shall be at least 5-1/4 inches. The covers shall be close fitting and dirt-tight. The top of the cover shall be flush with the top of the box rim.

E. A minimum of two (2) T-handles for 2-inch square operating nuts shall be provided. The T-handle wrenches shall be sized for the box length. Concrete boxes shall be the standard product of a Manufacturer of precast concrete structures.

F. The box length shall adapt to the length required for the depth of the line and to the depth of cover required over the pipe at the valve location without full extension. Concrete boxes shall be installed only in locations not subjected to vehicular traffic. The boxes shall have housings of sufficient size to completely cover the valve or service stop and shall be complete with covers.

G. All iron valve boxes of the same type, style, and duty shall be supplied by a single Manufacturer. The iron valve boxes shall be a product of the following Manufacturer:
   1. Crescent Foundry Company.
   2. East Jordan Iron Works Inc.
   3. Engineer approved equal.

2.15 VALVE IDENTIFICATION TAGS

A. All valves in piping including individual valves provided with equipment shall be tagged in accordance with the Drawings. The valve tags shall be provided with identifying numbers and letters to match the designations shown on the Drawings. All valve tags shall be provided with sufficient lengths of chain for attachment to the respective valve. All valve tags shall be designed and constructed in accordance with the following:
   1. Tag Size: 2-inch round.
   2. Tag Material: PVC (Lamacoid).
   3. Tag Background: Black.
   4. Tag Lettering: White.
   5. Chain: #16 stainless steel jack chain.

6. Lettering: Engraved (Lamacoid.)

B. All buried valves shall be provided with tags embedded in a concrete pad surrounding the valve box.

C. For valves with chain wheel actuators the tag shall be attached to the operating chain to allow for identification at operator level.

D. The Construction Management General Contractor (CMGC) shall confirm the final numbering sequence with the Engineer prior to ordering any tags.

E. All valve tags of the same type, style, and duty shall be supplied by a single Manufacturer. All valve tags shall be a product of the following Manufacturer:
   1. Seton Identification Products Inc.
   2. Emedco Inc.
   3. Engineer approved equal.

2.16 FINISHINGS & COATINGS

A. All coatings and lubricants in contact with "Potable Water" shall be certified as acceptable for use with that fluid. If the valve Manufacturer does not require finished coating on any interior surfaces, then the Manufacturer shall state so in writing and no finish coating shall be required, if approved by the Engineer.

B. Unless otherwise specified, all iron body valves shall be exterior primed with a shop coat of an Engineer approved rust-inhibitive primer. The primer shall be applied in accordance with the instructions of the paint Manufacturer. The primer shall be compatible with the finish coat provided. Unless otherwise specified, the finish coat shall match the coating of connecting pipe in type and color. All field painting shall be in accordance with Section 09 90 00 – Painting and Coating. Stainless steel, brass, bronze, and plastic body valves shall not require coating.

C. Unless otherwise specified or noted, all interior ferrous surfaces shall be given a shop finish of an asphalt varnish or epoxy coating in accordance with AWWA C550 and AWWA C509 standards.

D. The epoxy paint shall be either a two-part liquid material or a heat-activated (fusion) material except that only a heat-activated material shall apply if a valve coating is specified as "fusion" or "fusion bonded" epoxy. The epoxy lining and coating shall have a minimum 4.0 mils dry film thickness except where it is limited by valve operating tolerances. Safety isolation valves and lockout valves with handles, hand wheel's, or chain wheels shall be painted "Safety Yellow."

E. Ferrous surfaces obviously not intended to be painted shall be given a shop coat of grease or other acceptable rust-inhibitive coating.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install valves as shown on the Drawings and in strict accordance with the Manufacturer's recommendations. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward of the horizontal plane. Allow sufficient room for maintenance, removal and proper operation. All valves shall be located and oriented to permit easy access to the valve operator, and to avoid interferences.

B. All valves shall be independently supported. Valves shall not be supported by the connecting piping.

C. Flanged valve bolt holes shall be installed to straddle the vertical centerline of the pipe. Flanged faces shall be cleaned prior to inserting the gasket and bolts. All nuts shall be tightened progressively and uniformly. Threaded ends shall have the threads cleaned by wire brushing or swabbing prior to installation.

D. Where any valve or appurtenance installation is covered by a standard, the CMGC shall install such equipment in accordance with the standard unless otherwise specified or indicated on the Drawings. The CMGC shall certify any such installations are in accordance with all applicable standards.

E. Unless otherwise specified or shown on the Drawings, all valve connections/joints shall be installed in accordance with the specified and applicable standards. The CMGC shall be responsible for all verification of Manufacturer's torque requirements.

3.02 VALVE ORIENTATION

A. The operating stem of a manual valve shall be installed in a vertical position when the valve is installed in horizontal runs of pipe having centerline elevations of 4.5 feet or less above the finished floor, unless otherwise specified or indicated on the Drawings. The operating stem of a manual valve shall be installed in a horizontal position in horizontal runs of pipe having centerline elevations greater than 4.5 feet above the finish floor, unless otherwise specified or indicated on the Drawings.

B. All manually actuated valves three (3) inches and smaller shall have the valve indicators and operators located to display toward the normal operational locations.

3.03 PLUG VALVES

A. If a plug valve seat position is not shown in the contract Drawings, locate the seat position as follows: for horizontal flow, the flow shall produce an "unseating" pressure, and the plug shall open into the top half of valve; and for vertical flow, the seat shall be installed in the highest portion of the valve.

3.04 VALVE TESTING

A. Test all valves visually for leaks and proper operation under pressure. Test valves to ensure proper valve function and actuation. All valves shall be tested as part of the respective piping system or segment in accordance with Section 40 05 13 – Process Pipe and Fittings.

B. Valves may either be tested while testing pipelines, or as a separate test. It shall be demonstrated that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, and in both directions for two-way valve applications. Count and record the number of turns required to open and close each valve, and account for any discrepancies with the Manufacturer's data.

C. Air and vacuum relief valves shall be examined as the associated pipe is being filled to verify venting and seating is fully functional. Set, verify, and record set pressures for all relief and regulating valves. Self-contained automatic valves shall be tested at both maximum and minimum operating ranges and reset upon completion of test to the design value.

D. Take care not to overpressure any valve and appurtenances during testing.

3.05 RETESTING

A. If the equipment does not successfully pass the tests listed above, the Manufacturer/CMGC shall repair the equipment and perform the tests again until passing the tests successfully. If any deficiencies are revealed during any test, such deficiencies shall be corrected and the tests shall be re-conducted at no additional cost to Atlantic Richfield Company or the Engineer.

3.06 CLEANING

A. All items, including but not limited to all valves & valve interiors, shall be thoroughly cleaned prior to installation, testing, and final acceptance. All dirt, debris, and other foreign materials shall be removed.

3.07 TESTING OF BACKFLOW PREVENTERS

A. Provide certified testing of each backflow prevention assembly. Each assembly shall be tested using gauges and equipment specifically designed for the testing of backflow prevention assemblies. Each assembly shall be tested by an independent backflow prevention assembly testing agency.

B. Each backflow prevention assembly shall be tested for accuracy and proper functionality in accordance with the requirements of State or local regulatory agencies. If there is no State or local regulatory agency requirements, each assembly shall be tested for accuracy and proper functionality in accordance with the requirements of University of Southern California's Foundation of Cross Connection Control and Hydraulic Research or the American Water Works Association Manual of Cross Connection (Manual M-14), or any other approved testing laboratory having equivalent capabilities for both laboratory and field evaluation of backflow prevention assemblies. Provide a test report and form for each assembly. The test report shall include but is not limited to as a minimum, the following:
   1. Data on Device.
   2. Type of Assembly.
   3. Manufacturer.
   4. Model #.
   5. Serial Number.
   6. Size.
   7. Location.
   8. Test Pressure Readings.

C. The test report shall also include data on the testing firm. The data shall include but is not limited to the following:
   1. Name.
   2. Address.
   3. Certified Tester.
   4. Certified Tester Number.
   5. Date of Test.
   6. Serial Number and Test Data.

D. If units fail to meet the test standard requirements, each unit shall be repaired and retested to correct working order at no additional cost to Atlantic Richfield Company or the Engineer. Provide retesting of each unit following repairs.

END OF SECTION

SECTION 40 05 59
HYDRAULIC GATES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide hydraulic gates and all related accessories to provide complete operational gate systems in accordance with this Section, the Gate Schedule in the Drawings, and applicable reference standards listed in Article 1.02 including the following:
      a. Slide gates, weir gates, guides, operators, accessories and appurtenances.
      b. Attachments, foundations, anchors, grouting, support brackets, hardware.
   2. Hydraulic Gate Schedule: On the Drawings.

B. Related Requirements:
   1. Section 40 00 00 – Basic Process Materials and Methods.

1.02 REFERENCES

A. Reference Standards:
   1. American Water Works Association (AWWA):
      a. AWWA C 513 - Open-Channel, Fabricated-Metal Slide Gates.
      b. AWWA C 540 - Power Actuating Devices for Valves and Sluice Gates.
   2. ASTM International (ASTM):
      a. ASTM A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
      b. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.
      c. ASTM D4020 - Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials.
      d. ASTM F593 - Stainless Steel Bolts, Hex Cap Screws, and Studs.
      e. ASTM F594 - Standard Specification for Stainless Steel Nuts.
   3. Society for Protective Coatings (SSPC):
      a. SSPC-SP 5/NACE No. 1 - White Metal Blast Cleaning.
   4. American Welding Society (AWS):
      a. 6.1.4 AWS QC1 - Standard and Guide for Qualification and Certification of Welding Inspectors.
   5. American Society for Non-Destructive Testing (ASNT):
      a. SNT-TC-1A - Personnel Qualification and Certification in Nondestructive Testing.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-02 Shop Drawings:
      a. Shop Drawings shall show layouts and dimensions of equipment, major components, key alignment locations, and locations of bolt holes. Drawings shall show critical field dimensions identified by the manufacturer.

b. Provide detailed Drawings showing equipment fabrication, dimensions, methods of attachment including number, locations, and size of fasteners, and weights of fabrications. Include gate dimensions and the respective location for each application.
c. Shop Drawings shall also include details of critical dimensions, joints, connections, fasteners and anchors. Include the size, spacing, and locations of structural members, connections, attachments, openings and fasteners.
d. Drawings shall include detailed assembly instructions, principal dimensions, materials, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment, appurtenances, and equipment relationships to other parts of the Work including clearances for maintenance and operation.

2. SD-03 Product Data:
   a. Provide product data to verify compliance with the Specifications and to illustrate the construction and assembly of the products. Include compliance of materials and components with applicable CEAM, ASTM, American Gear Manufacturers Association (AGMA) and other standards as specified. List the manufacture, model and weights of major components. Include catalog cuts, illustrations, schedules, diagrams, performance charts, instructions and brochures illustrating size, physical appearance and other characteristics of materials, systems or equipment. Provide a detailed description of all materials used, including physical properties and methods of manufacturing and construction.
   b. Include a complete list of equipment and materials, including manufacturer's descriptive data and technical literature, catalog cuts, installation instructions, and parts schedules. Provide spare parts data for each different item of material and equipment specified. Include a complete list of parts and supplies.
3. SD-07 Closeout Submittals:
   a. Per Division 01 General Requirements.
   b. Operation and Maintenance Data:
      1) Submit operation and maintenance data in accordance with Division 01 General Requirements. Manual shall include but is not limited to the following:
         (a) A numbered parts list and predicted life of parts subject to wear.
         (b) Test data and performance information.
         (c) Installation instructions.
         (d) A written warranty statement.
      2) Operation and maintenance data shall also include all required cuts, Drawings, equipment lists, descriptions, etc., which are required to instruct operation and maintenance personnel unfamiliar with such equipment.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

PART 2 - PRODUCTS

2.01 GENERAL

A. Slide gates, weir gates and auxiliary components shall be designed to safely withstand the head and operating conditions of the installation as shown on the Gate Schedule, other Drawings and as specified. Slide gates and weir gates shall be used to isolate channels, tanks, pipes and vessels as shown on the Drawings. All slide gates and weir gates shall provide a seal system that meets the minimum requirements specified. All gates shall be designed to have adequate strength to prevent distortion in handling and placing and under any condition of service.

B. Details of gate construction including gate and stem type, dimensions, material, and other options are indicated in the Gate Schedule.

C. Materials and equipment shall be new and unused, except for testing as required. Where 2 or more pieces of equipment performing the same function are required, they shall be duplicate products of the same manufacturer.

2.02 MANUFACTURER

A. All gates of the same type, style, and duty shall be supplied by a single manufacturer. All slide gates and weir gates shall be a product of the following manufacturers:
   1. Whipps, Inc.
   2. Rodney Hunt-Fontaine Inc.
   3. Hydro Gate Company.
   4. Or equal.

2.03 QUALIFICATIONS OF MANUFACTURER

A. Materials and equipment shall be the standard products of a manufacturer regularly engaged in the production of such products and shall essentially duplicate items that have been in satisfactory use in identical applications in other wastewater treatment facilities. The manufacturer shall have a minimum of 5 years of documented experience design/production of equal or larger sized designs/models of slide gates and weir gates as specified.

B. The manufacturer shall provide an installation list of at least 5 similar installations, including contact names and phone numbers. All components shall be supported by a service organization that is, in the opinion of the Engineer, reasonably convenient to the Site to ensure parts and service can be acquired in a timely fashion.

2.04 UNIT DESCRIPTIONS

A. Provide the following slide gates and weir gates as part of the Work as specified. Refer to the Hydraulic Gate Schedule & Gate Details on the Drawings for additional details and requirements for each slide gate (SG), weir gate (WG) & electric motor operated gate (MG).

B. Materials of construction for each gate have been indicated on the Hydraulic Gate Schedule. Provide gate materials of construction as indicated on the Drawings and in conformance with the following requirements.

C. Refer to the gate details on the Drawings and Hydraulic Gate Schedule for additional details and specific design criteria for each gate. All slide gates and weir gates shall be sized to accommodate the dimensions and design head conditions as specified.

2.05 MATERIALS OF CONSTRUCTION

A. Gate Frames, Retainers & Discs: 6061-T6 high-strength extruded aluminum, ASTM A 240/A 240M Type 316 stainless steel, or Type 304L stainless steel as specified in the Hydraulic Gate Schedule.

B. Self-Contained Gate Frame Yokes: Stainless steel.

C. Seals: Neoprene ASTM D 4020 or UHMW polyethylene.

D. Bearing Strips: Ultra-high molecular weight polyethylene (UHMWPE).

E. Stems, Stem Guides & Stem Couplings: Type 304 stainless steel.

F. Stem Guide Bushings: UHMWPE or bronze.

G. Stem Lift Nuts & Stop Collars: ASTM B 584 bronze.

H. Rising Stem-to-Disc Connection: Cast aluminum.

I. Stem Cover: Clear plastic or polycarbonate.

J. Wall Thimbles: Type 304L stainless steel.

K. Floor Stands: Stainless steel.

L. Hand Cranks Case & Cover: Cast aluminum or epoxy coated ductile iron.

M. Hand Cranks Grip: Nylon or brass.

2.06 GATE FRAMES

A. Aluminum extrusions shall weigh a minimum of 3 pounds per foot for embedded and channel mounted guide frames. Aluminum extrusions for face mounted slide gates shall weigh a minimum of 4 pounds per foot. Surfaces of aluminum in contact with concrete shall be coated as indicated on the Drawings.

B. All stainless steel frame assemblies, including the guide members, invert member and yoke members shall be constructed of formed stainless steel plate with a minimum thickness of 1/4-inch.

C. The gate frame mounting style shall be embedded, face mounted, or wall thimble as shown on the Drawings.

D. The vertical face of the seal shall be in contact with the seating surface of the guide to provide a proper seal at the corners. Frames embedded in concrete shall have keyways to hold the frames in place. Aperture or end of channel gates shall utilize flat frame style side mounting with a flush bottom. The bottom frame shall be installed completely flush with the bottom of the installed structure and shall not create any lip or threshold on the floor. Provide a 1-inch grout pad for the sides and a recess size as recommended by the gate manufacturer for embedment of the invert member.

E. All gates with side frames and inverts bolted to the face of a wall shall have holes drilled 18 inches minimum apart in the frame for anchor bolts. All wall mounted or wall thimble mounted gates shall have a flange frame. The structural portion of the frame that

incorporates the seat/seals shall be formed into a 1-piece shape for rigidity. Provide a 1-inch grout pad between the frame and the concrete.

F. Invert:
   1. The invert of the frame shall be an angle or extrusion completely welded to the ends of the guides.
   2. The invert shall form a seating surface for the seat mounted on the disc or invert member. The shape of the seal shall produce a seating surface having a minimum ¾-inch width and the seal shall extend into the secondary slot of the guide.

G. Gussets:
   1. Gussets shall be provided as necessary to support the guide members in an unseating head condition. The gussets shall extend to support the outer portion of the guide assembly and shall be positioned to ensure that the load is transferred to the anchor bolts or the wall thimble studs.
   2. The frame shall extend to accommodate the entire height of the slide when the slide is in the fully opened position on upward opening gates or downward opening weir gates.

H. Yoke:
   1. On self-contained gates, a yoke shall be provided across the top of the frame. The yoke shall be formed by two structural members affixed to the top of the side frame members to provide a 1-piece rigid assembly. The yoke shall be designed to allow removal of the slide. A rigid invert member shall be provided across the bottom of the opening. The invert member shall be flush bottom type on upward opening gates. A rigid top seal member shall be provided across the top of the opening on gates designed to cover submerged openings. A rigid member shall be provided across the invert of the opening on downward opening weir gates.
   2. The frame shall be sufficiently proportioned so that where the guide extends above the operating floor to support the hoisting yoke, no further reinforcing of the frame shall be required.
   3. The arrangement of the yoke shall be such that the disc and stem can be removed without disconnecting the yoke.

2.07 GUIDES

A. Guides in the gate frame shall be single or dual slot design. The primary slot shall accept the plate of the disc and the second slot shall be sufficiently wide so that the reinforcing ribs of the disc shall extend into it. Guides shall be supplied with bearing strips on both the upstream and downstream sides of the disc to reduce friction along the guide surfaces. Guides shall be designed to mount on the face of, embedded in concrete, or to mount into an existing channel as shown on the Drawings.

2.08 DISC

A. The disc sliding member shall be reinforced with U-shaped or angle-shaped extrusions. Reinforcement shall be spaced not more than 16 inches apart and shall be welded to the plate. The disc shall be designed so that it will not deflect more than L/360 of the span or 1/16 inch, whichever is smaller under the design head conditions as shown on the Drawings. Reinforcing ribs shall extend into the guides so that they overlap the seating surface of the guide. All parts and structural components of the disc assembly shall have a minimum thickness of ¼-inch.

B. For stainless steel gates, the slide and reinforcing stiffeners shall be constructed of ASTM A 240/A 240M 304L stainless steel plate. When the width of the gate opening multiplied by

the maximum design head is 80 square feet or greater, the portion of the slide that engages the guide members shall be a thick edge design. The thick edge portion of the slide shall have a minimum thickness of 3 inches. Reinforcing stiffeners shall be welded to the slide and mounted horizontally. Vertical stiffeners shall be welded on the outside of the horizontal stiffeners for additional reinforcement. The stem connector shall be constructed of 2 angles or plates. The stem connector shall be welded to the slide. A minimum of 2 stainless steel bolts shall connect the stem to the stem connector.

2.09 OPERATING STEM

A. Operating stems shall have a minimum threaded outside diameter of 1-1/2 inches. The stem shall be constructed of solid bar for the entire length, the metal having a tensile strength of not less than 90,000 psi for stems that are 3 inches or less in diameter. Stems that are in excess of 3 inches in diameter shall have a tensile strength of 85,000 psi. Stems of more than 1 section shall be joined by stainless steel couplings. The coupling shall be bolted to the stems.

B. The threaded portion of the stem shall be provided with a 16 micro-finish or better. In compression, the stem shall be designed for a critical buckling load caused by a 40-pound effort on the crank or hand wheel with a safety factor of 2 using the Euler column formula. The stem shall be designed to withstand the tension load caused by the application of a 40-pound effort on the crank or hand wheel without exceeding 1/5 of the ultimate tensile strength of the stem material. Stems shall have a slenderness ratio (length to radius of gyration, L/R) of less than 200.

C. Rising stems shall be connected to the disc by means of a stem connection or 2 angle sections, which are threaded and bolted to the stem and welded to the disc. Non-rising stems shall have a lift nut, with adjustable bronze stop collars above and below the lift nut to prevent over-opening or over-c1osing of the gate.

D. Stem Guides:
   1. Stem guides shall be provided to ensure that the maximum L/R ratio for the unsupported part of the stem is 200 or less. All stem guides shall be adjustable in 2 directions.

E. Stem Covers:
   1. All rising stems shall be provided with fracture-resistant stem covers complete with Mylar indicator markings to indicate gate position. Stem covers shall not discolor or become opaque for a minimum of 5 years after installation. The top of the stem cover shall be closed. The bottom end of the stem cover shall be furnished with a housing or adapter plate for easy field mounting.

2.10 SEALS

A. Gates and their seals shall be designed such that under the design seating head, the leakage rate shall not exceed 0.1 gpm per foot of seating perimeter.

B. Slide gates and weir gates shall have a flush invert consisting of a specially molded resilient neoprene seal mounted in the invert extrusion. The neoprene seal shall be readily renewable. All seals shall be easily removable to allow for replacement and adjustment.

C. J or P type hollow bulb neoprene seals or ASTM D4020 UHMW polyethylene seals shall be provided on the guides of all slide gates if necessary to comply with leakage requirements specified. Seals shall be easily removable to allow for replacement and adjustment.

D. Gates may also be equipped with UHMW polyethylene seat/seals to restrict leakage and to prevent metal to metal contact between the frame and slide. The seat/seals shall extend to accommodate 1-1/2 times the height of the slide when the slide is in the fully closed or fully opened position. All upward opening gates shall be provided with a resilient seal to seal the bottom portion of the gate. The seal shall be attached to the invert member or the bottom of the slide and held in place with stainless steel attachment hardware.

E. All downward opening weir gates shall be provided with UHMW polyethylene seat/seals across the invert member. The seal system shall be durable and designed to accommodate high velocities and frequent cycling without loosening or suffering damage. All seals shall be bolted or otherwise mechanically fastened to the frame or slide. Arrangement with seals that are force fit or held in place with adhesives is unacceptable. The seals shall be mounted so as not to obstruct the water way opening.

2.11 OPERATORS

A. Unless otherwise specified or shown on the Drawings all slide gates and weir gates shall be actuated by a gear operated hand wheel or gear operated hand crank mounted on the yoke. The bench stand shall be fully enclosed and equipped with roller bearings above and below the operating nut. Provide a mechanical seal around the operating nut. The pinion shaft shall be stainless steel and supported on roller bearings. A mechanical seal shall be provided around the pinion shaft where it extends from the hoist enclosure.

B. A side mount or front mount operator system utilizing right angle bevel boxes, stainless steel interconnecting shafting, and flexible couplings shall be provided by the manufacturer when the bench stand is located over 48 inches above the operating floor. Chain and sprocket systems shall also be acceptable for remote operators. The transmission system design shall provide for the gate to be operated from a position 30 inches above the operating floor. Bevel boxes for the transmission system shall be provided with stainless steel pinion shafts supported on roller bearings. A mechanical seal shall be provided around the pinion shaft where it extends from the bevel box enclosure.

C. An arrow with the word OPEN shall be permanently attached or cast onto the operator to indicate the direction or rotation to open the gate. Unless otherwise specified or indicated on the Drawings, the direction of rotation to open shall be to the left (counterclockwise).

2.12 FLOOR STANDS

A. Floor stands shall be provided for all other gate operators not supported on the gate yoke. Floor stands shall be constructed of fabricated stainless steel. The pedestal height shall be such that the operator shaft is approximately 36 inches above the operating floor.

B. Where shown on the Drawings, floor stands shall be offset type mounted on the floor surface and offset to align with the gate stem. Floor stands shall be mounted on a heavily ribbed reinforced brackets designed to withstand all operating loads The bracket and anchor bolts shall be sized to transfer the upward or downward thrust required to ultimately fail the stem. The design and detail of the brackets and anchor bolts shall be provided by the gate manufacturer for review by the Engineer. The bracket, anchors, back plate and accessories shall be provided as part of the gate assembly by the gate manufacturer.

2.13 HAND WHEEL OPERATORS

A. Hand wheel operators shall have a minimum 15-inch and maximum 24-inch diameter hand wheel and shall operate the gate under the specified operating head with not greater than 40 pounds of force (rim-pull torque) on the hand wheel. All operators shall be fully enclosed,

equipped with roller bearings above and below the operating nut and include mechanical seals.

2.14 HAND CRANK OPERATORS

A. Crank operators shall have either single or double gear reduction depending upon the lifting capacity required. Double reduction operators shall also be 2-speed type with a square nut drive on the high speed and low speed shafts. Each type shall be provided with a threaded lift nut to engage the operating stem. Bearings shall be provided above and below a flange on the operating nut to support both opening and closing thrusts.

B. Operators shall be designed for a maximum crank effort of 40 pounds under the specified operating conditions. Gears, where required, shall be steel with machined cut teeth designed for smooth operation. The pinion shafts on crank-operated floor stands, either single or double ratio, shall be supported on tapered roller bearings and enclosed in a cast aluminum or ductile iron case and cover.

C. Positive mechanical seals shall be provided on the operating nut and the pinion shafts to exclude moisture and dirt and prevent leakage of lubricant out of the hoist. Fittings shall be provided for the lubrication of all gears and bearings. The crank shall be removable and have a revolving grip. The operator shall be specifically designed to accommodate actuation via a drill drive when the crank is removed.

D. Provide dual operators on gates to maintain stability of the disc. Dual operators shall be joined together by a shaft such that operating a crank on one will cause both operators to move together. All rotating shafts shall be provided with guard shields.

2.15 HARDWARE

A. All hardware, including, but not limited to bolts, nuts, washers, and anchors shall be 316 stainless steel. Provide all hardware, attachments, and related appurtenances for installation of the gates. All stainless steel bolts shall comply with ASTM F 593 standards. Stainless steel nuts shall comply with ASTM F 594 standards. All stainless steel shall conform to ASTM A 276 standards. All anchor bolts shall be a minimum of ½-inch diameter.

2.16 FINISHING

A. Before exposure to weather and prior to shop painting all ferrous metallic surfaces, including, but not limited to operators, supports, and floor stands shall be thoroughly cleaned, dry and free from all mill-scale, rust, grease, dirt and other foreign matter. For corrosion resistance, all ferrous metallic surfaces shall be finished in accordance with SSPC-SP 5 standards prior to prime painting at the factory.

B. All ferrous metallic surfaces shall be field applied with one coat of the Manufacturer’s standard two-part epoxy coating. Coatings shall be resistant to sewage, high humidity, hydrogen sulfide, and other chemicals normally found in wastewater.

C. Stainless steel, brass, bronze, aluminum, fiberglass reinforced plastic (FRP), galvanized, and plastic components shall not be painted. Nameplates shall not be painted. The coating shall be resistant to sewage and other chemicals normally found in wastewater.

D. All stainless steel gates shall be provided with a mill finish. Aluminum gates shall be provided with a mill finish.

2.17 WELDING

A. All welding shall use shielded arc, inert gas, metal inert gas (MIG) or tungsten inert gas (TIG) method. Filler wire shall be added to all welds to provide for a cross section equal to or greater than the parent metal. Butt welds shall fully penetrate to the interior surface and gas shielding to interior and exterior of the joint shall be provided. All welding shall be in accordance with the latest edition of the American Welding Society (AWS) standards. Field welding of aluminum shall not be permitted unless directed by the Engineer.

B. Design and fabrication of structural steel members shall be in accordance with American Institute of Steel Construction (AISC) and American Welding Society (AWS) Standards. The manufacturer shall comply with the most current listed standards and qualifications in Section 6 of AWS D1.1. Evidence of such AWS and AISC compliance shall be submitted with Shop Drawing submittals as follows:
   1. A minimum of 2 AWS Certified Welding Inspectors on staff shall conform to all standards, current or previous as listed in Section 6.1.4 of AWS QC1.
   2. AWS Non-Destructive Testing Inspectors (Level I, II, III) for Magnetic Particle and Ultra-Sonic testing (minimum 2 on staff) shall conform to all standards, current or previous as listed in and in conformance with ASNT TC-1A.

2.18 PASSIVATION

A. After fabrication, all stainless steel gates shall undergo a passivation process to ensure maximum resistance to corrosion. All stainless steel welds shall be bead blasted to remove weld scale. All welded areas shall be paste passivated. The gates shall be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the stainless steel. No stainless steel components shall be fabricated or assembled in a factory where carbon steel products are also fabricated, in order to prevent contamination by rust.

2.19 NAMEPLATES

A. Each major item of equipment shall have the manufacturer's name, address, type or style, model or serial number, catalog number, and all other pertinent data on a plate secured to the item of equipment per Specification 40 00 00.

2.20 OILS & LUBRICANTS

A. The manufacturer shall state in the operating and maintenance manual the amount of and Specification for lubricants. All lubricants for the equipment shall be non-proprietary and easily obtainable from a local source for operations staff convenience. Designs which utilize proprietary or special lubricants are not acceptable.

B. All lubrication fittings shall be brought to the outside of all equipment so that they are readily accessible from the outside without the necessity of removing covers, plates, housings, guards or other appurtenances. All lubrication fittings of all gates shall be readily accessible from operator level. Lubrication fittings which are located in areas requiring the Atlantic Richfield Company Representative to enter channels for access are not acceptable. Provide zerk-type fittings for all lubrication points.

2.21 SPECIAL TOOLS

A. Furnish 1 set of all special tools required to completely assemble, disassemble, or maintain the equipment. Special tools shall refer to oversized or specially dimensioned tools, special attachments or fixtures, or any similar items. Provide 1 set of special tools for each size of equipment or related system.

2.22 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install all equipment in accordance with the Manufacturer's written instructions, and as directed on site by the Manufacturer's representative and/or Engineer. Correct installation and assembly of the equipment shall be the Construction Management General Contractor's (CMGC) responsibility. Install all gates and appurtenances in accordance with the Contract Drawings and the Manufacturer's installation instruction manual.

B. Coated gate components shall be handled in a manner so as to avoid damaging the coating. All damaged coatings shall be repaired.

C. Gates with embedded guides and inverts shall be installed in accordance with the recommendations of the Manufacturer and Engineer. All gates shall be aligned, secured, and checked for free operation prior to being grouted in place.

3.02 FIELD TESTING

A. Prior to acceptance, an operational test of all gates shall be performed to determine if the installed equipment meets the purpose and intent specified. Tests shall demonstrate that the equipment is not mechanically, structurally, or otherwise defective; is in safe and satisfactory operating condition; and conforms to the specified operating characteristics. Tests shall include checks for proper alignment, proper operation without binding, proper connections, and satisfactory operational performance. Provide a demonstration of the ability to operate each gate by opening and closing the gate completely without vibration or jamming.

B. Provide all the requirements to conduct a proper field test which include, but are not limited to water, facilities, labor, materials, supplies and test instruments.

C. After installation, all gates shall be field tested at maximum differential head for a minimum period of 2 hours to ensure that all items of the equipment are in compliance with the Specifications, including the minimum leakage requirements specified. The maximum allowable leakage for the gates shall be 0.1 gpm per foot of perimeter under the design seating head. Gate leakage shall meet or exceed the requirements of AWWA C 513 standards.

3.03 RETESTING

A. If the equipment does not successfully pass the tests listed above, the Manufacturer shall repair the equipment and perform the tests again until passing the tests successfully. If any deficiencies are revealed during any test, such deficiencies shall be corrected, and the tests shall be reconducted at no additional cost to Atlantic Richfield Company.

3.04 MANUFACTURER'S SERVICES

A. Services of a Manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified shall be provided. The on-site man days listed below are exclusive of travel time and do not relieve the CMGC of the obligation to provide sufficient service to place the equipment into satisfactory operation.

B. The Manufacturer's representative shall supervise the installation, adjustment, and testing of the equipment. The Manufacturer's representative shall be present for a period of not less than one (1) day to inspect the installed equipment, supervise the initial test run, and to provide instruction to the plant personnel.

C. The Manufacturer's representative shall provide a certification of proper installation and satisfactory operation to Atlantic Richfield Company and the Engineer. Certification shall be signed and dated by Manufacturer's representative.

D. The Manufacturer's representative shall make all necessary adjustments and settings to the gates.

3.05 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.06 STARTUP AND COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.07 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 40 05 59.16
STOP LOGS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide stop logs and all related accessories to provide complete operational stop log systems in accordance with this Section, the Stop Log Schedule in the Drawings, and applicable reference standards listed in Article 1.02 including the following:
      a. Stop logs, guide frames, stop log lifters, accessories, and appurtenance.
      b. Attachments, foundations, anchors, grouting, support brackets, hardware.

B. Related Requirements:
   1. Section 40 00 00 – Basic Process Materials and Methods.

1.02 REFERENCES

A. Reference Standards:
   1. ASTM International (ASTM):
      a. ASTM A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
      b. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.
      c. ASTM D4020 - Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials.
      d. ASTM F593 - Stainless Steel Bolts, Hex Cap Screws, and Studs.
      e. ASTM F594 - Standard Specification for Stainless Steel Nuts.
   2. American Welding Society (AWS):
      a. 6.1.4 AWS QC1 - Standard and Guide for Qualification and Certification of Welding Inspectors.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-02 Shop Drawings:
      a. Shop Drawings shall show layouts and dimensions of equipment, major components, key alignment locations, and locations of bolt holes. Drawings shall show critical field dimensions identified by the manufacturer.
      b. Provide detailed Drawings showing equipment fabrication, dimensions, methods of attachment including number, locations, and size of fasteners, and weights of fabrications. Include stop log assembly dimensions and the respective location for each application.
   2. SD-03 Product Data:
      a. Include a complete list of equipment and materials, including manufacturer's descriptive data and technical literature, catalog cuts, installation instructions, and parts schedules for stop logs, guide frames, and stop log lifter. Provide spare parts

data for each different item of material and equipment specified. Include a complete list of parts and supplies.
    b. Submit documentation of maximum bending stress/deflection of the stop logs under the maximum design head.
3. SD-07 Closeout Submittals:
    a. Per Division 01 General Requirements.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

1.08 MAINTENANCE

A. Furnish spare parts and special tools as recommended by manufacturer. Make interchangeable with and of same material and workmanship as corresponding original parts.

1.09 WARRANTY

A. The Manufacturer's warranty shall commence at the date of substantial completion or partial utilization.

PART 2 - PRODUCTS

2.01 GENERAL

A. Stop log assemblies shall be as specified herein and have the characteristics and dimensions shown on the Stop Log Schedule and Drawings.

B. Stop logs, guide frames, stop log lifter, and auxiliary components shall be designed to safely withstand the head and operating conditions of the installation as shown on the Stop Log Schedule, other Drawings, and as specified. Stop logs will be used to isolate channels, tanks, pipes and vessels as shown on the Drawings.

C. Leakage shall not exceed 0.05 gpm/ft of wetted seal perimeter.

D. Stop logs shall be provided with a continuous resilient seal along the bottom edge of each stop log. Vertical seals shall be mechanically fastened to the guide frame rails.

E. Stop logs shall be of the height as shown on the Stop Log Schedule and Drawings and be designed to function properly when stacked in any order.

F. Stop logs shall be designed to be self-draining, non-buoyant and to drop into place under their own weight without any downward pressure necessary.

G. All stop logs shall be designed to have adequate strength to prevent distortion in handling and placing and under any condition of service.

H. All welds shall be performed by welders with AWS certification.

2.02 QUALIFICATIONS OF MANUFACTURER

A. All of the equipment specified under this Section shall be furnished by a single manufacturer with a minimum of 5 years of experience designing and manufacturing stop logs. The manufacturer shall have manufactured stop logs for a minimum of 100 projects.

B. All components shall be supported by a service organization that is, in the opinion of the Engineer, reasonably convenient to the Site to ensure parts and service can be acquired in a timely fashion.

2.03 MANUFACTURERS

A. All gates of the same type, style, and duty shall be supplied by a single manufacturer. All slide gates and weir gates shall be a product of the following manufacturers:
   1. Whipps, Inc.
   2. Rodney Hunt-Fontaine Inc.
   3. Hydro Gate Company.
   4. Waterman Valve.
   5. Or equal.

2.04 MATERIALS

A. All structural components of the stop logs and guide frames shall be fabricated of aluminum or stainless steel as indicated by the Stop Log Schedule.

B. Aluminum Components:
   1. Mill finish on all aluminum components.
   2. Field coat all aluminum in contact with concrete with a heavy coat of bitumastic paint.
   3. Clean all welds to provide a uniform finish.

C. Stainless Steel Components:
   1. Mill finish on all stainless steel components.
   2. Passivate all welds to remove weld burn and scale.

2.05 STOP LOGS

A. Stop logs shall be constructed of extruded aluminum or formed stainless steel shapes with a minimum thickness of 1/4-inch.

B. Individual stop log height shall be as indicated on the Stop Log Schedule.

C. Each stop log shall be provided with 2 alignment pins to ensure log stack alignment in service.

D. Provide two slots in the top of each stop log for removal and installation via the stop log lifter.

E. Stop log design shall include adequate provisions for drainage when removed.

F. Performance:
   1. Maximum bending stress shall not exceed 7600 psi at the maximum operating head.
   2. Maximum deflection shall not exceed 1/360 of stop log span at the maximum operating head.

2.06 FRAME GUIDES

A. Frame guides or grooves and invert members shall have a minimum thickness of ¼-inch aluminum or stainless steel.

B. Frame design shall allow for embedded mounting or mounting directly to a wall with stainless steel anchor bolts and grout. Mounting style shall be as shown on the Stop Log Schedule and Drawings.

C. Provide flush bottom invert member across the bottom of the guides.

2.07 SEALS

A. Each stop log shall be outfitted with a continuous resilient lip seal along the bottom and both sides to restrict leakage in accordance with the requirements listed in this specification.
   1. Lip seal shall be constructed of urethane or rubber and shall be mechanically retained to the stop log.
   2. Lip seal shall be activated by a combination of the weight of the stop log and the differential water pressure, which pushes the seal against the inside of the groove assembly.
   3. Stop logs using rubber “J” seals or “P” seals are not acceptable.

2.08 LIFTER

A. Provide one stop log lifter for each different guide frame width.

B. Lifter shall be constructed of aluminum and shall be outfitted with UHMW guide bars and stainless steel fasteners.

C. Lifting hooks on the lifter shall be designed to engage the slots in the top of the stop logs. Incorporate lanyard release into the design.

D. The lifter shall be capable of installing and removing all stop logs of the same width whether they are installed or at the operating floor level.

2.09 STORAGE RACKS

A. If shown on the Drawings, provide stop log storage racks to house stop logs while they are not in use.

B. Storage racks shall be constructed of aluminum and shall be mounted as shown on the Drawings.

2.10 ANCHOR BOLTS

A. Anchor bolts shall be provided by the stop log manufacturer for mounting the guide frames and storage racks (if applicable).
   1. Quantity and location shall be determined by the stop log manufacturer.
   2. If epoxy type anchor bolts are provided, the stop log manufacturer shall provide the studs and nuts.
   3. Anchor bolts shall have a minimum diameter of 1/2-inch.

2.11 NAMEPLATES

A. Stop logs, guide frames, and lifting device shall include the manufacturer's name, address, type or style, model or serial number, catalog number, and all other pertinent data on a plate secured to the item of equipment per Section 40 00 00 – Basic Process Materials and Methods.

2.12 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Review installation drawings and installation instructions prior to installing the gate frames.

B. Prior to installation, check all stop log grooves and remove and clean all foreign matter. Clean all contact surfaces on each stop log and guide frame to ensure a proper fit and seal.

C. Install guide frames in a true vertical plane, square and plumb.

D. Fill voids between guide frames and wall with non-shrink grout in accordance with the manufacturer’s recommendations.

3.02 FIELD TESTING

A. At the discretion of the engineer, each stop log assembly shall be water tested at maximum differential head for a minimum period of 2 hours to ensure that all items of the equipment are in compliance with the Specifications and ensure that leakage does not exceed the allowable leakage rates.

B. Provide all the requirements to conduct a proper field test which include, but are not limited to water, facilities, labor, materials, supplies and test instruments.

3.03 RETESTING

A. In the event that any unit fails to meet the above requirements, the necessary changes shall be made and the unit retested. If the unit remains unable to meet the test requirements to the satisfaction of the Engineer, it shall be removed and replaced with a satisfactory unit at no additional cost to Atlantic Richfield Company.

3.04 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.05 STARTUP AND COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.06 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 40 61 01
INSTRUMENTATION AND CONTROLS GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide instrumentation and controls in accordance with this Section and applicable reference standards listed in Article 1.02.

B. Work by Construction Management General Contractor (CMGC):
   1. PLC Programming.
   2. OIT Programming.
   3. HMI Programming.
   4. Integration of new SCADA system.

C. Related Requirements:
   1. Division 26 Electrical – Specifications for electrical wiring standards and practices.
   2. Section 40 63 43 – Programmable Logic Controllers.
   3. Section 40 67 00 – Control System Equipment Panels and Racks.
   4. Section 40 70 00 – Instrumentation for Process Systems.
   5. Section 40 81 00 – System Integrator Qualifications and Summary of Work.
   6. Section 40 81 35 – SCADA System Programming.
   7. Section 40 81 40 – SCADA System Reporting.
   8. Section 40 81 50 – SCADA System Factory Testing.
   9. Section 40 81 51 – SCADA System Checkout and Startup.

1.02 REFERENCES

A. Reference Standards:
   1. American National Standards Institute (ANSI).
   2. ASTM International (ASTM).
   3. FM Global (FM).
   4. International Society of Automation (ISA):
      a. ISA-RP60.3 - Recommended Practice.
   5. National Electrical Manufacturers Association (NEMA).
   6. National Fire Protection Association (NFPA):
      a. NFPA 70 – National Electric Code (NEC).
      b. NFPA 79 - Electrical Standard for Industrial Machinery.
   7. Occupational Safety and Health Administration (OSHA).
   8. Underwriters Laboratories (UL):
      a. Standard 508A - Standard for Industrial Control Panels.

1.03 DEFINITIONS

A. PLC – Programmable Logic Controller.

B. RIO – Remote Input/Output Rack.

C. OIT – Operator Interface Terminal.

D. HMI – Human Machine Interface.

E. RTU – Remote Terminal Unit.

F. I/O – Input/Output.

G. SCADA – Supervisory Control and Data Acquisition.

H. Modules – Devices that plug into a chassis or connect to an adjacent module and are keyed to allow installation in only one direction.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.
   1. Coordinate equipment, instrument and material delivery with Project schedule. Notify Engineer if delivery schedule of equipment, instruments, or material affects Project schedule. Include documentation from equipment Supplier indicating revised delivery schedule and reason for change.
   2. Coordinate delivery of equipment, instruments or materials for installation in system or control panel provided under Section 40 62 70, Section 40 63 43 – Programmable Logic Controllers, Section 40 67 00 – Control System Equipment Panels and Racks, and Section 40 70 00 – Instrumentation for Process Systems.

1.05 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-02 Shop Drawings:
      a. SCADA Control Panels: In accordance with Section 40 67 00 – Control System Equipment Panels and Racks.
   2. SD-03 Product Data:
      a. Instrumentation: In accordance with Section 40 70 00 – Instrumentation for Process Systems.
      b. PLC and OIT: In accordance with Section 40 63 43 – Programmable Logic Controllers.
      c. SCADA Computers and Software: In accordance with Section 40 62 70.
   3. SD-07 Closeout Submittals:
      a. Provide operation procedures, equipment descriptions, intended modes of operation, system unit testing procedures and safety measures during operation.
      b. Provide record drawings and instructions for maintenance of system equipment. Incorporate maintenance procedures and schedules, coordinate and cross-reference to detailed operational procedures provided by manufacturers.
      c. Include a list of local, authorized distributor's service departments stocking manufacturer's parts and equipment and providing local service.
      d. Instrument list or ISA data sheets, including tag numbers.
      e. Configuration and programming manuals for each type of PLC and each type of OIT.
      f. Copies of all Shop Drawings, reports, maintenance data, and schedules, description of operation, and spare parts information.
      g. Control panel section of O&M manuals shall include:
         1) Record drawings of control panels updated to reflect the panels after checkout and startup.
         2) Installation and operation manuals for all major control panel components, network switches, PLCs, I/O modules, and communication equipment.

1.06 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.08 ACCEPTANCE AT SITE

A. Check equipment, instruments and materials for damage or defects within 7 days of delivery.

1.09 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

1.10 MAINTENANCE

A. Extra Materials and Spare Parts: as specified below. Make interchangeable with and of same material and workmanship as corresponding original parts.

B. Control Panel Spares: One of each type of the following:
   1. Surge arrestor.
   2. Fuses (minimum 10 percent spares of each type).
   3. 24 VDC communication power supply.
   4. Intrinsic safety barrier.
   5. Radio.

C. Programmable Logic Controllers: One of each type of the following:
   1. PLC power supply.
   2. PLC processor.
   3. I/O module.
   4. Communication module.
   5. Memory module.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Provide instruments, SCADA control panels, and materials in accordance with Division 01 General Requirements.
   1. Verify availability of equipment, instruments and materials and submit an “or-equal” or substitute if production is discontinued.

2.02 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.02 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.
   1. Test instruments and SCADA control panels for proper termination and operation, in presence of Engineer.
   2. Calibrate instruments in accordance with manufacturer's recommended procedure.

3.03 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 40 63 43
PROGRAMMABLE LOGIC CONTROLLERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide programmable logic controllers and operator interface terminals in accordance with this Section and applicable reference standards listed in Section 40 61 01 – Instrumentation and Controls General Requirements.

B. Work by Others: As specified in Section 40 61 01 – Instrumentation and Controls General Requirements.

C. Related Requirements:
   1. Section 40 61 01 – Instrumentation and Controls General Requirements.
   2. Section 40 67 00 – Control System Equipment Panels and Racks.

1.02 REFERENCES

A. Reference Standards: In accordance with Section 40 61 01 – Instrumentation and Controls General Requirements.

B. Definitions: In accordance with Section 40 61 01 – Instrumentation and Controls General Requirements.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: In accordance with Section 40 61 01 – Instrumentation and Controls General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-07 Closeout Submittals:
      a. Per Division 01 General Requirements.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Provide PLCs and OITs supplied from manufacturers regularly engaged in the production of such products. Provide standard products where possible.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Acceptance at Site:
   1. Check equipment, instruments, and materials for damage or defects within 7 days of delivery. Repair or replace to satisfaction of Engineer.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

1.08 MAINTENANCE

A. Extra Materials and Spare Parts: As specified in Section 40 61 01 – Instrumentation and Control General Requirements.

PART 2 - PRODUCTS

2.01 PROGRAMMABLE LOGIC CONTROLLERS

A. PLC Hardware And Programming Software: By same manufacturer.

B. House PLCs in new or existing control panel as specified in Section 40 67 00 – Control System Equipment Panels and Racks and Drawings. Provide 120VAC, 60 Hz, single phase power to control panel.

C. Minimum PLC input/output (I/O) requirements as indicated on Drawings. Provide additional 20 percent active spare I/O wired to terminal blocks; relay outputs, wired to interposing relays.

D. Provide PLC rack or mounting space to accommodate additional 20 percent minimum spare slots for future expansion.

E. Provide microprocessor based PLC devices with power supplies, processors, process input and output modules, communication cards and chassis, mounted in control panel.
   1. Size power supplies to accommodate analog signals, including spares, and card's entire I/O capacity.

F. Provide PLC capable of stand-alone operation in the event of SCADA network or SCADA computer failure.

G. Provide UL listed PLC system using modular, field expandable design.

H. Module design shall prohibit upside down insertion or connection of modules, and be compatible with processor type specified.

I. Operate programmable controller hardware at ambient temperature of 32-140 degrees F. Ambient temperature rating for storage: minus 40-185 degrees F.

J. Provide PLC hardware to function continuously in relative humidity range of 5 95 percent, non-condensing.

K. Provide PLC system designed and tested to operate in the high electrical noise environment of an industrial plant.

L. Module-expandable PLCs and associated modules:
   1. Series processor acceptable level of quality: Equivalent to Allen-Bradley CompactLogix.
   2. Discrete input modules acceptable level of quality: Equivalent to Allen-Bradley 1769-IQ16.
   3. Discrete output modules acceptable level of quality: Equivalent to Allen-Bradley 1769-OW16.

4. Analog input modules acceptable level of quality: Equivalent to Allen-Bradley 1769-IF8.
5. Analog output modules acceptable level of quality: Equivalent to Allen-Bradley 1769-OF4.

2.02 OPERATOR INTERFACE TERMINALS

A. House OITs in new or existing control panel as specified in Section 40 67 00 – Control System Equipment Panels and Racks and Drawings.

B. Operator interface terminal: color graphic display connecting directly to PLC communication port or a communication module, allowing viewing and changing of PLC parameters, rated NEMA 4/4X, powered by 120VAC with integrated real time clock and battery backup.

C. Minimum OIT resolution of 320 by 240 VGA graphics with 16-bit color graphics, touch screen operation. Minimum display size: 5.5 inch with display area of 4.4 inches by 3.3 inches.

D. Provide OIT with 10MB internal project memory with compact flash port. Provide 1 GB compact flash card for each operator terminal.

E. Provide OIT with real-time trending of process variables.

F. Provide OIT with active and historical alarm screens with ability to acknowledge and clear.

G. Provide OIT with ability to display a selectable screen based on specific alarm bits.

H. Provide all communication modules and cables for OIT - PLC communications. PLC interface: Ethernet/IP. RS-232: available for use.

I. Provide and coordinate communications protocol drivers to establish reliable communications between PLC and OIT.

J. Provide OIT programming & configuration cables.

K. Provide OIT with licensed copy of programming software.

L. OIT acceptable level of quality: equivalent to Allen-Bradley PanelView Plus 7 10.4-inch Color active-matrix TFT Touch Panel, part number 2711P-T10C22D9P.

2.03 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 - EXECUTION

(NOT USED)

END OF SECTION

SECTION 40 67 00
CONTROL SYSTEM EQUIPMENT PANELS AND RACKS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide all wiring, labor, tools, materials, and equipment to furnish, install, and test control panels and enclosures in accordance with this Section and applicable reference standards listed in Section 40 61 01 – Instrumentation and Controls General Requirements and shop drawing level drawings.

B. Work by Others: As specified in Section 40 61 01 – Instrumentation and Controls General Requirements.

C. Related Requirements:
   1. Section 26 20 00 – Interior Distribution System.
   2. Section 40 61 01 – Instrumentation and Controls General Requirements.
   3. Section 40 63 43 – Programmable Logic Controllers.

1.02 REFERENCES

A. Reference Standards: As specified in Section 40 61 01 – Instrumentation and Controls General Requirements.

B. Definitions: In accordance with Section 40 61 01 – Instrumentation and Controls General Requirements.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: In accordance with Section 40 61 01 – Instrumentation and Controls General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures and Section 40 61 01 – Instrumentation and Controls General Requirements:
   1. SD-02 Shop Drawings:
      a. A letter with copy of fabrication drawings confirming control panel fabricator will fabricate control panels as specified on shop drawing level control panel drawings may be provided in lieu of Shop Drawings.
   2. SD-03 Product Data:
      a. As listed below unless letter regarding shop drawing level control panel drawings are submitted per Paragraph 1.04.A.1.a. above.
         1) Bill of materials (BOM) for each control panel, including panel tag name or number and component description, quantity, manufacturer name and model number for each component used in fabrication. BOM: keyed to easily correlate components shown in bill of materials with components shown on control panel equipment layout Drawings.

2) Manufacturer's literature for each component identified on BOM. Clearly designate part number with highlights or arrows.
3) Equipment layout drawings for each control panel
4) Panel communication diagrams for each control panel
5) Power wiring diagrams for each control panel
6) Programmable logic controllers (PLC) input/output (I/O) wiring diagrams, on a module-by-module basis

3. SD-07 Closeout Submittals:
   a. Per Division 01 General Requirements and Section 40 61 01 – Instrumentation and Controls General Requirements.
   b. As-Built Drawings:
      1) After fabrication of control panels and factory acceptance testing is complete, panel shop shall provide drawings of control panels, representing as-built conditions. Submit panel drawings in AutoCAD DWG and Adobe PDF file formats, on DVD-R media.
      2) Submit with panels at delivery.
      3) Legible red-line markups of shop drawing level drawings from panel shop may be provided if used in lieu of Shop Drawings.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Qualifications: Per Division 01 General Requirements and as follows:
   1. Control Panel Fabricator/Panel Shop Fabrication Facility: UL 508A certified, in operation at least 5 years, regularly engaged in furnishing, installing, and wiring similar equipment for use in water and wastewater treatment facilities, and minimum of 3 projects of similar scope in past 5 years.
   2. Surge Protection: Provided by manufacturer with minimum of 5 years' experience in production of this equipment.

C. Panel Shop:
   1. Following control panel fabrication, apply power to each panel to ensure panels are wired correctly and devices contained within panels power up correctly. Provide written confirmation that a power up test was completed.
   2. Complete point-to-point wiring checkout for wiring contained in control panels and correct any errors or omissions found. Provide written confirmation that checkout was completed.
   3. Provide Engineer 5 days' notice of completion of control panel fabrication and have control panels available in their facility for Factory Acceptance Test by Engineer or System Integrator. Control panels may not be shipped prior to execution of Factory Acceptance Test unless indicated in writing by Engineer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements and Section 40 61 01 – Instrumentation and Controls General Requirements.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

1.08 MAINTENANCE

A. Extra Materials and Spare Parts: As specified below. Make interchangeable with and of same material and workmanship as corresponding original parts.

B. Control Panel Spares: In accordance with Section 40 61 01 – Instrumentation and Controls General Requirements.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Procurement of materials and manufacture of control panels shall not begin until related submittals have been reviewed and approved by the Engineer.

2.02 CONTROL PANEL COMPONENTS

A. Control Panel Components and Recommended Manufacturers

Control Panel Components	Expected level of quality: equivalent to listed manufacturers	Comments
Enclosures	Hoffman Hammond Saginaw	Suitable for use in environments where located per (NEMA, NFPA, etc.)
Programmable Logic Controllers (PLCs)		Refer to Section 40 63 43 – Programmable Logic Controllers
Operator Interface Terminals (OITs)		Refer to Section 40 63 43 – Programmable Logic Controllers
Wireway	Panduit Hoffman	
DIN Rail	Allen Bradley Phoenix Contact	
Radio Equipment		Match existing Site standards as necessary.
Terminal Blocks	Allen Bradley Phoenix Contact Entrelec	Utilize 2-tier terminal blocks wherever possible to conserve panel space.
Terminal Block Fuse Holders	Allen Bradley Phoenix Contact Entrelec	Specify fuse holders with blown fuse indicators.
Circuit Breakers	Square D Allen Bradley	
120VAC Surge Suppressors	Phoenix Contact Square D	
Analog Surge Suppressors	Phoenix Contact Citel	
Media Converters	N-Tron B&B Electronics L-Com	Provide with DIN rail mount converters as required on the network architecture
Fuses	Bussman Ferraz Shawmut	All glass fuses in control panels shall be fast acting style. Motor circuit protection and/or inductive load fuses shall be time delay style.

Control Panel Components	Expected level of quality: equivalent to listed manufacturers	Comments
Control Relays	Allen Bradley Square D Omron	Include all required bases, hardware, etc.
Power Supplies	Sola Phoenix Contact Allen Bradley	Provide with power supplies sized as required for equipment contained within the enclosures and to supply field equipment connected to the enclosure.
Intrinsic Safety Barriers	Pepperl & Fuchs MTL Phoenix Contact	Discrete barriers shall be 2-channel barriers. Analog barriers shall be 2-wire barriers.
Ethernet Switches (Unmanaged)	Moxa B&B Electronics	Switches shall be provided with direct-wired low voltage power source within the enclosure.
Ethernet Switches (Managed)	N-Tron B&B Electronics Allen Bradley	All switches comprising the ring topology throughout the facility shall be provided from the same manufacturer.
Fiber Patch Panels	L-Com B&B Electronics	Provide with panel mount patch panels for incoming fiber optic cables as required
Emergency Power System	Sola Phoenix Contact Meanwell	Include uninterruptible power supply (UPS) in each control panel sized to furnish with at least 10 minutes of emergency power.
Panel Heaters	Hammond Hoffman	Provide with panel heaters for outside control panels where temperature is a concern for electronic components.
Receptacles	Pass & Seymour Hubbel Leviton	Provide with receptacle for UPS and convenience receptacle in each PLC control panel.
Pilot/Status Lights (Push to test)	Allen Bradley General Electric Square D	Color code as follows: Red-Fault, Green-Run
HOR, On/Off, L/R switches and push buttons	Allen Bradley General Electric Square D	Refer to Section 26 20 00 – Interior Distribution System. Furnish switches and push buttons with matching nameplate

2.03 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 - EXECUTION

3.01 CONTROL PANEL FABRICATION

A. General:
   1. Fabricate panels per Drawings.
   2. Control panels shall include PLC, required I/O modules with chassis, if applicable, power supply, cables, and all appurtenances. Enclosures shall include switches, lights, annunciators and all appurtenances. Furnish panels and materials from one Supplier.
   3. Provide electronic equipment utilizing printed circuitry and epoxy or equal coating to prevent contamination by dust, moisture, and fungus. Solid-state components: rated to provide reliable performance over ambient atmosphere fluctuations between 0 – 140 degrees F and 0 – 95 percent relative humidity, non-condensing. Field mounted

equipment and system components: designed for installation in dusty, humid, and slightly corrosive service conditions.

4. Equipment installed in a hazardous area shall meet Class, Group, and Division to comply with the NFPA 70.
5. Provide heavy duty equipment, cabinets, and devices designed for continuous industrial service.
6. Fabrication requirements of control panels, enclosures, consoles, and cabinets.
    a. Size control panel enclosures to provide at least 20 percent spare space for future expansion.
    b. Provide PLC hardware to accommodate minimum 20 percent spare of each I/O type used in panel, wired to terminals and interposing relays during fabrication process.
    c. Provide control panel assemblies in compliance with UL 508A Standards.

B. Wiring:
1. Interconnecting wiring: stranded and have 600-volt insulation.
2. Power distribution wiring on line side of fuses in accordance with Section 26 20 00 – Interior Distribution System.
3. Power and low voltage direct current (DC) wiring systems: routed in separate wireways. Crossing of power distribution wiring and control wiring: at right angles. Different system wires routed parallel to each other: separated by at least 6 inches. Different wiring systems shall terminate on separate terminal blocks. Wiring troughs may not be filled to more than 60 percent visible fill.
4. All wiring shall terminate onto single-or-double tier terminal blocks, where each terminal is sequentially numbered with a unique identifier. Direct interlock wiring between equipment is not allowed. Control panel: fabricated with minimum 20 percent spare terminals. Terminal blocks: arranged in vertical rows and separated into groups; power, alternating current (AC) control, DC signal. Terminal blocks: compression screw type. Spring-clamp style terminals will not be accepted.
    a. Discrete inputs (DI) and discrete outputs (DO) shall have 2 terminals per point with adjacent terminal assignments. Active and spare points: wired to terminal blocks.
    b. Analog inputs (AI) and analog outputs (AO) shall have a minimum of 3 terminals per shielded pair. Provide 3 terminals for direct connection of powered, 4-wire loops. Provide 4 terminals for direct connection of loop powered, 2-wire loops. Provide 5 terminals for connection of analog loops incorporating a local indicator or recorder. One terminal is for shielded ground connections for cable pairs. Ground the shielded signal cable at the PLC cabinet. Wire active and spare points to terminal blocks.
    c. Wire and tube markers in accordance with Section 26 20 00 – Interior Distribution System.
    d. Only 1 side of a terminal block row shall be used for internal wiring. Field wiring side of terminal shall not be within 6 inches of side panel or adjacent terminal, or within 8-inches of bottom of panel.
    e. Locate terminals for field wiring to reduce amount of routing through wireway to carry wiring to termination point.
5. Provide wiring, internal to panel and field wiring, with service loop to allow for future adjustment of termination point. Service loop: no more than 4-5 inches, stored in associated wireway.
6. Identify live circuit wiring, independent of the panel's normal circuit breaker protection.
7. All wiring shall be clearly tagged and color-coded in accordance with NEC. All tag numbers and color-coding shall correspond to panel wiring diagrams prepared by Engineer. All power wiring, control wiring, grounding, and DC wiring shall utilize

different color insulation for each wiring system used. Utilize the following color coding scheme.

a. Incoming 120 VAC Hot – Black.
b. 120 VAC Hot Wiring (control circuit wires downstream of panel circuit breaker) – Red.
c. 120 VAC Neutral – White.
d. Ground – Green with yellow stripe.
e. DC Wiring – Blue.
f. DC Common – White with blue stripe.
g. Intrinsically Safe Wiring - Light Blue.
h. Foreign Voltage – Yellow.

C. Control Panel Loss of Power:
1. Each control panel containing a PLC shall have an input configured to alarm the operators upon loss of main control panel power. Display alarm on SCADA nodes to alert operators that attention is required.
2. Provide control panels containing a backup PLC for wetwell level control with an input configured on the main PLC to alarm operators upon loss of backup PLC power.

D. Control Panel Overcurrent Protection:
1. Overcurrent protection devices: properly sized to protect associated devices and loads.
2. Circuit breakers: sized to protect associated equipment and provide necessary power to operate.
3. Fuses:
a. Glass fuses not associated with motor circuit protection or inductive loads: specified as fast-acting style. Fuses associated with motor circuit protection or inductive loads: specified as time delay style.

E. Lightning/Surge Suppression:
1. Provide to protect control panel and associated equipment from surges on incoming power circuits, or those induced by lightning strikes and propagated along signal or power lines connected to control panels. Surge protection: sized properly for intended purpose.
2. 120 VAC Surge Suppression:
a. Provide incoming 120 VAC power source for control panel with surge suppression located in the control panel. Provide surge suppressors with auxiliary contact, connected to PLC to indicate surge suppressor failure. If there are multiple circuits within the same control panel, provide each incoming 120 VAC power source with surge suppression.
3. Analog Signal Surge Suppression:
a. Supply analog signals connected to equipment or instrumentation located outside the building where the control panel is installed with DIN rail mounted surge suppression in control panel. Provide surge protection at both ends of signal cable and mount surge protection as close to equipment, instrument, or termination point as possible. Provide minimum of 10 kA surge current suppression.
4. Telephone Line and Ethernet Surge Suppression:
a. Provide copper-based telephone lines and Ethernet cabling connected to control panel that leaves the building that houses the control panel with surge suppression in the control panel. Provide surge protection at both ends of telephone or Ethernet cabling and mount surge protection as close to termination point as possible.

F. Selector Switches, Pushbuttons and Pilot Lights:
   1. Provide for the enclosures in accordance with Section 26 20 00 – Interior Distribution System.

G. Uninterruptible Power Supplies:
   1. Provide control panel containing PLC with an uninterruptible power supply (UPS) sized to provide minimum of 10 minutes of power in event of main control power loss. Provide at minimum, UPS with relay contact outputs, connected to the PLC to indicate UPS fault and UPS low battery conditions.

H. Ethernet Switches:
   1. Configure ethernet switches to accept number of connections shown on Drawings.
   2. Provide ethernet switches with minimum of 20 percent spare RJ-45 ports available for future expansion.

I. Seal Fail and Motor Temperature Relays:
   1. Pumps, mixers and other equipment equipped with proprietary seal fail and motor temperature relays, require relays to be mounted in the SCADA control panel. Seal fail and motor over temperature alarm contacts: connected to PLC as discrete inputs.

J. Intrinsic Safety Barrier Panels:
   1. Mount intrinsic safety barriers required for interfacing with equipment and instruments located in a classified area, in panel separate from control panels.
   2. Panels housing intrinsic safety barriers: laid out to facilitate separation of hazardous and non-hazardous wiring. Wireway containing hazardous area wiring: clearly indicated.

K. Equipment Mounting/Arrangement:
   1. Mount components in a manner that permits servicing, adjustment, testing and removal without disconnecting, moving or removing any other component. Mount components on inside of panels on removable plates, not directly to enclosure. Mounting: rigid and stable unless shock mounting is required by manufacturer to protect from vibration. Identify components with plastic or metal engraved tags attached with drive pins adjacent to each component, identifying the component in accordance with the Drawings and Specifications.
   2. Install exterior panel mounted equipment with suitable gaskets, faceplates, and other measures required to maintain NEMA rating of panel.
   3. Provide minimum of 1-1/2 inches between panel wireway and terminal blocks for easy access to wiring.
   4. Maintain manufacturer recommended spacing around panel-mounted equipment.
   5. ISA-RP60.3 Recommended Practice: used as a guide in layout and arrangement of panels and panel mounted components.

L. Nameplates:
   1. Furnish panels and panel devices with nameplates identifying panel and individual devices with the following:
      a. Device tag number: As shown on Drawings.
      b. Functional description.
      c. Functional control description.
   2. Furnish 3/32-inch thick, black and white, Lamacoid nameplates with engraved inscriptions, unless escutcheon plates are specified or noted on Drawings. Letters: black against a white background. Edges of nameplates: beveled and smooth. Affix to panels using #4-40 threaded stainless steel button head hex screws.

3.02 INSTALLATION AND MOUNTING

A. Location of control panel shown on Drawings is approximate. Obtain information relevant to process control placement Work in the field. Exact location: approved by Atlantic Richfield Company or Engineer during construction. In case of interference with other Work, proceed as directed by Engineer.

3.03 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.04 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

B. Power up SCADA Panel upon delivery to Atlantic Richfield Company.

C. Power up control panels upon installation. Test field wiring for proper termination. Analog signals: simulated for a full scale 4-20mA test.

D. Provide testing of SCADA system with Integrator after installation of control panels and instruments, and termination of field wiring to panels is complete. Start up and testing: witnessed by Atlantic Richfield Company and Engineer.

3.05 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 40 70 00
INSTRUMENTATION FOR PROCESS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide labor, materials and equipment necessary to install and start-up instruments as specified in accordance with this Section and applicable reference standards listed in Section 40 61 01 – Instrumentation and Controls General Requirements.

B. Work by Others: As specified in Section 40 61 01 – Instrumentation and Controls General Requirements.

C. Related Requirements: As specified in Section 40 61 01 – Instrumentation and Controls General Requirements.

1.02 REFERENCES

A. Reference Standards: In accordance with Section 40 61 01 – Instrumentation and Controls General Requirements.

B. Definitions: In accordance with Section 40 61 01 – Instrumentation and Controls General Requirements.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, sequencing, and scheduling: in accordance with Section 40 61 01 – Instrumentation and Controls General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 40 61 01 – Instrumentation and Controls General Requirements and Section 01 33 00 – Submittal Procedures:
   1. SD-02 Shop Drawings:
      a. As applicable for products specified herein.
   2. SD-03 Product Data:
      a. Instrument data sheet for each instrument.
      b. Product name and tag number as shown on the Drawings.
      c. Manufacturers complete model number.
      d. Location of device.
      e. Input - output characteristics.
      f. Range, size, and graduations.
      g. Physical size with dimensions, NEMA enclosure classification and mounting details.
      h. Materials of construction of components.
      i. Calibration certificates provided by manufacturer.
   3. SD-05 Test Reports:
      a. As specified in this Section.

4. SD-07 Closeout Submittals:
    a. In accordance with Division 01 General Requirements and Section 40 61 01 – Instrumentation and Controls General Requirements.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

1.08 MAINTENANCE

A. Provide in accordance with Section 40 61 01 – Instrumentation and Controls General Requirements.

PART 2 - PRODUCTS

2.01 INSTRUMENTATION – GENERAL

A. Provide brackets and hangers for all equipment.

B. Instrumentation supplied must be the manufacturer's latest design and produce or be activated by signals that are established standards for the water and wastewater industries.

C. Instrumentation requiring power supplied from a source other than the control panel to which it is connected must operate on 120 VAC, single phase, 60 HZ current, unless specifically indicated otherwise. This power will be supplied from the closest local electrical lighting panel with a breaker for each circuit.

D. Electronic instrumentation must be solid-state. Analog control signals shall be linear and be industry standard currents of 4 to 20 mA DC, however, signals between instruments within the same panel or cabinet may be 1-5 VDC, or the like. No zero based signals are allowed.

E. Outputs of equipment that are not of the standard signals as outlined, will have the output immediately raised or converted to compatible standards signals for remote transmission. No zero-based signals are allowed.

F. Instruments shall be provided with stainless steel mounting hardware or galvanized steel floor stands, wall brackets, or instrument racks as appropriate for each location.

G. Equipment installed in a hazardous area shall meet class, group, and division as shown on the electrical Drawings, to comply with the National Electrical Code.

H. Indicators and recorder readouts must be linear in the process units.

I. Transmitters shall be provided with either integral indicators or remote-mount indicators with process units accurate to plus or minus 2 percent.

J. Electronic equipment must be the manufacturer's latest design. Circuit boards and associated components must have suitable conformal coating to prevent contamination by dust, moisture, and fungus. Solid-state components must be conservatively rated for their purpose to assure optimum long-term performance and dependability over normally anticipated atmospheric conditions of temperature, pressure, and humidity. The field-mounted equipment and system components shall be designed for installation in dusty, humid, and slightly corrosive service conditions.

K. Instruments furnished shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and will consist of equipment models that are currently in production. All equipment provided shall be of modular construction and be capable of field expansion.

L. Lightning/Surge Suppression - Provide individual surge protection means for each field instrument mounted outside the building from the control panel to which they are connected. Instruments mounted inside the same building as the control panel to which they are connected shall not require surge protection.

M. Instruments shall be provided as indicated on the instrument index and in the Instrument Data Sheets, included as an attachment at the end of this Section. These documents include the instrument tag names, physical requirements, control requirement, and basis of design manufacturer and model number information.

2.02 INSTRUMENTS

A. Provide as specified in Instrumentation Index and Data Sheets.

2.03 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 - EXECUTION

3.01 INSTALLATION AND MOUNTING

A. Provide labor, tools, material, and equipment required to install instruments in the locations shown on the Drawings, in accordance with manufacturer-recommended installation and mounting practices. The location of equipment, transmitters, alarms, and similar devices shown on the Drawings are approximate only. Exact locations shall be approved by the Engineer during construction. Obtain in the field information relevant to the placing of process control Work and in case of any interference with other Work, proceed as requested by the Engineer.

B. Make necessary mechanical changes to install new instrumentation and associated equipment provided under this Contract. This Work includes fittings, fabrications, supports, guides, restraints, bolting, gaskets, and accessories.

C. The instrumentation Drawings indicate the intent of the interconnections between the individual instruments. Any exceptions should be noted and communicated to the Engineer in writing.

D. Instrument cabinets located outdoors or in unheated locations shall be provided with heating or cooling devices as necessary to maintain all instruments and/or electronics installed in those cabinets within their design temperature limits.

E. Install brackets and hangers to avoid interference with other equipment.

F. The shield on each process instrumentation cable shall be continuous from source to destination and be grounded as directed by the manufacturer of the instrumentation equipment, but in no case shall more than 1 ground point be employed for each shield.

G. Coordinate the installation, placing and location of system components, their connections to the process equipment panels, cabinets, and devices. Ensure field wiring for power and signal circuits is done in accordance with best Industry Practice and provide for necessary system grounding to ensure a satisfactory and functioning installation.

3.02 INSPECTION AND TESTING

A. Submit detailed test, procedure, and startup instructions for each instrument.

B. Provide the services of a qualified service representative for checking the installation, making the necessary adjustments and calibrations, placing the equipment in operation, and performing the acceptance tests. The representative will be available for not less than 2 days to instruct operating personnel in the use, operation, and maintenance of the equipment during the initial operating period.

C. Test and calibrate in place the instrumentation to demonstrate that it meets the accuracy requirements for the conditions specified. Provide labor, equipment, and incidentals required for the tests, including electric power, water, instrument air, etc. required for tests. The Engineer will witness field tests and conduct field inspections. Provide the Engineer a minimum of 10 working days' notice of the dates and times scheduled for tests. Rectify any deficiencies found and retest Work affected by such deficiencies at the Construction Management General Contractor's (CMGC) expense. Record data from each field test will be recorded and documented in a formal field test report.

3.03 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.04 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.05 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

3.06 ATTACHMENTS

A. Instrument index and associated data sheets.

END OF SECTION

INSTRUMENT INDEX			
Drawing Number	**Instrument Tag**	**Instrument Description**	**Notes**
M2.1	LT-0300	Pond 3 Ultrasonic Level Transmitter	0-9 Feet
M2.1	LT-0301	Pond 3 Outlet Structure Ultrasonic Level Transmitter 1	0-16 Feet
M2.1	LT-0302	Pond 3 Outlet Structure Ultrasonic Level Transmitter 2	0-16 Feet
M2.1	LT-0303	Pond 3 Wet Well Ultrasonic Level Transmitter	0-16 Feet
M2.1	LSHH-0390	Maintenance Building Flood Switch	
M2.1	PI-0311	Recirculation Pump No.1 Suction Pressure Gauge	-10 - 35 PSI
M2.1	PI-0312	Recirculation Pump No.1 Discharge Pressure Gauge	0 - 30 PSI
M2.1	PI-0321	Recirculation Pump No.2 Suction Pressure Gauge	-10 - 35 PSI
M2.1	PI-0322	Recirculation Pump No.2 Discharge Pressure Gauge	0 - 30 PSI
M2.1	PIT-0100	Recirculation Pump Discharge Pressure Transmitter	0-30 PSI
M2.1	FIT-0311	Pond 3 Outlet Structure to Recirculation Vault 1 Flow Meter	278 GPM
M2.1	FIT-0321	Pond 3 Outlet Structure to Recirculation Vault 2 Flow Meter	193 GPM
M2.1	FIT-0341	Pond 3 Outlet Structure to Recirculation Vault 4 Flow Meter	426 GPM
M2.1	FIT-0332	Recirculation Pump to Bog 3.1 Flow Meter	215 GPM
M2.1	FIT-0347	Recirculation Pump to Bog 4.1 Flow Meter	193 GPM
M2.2	PI-0111	Pool 1 Return Pump Suction Pressure Gauge	0 - 50 PSI
M2.2	PI-0112	Pool 1 Return Pump Discharge Pressure Gauge	0 - 60 PSI
M2.2	LSHH-0190	Recirculation Vault 1 Flood Switch	
M2.2	FIT-0101	Pond 1 to Pond 3 Discharge Structure Flow Meter	54 GPM
M2.3	PI-0211	Pool 2 Return Pump Suction Pressure Gauge	0 - 20 PSI
M2.3	PI-0212	Pool 2 Return Pump Discharge Pressure Gauge	0 - 20 PSI
M2.3	LSHH-0290	Recirculation Vault 2 Flood Switch	
M2.3	FIT-0201	Pond 2 to Pond 3 Discharge Structure Flow Meter	193 GPM

INSTRUMENT INDEX (continued)			
Drawing Number	**Instrument Tag**	**Instrument Description**	**Notes**
M2.4	PI-0411	Pool 4 Return Pump Suction Pressure Gauge	0 - 25 PSI
M2.4	PI-0412	Pool 4 Return Pump Discharge Pressure Gauge	0 - 25 PSI
M2.4	LSHH-0490	Recirculation Vault 4 Flood Switch	
M2.4	FIT-0401	Pond 4 to Pond 3 Discharge Structure Flow Meter	202 GPM
M2.5	LT-0510	Forebay Level Transmitter	0-10 Feet
M2.5	FIT-0590	Recharge Water Flow Meter	4.5 – 45 GPM
M2.5	PIT-0510	Forebay Recirculation Pump Discharge Pressure Transmitter	0-13 PSI
M2.5	LT-0501	Forebay to Permanent Pond 1 Culvert 1 Level Transmitter	0-5.15 Feet
M2.5	LT-0502	Forebay to Permanent Pond 1 Culvert 2 Level Transmitter	0-5.15 Feet
M2.5	LT-0503	Forebay to Permanent Pond 1 Culvert 3 Level Transmitter	0-5.15 Feet
M2.5	LT-0504	Forebay to Permanent Pond 1 Culvert 4 Level Transmitter	0-5.15 Feet
M2.5	FIT-0501	Forebay to Permanent Pond 1 Culvert 1 Flow Meter	0-225 GPM
M2.5	FIT-0502	Forebay to Permanent Pond 1 Culvert 2 Flow Meter	0-225 GPM
M2.5	FIT-0503	Forebay to Permanent Pond 1 Culvert 3 Flow Meter	0-225 GPM
M2.5	FIT-0504	Forebay to Permanent Pond 1 Culvert 4 Flow Meter	0-225 GPM

LEVEL INSTRUMENTATION
DATA SHEETS

Woodard & Curran	LEVEL SWITCHES	TAG NO:	*LSHH-0190, LSHH-0290, LSHH-0390, LSHH-0490*		
PROJECT NUMBER:	*0231351.04*	REV	REVISION DESCRIPTION	BY	DATE
DESCRIPTION:	*Buffalo Gulch Remedial Action Plan Butte Priority Soils Operable Unit*	A	60% Submittal	RSS	12/2022

SERVICE:	*Flood Alarms*			
Acceptable Level of Quality Equal To:	Manufacturer:	*Madison*		
	Model Number:	*MSB8800*		
GENERAL	Type:	*Vertical Float*	Float/Displacer Size:	*2”*
	Probe Length:	*NA*	Spring Material:	*NA*
	Probe Inactive Length:	*NA*	Power Supply:	*24 VDC*
	Probe Sheath Material:	*NA*	Area Class:	*Unclassified*
	Probe Material:	*NA*	Enclosure Class:	*NA*
	Process Connection:	*NA*	Enclosure Mounting:	*NA*
	Max Press:	*100 PSI*	Switch Type:	*SPST*
	Temp Rating:	*221 °F*	Sw. Contact Rating:	*0.5 A*
	Stilling Well:	*No*	Conduit Connection:	*N/A*
	Body Material:	*Polypropylene*	Cable Length:	*1.8 meter*
	Float/Disp. Material:	*Polypropylene*	Cable Jacket Mat’l:	*Chlorinated Polyethylene*
CALIBRATION	1st Switch Level:		3rd Switch Level:	
	2nd Switch Level:			
PROCESS DATA	Proc Fluid / State:	*Water*	Vessel Agitated:	*Water like*
	Specific Gravity:	*Water like*	Vessel Height:	*Water like*
	Percent Solids:	*Water like*	Vessel Material:	*Water like*
	Conductivity:	*Water like*	Flow (Min/Oper/Max):	
	Di-Electric Const.:	*Water like*	Flow Units:	
	Viscosity:	*Water like*	Pressure (Min/Oper/Max):	*Ambient*
	Line Size / Sched.:	*NA*	Pressure Units:	*PSI*
	Line No.:	*NA*	Temperature (Min/Oper/Max):	*45* / *110*
	Equipment Number:	*NA*	Temperature Units:	*°F*
ACCESSORIES	Tether/Weight:		Option-1:	*NA*
	Loc. Indicators/Style:		Option-2:	*NA*
	Instrument Tag:	*Yes – SS, Engraved*	Option-3:	*NA*
NOTES	*1.*			
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Woodard & Curran	RADAR LEVEL TRANSMITTER	TAG NO:	LT-0300, LT-0301, LT-0302, LT-0303, LT-0510, LT-0501, LT-0502, LT-0503, LT-0504

PROJECT NUMBER:	*0231351.04*	REV	REVISION DESCRIPTION	BY	DATE
DESCRIPTION:	*Buffalo Gulch Remedial Action Plan Butte Priority Soils Operable Unit*	A	60% Submittal	RSS	12/2022

SERVICE:	*Level Indication*			
Acceptable Level of Quality Equal To:	Manufacturer:	*Vega*	Part Number:	*PS6X - 222 UE6*
	Model Number:	*Vegapuls 6X*		

GENERAL	Type:	*Radar*	Beam Angle / Width:	*3°*
	Mounting:	*Bracket*	Process Connection:	
	Measuring Element:		Signal Connection:	*½" NPT*
	Ref. Connection:		Mat'l Body / Flange:	*Plastic*
	Span Range Min/Max:	*0'-393.7'*	Housing Material (Wet):	
	Press/Temp Rating:		Housing Mat'l (Non-Wet):	
	Accuracy:		Transmitter Mounting:	*Integral*
	Area Classification:	*Unclassified*	Power Supply:	*24VDC Loop*
	Enclosure Rating:	*IP66/IP67*	Cable Length:	
	Output Signal:	*4-20 mA*	Local Indicator/Style:	*Yes - LCD*
	Drain & Vent:	*No*		

CALIBRATION	Process (0% / 100%):		
	Output (4mA / 20mA):	*See Instrument List*	

PROCESS DATA	Proc Fluid / State:	*Water like*	Flow (Min/Oper/Max):			
	Specific Gravity:	*Water like*	Flow Units:			
	Density:	*Water like*	Pressure (Min/Oper/Max):			
	Conductivity:	*Water like*	Pressure Units:			
	Viscosity:	*Water like*	Temperature (Min/Oper/Max):			
	Line Size / Sched.:		Temperature Units:			
	Line No.:		Level Range in Inches:			

ACCESSORIES	Ind. Scale/Range:		Option-1:
	Device Tag:	*Yes- SS, Engraved*	Option-2:

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FLOW INSTRUMENTATION
DATA SHEETS

Woodard & Curran	MAGNETIC FLOWMETERS	TAG NO: *FIT-0101*			
PROJECT NUMBER:	*0231351.04*	REV	REVISION DESCRIPTION	BY	DATE
DESCRIPTION:	*Buffalo Gulch Remedial Action Plan Butte Priority Soils Operable Unit*	A	60% Submittal	RSS	12/2022

SERVICE:

Acceptable Level of Quality Equal To:	Manufacturer:	*Rosemount*	Part Number:	*8750WDMW1A1FTSA020SA1*
	Model Number:	*8750W*		

	Meter Size:	*2.0"*	Electrode Material:	*316 SS*
	Flow Range:	*0.418 – 411.77 GPM*	Ground Type:	*Ground Rings*
	End Connections:	*Flange*	Ground Material:	*Stainless Steel*
`	Tube Material:	*Stainless Steel*	Line Size:	*2.0"*
	Liner Material:	*PTFE*	Line Material:	Choose an item.
	Electrode Type:	*Standard*	Enclosure Rating:	Choose an item.
			Area Classification:	Choose an item.

TRANSMITTER	Mounting:	*Remote Wall Mount*	Enclosure Material:	Choose an item.
	Cable Length:	*NA*	Enclosure Rating:	Choose an item.
	Power Supply:	*120VAC*	Area Classification:	Choose an item.
	Local Indicator/Style:	*LCD*	Alarm Relay Form:	Choose an item.
	Totalizer:	Choose an item.	Comm. Protocol:	Choose an item.

CALIBRATION	Process (0% / 100%):	*0-70 GPM*	Pulse Output / Value:	
	Output (4mA / 20mA):	*0-70 GPM*		

PROCESS DATA	Proc Fluid / State:	*Water like*	Flow (Min/Oper/Max):	*0*	*54*	*70*
	Specific Gravity:	*Water like*	Flow Units:	*GPM*		
	Percent Solids:	-	Pressure (Min/Oper/Max):			
	Conductivity:	*Water like*	Pressure Units:	Choose an item.		
	Viscosity:	*Water like*	Temperature (Min/Oper/Max):			
	Line Size / Sched.:	*2.0"*	Temperature Units:	Choose an item.		
	Line No.:	-				

ACCESSORIES	Empty Tube Detection:	*NA*	Option:	
	Instrument Tag:	*Yes - SS, Engraved*	Option:	
	Calibration Standard:	*Yes*	Option:	

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Woodard & Curran	MAGNETIC FLOWMETERS	TAG NO:	*FIT-0321, FIT-0347, FIT-0201, FIT-0401*		
PROJECT NUMBER:	*0231351.04*	REV	REVISION DESCRIPTION	BY	DATE
DESCRIPTION:	*Buffalo Gulch Remedial Action Plan Butte Priority Soils Operable Unit*	A	60% Submittal	RSS	12/2022

SERVICE:

Acceptable Level of Quality Equal To:	Manufacturer:	*Rosemount*	Part Number:	*8750WDMW1A1FTSA030SA1*
	Model Number:	*8750W*		

	Meter Size:	*3.0"*	Electrode Material:	*316 SS*
	Flow Range:	*0.922 – 907.17 GPM*	Ground Type:	*Ground Rings*
	End Connections:	*Flange*	Ground Material:	*Stainless Steel*
`	Tube Material:	*Stainless Steel*	Line Size:	*4.0"*
	Liner Material:	*PTFE*	Line Material:	Choose an item.
	Electrode Type:	*Standard*	Enclosure Rating:	Choose an item.
			Area Classification:	Choose an item.

TRANSMITTER	Mounting:	*Remote Wall Mount*	Enclosure Material:	Choose an item.
	Cable Length:	*NA*	Enclosure Rating:	Choose an item.
	Power Supply:	*120VAC*	Area Classification:	Choose an item.
	Local Indicator/Style:	*LCD*	Alarm Relay Form:	Choose an item.
	Totalizer:	Choose an item.	Comm. Protocol:	Choose an item.

CALIBRATION	Process (0% / 100%):	*0-250 GPM*	Pulse Output / Value:	
	Output (4mA / 20mA):	*0-250 GPM*		

PROCESS DATA	Proc Fluid / State:	*Water like*	Flow (Min/Oper/Max):	*0*	*193*	*250*
	Specific Gravity:	*Water like*	Flow Units:	*GPM*		
	Percent Solids:	-	Pressure (Min/Oper/Max):			
	Conductivity:	*Water like*	Pressure Units:	Choose an item.		
	Viscosity:	*Water like*	Temperature (Min/Oper/Max):			
	Line Size / Sched.:	*4.0"*	Temperature Units:	Choose an item.		
	Line No.:	-				

ACCESSORIES	Empty Tube Detection:	*NA*	Option:	
	Instrument Tag:	*Yes - SS, Engraved*	Option:	
	Calibration Standard:	*Yes*	Option:	

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Woodard & Curran	MAGNETIC FLOWMETERS	TAG NO:	*FIT-0311, FIT-0332*

PROJECT NUMBER:	*0231351.04*	REV	REVISION DESCRIPTION	BY	DATE
DESCRIPTION:	*Buffalo Gulch Remedial Action Plan Butte Priority Soils Operable Unit*	A	60% Submittal	RSS	12/2022

SERVICE:

Acceptable Level of Quality Equal To:	Manufacturer:	*Rosemount*	Part Number:	*8750WDMW1A1FTSA040SA1*
	Model Number:	*8750W*		

	Meter Size:	*4.0"*	Electrode Material:	*316 SS*
	Flow Range:	*1.587 – 1562.2 GPM*	Ground Type:	*Ground Rings*
	End Connections:	*Flange*	Ground Material:	*Stainless Steel*
`	Tube Material:	*Stainless Steel*	Line Size:	*4.0"*
	Liner Material:	*PTFE*	Line Material:	Choose an item.
	Electrode Type:	*Standard*	Enclosure Rating:	Choose an item.
			Area Classification:	Choose an item.

TRANSMITTER	Mounting:	*Remote Wall Mount*	Enclosure Material:	Choose an item.
	Cable Length:	*NA*	Enclosure Rating:	Choose an item.
	Power Supply:	*120VAC*	Area Classification:	Choose an item.
	Local Indicator/Style:	*LCD*	Alarm Relay Form:	Choose an item.
	Totalizer:	Choose an item.	Comm. Protocol:	Choose an item.

CALIBRATION	Process (0% / 100%):	*0-350 GPM*	Pulse Output / Value:	
	Output (4mA / 20mA):	*0-350 GPM*		

PROCESS DATA	Proc Fluid / State:	*Water like*	Flow (Min/Oper/Max):	*0*	*250*	*350*
	Specific Gravity:	*Water like*	Flow Units:	*GPM*		
	Percent Solids:	-	Pressure (Min/Oper/Max):			
	Conductivity:	*Water like*	Pressure Units:	Choose an item.		
	Viscosity:	*Water like*	Temperature (Min/Oper/Max):			
	Line Size / Sched.:	*4.0"*	Temperature Units:	Choose an item.		
	Line No.:	-				

ACCESSORIES	Empty Tube Detection:	*NA*	Option:	
	Instrument Tag:	*Yes - SS, Engraved*	Option:	
	Calibration Standard:	*Yes*	Option:	

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Woodard & Curran	MAGNETIC FLOWMETERS	TAG NO: *FIT-0341*			
PROJECT NUMBER:	*0231351.04*	REV	REVISION DESCRIPTION	BY	DATE
DESCRIPTION:	*Buffalo Gulch Remedial Action Plan Butte Priority Soils Operable Unit*	A	60% Submittal	RSS	12/2022

SERVICE:

Acceptable Level of Quality Equal To:	Manufacturer:	*Rosemount*	Part Number:	*8750WDMW1A1FTSA060SA1*
	Model Number:	*8750W*		

	Meter Size:	*6.0"*	Electrode Material:	*316 SS*
	Flow Range:	*3.602 – 3545.2 GPM*	Ground Type:	*Ground Rings*
	End Connections:	*Flange*	Ground Material:	*Stainless Steel*
`	Tube Material:	*Stainless Steel*	Line Size:	*6.0"*
	Liner Material:	*PTFE*	Line Material:	Choose an item.
	Electrode Type:	*Standard*	Enclosure Rating:	Choose an item.
			Area Classification:	Choose an item.

TRANSMITTER	Mounting:	*Remote Wall Mount*	Enclosure Material:	Choose an item.
	Cable Length:	*NA*	Enclosure Rating:	Choose an item.
	Power Supply:	*120VAC*	Area Classification:	Choose an item.
	Local Indicator/Style:	*LCD*	Alarm Relay Form:	Choose an item.
	Totalizer:	Choose an item.	Comm. Protocol:	Choose an item.

CALIBRATION	Process (0% / 100%):	*0-550 GPM*	Pulse Output / Value:	
	Output (4mA / 20mA):	*0-550 GPM*		

PROCESS DATA	Proc Fluid / State:	*Water like*	Flow (Min/Oper/Max):	*0*	*426*	*550*
	Specific Gravity:	*Water like*	Flow Units:	*GPM*		
	Percent Solids:	-	Pressure (Min/Oper/Max):			
	Conductivity:	*Water like*	Pressure Units:	Choose an item.		
	Viscosity:	*Water like*	Temperature (Min/Oper/Max):			
	Line Size / Sched.:	*6.0"*	Temperature Units:	Choose an item.		
	Line No.:	-				

ACCESSORIES	Empty Tube Detection:	*NA*	Option:	
	Instrument Tag:	*Yes - SS, Engraved*	Option:	
	Calibration Standard:	*Yes*	Option:	

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PRESSURE INSTRUMENTATION
DATA SHEETS

Woodard & Curran	PRESSURE GAUGES	TAG NO:	*PI-0311, PI-0321*		
PROJECT NUMBER:	*0231351.04*	REV	REVISION DESCRIPTION	BY	DATE
DESCRIPTION:	*Buffalo Gulch Remedial Action Plan Butte Priority Soils Operable Unit*	A	60% Submittal	RSS	12/2022

SERVICE:	*Recirculation Pump Suction Pressure Indication*			
Acceptable Level of Quality Equal To:	Manufacturer:	*Ashcroft*		
	Model Number:	*1279*	Part Number:	*451279SSL02LXNHV/60#*
GENERAL	Type:	*Gauge*	Socket Material:	*316SS*
	Gauge Size:	*4.5"*	Conn. Size / Loc:	*1/4" / Lower*
	Color Face/Letter:	*White / Black*	Gauge Range:	*-15 – 60 PSI*
	Case Material:	*Black Phenolic*	Accuracy:	*+/-0.5%*
	Ring Material:	*Polycarbonate*	Liquid Filled Gauge:	*Yes*
	Lens Material:	*Glass*	Liquid Fill Material:	*Glycerin*
	Blow Out Protect.:	*Yes*	Throttle Screw:	*NA*
	Tube Material:	*316SS*	Overload Stop:	*NA*
DIAPHRAGM SEAL	Diaphragm Seal:	*NA*	Diaphragm Proc. Conn.:	*NA*
	Diaphragm Seal Type:	*NA*	Housing Mat-Wet:	*NA*
	Diaphragm Material:	*NA*	Housing Mat-Non Wet:	*NA*
	Diaphragm Seal Fill:	*NA*		
PROCESS DATA	Proc Fluid / State:	*Water like*	Flow (Min/Oper/Max):	
	Specific Gravity:	*Water like*	Flow Units:	Choose an item.
	Percent Solids:	-	Pressure (Min/Oper/Max):	*-10* / *35*
	Conductivity:	*Water like*	Pressure Units:	*PSI*
	Viscosity:	*Water like*	Temperature (Min/Oper/Max):	
	Line Size / Sched.:	-	Temperature Units:	Choose an item.
	Line No.:	-		
ACCESSORIES	Remote Capillary (Yes/No):	No		
	Capillary Material:			
	Capillary Length:			
	Instrument Tag:	*Yes- SS, Engraved*		
NOTES	*1.*			
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Woodard & Curran	PRESSURE GAUGES	TAG NO:	*PI-0211, PI-0212*		
PROJECT NUMBER:	*0231351.04*	REV	REVISION DESCRIPTION	BY	DATE
DESCRIPTION:	*Buffalo Gulch Remedial Action Plan Butte Priority Soils Operable Unit*	A	60% Submittal	RSS	12/2022

SERVICE:	*Pump Suction/Discharge Pressure Indication*			
Acceptable Level of Quality Equal To:	Manufacturer:	*Ashcroft*		
	Model Number:	*1279*	Part Number:	*451279SSL02LXNH20#*
GENERAL	Type:	*Gauge*	Socket Material:	*316SS*
	Gauge Size:	*4.5"*	Conn. Size / Loc:	*1/4" / Lower*
	Color Face/Letter:	*White / Black*	Gauge Range:	*0 – 20 PSI*
	Case Material:	*Black Phenolic*	Accuracy:	*+/-0.5%*
	Ring Material:	*Polycarbonate*	Liquid Filled Gauge:	*Yes*
	Lens Material:	*Glass*	Liquid Fill Material:	*Glycerin*
	Blow Out Protect.:	*Yes*	Throttle Screw:	*NA*
	Tube Material:	*316SS*	Overload Stop:	*NA*
DIAPHRAGM SEAL	Diaphragm Seal:	*NA*	Diaphragm Proc. Conn.:	*NA*
	Diaphragm Seal Type:	*NA*	Housing Mat-Wet:	*NA*
	Diaphragm Material:	*NA*	Housing Mat-Non Wet:	*NA*
	Diaphragm Seal Fill:	*NA*		
PROCESS DATA	Proc Fluid / State:	*Water like*	Flow (Min/Oper/Max):	
	Specific Gravity:	*Water like*	Flow Units:	Choose an item.
	Percent Solids:	-	Pressure (Min/Oper/Max):	*0* / *20*
	Conductivity:	*Water like*	Pressure Units:	*PSI*
	Viscosity:	*Water like*	Temperature (Min/Oper/Max):	
	Line Size / Sched.:	-	Temperature Units:	Choose an item.
	Line No.:	-		
ACCESSORIES	Remote Capillary (Yes/No):	No		
	Capillary Material:			
	Capillary Length:			
	Instrument Tag:	*Yes- SS, Engraved*		
NOTES	*1.*			
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Woodard & Curran	PRESSURE GAUGES	TAG NO:	*PI-0312, PI-0322, PI-0411, PI-0412*		
PROJECT NUMBER:	*0231351.04*	REV	REVISION DESCRIPTION	BY	DATE
DESCRIPTION:	*Buffalo Gulch Remedial Action Plan Butte Priority Soils Operable Unit*	A	60% Submittal	RSS	12/2022

SERVICE:	*Pump Suction/Discharge Pressure Indication*			
Acceptable Level of Quality Equal To:	Manufacturer:	*Ashcroft*		
	Model Number:	*1279*	Part Number:	*451279SSL02LXNH30#*
GENERAL	Type:	*Gauge*	Socket Material:	*316SS*
	Gauge Size:	*4.5"*	Conn. Size / Loc:	*1/4" / Lower*
	Color Face/Letter:	*White / Black*	Gauge Range:	*0 – 30 PSI*
	Case Material:	*Black Phenolic*	Accuracy:	*+/-0.5%*
	Ring Material:	*Polycarbonate*	Liquid Filled Gauge:	*Yes*
	Lens Material:	*Glass*	Liquid Fill Material:	*Glycerin*
	Blow Out Protect.:	*Yes*	Throttle Screw:	*NA*
	Tube Material:	*316SS*	Overload Stop:	*NA*
DIAPHRAGM SEAL	Diaphragm Seal:	*NA*	Diaphragm Proc. Conn.:	*NA*
	Diaphragm Seal Type:	*NA*	Housing Mat-Wet:	*NA*
	Diaphragm Material:	*NA*	Housing Mat-Non Wet:	*NA*
	Diaphragm Seal Fill:	*NA*		
PROCESS DATA	Proc Fluid / State:	*Water like*	Flow (Min/Oper/Max):	
	Specific Gravity:	*Water like*	Flow Units:	Choose an item.
	Percent Solids:	-	Pressure (Min/Oper/Max):	*See Instrument List*
	Conductivity:	*Water like*	Pressure Units:	*PSI*
	Viscosity:	*Water like*	Temperature (Min/Oper/Max):	
	Line Size / Sched.:	-	Temperature Units:	Choose an item.
	Line No.:	-		
ACCESSORIES	Remote Capillary (Yes/No):	No		
	Capillary Material:			
	Capillary Length:			
	Instrument Tag:	*Yes- SS, Engraved*		
NOTES	*1.*			
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Woodard & Curran	PRESSURE GAUGES	TAG NO:	*PI-0111, PI-0112*		
PROJECT NUMBER:	*0231351.04*	REV	REVISION DESCRIPTION	BY	DATE
DESCRIPTION:	*Buffalo Gulch Remedial Action Plan Butte Priority Soils Operable Unit*	A	60% Submittal	RSS	12/2022

SERVICE:	*Pump Suction/Discharge Pressure Indication*			
Acceptable Level of Quality Equal To:	Manufacturer:	*Ashcroft*		
	Model Number:	*1279*	Part Number:	*451279SSL02LXNH60#*
GENERAL	Type:	*Gauge*	Socket Material:	*316SS*
	Gauge Size:	*4.5"*	Conn. Size / Loc:	*1/4" / Lower*
	Color Face/Letter:	*White / Black*	Gauge Range:	*0 – 60 PSI*
	Case Material:	*Black Phenolic*	Accuracy:	*+/-0.5%*
	Ring Material:	*Polycarbonate*	Liquid Filled Gauge:	*Yes*
	Lens Material:	*Glass*	Liquid Fill Material:	*Glycerin*
	Blow Out Protect.:	*Yes*	Throttle Screw:	*NA*
	Tube Material:	*316SS*	Overload Stop:	*NA*
DIAPHRAGM SEAL	Diaphragm Seal:	*NA*	Diaphragm Proc. Conn.:	*NA*
	Diaphragm Seal Type:	*NA*	Housing Mat-Wet:	*NA*
	Diaphragm Material:	*NA*	Housing Mat-Non Wet:	*NA*
	Diaphragm Seal Fill:	*NA*		
PROCESS DATA	Proc Fluid / State:	*Water like*	Flow (Min/Oper/Max):	
	Specific Gravity:	*Water like*	Flow Units:	Choose an item.
	Percent Solids:	-	Pressure (Min/Oper/Max):	*See Instrument List*
	Conductivity:	*Water like*	Pressure Units:	*PSI*
	Viscosity:	*Water like*	Temperature (Min/Oper/Max):	
	Line Size / Sched.:	-	Temperature Units:	Choose an item.
	Line No.:	-		
ACCESSORIES	Remote Capillary (Yes/No):	No		
	Capillary Material:			
	Capillary Length:			
	Instrument Tag:	*Yes- SS, Engraved*		
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Woodard & Curran	PRESSURE TRANSMITTERS	TAG NO: PIT-0100, PIT0510			
PROJECT NUMBER:	*0231351.04*	REV	REVISION DESCRIPTION	BY	DATE
DESCRIPTION:	*Buffalo Gulch Remedial Action Plan Butte Priority Soils Operable Unit*	A	60% Submittal	RSS	12/2022

SERVICE:	*Pump Discharge Pressure*			
Acceptable Level of Quality Equal To:	Manufacturer:	*Rosemount*		
	Model Number:	*2051TG1A2B21AS5*		
GENERAL	Span Range Min/Max:	*-14.7 – 30 PSI*	XMTR Body Material:	*Aluminum*
	Output Signal:	*4-20 mA*	XMTR Element Material:	*316L SS*
	Accuracy:	*0.065%*	XMTR Fill Fluid:	*Silicone*
	Power Supply:	*24 VDC Loop*	Diaphragm Seal:	*NA*
	Max. Press. Rating:		Seal Material (Non-Wet):	*NA*
	Area Classification:	*Unclassified*	Dia/Housing (Wet):	*NA*
	Enclosure Rating:	*NEMA 4X*	Fill Fluid:	*NA*
	Local Indicator/Type:	*Yes - LCD*	Capillary Length:	*NA*
	Mounting:	*Integral*	Capillary Material:	*NA*
	Connection-Process:	*1/2" NPT*		
CALIBRATION	Process (0% / 100%):			
	Output (4mA / 20mA):	*See Instrument List*		
PROCESS DATA	Proc Fluid / State:	*Water like*	Flow (Min/Oper/Max):	
	Specific Gravity:	*Water like*	Flow Units:	Choose an item.
	Percent Solids:	-	Pressure (Min/Oper/Max):	
	Conductivity:	*Water like*	Pressure Units:	Choose an item.
	Viscosity:	*Water like*	Temperature (Min/Oper/Max):	
	Line Size / Sched.:		Temperature Units:	Choose an item.
	Line No.:			
ACCESSORIES	Vent/Drain:	*NA*	Option-1:	
	Instrument Tag:	*Yes- SS, Engraved*	Option-2:	
	Manifold Valve:	*Yes*	Option-3:	
NOTES	*1.*			
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END OF ATTACHMENTS

SECTION 40 81 00
SYSTEM INTEGRATOR QUALIFICATIONS AND SUMMARY OF WORK

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide the services of a system integrator who shall provide all labor and incidentals as required to program, test, and start-up and make operational a complete Supervisory Control and Data Acquisition (SCADA) system in accordance with this Section and applicable reference standards listed in Article 1.02.
   2. The system shall be as specified in the Contract Documents. The system integrator provides all programmable logic controllers (PLC) programming, human-machine interface (HMI) screen development, operator interface terminals (OIT) screen development, testing, and startup services. The physical installation and wiring of the instrumentation is by Construction Management General Contractor (CMGC).

1.02 REFERENCES

A. Reference Standards:
   1. The Instrumentation, Systems and Automation Society (ISA).
   2. Underwriters' Laboratories, Inc. (UL).
   3. American Water Works Association (AWWA).
   4. National Electrical Manufacturer's Association (NEMA).
   5. Occupational Safety and Health Administration (OSHA).
   6. American National Standards Institute (ANSI).
   7. National Fire Protection Association (NFPA).
   8. National Fire Protection Association 79, Annex "D" Standards (NFPA).
   9. Institute of Electrical and Electronic Engineers (IEEE).
   10. National Electrical Code (NEC).
   11. Factory Mutual (FM).

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-06 Certificates:
      a. Qualifications Package Submittal:
         1) The system integrator shall submit a qualifications package (one electronic copy) as listed below, for review and approval to demonstrate compliance with the requirements described. The submittal shall include demonstration of all requirements, including but not limited to:
            (a) Include resumes for Project Manager, Field Engineers, and Technicians demonstrating comparable projects and field experience.
            (b) List the names and home office location of the Engineers and Technicians located within 75 miles and within 2 hours travel time of the Project Site.

(c) Project references for water or wastewater projects.

2. SD-07 Closeout Submittals:
   a. Operation and Maintenance Data:
      1) Provide Operation and Maintenance (O&M) Manuals in draft form prior to final system startup.
      2) Furnish O&M manuals as listed below and in accordance with Section 40 81 35 – SCADA System Programming and Section 40 81 40 – SCADA System Reporting for minimum design standards.
      3) The O&M manual shall include installation, set-up, and troubleshooting manuals for the Project instrumentation.
      4) The O&M manual shall include fully documented as-built PLC programs printouts (print double sided) including file name and date, control panel name, processor information, message configuration, PID control block configuration, communications channel configuration, program file list, status file, data file list, address/symbol database, and program files. It shall include data file tables for all tables storing set points, for constant values used to configure the rack equipment, for timers and counters. It shall include the processor serial number, current firmware revision.
      5) The O&M manual shall include fully documented as-built OIT programs printouts including file name and date, control panel name, application settings including terminal setup, communications setup, tag database, alarms, security setup, serial number, and current firmware revision. Also, include the screen dump report identifying the objects with their associated tags and functions.
      6) The O&M manual shall include as built SCADA system AutoCAD Drawings.
      7) The O&M manual shall include an operations section with a step-by-step procedure for starting up and shutting down the SCADA computers and SCADA application software. It shall contain procedures for logging into the SCADA system, SCADA screen navigation, alarms interpretation and acknowledgment, equipment control functions, set point modification and use of historical trends.
      8) The O&M manual shall include a maintenance section showing typical trouble shooting procedures for SCADA computers, software, control panels, and communications equipment.
      9) The O&M manual shall include DVDs labeled Emergency Recovery Files, which shall have fully documented PLC, OIT, HMI, alarm notification and reporting files in their native format and an image file of each SCADA computer for the restoration of the system.

B. PLC Program OIT and HMI Screen Submittals:
   1. Within 2 weeks of notice to proceed, provide templates or examples of PLC programs, HMI screens, and OIT screens to the construction manager for review and comment. These submittals shall reflect the intended approach to execute the Work under this Contract and comply with all requirements of these Contract Documents.
   2. Coordinate a meeting with the construction manager to review templates and examples and associated design-builder comments and questions no more than 2 weeks after submission.
   3. Submit to construction manager 90 percent PLC programs, HMI screens and OIT screens a minimum of 3 weeks prior to scheduled commissioning of system.
   4. Coordinate final review meeting no less than 1 week after, and no more than 2 weeks after 90 percent submission. At this meeting, the construction manager will review 90 percent submittal. After all comments are addressed, final edits can be made.

C. SCADA Reporting Submittals:
   1. Coordinate and schedule a meeting with the construction manager, design-builder, and plant personnel to review reporting requirements. Submit a proposed schedule and agenda for a SCADA Reporting Kickoff Meeting with the construction manager and design-builder. The meeting shall include all compliance reports and any internal reports required by the construction manager and plant personnel, identification of report users and administrators. NOTE: Plant personnel shall be given the option to input data manually into reports and not be limited to data available automatically from the SCADA system.
   2. Provide a schedule and meeting agenda to review with the construction manager and plant personnel a first draft of the reports and subsequent meeting to review a 90 percent complete version of the reports.
   3. Submit a proposed schedule and agenda for a SCADA reports first draft review meeting with the construction manager and plant personnel. The meeting shall include review of the compliance reports and other reports identified in the Kickoff meeting. The submittal shall include examples of the first draft reports. The meeting shall identify any changes to the first draft reports to be used in finalizing the reports.
   4. Submit a proposed schedule and agenda for a SCADA reporting final edits review meeting with the construction manager and plant personnel. The meeting shall include review of final state of the reports. The submittal shall include examples of the final reports.
   5. Implement reports as approved by the construction manager and plant personnel during final edits review meeting and provide 4 hours of report user training to the plant operations staff.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Qualifications: Per Division 01 General Requirements for System Integrator and as follows.
   1. Employ personnel on this Project who have a minimum of 5 years' experience programming and starting up SCADA related hardware, computers, voice cards, and alarm dialers, Allen-Bradley PLC and OIT, power monitors, radios, routers and other network communications equipment.
   2. Employ personnel on this Project who have completed factory training in development of the SCADA software for HMI, PLC, OIT programming, alarm notification software and reporting software.
   3. Personnel shall be experienced configuring process instrumentation typically found in a water or wastewater treatment plant. Key personnel shall include, at a minimum, the lead field technician.
   4. Successfully completed Work of equal or greater complexity on at least 3 other similar projects within the last 5 years.
   5. The system integrator shall maintain a permanent, fully staffed, and equipped office within 2 hours travel time of the Project Site with full time employees capable of programming, troubleshooting and testing the SCADA system specified.
   6. For the duration of the Project (system startup until one month after startup completion) the system integrator shall provide an on Site response within 4 hours of notification. For the remainder of the Warranty Period, the system integrator shall provide on Site response within 1 business day.
   7. The system integrator responsibilities include but are not limited to;
      a. Integrating all SCADA computer hardware and software that are part of the SCADA system.

b. Integrating all communications equipment including modems, routers, Ethernet switches, alarm dialers and remote access equipment.
c. Integrating all SCADA control panels (except vendor supplied control panels) needed for the complete monitoring and control of the SCADA system as described in the Contract Plans, equipment O&M manuals and submittals, Specifications and applicable codes.
d. Installation, programming and testing of all software (except vendor supplied panels) needed for the complete monitoring and control of the SCADA system as described in the Contract Plans, Specifications and applicable codes by or under the supervision of qualified personnel.
e. Preparation, assembly, and correction of all submittals in accordance with the Contract Documents.
f. Proper interfacing of the SCADA hardware, software, field devices and panels, including required interfacing with packaged control systems furnished by other equipment Suppliers, and with the plant electrical system.
g. Supervision of the installation of SCADA, instrument tests, control panels, wiring checkout to the SCADA control panels, and other components required by or under the supervision of qualified personnel.
h. Documentation (check sheets) of I/O testing and startup of the SCADA system.
i. Training of Atlantic Richfield Company's personnel in operation and maintenance of the SCADA system. A minimum of 8 hours formal training is required for all SCADA operations staff. Formal training can be a combination of on Site classroom style with handouts, whiteboard or projector and hands on usage of the SCADA system. Training shall include one, 4-hour session, 1 week prior to system startup, as well as two, 2-hour follow-up sessions after the system is successfully started up and accepted by the construction manager. The system integrator shall submit training agendas for all sessions to the construction manager for review and approval prior to scheduling the training sessions.
j. Coordination with the design-builder's installation Contractor on handling of all warranty obligations for the SCADA system components or any errors or omissions related to SCADA programming for a period of 12 months
k. Maintaining one on Site, up to date, copy of the integration plan and applications including fully documented programs for use in restoring the system during startup should part of the SCADA control system fail. The documented programs can be backups of the native electronic files. See Section 40 81 35 – SCADA System Programming and Section 40 81 40 – SCADA System Reporting for minimum design standards.
l. One hard copy and one electronic copy, on DVD, of the SCADA Operations and Maintenance Manual.

8. System Integrator Project Personnel:
   a. Project Manager:
      1) The system integrator shall appoint a Project manager who shall coordinate and schedule all SCADA Work and assure that the Project schedule is met.
      2) The Project manager shall act as the liaison with the design-builder's installation Contractor and the construction manager, for the integration, testing and startup of the SCADA system and shall assist in all matters required for proper coordination and interfacing of the equipment and processes.

b. Field Engineer:
    1) The system integrator shall appoint a field Engineer with responsibilities as follows:
        (a) Installed system checkout, adjustment, and start up including tuning of all control loops.
        (b) SCADA support services for the duration of any equipment or system availability trials.
        (c) Involvement in the on Site system training of plant personnel.
        (d) Resolving of control problems encountered during initial startup and testing of all SCADA equipment.

C. Integration:
1. The integration tasks include, but are not limited to, the following:
    a. Integrate new control panels (CP-1 and CP-2) with associated PLCs, OITs, fiber terminations, and communication equipment for supervisory monitoring and control of equipment and processes installed under this Contract. Coordinate programming to interface with other site equipment and SCADA computers.
    b. Configuration of all programs in accordance with the Contract Drawings.
    c. Input/output (I/O) counts and details shown on control panel drawings are for design and estimating purposes only. The system integrator shall be responsible for configuration of all I/O within control panels required to provide a complete and functional SCADA system.
    d. Participate in startup testing of all equipment, instruments and controls to ensure operation of systems.

D. Testing:
1. The system integrator shall allocate time for control panel testing, full field-testing of instrumentation, PLC, OIT, and HMI, and reporting programs in accordance with the Contract Documents. The system integrator shall provide documentation (checklists) as a record of testing I/O points through to OIT and HMI screens.

E. Coordination and Progress Meetings:
1. The system integrator shall be responsible for the scheduling with the design-builder's installation Contractor and coordinating the system integration with regard to all other Work on the Site and in accordance with the provisions of the General Conditions. The coordination shall be documented on the Project Schedule.
2. The system integrator shall be responsible for scheduling with the construction manager all PLC, HMI, OIT, and reporting submittal review meetings.
3. Routine progress and coordination meetings will be scheduled by the construction manager. The system integrator shall be required to attend weekly meetings, or as scheduled by construction manager.
4. The purpose of the meetings shall be to review the progress of the Work involving the controls system and provide coordination for integration of the equipment to ensure Project schedule is met.
5. Representatives at the meetings shall have the authority to make all necessary decisions. Decisions and statements made at the meetings shall commit the system integrator to agreed procedures and schedules.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

(NOT USED)

END OF SECTION

SECTION 40 81 35
SCADA SYSTEM PROGRAMMING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide programming provided using the Supervisory Control and Data Acquisition (SCADA) computers, SCADA software, the SCADA control panels and communications equipment specified by the Contract Documents. The Plant Monitoring and Control System (System Integrator) Supplier shall provide all the labor and any equipment or materials not listed above as needed to program this equipment in accordance with this Section.
   2. It is not the intent of this Specification to define exactly how the System Integrator shall integrate this Project. The flexibility of the software allows the programmer to accomplish the same task by using a number of different methods. The System Integrator is required to create modules of program code and use them consistently throughout the programs.
   3. The Human Machine Interface (HMI) programming shall be for one SCADA computer located at the Butte Treatment Lagoons. The programming includes process screens, database, communication driver, historical trending, alarm handling, security, networking, and reporting.
      a. Screen List – TBD.

1.02 REFERENCE STANDARDS

A. Reference Standards.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures.

B. Refer to Section 40 61 01 – Instrumentation and Controls General Requirements.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

1.06 DELIVERY, STORAGE AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.01 PLC PROGRAMMING STANDARDS

A. PLC Program Structure:
   1. The Programmable Logic Controller (PLC) programs shall be organized in subroutines that aid troubleshooting and maintenance. For example:
      a. Analog input scaling (to engineering units) subroutine.
      b. Fault detection and de-bounce timer subroutine.
      c. Alarm handling subroutine.
      d. Flow total subroutine.
      e. Equipment runtime hour's subroutine.
      f. Separate major equipment monitoring and control subroutines.
      g. HMI set points subroutine.
      h. Communications subroutine.
      i. Include a minimum of six spare subroutines for future use.

B. Data Files:
   1. Reserve a minimum of 2 data files for use in passing status to or from vendor supplied PLC systems.
   2. Use separate data files; commands to the PLC, and status from the PLC.
   3. Organize memory such that status bits and words used by the Operator Interface Terminal (OIT) or HMI are in contiguous registers within their own data files, and organize the command bits and set point words used by the OIT or HMI in contiguous registers within their own data files so as to optimize communication efficiency.
   4. All math and scaling shall be handled in PLC logic, not in the OIT or HMI, and shall return results in engineering units consistent with the OIT and HMI display.

C. PLC Program Documentation:
   1. The PLC program shall be clearly documented using rung comments, instruction comments, and tags. Documentation shall be clear, provide descriptions, and comments as needed to simplify support and future development of the system. The System Integrator shall use address symbols consistent with OIT and HMI tag name programming. Rung comments shall be used to describe functions of areas of code.

D. PLC Program Basic Features:
   1. All PLC programs shall include basic error trapping such that preventable errors do not fault the processor.
   2. The main program subroutine file shall include a health bit to indicate the processor is in RUN mode. This bit shall be monitored as a fault in the HMI.
   3. The program shall track using counters the success or failure of each attempt to communicate via message blocks to other between PLCs. The counters shall be logged historically and displayed on trend screens.
   4. The program shall include alarm-handling logic that incorporates adjustable delay timers for each alarm, unacknowledged alarm bits for each alarm and acknowledged (but still in alarm) bits for each alarm.

5. Alarm timers shall include a SCADA HMI screen adjustable set point. Each alarm shall include an Alarm Disable code that can be enabled or disabled from a SCADA HMI screen.
6. All motor driven equipment, except motorized valves, shall have daily run hours accurate to tenths of hours and total run hours up to 99,000 hours. The daily run hour counter shall reset at midnight.
7. Each flow meter shall display on SCADA instantaneous flow, total flow, today's flow total and yesterday's flow total. The transition from today's to yesterday's flow totals shall typically occur at midnight.

3.02 LOCAL OIT PROGRAMMING STANDARDS

A. Local OIT Program Structure:
   1. The OIT is intended as a local backup to the SCADA HMI system for the graphics and text links used to display status of equipment, process conditions, and set points that shall be developed and organized so as to be as consistent as possible with the plant SCADA HMI.
   2. Each OIT shall include an overview screen, an alarm summary screen and a process screen for each major piece of equipment or process associated with that PLC cabinet. A secure login shall be provided for all set points, control buttons and alarm acknowledgement.
   3. The OIT database tag names and descriptions shall be consistent with the associated PLC logic where practical. All tags shall display and pass process variables and set points scaled to engineering units consistent with the PLC logic.
   4. All mathematical, comparison, or scaling functions shall be programmed at the PLC code level, and not at the OIT tag or database level.

B. Local OIT Program Basic Features:
   1. When initialized, the OIT shall default to an overview screen that displays date, time and critical process information for its associated PLC.
   2. The Alarm Summary shall display unacknowledged alarms and acknowledged active alarms. Alarms acknowledged at the OIT shall synchronize with all SCADA HMI alarm summaries.

3.03 COMPUTER HMI PROGRAMMING STANDARDS

A. HMI Program Structure - Security:
   1. The SCADA HMI security shall be configured with a minimum of five groups. The Construction Manager shall provide a list of users to enter into each group. The groups shall be Guest, Operator, Supervisor, Maintenance, and Administrator.
   2. The Guest group shall allow navigation to process and trend screens only. A Guest shall not have the ability to modify set points, operate screen controls, acknowledge alarms, disable alarms, navigate to other applications, or access operating system tools.
   3. The Operator group shall include all Guest group rights with the additional ability to modify defined set points and screen controls, acknowledge alarms, and navigate to other applications.
   4. The Supervisor group shall include all Operator group rights with the additional ability to modify all set points and all screen controls, access operating system tools and disable alarms.
   5. The Maintenance group shall include all Supervisor group rights. Additional maintenance group rights shall be defined by the Construction Manager.

6. The Administrator group shall allow full access to all SCADA functions and is typically reserved for the Atlantic Richfield Company's SCADA administrator and System Integrator.

B. HMI Program Structure - Screen Development:
   1. The integrator shall use a hierarchical layout with overviews for each process area and major pieces of equipment. Overviews shall include equipment status and current process values. Navigation buttons from the overviews shall navigate to screen or pop-ups that provide set points and controls. Overview screens shall mimic actual plant equipment layout and orientation.
   2. All screens shall include a banner at the top of the screen containing the system date and time, a screen name identifying what is found on the screen, the user who is logged into the HMI, an Alarm indicator that flashes whenever a new alarm is detected and a link to the menu system screen.
   3. There shall be an Alarm Summary screen showing all current acknowledged and unacknowledged alarms. Each alarm shall show date and time of the alarm, the tag name and description, alarm priority and alarm area. The Alarm Summary shall post newest alarms at the top. Unacknowledged alarms shall use white text on a flashing red background. Acknowledged alarms shall use white text on a steady red background. All alarm activity shall be logged to a historical file.

C. HMI Program Structure - Tag Names:
   1. Database tag names and descriptions shall be consistent with the design Drawings, the sequence of operations description, and the equipment and instrument list. Where possible, the tag name shall include the instrument tag. When configuring the database tag names, consideration shall be given to the integration of other remote pumping stations in future Projects.

D. HMI program Structure - Historical Collection and Trending:
   1. All process analog signals shall be historically collected for trending and reporting purposes. Historical files shall not be configured to automatically delete or overwrite.
   2. Historical trend screen shall include a calendar object that allows operators to select the start date of the trend. The trend duration shall also be selectable. Typical durations shall include 1 hour, 4 hour, 8 hour, 1 day, and a custom duration option.

E. HMI Program Structure - Redundancy:
   1. The SCADA nodes shall be configured to be redundant. If one SCADA node fails, operators shall be able to use the second SCADA node to review the all process and control data.
   2. SCADA HMI client nodes shall be configured so they can source their data from either SCADA node.

F. HMI Program Structure - Alarm Handling:
   1. The display of SCADA alarms shall be constant across all SCADA HMI and OIT alarm summaries. Alarms shall have the ability to be acknowledged from any HMI or OIT, then synchronize to all others.

G. HMI Program Structure - Graphic Objects:
   1. The HMI screens shall primarily use the graphical objects provided with the development package library. Embedded graphic files (bitmaps, CAD files, etc.) can be used. The use of third party graphical objects is prohibited without Construction Manager authorization.

2. The graphic objects representing equipment, instruments, etc. shall be programmed so that, when clicked on, shall open a screen or pop-up menu. This pop-up menu shall allow access to the following information for that specific equipment or instrument:
    a. Construction Drawings.
    b. Catalog cut sheet/data sheet.
    c. O&M/instruction manual.
    d. These files shall be stored locally on each SCADA HMI and shall be presented in PDF format.

H. HMI Program Structure - Font Size:
1. Font size and type shall be bold text, True Type Arial font, size 12. Process variable descriptions and associated engineering unit symbols shall be True Type Arial font, size 10. Exceptions may be made for clarity.

I. HMI Program Structure - Graphic Size:
1. The standard HMI graphic screens shall be 1024 x 768 resolution. Larger standard widescreen resolutions may be acceptable if the System Integrator demonstrates the compatibility and stability of the format with the computer display and the remote support Keyboard Video & Mouse (KVM) solution.
2. Standard color palates shall be used for all HMI and OIT screens.

J. HMI Program Operations and Maintenance (O&M) Manual:
1. The O&M manual shall include:
    a. An operations section describing step-by-step procedures for starting up and shutting down the SCADA computers and SCADA software.
    b. How to log into the system security, navigate through the screens, interpret equipment status and alarms, modify set points and screen controls, and use historical trends.
    c. The manual shall describe how to open and use other SCADA related applications.
    d. How to modify the SCADA system security
    e. How to troubleshoot SCADA communications drivers and database
    f. How to backup and restore SCADA application files in a common format and native format.
    g. How to create and restore a computer system backup image file
    h. Printouts of the screens' database communication driver. A record of software and computer hardware version numbers, computer configuration, file locations and complete license registrations including support Contract information.

K. HMI Program Basic Features:
1. Equipment monitored or controlled by the SCADA system shall have its status displayed on a SCADA screen, either graphically, textually, or both. Where a graphical object is used to represent status, the object shall change shape or color based on status. Note: While it is useful to have animated graphical objects, this shall not be a substitution for a numerical or text indication of the status.
2. Examples for displaying dynamic graphical objects include:
    a. Graphical Object Status - color change.
    b. Running/On = Green.
    c. Stopped/Off = Red.
    d. Open = Green.
    e. Moving = Yellow.
    f. Closed = Red.

3. Typical examples for displaying dynamic text links include:
    a. Text Object Status - label change.
        1) Running status = Running/Stopped, On/Off.
        2) Position status = Open/Moving/Closed, Local/Remote.
        3) Selector status = Hand/Off/Auto.
        4) Commands = Required, Not Required.
4. The use of objects for selection or control shall be consistent throughout the Project. Command buttons shall have a label on or above the button indicating their function. They shall include either a border around the button or a text link that indicates that the button has been selected.
5. Text links used for entering set points shall be consistent throughout the Project. Text links shall have a label above, on, or next to them indicating their function. Numerical or alphanumerical text displaying current values shall use black text inside a gray box. Data entry links, numerical or alphanumerical, shall use yellow text inside a black box.
6. Tank or storage objects shall have a text link indicating the measured amount of media in the tank. Tick marks on the side of the tank shall show the upper and lower limits of measurement. All units shall be consistent with those shown in the Plans and Specifications.
7. Command buttons and data entry links shall be secured using the HMI security. Text links shall be limited such that the user cannot enter a value outside an acceptable range. The limits of the data entry range shall be displayed when the operator enters the new value. Set point text links shall always show the value currently being used by the process.

3.04 ALARM MONITOR PROGRAMMING STANDARDS

A. The alarm monitoring software shall be configured to include a list of alarms based on the plant processes and communication. The list shall include alarms for each piece of equipment and process area of the treatment plant and remote stations. It shall include watchdog alarms for whenever a PLC is taken out of RUN mode, when a control panel or drive is powered OFF or not communicating, and if the Alarm Monitor software loses communication with the SCADA HMI software.

B. The alarm monitoring software shall be configured to include a list of Operators, Maintenance and Administration personnel. Each name in the list shall include unique login access code and a unique alarm acknowledgement code. Each name shall be associated with either a home phone number, a cell phone number, a pager number, or backup numbers (Police, Fire, PA system).

C. The alarm monitoring software shall be configured to include a list of schedules, which reflect normal weekday operations, night operations and weekend operations.

D. The alarm monitoring software shall be configured to allow an administrator to add or remove names from the list of available staff to call and change the order of calling.

3.05 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.06 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.07 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 40 81 40
SCADA SYSTEM REPORTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide Supervisory Control and Data Acquisition (SCADA) system reporting in accordance with this Section.
   2. The reports shall be based on the compliance reports Atlantic Richfield Company will submit to the EPA and operations reports produced on a monthly basis. At a minimum, the reports shall include:
      a. (1) Master Monthly report.
      b. (1) Regulatory Agency report.
      c. (1) Miscellaneous operational reports.

1.02 REFERENCES

A. Reference Standards.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures.

B. Refer to Section 40 61 01 – Instrumentation and Controls General Requirements.

1.05 QUALITY CONTROL

A. Provide in Accordance with Division 01 General Requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.07 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.01 REPORTS

A. Compliance Reports:
   1. Create compliance reports per EPA regulations. Automate reports to query SCADA historical data, real time data, and lab data as needed. Use the scheduler tool to update the report daily.
   2. All compliance reports shall include the state approved format including header, organization of data columns, station identifier, license and permit information, date and time, document number, form number, signature, and comments field.

B. Operational Reports:
   1. Create operational reports to capture equipment runtime hours, water quality, flow minimum, flow maximum, flow average, flow totals, and water levels. Automate reports to query historical data, real time data, and lab data as needed. Use the scheduler tool to update the reports daily.
   2. Variables used in the reports shall use tag names and descriptions consistent with the Human Machine Interface (HMI), Programmable Logic Controller (PLC), and Operator Interface Terminal (OIT) databases.
   3. Report spreadsheet cells shall be formatted to display data resolution consistent with the format used in the SCADA HMI.
   4. Report spreadsheet cells that are used for manual data entry shall be identified by either a colored border or colored background.
   5. Report workbooks shall have a pushbutton or other simple means for retrieving the data required to complete the report shall the scheduler be disabled or shut off.
   6. Report workbooks shall include a sheet listing the complete tag name for each tag queried from the SCADA HMI.
   7. The completed reports shall be installed on the designated SCADA computer. The scheduler shall use the Final Report templates to create all of the daily and monthly workbooks. These workbooks shall include the report name and period for the report in the file name (ex., September 2022 49-1 FORM SPREAD SHEET.XLS).
   8. The reports shall be demonstrated using SCADA data.

3.02 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.03 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 40 81 50
SCADA SYSTEM FACTORY TESTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes
   1. Provide all labor, materials, and equipment needed to demonstrate Supervisory Control and Data Acquisition (SCADA) panels and associated equipment to meet fabrication requirements in accordance with this Section.
   2. This section defines the minimum factory testing requirements for the SCADA system.
   3. The Work includes demonstrating the installation and configuration of SCADA hardware, software, computers and communications equipment. It includes proving the status for process, equipment, controls and set points are displayed as required. It includes demonstrating SCADA security and remote access. It includes proving the required monitoring and control information is successfully passed back and forth between the SCADA system and vendor supplied control panels.

1.02 REFERENCES

A. Reference Standards.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures. The following shall be submitted in accordance with Section 40 61 01 – Instrumentation and Controls General Requirements as well as including specific submittal information as indicated herein:
   1. SD-01 Preconstruction Submittals:
      a. Submit a proposed schedule, agenda, and procedures for performing an in-house Factory Acceptance Test (FAT). All of the tasks in the FAT should be demonstrated again to a more extensive level on Site when systems are started up. These tasks would include demonstrating proper communications, monitoring, control, and reporting as required by the Contract Documents.
   2. SD-05 Test Reports:
      a. After receiving approval for the test procedures, the System Integrator shall perform the in-house FAT for the Design-Builder and submit the test results to the Construction Manager.
      b. Following successful FAT test and approval, the control panel manufacturer shall ship the control panels, computers, software, and hardware to the job Site.
   3. SD-06 Certificates:
      a. The control panel manufacturer and systems integrator shall submit a memo to the Construction Manager documenting that all applicable SCADA hardware and software is registered to the Atlantic Richfield Company and that extended support programs are in place.
   4. SD-07 Closeout Submittals:
      a. Per Division 01 General Requirements.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.01 PROGRAMS AND HARDWARE TESTING

A. The programs and hardware testing shall include, but not be limited to:
   1. Control panel layout, wiring practice, completeness, and adherence to applicable codes.
   2. Programmable Logic Controllers (PLC) and their associated ladder logic files.
   3. Operator Interface Terminals (OIT) and their associated configuration software.
   4. SCADA computers and their associated operating system.
   5. Human Machine Interface (HMI) software configuration.
   6. Alarm Monitoring software configuration and their associated modems and voice cards.
   7. Reporting software and associated scheduler.
   8. Network communications equipment and associated configuration software.

3.02 COORDINATION

A. The Work includes the System Integrator coordinating a meeting with the Design-Builder's installation Contractor, Construction Manager, and Design-Builder to demonstrate the control panels, computers, and software. At a minimum, a factory acceptance test shall be performed.

3.03 FACTORY ACCEPTANCE TEST

A. The Contract requires that SCADA computers, control panels PLCs, OITs communicate via an Ethernet local area network. It requires all software starts automatically, hardware is recognized and functional and the software provides the monitoring, control, alarm handling, historical collection, trending, and reporting as required by the Contract Documents and approved submittals.

B. The intent of the FAT is to confirm, as best possible, control panels and associated hardware are functional prior to installation in the field. The intent of the program test of the SCADA software and hardware is to demonstrate the acceptable structure and function of typical blocks of code. It is not the intent to test every possible point or screen or database tag. Complete testing of all points shall be done during Site checkout and startup testing.

C. FAT Application Acceptance Tests:
   1. SCADA Computers: General setup, test, and confirm the following per the Specifications:
      a. All computer hardware required by the Contract Documents is installed on SCADA computers.
      b. All SCADA software required by the Contract Documents is installed on SCADA computers.
      c. SCADA computers power up without error messages.
      d. Computer operating system security has been configured so they automatically login as guest user on startup.
      e. All SCADA applications load automatically in the correct sequence on startup.
      f. The SCADA computers are configured for the Ethernet network the SCADA system uses.
      g. The alarm notification hardware and software is operational, dials out under alarm conditions, and receives incoming calls to query status and acknowledge alarms.
      h. The remote access hardware and software has been configured to allow an authenticated user access to the SCADA system via the Internet.

D. SCADA Control Panel Checkout: PLCs, OITs and radio, test and confirm the following per Specifications:
   1. Confirm each control panel confirms with the Bill of Material (BOM) and panel layout Drawings.
   2. Power up all panel equipment.
   3. Confirm discrete input/output (I/O) points from terminal block to digital input and output cards.
   4. Confirm analog input/output points from terminal block to analog input/output cards. Confirm correct 4-20 mA signal at 4 mA, 12 mA, and 20 mA.
   5. Load PLC program, set PLC to RUN mode, cycle PLC power and confirm PLC returns to run mode.
   6. Configure and test PLC communication on the SCADA network.
   7. Load OIT program, cycle OIT power, confirm OIT returns to RUN mode.
   8. Confirm OIT is configured to communicate on the SCADA network.
   9. The battery backup, uninterruptible power supply (UPS) is charged, provides backup power and the required status contacts are operational.

E. Monitoring And Control Program Checkout: Test and confirm the following per the Specifications:
   1. HMI screens, set points and command controls have the correct security configuration.
   2. HMI screen navigation operates correctly between all screens.
   3. OIT screens, set points and command controls have correct security applied.
   4. OIT screen navigation works correctly on all screens.
   5. Confirm connectivity of PLC I/O to correct displays on HMI screens.
   6. Confirm connectivity from HMI screen controls to PLC registers.
   7. Confirm discreet messaging from PLC to PLC, and PLC to OIT operates correctly.
   8. Confirm HMI tag database to PLC driver configuration is optimized.

F. Alarm Monitoring Program Checkout: Test and confirm the following per the Specifications:
   1. Confirm alarms display correctly in the Alarm Summary, HMI navigation bar and alarm monitoring software.
   2. Confirm alarms are logged correctly to the historical alarm file.
   3. Confirm alarms annunciate correctly and audibly on SCADA computers.
   4. Confirm voice and alarm pager messages operate correctly per the callout list.

5. Confirm alarm-monitoring software accepts incoming voice calls, properly authenticates user, announces alarms and accepts remote acknowledgement.

G. Historical Collection Program Checkout: Test and confirm the following per the Specifications:
   1. Confirm analog process tags and required set points historically collected in correct files.
   2. Confirm historical collection archives at correct intervals with correct deadband.
   3. Confirm HMI trend screens allow correct selection and display of collected data.

H. Reporting Program Checkout: Test and confirm the following per the Specifications:
   1. Confirm all configured reports post required data accurately.
   2. Confirm manually entered report data functions correctly.
   3. Confirm report scheduler executes correctly.
   4. Confirm report print function operates correctly.
   5. Confirm report database and report files archive to the correct location.
   6. Confirm reports can execute manually in the event of a scheduler error.

3.04 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.05 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.06 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 40 81 51
SCADA SYSTEM CHECKOUT AND STARTUP

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Perform demonstration of the acceptable configuration of Supervisory Control and Data Acquisition (SCADA) hardware, software, computers, and communications equipment in accordance with this Section.

1.02 REFERENCES

A. Reference Standards.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures. The following shall be submitted in accordance with Section 40 61 01 – Instrumentation and Controls General Requirements as well as including specific submittal information as indicated herein:
   1. SD-01 Preconstruction Submittals:
      a. Submit a proposed schedule and agenda for a startup meeting with the Construction Manager. The meeting shall include review of team members, their responsibilities, and a timeline coordinated with the Design-Builder's installation contractor for proposed dates to test of all major SCADA components.
      b. Submit a proposed schedule, agenda, and test procedures for performing an on-Site Application Acceptance Test (AAT) to be witnessed by the Construction Manager. All tasks in the AAT shall demonstrate correct communications, monitoring, control, and reporting.
   2. SD-05 Test Reports:
      a. Submit documentation to record results of testing activities described in this Section to the Construction Manager. Only the Construction Manager-reviewed documentation shall be permissible for recording test results.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.07 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.01 PROGRAMS AND HARDWARE TESTING

A. The programs and hardware testing shall include, but not be limited to:
   1. SCADA Control panels and their associated wiring.
   2. Programmable Logic Controllers (PLC) and their associated ladder logic files.
   3. Operator Interface Terminals (OIT) and their associated configuration software.
   4. SCADA computers and their associated operating systems.
   5. Human Machine Interface (HMI) software.
   6. Reporting software and associated scheduler.
   7. Network and radio communications equipment and associated configuration software.
   8. Remote access hardware and associated configuration software.
   9. Variable Frequency Drives (VFD).

3.02 COORDINATION

A. The System Integrator is required to coordinate with and assist the Design-Builder's electrical contractor and instrumentation technician during on Site testing (commissioning) of equipment and instrumentation. Commissioning shall include confirming that all field wiring is terminated in the control panel correctly and confirming equipment status signals and instrumentation signals are received correctly.

B. The System Integrator is required to participate in progress and coordination meetings with the Design-Builder's installation contractor, construction manager, and design-builder to schedule commissioning in a way that ensures the safe and proper operation of the treatment plant and process, in a manner that is convenient to the Atlantic Richfield Company. At a minimum, the System Integrator shall attend the following meetings:
   1. Kickoff meeting.
   2. Weekly progress and scheduling meetings.
   3. Daily construction startup meetings as required.

3.03 TESTS

A. SCADA computers are configured to communicate to the control panel PLCs, OITs, power monitors, and each other over an Ethernet network within the treatment plant. All systems communicating remotely shall be configured and tested to ensure all necessary communication between remote Sites, occurs correctly. All software shall start automatically, hardware is recognized and functional, and the software provides the monitoring, control, alarm handling, historical collection, trending, and reporting as required by the approved submittals. The tests shall include:
   1. Application Acceptance Tests (AAT).
   2. SCADA Computers: General setup, test, and confirm the following per Specifications:
      a. SCADA computer hardware is installed on all SCADA computers.
      b. SCADA software is installed on all SCADA computers.
      c. SCADA computers power up correctly.
      d. SCADA node operating system security is configured to automatically log in as guest when powered up.
      e. SCADA computer applications load automatically in the correct sequence on power up.

f. SCADA alarm notification hardware operates correctly and dials out and receives incoming calls correctly.
g. SCADA remote access hardware has been configured to allow an authenticated user access to the SCADA computers via the Internet.

3. SCADA Control Panel Checkout: PLCs & OITs, test and confirm the following per Specifications:
   a. Confirm each panel installation against the Bill of Material (BOM) and panel layout Drawings.
   b. Power all panel equipment and confirm correct operation.
   c. Confirm all discrete input/output (I/O) points between field device and PLC digital input and output cards operate correctly.
   d. Confirm all analog input points between field device and analog input channels operate correctly.
   e. Confirm the PLC processor has the correct program installed and is in RUN mode.
   f. Confirm the PLC is communicating correctly via the SCADA Ethernet network and communicating correctly via the licensed frequency radio network to remote Sites.
   g. Confirm all OIT devices are loaded with the correct programs and are in RUN mode.
   h. Confirm all OIT devices are communicating correctly.
   i. Confirm all uninterruptible power supplies (UPS) are operating correctly.
4. Monitoring And Control Program Checkout: Test and confirm the following per the Specifications:
   a. Confirm all HMI screens, set points and command controls have the correct security configured.
   b. Confirm all HMI screen navigation operates correctly.
   c. Confirm all OIT screen, set points and command controls have the correct security configured.
   d. Confirm all OIT screen navigation operates correctly.
   e. Confirm operation of each I/O point from PLCs to correct display on HMI screens.
   f. Confirm correct operation of each set point and command control from the HMI to PLC.
   g. Confirm correct operation of messages from PLC to PLC and PLC to OIT.
   h. Confirm correct operation of HMI tag database and driver polling, phasing and deadbands of PLC.
5. Alarm Monitoring Program Checkout: Test and confirm the following per the Specifications:
   a. Confirm correct operation of alarm in the Alarm Summary, HMI navigation bar, applicable OIT, and the alarm monitoring software.
   b. Confirm alarms are logged correctly in the historical alarm file.
   c. Confirm alarms annunciate correctly on SCADA computers.
   d. Confirm voice and alarm pager calls operate correctly per the required schedule.
   e. Confirm alarm-monitoring software accepts incoming voice calls, properly authenticates user, announces alarms and accepts remote acknowledgement from the incoming caller or HMI Alarm Summary screen.
   f. Confirm alarms acknowledged from the OIT appear acknowledged in the SCADA HMI and alarm monitoring software.
6. Historical Collection Program Checkout: Test and confirm the following per Specifications:
   a. Confirm all analog process tags and required set points historically collected in appropriate files.
   b. Confirm the historical collector archives at specified intervals correctly.
   c. Confirm HMI trend screens allow proper selection and display of historical data.

7. Reporting Program Checkout: Test and confirm the following per Specifications:
    a. Confirm all configured reports post required data accurately.
    b. Confirm manually entered report data functions correctly.
    c. Confirm report scheduler executes correctly.
    d. Confirm report print function operates correctly.
    e. Confirm report database and report files archive to the correct location.
    f. Confirm reports can execute manually in the event of a scheduler error.

3.04 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.05 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.06 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION

SECTION 40 92 14
ELECTRIC GATE OPERATORS

PART 1 - GENERAL

1.01 SUMMARY

A. Furnish, install, test, and make ready for operation; self-contained, electric operators as specified herein. Provide all ancillary supporting systems, including but not limited to all wall brackets, anchor bolts, conduit, wiring, supports and other related appurtenances. The operator, switches and ancillary equipment shall be assembled and supplied as a complete integral functioning unit. Provide all related appurtenances, including but not limited to piping, wiring, attachments, foundations, anchors, supports, and all related accessories to provide complete operational electric operator systems.

1.02 REFERENCES

A. Reference Standards:
   1. ASTM International (ASTM):
      a. ASTM F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
      b. ASTM F594 - Standard Specification for Stainless Steel Nuts.
   2. American Water Works Association (AWWA):
      a. AWWA C 540 - Power Actuating Devices for Valves and Sluice Gates.
   3. National Electrical Manufacturers Association (NEMA):
      a. NEMA ICS 6 - Industrial Control and Systems Enclosures.
      b. NEMA MG 1 - Standard for Motors and Generators.
   4. Society for Protective Coatings (SSPC):
      a. SSPC SP 10 (2007) - Near-White Blast Cleaning.

1.03 SUBMITTALS

A. The following shall be submitted in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-02 Shop Drawings:
      a. Shop drawings shall include descriptive literature, bulletins and/or catalogs of the equipment as well as a complete bill of materials. Include the weights of all components. Provide complete data on the electric operator, and provide actuator wiring diagrams showing all switches, disconnects, wires, contacts, lights, buttons, terminals, devices, etc. Include a description of the operating features of the actuator, connections to remote and field mounted equipment and logic diagrams. The Drawings shall specifically outline all required clearances for maintenance and manual hand wheel operation.
   2. SD-03 Product Data:
      a. The actuator and gate Manufacturers shall submit data including details of construction, extent of shop assembly of the units and a detailed description of the installation procedures. The Manufacturers shall submit standard drawings or catalog cuts of the assembled gate and actuator. Specifically indicate any required clearance dimensions for maintenance and operation.
      b. The type, thickness, application procedure, and test for coatings, and non-metallic and metallic linings shall also be included. Provide wiring and control diagrams for

the electric actuators. Specifically include all "dry contacts" provided as well as the Electrical Hazard Area Classification of the units.

3. SD-05 Test Reports:
    a. Manufacturer’s Field Reports:
        1) Field reports shall include all requirements of Division 01 General Requirements including but not limited to written certification of proper installation, initial adjustments and satisfactory operations, dated and signed by a Manufacturer's representative.
4. SD-07 Closeout Submittals:
    a. Operation & Maintenance Data:
        1) Submit operation and maintenance data for each actuator assembly in accordance with Division 01 General Requirements. In addition to the requirements of Division 01, the manuals shall include but is not limited to the following.
        2) Complete information on operation, installation, lubrication, adjustment, safety precautions, routine and special maintenance disassembly, repair, reassembly, and trouble diagnostics of each actuator. The manuals shall contain attached copies of the factory and field test reports as well as a description of the unit and its component parts.
        3) Operation and Maintenance Data shall include all required cuts, drawings, equipment lists, descriptions, etc., which are required to instruct operation and maintenance personnel unfamiliar with such equipment.

1.04 QUALIFICATIONS OF MANUFACTURER

A. Materials and equipment shall be the standard products of a Manufacturer regularly engaged in the production of such products and shall essentially duplicate items that have been in satisfactory use in identical applications in other wastewater treatment facilities.

B. Equipment shall be supported by a service organization that is, in the opinion of the Engineer, reasonably convenient to the site to ensure parts and service can be acquired in a timely fashion.

1.05 QUALITY CONTROL

A. The gate and electric actuator shall be assembled at the factory by the Actuator Manufacturer. All mounting hardware used for attaching the actuator to the gate shall be designed according to the top-works dimensions for the specific gate type to be supplied by the chosen gate Manufacturer. The gate/actuator combination shall be shipped from the Actuator Manufacturer pre-assembled. Field mounting of the actuator to the gate shall not be acceptable under any circumstances.

B. Electric operators for gates may be field mounted and calibrated by an authorized representative of the actuator manufacturer. Provide the services of the actuator manufacturer for field mounting, calibration, startup, and testing of all field mounted gate operators.

1.06 DELIVERY, STORAGE AND HANDLING

A. Surfaces such as female threads, internal mechanical joint ends or flange faces shall be protected from damage during shipment. Inspect the materials delivered to the site for damage. The gates shall be stored with a minimum of handling. The materials shall be stored on site in enclosures or under protective coverings. Rubber gaskets shall be stored under cover out of direct sunlight. Materials shall not be stored directly on the ground. The inside of gates and fittings shall be kept free of dirt and debris.

B. Materials delivered and placed in storage shall be stored with protection from the weather, excessive humidity variation, excessive temperature variation, dirt, dust and/or other contaminants. Proper protection and care of material before, during and after installation shall be the Construction Management General Contractor's (CMGC) responsibility. Any material found to be damaged shall be replaced at the CMGC's expense. Materials shall be stored with protection from puncture, dirt, grease, moisture, mechanical abrasions, excessive heat, ultraviolet (UV) radiation, or other damage. Gate and actuator assemblies shall be handled and stored in accordance with the Manufacturer's recommendations.

1.07 WARRANTY

A. The Manufacturer shall provide a full and comprehensive warranty for the electric operator assemblies as well as all other related equipment specified in this section. The equipment shall be warranted to be free from defects in workmanship, design, and materials for a period of not less than one (1) year. If any parts of the equipment supplied under this section should fail during the Manufacturer's warranty period, replacement of parts or the unit itself shall be provided. The units shall be restored to active working service at no expense to Atlantic Richfield Company of the equipment. The Manufacturer shall incur all costs including but not limited to parts, labor, service, technicians, shipping, and handling required for restoration of equipment to active service as required under the Manufacturer's warranty. The Manufacturer's warranty shall commence at the date of substantial completion or partial utilization.

1.08 SPECIAL TOOLS

A. Provide one set of all special tools required to completely assemble, disassemble, or maintain the actuated gate assemblies. Special tools shall refer to oversized or specially dimensioned tools, special attachments or fixtures, or any similar items required for maintenance and/or operation of the specified equipment.

PART 2 - PRODUCTS

2.01 GENERAL

A. Electric actuators shall be capable of fully opening and closing all gates under maximum hydraulic head and shall conform to the requirements of AWWA C 540 standards. Quarter-turn actuators shall be self-locking under normal operating conditions in order to hold the gate in an intermediate position. All actuators shall be designed for indoor or outdoor service as specified within a temperature range of -20 to +175 degrees Fahrenheit.

B. Actuators shall be capable of mounting in any position. At a minimum, all actuators shall include but are not limited to a motor, power gearing, travel limit switches, torque limit switches, manual hand wheel operator, terminals for motor power and controls and a separable worm gear operator. An adjustable stop shall be provided to set closing torque and to provide adjustment to compensate for change in pressure differential or flow direction change.

C. Each electric actuator shall be factory wired with all major components including but not limited to; motors, reversing motor starters, control power transformers, pilot devices (push buttons, selector switches, position lights), torque switches, position limit switches, status lights, position contacts, status contacts, thermostatically controlled space heaters (if specified), and terminals.

2.02 UNIT DESCRIPTIONS

A. Provide the following electric operators as part of the Work as indicated in the Slide Gate Schedule.

2.03 PROCESS DESIGN CONDITIONS

A. All electric operators shall be sized to accommodate the respective gate torque requirements. The actuator and gate Manufacturer shall coordinate to ensure that the actuator torque capacity requirements meet and exceed each respective gate.

B. Remote pushbutton station shall be remotely located within the Maintenance Building.

2.04 OPERATING SPEED

A. Unless otherwise specified all electric actuators shall utilize worm gear or helical gearing for all size gates. Operating speeds for actuators shall be selected to fully open or fully close the gate within 20 seconds.

2.05 ACTUATOR ENCLOSURES

A. At a minimum, all operator enclosures shall be of a watertight design in accordance with NEMA 4X standards. Provide explosion proof and other service duty enclosures for operators as previously specified. All covers and entries shall be provided with watertight seals. The terminal compartment and limit switch compartment covers shall be fastened to the gear housing by 316 stainless steel bolts which are "captured" to prevent loss when the covers are removed.

B. The gear housing and all load-bearing enclosures shall be constructed of epoxy coated cast iron. Non-load bearing enclosures and covers shall be constructed of aluminum, cast iron or steel. All housings shall be designed, manufactured, and inspected to guarantee against the ingress of moisture.

C. Actuator enclosures rated NEMA 7 shall be designed for use and U.L. listed for a Class 1, Division 1, Groups C&D, "Explosion Proof", Environment. Refer to the "Electrical Hazard Area Classifications" in the Contract Documents for specific electrical hazard requirements of various areas/locations for each operator. Enclosures in "Unclassified Spaces" which are "Dry" shall be rated NEMA 4. Enclosures in "Corrosive" or "Wet" spaces shall be rated NEMA 4X. Provide enclosure ratings for each operator as previously specified.

2.06 ELECTRICAL REQUIREMENTS

A. Electrical operators provided as part of this Section, shall comply with the provisions of the Contract Documents. Unless otherwise specified or indicated on the Drawings, all operators shall be suitable for a 460 volt, 3 phase, 60 hertz power supply.

2.07 GEARING

A. Motor speed reduction shall be by means of a gear train consisting of hardened steel spur gears and a self-locking worm and worm gear set. The worm shall be heat treated alloy steel or bronze and have a worm thread surface which is rolled or ground. Non-metallic gears in the power train shall not be acceptable. Operating time/output RPM changes shall easily be accomplished by spur gear set changes without having to change motor RPM.

B. All power gearing shall be constructed of hardened steel or bronze and shall be permanently lubricated with grease. The drive nut shall be separable from the gear

assembly to facilitate mounting of the actuator onto the gate. The drive nut shall also be splined to allow actuator mounting on the valve at ninety-degree intervals so that the gate/actuator combination may be positioned in order to minimize interference with any adjacent equipment.

C. All limit switch gearing and feedback potentiometer reduction gearing shall be made of steel or bronze and shall be adequately lubricated. All rotating shafts shall be supported by anti-friction bearings.

2.08 MOTOR

A. The drive motor shall be designed for actuator service and shall be characterized by high starting torque, low stall torque and low inertia. The motor shall be capable of starting against its rated load in either open or closed direction when voltage to the motor terminals is +/- 10% of the nominal voltage rating.

B. The motor shall be induction type with Class F (Tropicalized) insulation. Class B thermal switches shall be imbedded 120 electrical degrees apart in the motor windings to ensure safe shut-down should there be excess current draw, resulting in high winding temperatures above a Class B temperature rise.

C. The motor housing shall be totally enclosed and non-ventilated. The enclosure housing shall be provided with cooling fins for dissipation of heat. All motor housings shall be constructed of aluminum or cast iron.

D. The motor shall be capable of operation in any position. All motors shall be properly sealed from the grease-filled lubrication gear case. The motor shall be designed such that its removal will not result in loss of lubricant. All motors shall be provided with plug and socket electrical connections to facilitate removal and replacement.

E. Motor replacement shall not require recalibration of the actuator's torque output and shall not require the use of computers. Motors shall be field replaceable as a complete assembly, (motor housing, bearings, rotor, stator and end bells/flanged mounting adapter).

2.09 HAND WHEEL

A. All actuators shall be provided with a hand wheel or hand crank located in a 90-degree plane from the actuator output drive, with a maximum rim pull requirement of 40 pounds for gate travel loads. An external manual declutch lever shall be included to place the actuator in the manual mode. The lever shall not require more than a 10-pound force to engage even when the gate has been tightly seated. The hand wheel drive shall permit manual operation in a reasonable time, related to gate size. The motor shall be unable to operate when the hand wheel is operating.

B. The lever shall be pad-lockable in either the "manual hand wheel" or "automatic motorized" operational modes. Operation via the motor shall not cause the hand wheel to rotate, and operation of the hand wheel shall not cause the motor to rotate.

C. All hand wheels shall operate in the "Counter-clockwise" direction "Left" to OPEN. Engagement of the hand wheel gearing shall not disconnect the electric actuator self-locking worm gearing from the driven load. This shall be provided as a safety feature, independent of the gate stem/nut static friction, to prevent movement of the driven load. An inoperable motor shall not prevent manual operation of the assembly under any circumstances.

2.10 LIMIT SWITCHES

A. Travel limit switches shall be provided to de-energize the motor control circuit when the actuator reaches the limit of travel in either the "Open" or "Closed" directions. Limit switches shall be geared to the drive mechanism and in step with actual gate position at all times, whether operation is by power or manual mode.

B. Switches shall be activated by a rotor type design. Contacts shall be silver and have a rating to carry out the full control current. A minimum of three (3) "Normally Open" (N.O.) and three (3) N.C. contacts shall be provided for each direction of travel. The limit switch gear mechanism shall be enclosed to prevent entrance of foreign matter or wire entanglement.

C. All contacts shall be completely sealed in an enclosure conforming to the "Electrical Hazard Area Classifications" as previously specified to prohibit electrical shock while adjustments are being made, eliminate short circuits and to ensure against fouling by contaminants. Limit switches shall be fully and safely adjustable while power is supplied to the actuator. Switches shall be capable of limit adjustment with no more than five (5) full turns of the limit switch adjustment spindle.

D. All switches shall be single pole, double throw, at either limit of "Open", "Closed" or both limits. All switches shall be enclosed in a NEMA 4X enclosure for "Corrosive, Outdoor or Wet Spaces" and a NEMA 4 enclosure for "Unclassified Dry Spaces". All contacts for use in NEMA 4X and NEMA 4 enclosures shall be rated for 10 Amps at 120 VAC. Provide NEMA 7 switch enclosures, UL listed for a Class 1, Division 1, Groups C&D, "Explosion Proof" environments as indicated. Refer to the "Electrical Hazard Area Classifications" as previously specified for the requirements of each actuator.

2.11 TORQUE SWITCHES

A. Torque limit switches shall be provided to de-energize the motor control circuit should the gate encounter an obstruction during travel. Each actuator shall have an open and closed direction torque limit switch. The torque switches shall be mechanically operated and shall be adjustable in units of torque. All torque limit switches shall be adequately rated to carry the control current. All electrical contacts for torque switches shall be completely sealed.

2.12 POSITION INDICATION

A. For multi-turn gate actuators, a dial window indicator shall be located on the limit switch compartment cover.

B. The indicator shall be labeled 0 to 100% open. The actuator position indication shall continuously show the position of the gate. The position indication shall operate when the actuator is in either "Automatic" (Electrically Operated) or "Manual" (Hand Operated) modes.

2.13 ELECTRICAL CONTROLS

A. At a minimum, each actuator shall be furnished with separate power and control terminal strips. All switches shall be housed in a control compartment meeting the "Electrical Hazard Area Classifications" previously indicated. The enclosure shall have a bonded O-ring seal and a hinged cover. Cover bolting shall be through captive 316 stainless steel hex head screws.

B. All built-in controls shall be through an integrated modular package which shall be completely wired. All built-in controls shall be easily removable or replaceable, as a

complete package, by removal of four (4) captive screws. Motor leads and power supply leads shall be terminated to strips located on the control package. Power supply terminals (5 points minimum) and control supply terminals (48 points minimum) shall be physically isolated from each other to protect against transient voltages. The terminal strips shall be completely shrouded with a high impact resistant plastic cover to avoid accidental terminal contact.

C. All terminal screws shall be nickel plated and pre-inserted. The controls shall include a snubber circuit to provide control voltage protection for switches and electronics for voltage surges. All electrical components of the package, such as reversing contactors, transformers, etc., shall be unidirectional plug connected to provide easy removal and replacement without concerns for proper wiring connections. All optional control requirements such as modulating control, 2-wire control, interposing relays, etc. shall be through plug-in printed circuit type boards having gold plated contact connectors.

D. Each actuator shall include an integral (built-in) reversing contactor. Control voltage shall be 120 volt, single phase, 60 hertz. "Normally Open" (N.O.) seal-in contacts for momentary contact pushbutton control and "Normally Closed" (N.C.) contacts for electrical interlocks shall be supplied. The contactor shall be both electrically and mechanically interlocked. The contactor shall be completely wired as an assembly and plug connected to the control package.

E. The actuator shall include an integral control power transformer providing 120 VAC. The control power transformer shall be epoxy impregnated and encapsulated to prevent moisture incursion. The control power transformer shall be completely wired as an assembly with plug connections. The control power transformer shall be dual fused and shall include both primary and secondary fuse protection. Fuses shall easily be accessed and replaced without having to remove components or assemblies other than removal of a terminal strip cover.

F. All electrical terminals shall be housed in a compartment that is isolated from the limit/torque switch compartment. All control and motor power terminations shall be plug and socket type so that removal of the terminal compartment cover simultaneously disconnects all wiring from the actuator.

2.14 PUSHBUTTONS

A. Each actuator shall be supplied with "Open-Stop-Close" integrally or remotely mounted pushbuttons as previously indicated. Pushbuttons shall be double O-ring sealed and include a protective silicone boot. Seal material shall be resistant to ozone and ultraviolet light. The design shall permit operation of the buttons when the electrical enclosure cover is open.

2.15 INDICATING LIGHTS

A. The actuator shall include long life high intensity LED type pilot lights to indicate "Open" and "Closed" gate positions as follows:
   1. Green shall indicate gate "Open".
   2. Red shall indicate gate "Closed".

B. Coordinate the color indication for open/closed positions with the Engineer and Atlantic Richfield Company prior to ordering. Provide a white "Power-on" light and amber "Torque Overload" (fault) indication lights.

2.16 SELECTOR SWITCHES

A. The actuators shall include a "Local" 3-position selector switch, for local-off-remote (LOR) (auto) control. The selector switch shall be pad-lockable in any position. The actuator shall be provided with a "Normally Open" (N.O.) dry contact for remote indication that the Local-Off-Remote is in the "Remote", "Local" or "Off" positions.

2.17 OPEN/CLOSE SERVICE CONTROLS

A. Electric operators arranged for "Open-Close" operation shall open and close the gate between the limit switch settings in response to local operation of an Open-Stop-Close pushbutton station furnished and mounted as an integral part of the control system or from a remote signal. The controls shall consist of a circuit breaker and reversing starter.

2.18 REMOTE PUSHBUTTON STATIONS

A. If previously specified or under conditions where actuators are mounted below the finished, below the finished floor, below tank covers or six (6) feet or greater above the finished floor; provide remote pushbutton stations in separate enclosures for mounting at easily accessible locations. Pushbutton station enclosures shall be Type 316 stainless steel or aluminum. Control circuits shall be 120 volts, single phase, 60 hertz, supplied by a control power transformer. All remote pushbutton stations shall be manufactured to NEMA ICS 6 standards.

B. Pushbutton station enclosures shall be rated in accordance with the "Electrical Hazard Area Classifications" previously indicated for each actuator. Pushbutton station enclosures shall be NEMA 7, and be UL listed for Class 1, Division 1, Group C&D, "Explosion Proof" environments where indicated. All other enclosures shall be NEMA 4 for "Unclassified Dry Spaces" and NEMA 4X for "Corrosive Wet Spaces". At a minimum all pushbutton stations shall include but are not limited to indicating lights for "Open" (Green), "Closed" (Red), "Power-On" (White) and "Overload" (Orange). Confirm the lighting color coding with the Engineer prior to ordering the actuators.

2.19 ENCLOSURE HEATER

A. If previously specified or indicated on the Drawings, the actuator shall be provided with a heater. The heater shall be installed in the limit switch compartment to prevent water vapor condensation and/or freezing in outdoor applications. The heater shall not require a separate power source feed. The heater shall include provisions to allow for it to be "Turned Off" manually.

2.20 HARDWARE

A. All Bolts, nuts, anchors, washers, appurtenances and related fastening hardware shall be type 316 stainless steel. All stainless-steel components shall be electro-polished or pacified to obtain maximum corrosion resistance. All necessary hardware, attachments, and related appurtenances for installation of all equipment shall be provided. All stainless-steel bolts shall comply with ASTM F 593 standards. Stainless steel nuts shall comply with ASTM F 594 standards.

2.21 FINISHING

A. All external ferrous metallic surfaces of the equipment shall be provided with two-part or fusion bonded epoxy coating. The coating shall be resistant to sewage, high humidity, hydrogen sulfide, and other chemicals normally found in wastewater. Stainless steel, brass, bronze, brass, aluminum, FRP and plastic components shall not be painted.

B. Before exposure to weather and prior to shop painting all ferrous metallic surfaces including but not limited to motors, etc. shall be thoroughly cleaned, dry and free from all mill-scale, rust, grease, dirt and other foreign matter. All items not manufactured from corrosion resistant materials, or otherwise protected shall be blast cleaned to SSPC SP 10 standards prior to painting. All nameplates shall be properly protected during painting.

2.22 NAMEPLATES

A. Each major item of equipment shall have the Manufacturer's name, address, type or style, model or serial number, catalog number, rated capacity, speed, and all other pertinent data on a plate secured to the item of equipment per Section 40 00 00 – Basic Process Materials and Methods. The nameplate for each electric actuator shall show at least the minimum information required by NEMA MG 1 standards.

2.23 GATES

A. All gates shall be in accordance with Section 40 05 59 – Hydraulic Gates as well as the Gate Schedule on the Drawings. All gates (Electrically Operated and/or Manual) of the same type, style, and duty shall be supplied by a single Manufacturer. The CMGC and electric actuator Manufacturer shall coordinate to ensure the gate portion of the actuated gate assembly is uniform throughout the entire project. The use of a different gate Manufacturer for "Manual Gates" and "Electrically Operated Gates" shall not be acceptable.

B. The electric actuator Manufacturer shall provide all necessary mounting assemblies for attachment to the gate; including but not limited to all brackets, mounting legs, plates, etc. to provide a complete an operational assembly.

C. The gate Manufacturer shall provide the actuator Manufacturer with the appropriate torque requirements for gate operation. It shall be the responsibility of the equipment Manufacturers (Gate and Actuator) to ensure the actuator is appropriately sized for the torque requirements and operational speeds specified.

2.24 SPARE PARTS

A. The Manufacturer shall supply one (1) complete sets of spare parts. At minimum, a set of spare parts shall include the following:
   1. One (1) set of bearings.
   2. One (1) set of all O-rings and seals.

B. All spare parts shall be individually boxed with the project name and part number clearly identified on each individual box. All spare parts shall be shipped in a separate crate with appropriate labeling. Spare parts shall be stored indoors in a temperature-controlled environment.

2.25 OILS AND LUBRICANTS

A. The Manufacturer shall state in the operating manual the amount of and specification for any lubricants. All lubricants for the equipment shall be non-proprietary and easily obtainable from a local source for operations staff convenience. Designs which utilize proprietary and/or special lubricants shall not be acceptable.

2.26 DESIGN BASIS MANUFACTURER

A. All electric operators of the same type, style, and duty shall be supplied by a single Manufacturer. All electric operators shall be a product of the following Manufacturer:
   1. Rotork Controls, Inc.

2. Limitorque, Inc.
3. Engineer approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Each operator shall be installed in accordance with the written instructions of the Manufacturer and under the direct supervision of the Manufacturer's representative. Correct installation and assembly of the operators and ancillary equipment shall be the CMGC's responsibility. Install all electric operators and appurtenances in accordance with the Drawings and the Manufacturers' installation instruction manual.

B. All appurtenances required for a complete system shall be provided, including but not limited to such items as piping, conduit, wall sleeves, wall pipes, concrete foundations, anchors, grouting, drivers, power supply, and controls.

C. Provide the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the Manufacturer's recommendations.

D. Install the operators with stems pointed up, in a vertical position where possible, but in no case with stems pointed downward of the horizontal plane. Allow sufficient room operators for maintenance, removal, and proper operation.

3.02 FIELD TESTING

A. The electric operator system startup and demonstration period shall include the provisions of Division 01 and shall also include but is not limited to that which is specified herein.

B. Prior to acceptance, an operational test of all operators and control systems shall be performed to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that the equipment is not electrically, mechanically, structurally, or otherwise defective; is in safe and satisfactory operating condition; and conforms to the specified operating characteristics. Prior to applying electrical power to any motor driven equipment, the drive train shall be rotated by hand to demonstrate free operation of all mechanical parts. Tests shall include but are not limited to checks for excessive vibration, leaks in all piping and seals, correct operation of control systems and equipment, proper alignment, excessive noise levels, and power consumption.

C. A gate seating test shall be performed. Test and examine all gates visually for leaks and for proper operation under pressure while completing adjacent tests.

D. An actuation test shall be performed. Time the actuation and record the time. If time from fully closed to fully open is greater than the operational time previously specified, then the installation shall not be acceptable.

E. Where applicable the operators shall be tested in hand mode by opening and closing the operator manually. Where applicable the automatic throttling operation shall be checked.

F. Provide all the requirements to conduct proper field tests which include but are not limited to: power, water, facilities, labor, materials, supplies and test instruments.

G. In the presence of a Manufacturer's representative, test and inspect "all" necessary controls which include but are not limited to: hard wired interlocks required for the operators to function properly without causing damage to the equipment. The Manufacturer's representative shall provide the CMGC and Engineer with the necessary set points "In

Writing" prior to the site acceptance test visit as outlined in the submittals. The operator Manufacturer shall certify "In Writing" that the operator and control assemblies have been properly installed and are functioning correctly.

3.03 RETESTING

A. If any deficiencies are revealed during any test, such deficiencies shall be corrected and the tests shall be re-conducted without malfunction, at no additional cost to Atlantic Richfield Company or the Engineer.

3.04 MANUFACTURER'S SERVICES

A. Services of a Manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified shall be provided. The on-site man days listed below are exclusive of travel time and do not relieve the obligation to provide sufficient service to place the equipment into satisfactory operation.

B. The service technician shall supervise the installation, adjustment, and testing of the equipment. The Manufacturer's service technician shall be present for a period of not less than two (2) days, to inspect the installed equipment, supervise the initial test run, and to provide instruction to the plant personnel.

C. The Manufacturer's representative shall provide a certification of proper installation and satisfactory operation to the Engineer. Certification shall be signed and dated by the Manufacturer's representative.

3.05 FIELD TRAINING

A. A field training course shall be provided for designated operating and maintenance staff members. Training shall be provided in conjunction with the visit from the manufacturer's representative. The visit shall start after the systems are functionally complete but prior to final acceptance tests. Field training shall cover all the items contained in the operating and maintenance manuals, including normal operations, troubleshooting, maintenance, lubrication, and other related work.

END OF SECTION

SECTION 41 22 13
PORTABLE DAVIT CRANE ASSEMBLIES

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Provide portable davit crane assemblies for lifting and removal of submersible process equipment from tanks, wet wells, and other locations as shown on the Drawings and as specified herein. Provide all related appurtenances, including but not limited to foundations, anchors, supports, bases, and all related accessories to provide complete operational davit crane systems as specified herein and as shown on the Drawings. All appurtenances, accessory equipment, and auxiliaries for complete lifting systems shall be provided.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Unless otherwise noted, the most recent version of the listed publications, including revisions, at time of Bid opening shall apply.

B. ASTM International (ASTM):
   1. ASTM F 593 - Stainless Steel Bolts, Hex Cap Screws, and Studs.
   2. ASTM F 594 - Standard Specification for Stainless Steel Nuts.

1.03 SUBMITTALS

A. The following shall be submitted in accordance with Section 01 33 00 – Submittal Procedures. All submittals shall have pertinent numerical data and information specified in the "English" language using "English" units. The submittals shall include but are not limited to the following:
   1. SD-02 Shop Drawings:
      a. Provide certified shop and erection Drawings showing all important and pertinent details of construction, erection, and assembly. The drawings shall provide anchor bolt locations and crane base assembly dimensions. Drawings shall specifically outline crane capacities, arm extension angles, hook heights, winches, finishing, lifting cable, hardware, etc.
      b. Provide sufficient product data to verify compliance with the specifications and to illustrate the construction and assembly of the products. Include compliance of materials and components with applicable CEAM, ASTM, AGMA and other standards. List the manufacture, model and weights of major components. Include catalog cuts, illustrations, schedules, diagrams, performance charts, instructions and brochures illustrating size, physical appearance and other characteristics of materials, systems or equipment.
   2. SD-03 Product Data:
      a. Clearly show all details, parts, and adequately describe parts or have proper identification marks. Product data shall include descriptive literature, bulletins, and/or catalog cut sheets for the equipment. Provide a complete list of materials for the equipment. Provide a complete description of the surface preparation and shop painting/finishing.
      b. Provide a tabulated crane submittal list for review by the Engineer. The list shall allow for review of the proposed crane assemblies to be used for each respective

piece of process equipment. At a minimum the tabulated list shall include but is not limited to the following information/data:
1) Submersible equipment to be lifted.
2) Tag number.
3) Location.
4) Total maximum weight (including motor, slide bracket, shelf, etc.). Provide the total weights of the "submitted" submersible equipment.
5) Submitted crane.
6) Crane capacity.
7) Crane rating as a percentage of weight lifted.

3. SD-06 Certificates:
   a. The Manufacturer shall provide a certificate of compliance stating the equipment meets or exceeds OSHA Standards. The Manufacturer shall also provide statements signed by responsible officials of the equipment stating the that the product, system or material meets the specification requirements. The statements shall be dated after award of project contract and clearly name the project.
4. SD-07 Closeout Submittals:
   a. Manufacturer's operation and maintenance instructions.

1.04 QUALIFICATIONS OF MANUFACTURER

A. Materials and equipment shall be the standard products of a Manufacturer regularly engaged in the production of such products and shall essentially duplicate items that have been in satisfactory use in identical applications in other wastewater treatment facilities. The Manufacturer shall have a minimum of five (5) years of documented experience in the design and production of portable davit crane equipment of all types, and not less than five (5) years of experience in the production of equal or larger sized models of the exact equipment as specified herein.

B. The equipment supplier shall provide a list of at least twenty (20) similar installations, including contact names and phone numbers. All equipment shall be supported by a service organization that is, in the opinion of the Engineer, reasonably convenient to the site to ensure parts and service can be acquired in a timely fashion.

1.05 DELIVERY, STORAGE AND HANDLING

A. Save all boxes and crates that the crane(s) are shipped in for future re-packaging as required by Atlantic Richfield Company. Store all parts in enclosures or under covers in a cool clean place away from corrosive chemicals and moisture. Inspect the materials delivered to the site for damage. Do not store materials directly on the ground. Any material found to be damaged shall be replaced at the Construction Management General Contractor's (CMGC) expense.

1.06 WARRANTY

A. The manufacturer shall provide a full & comprehensive warranty for all equipment specified in this section. The equipment shall be warrantied to be free from defects in workmanship, design, and materials for a period of two (2) years. If any parts of the equipment supplied under this section should fail during the Manufacturer's warranty period, replacement of parts or the unit itself shall be provided. The units shall be restored to active working service at no expense to the Owner of the equipment. The Manufacturer shall incur all costs including but not limited to parts, labor, service, technicians, shipping, and handling required for restoration of equipment to active service as required under the Manufacturer's warranty.

1.07 SPECIAL TOOLS

A. Provide one (1) set of all special tools required to completely assemble, disassemble, or maintain the equipment. Special tools shall refer to oversized or specially dimensioned tools, special attachments or fixtures, or any similar items. One (1) set of special tools shall be provided for each size of equipment or related system.

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide complete portable davit crane assemblies for removal of submersible process equipment from tanks and wells as shown on the Drawings. The portable davit crane assemblies shall be complete and include but are not limited to a winch with operating handle, screw-jack, base assembly, rotatable support mast, lifting cable, adjustable boom arm, and lifting hook.

2.02 UNIT DESCRIPTIONS

A. Provide davit crane(s) ("DC") which shall be used for lifting equipment. Position the crane base ("CB") such that the crane lift hook can be positioned above the respective equipment for removal. Ensure the submitted crane has a sufficient hook height to allow complete removal of each piece of equipment from the tanks, well or hatch. Provide the following davit cranes and crane bases:

Tag #	Capacity	Location	Lifted Equipment
DC-100	¼ Ton (500 lbs)	Portable	Equipment located in Recirculation Vaults, Forebay, Pond 1, 2, and 4
DC-300	1 Ton (2000 lbs)	Maintenance Building Upper Level	Recirculation Pumps No. 1 and 2

Tag #	Type	Location	Lifted Equipment
CB-1	Pedestal	Portable	Equipment located in Recirculation Vaults, Forebay, Pond 1, 2, and 4
CB-2	Socket (wall mount)	Maintenance Building Upper Level	Recirculation Pumps No. 1 and 2

B. Provide cables, lift hooks, swaged ball fittings and all related appurtenances for each piece of equipment to be lifted. The lift hooks, cables and related appurtenances will remain permanently affixed to each submersible piece of equipment as shown on the drawings. The lift cable will be coiled and attached to a hook inside the wet well, under the tank covers or under hatches as shown on the Drawings.

C. Provide crane base height extension for each crane as needed to accommodate the piece of equipment to be lifted.

2.03 CRANE DESIGN

A. The crane assemblies shall be designed with an adjustable boom arm capable of telescoping "horizontally" to a minimum of four (4) different lengths. The boom arm shall be capable of adjustment in height while under load with a ratchet style screw-jack. The boom arm shall be adjustable between an angle parallel to the ground (90 degrees with respect to the mast), with vertical adjustment upward approximately 45 degrees from the

aforementioned horizontal position. The boom arm shall be lockable at any position between the fully vertical and fully horizontal positions.

B. Each crane shall be capable of complete 360-degree rotation on a pin and sleeve bearing in the base assembly. Each crane shall be provided with a handle on the boom to facilitate rotation.

C. Each crane shall be specifically designed to be disassembled for storage and transport. The weight of a single piece of the crane assembly shall not exceed 85 pounds. The total weight of the assembled crane shall not exceed 260 pounds.

2.04 LIFTING CAPACITY

A. Each crane shall be designed for a "Minimum" rated capacity of at least 115% of the total weight of the respective equipment to be lifted. Provide a list of capacity rating percentages of weight lifted for each respective crane and piece of equipment as previously outlined in the submittals. Specifically take into account the reductions in overall crane capacities with the corresponding extension and vertical angle of the boom arm as required for base positioning.

2.05 WINCH

A. The crane assembly shall be provided with a 304 stainless steel spur gear hand winch. The winch assembly shall be provided with a brake for load control. The winch assembly shall not exceed 30 pounds. The winch assembly shall be provided with a quick disconnect anchor for quickly attaching or removing wire rope equipped with a swaged ball fitting.

2.06 FINISH

A. The entire crane assembly shall be entirely constructed from 304 stainless steel with an electro-polished finish for superior corrosion resistance.

2.07 BASE ASSEMBLY

A. Unless otherwise specified or indicated on the Drawings, each crane shall be supplied with a pedestal base (upright mount) assembly as shown on the Drawings. Each base assembly shall be constructed of 304L stainless steel. Each base assembly shall be supplied with a plastic base cover and weep hole to allow for water drainage. The cover shall prevent water from collecting in the base mast hole when the crane is removed. The base assembly shall be installed in accordance with the Manufacturer's recommendations.

B. The base assembly shall be designed to support the maximum mast moment and axial force in tension which is distributed from the crane to the base assembly when operating the crane boom arm at the maximum horizontal extension and highest vertical angle.

2.08 LIFTING CABLE

A. Each crane shall be supplied with 304 stainless steel wire rope with a 304 stainless steel eye hook and swaged ball fitting to work with the quick disconnect anchor on the winch. Provide cable length with adequate slack to lower the equipment to the bottom of the tank/vessel as well as completely remove the equipment in its entirety from the tank/vessel for servicing. The lifting cable shall be rated for at least 150% of the total load to be lifted. Provide cables, lift hooks, swaged ball fittings and all related appurtenances for each piece of equipment to be lifted.

B. Provide a 304 stainless steel wire rope keeper for each piece of submersible equipment to be lifted. Field verify the final installed location of the wire rope keeper with the Engineer and Atlantic Richfield Company prior to installation. The wire rope keeper shall be designed to secure the free end of the lifting cable when it is detached from the crane.

2.09 HARDWARE

A. Each davit crane base assembly shall be attached to the concrete base via coarse thread fasteners, grade 5 or better. Torque for Grade 5 fasteners without lubrication shall be 150 ft-lbs. Sizing of fasteners shall be in accordance with the manufacturer's recommendations. All fastening devices including but not limited to bolts, nuts, and washers shall be 316 stainless steel. Take care not to over tighten fasteners. Over tightening may strip threads or cause damage to other parts of the crane assembly.

B. All Bolts, nuts, anchors, washers, appurtenances and related fastening hardware shall be type 316 stainless steel. All stainless steel components shall be electro-polished or pacified to obtain maximum corrosion resistance. All necessary hardware, attachments, and related appurtenances for installation of all equipment shall be provided. All stainless steel bolts shall comply with ASTM F 593 standards. Stainless steel nuts shall comply with ASTM F 594 standards.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install the portable davit crane assemblies in strict accordance with the Manufacturer's recommendations as well as the Contract Documents. Position the crane so the operator can stand clear of the load, and out of the path of a broken wire rope that could snap back and potentially cause injury. Attach the crane base assembly to rigid and level foundations as shown on the Drawings. Installation of the base on an uneven surface shall not be acceptable and may cause the boom to rotate in the direction the mast is leaning. The base surface shall be level to at least (+/-) 1/16 of an inch. The foundation shall be designed to support the crane and its load under all load conditions, including shock loading. Field verify the final location of all base/crane assemblies with the Engineer and Atlantic Richfield Company prior to installation. Provide a non-shrink grout leveling pad under each crane base.

3.02 TESTING

A. Conduct field testing of each portable davit crane assembly in the presence of the Engineer and Atlantic Richfield Company. Provide all labor and weights for testing of the portable davit crane assemblies. Demonstrate the portable davit crane assembly is capable of completely removing each piece of equipment in its entirety from the tank/vessel to the satisfaction of Atlantic Richfield Company and Engineer.

3.03 RETESTING

A. If the specified equipment fails to meet the specified testing requirements, the equipment shall be modified and retested. If the equipment remains unable to meet the test requirements to the satisfaction of the Engineer or Atlantic Richfield Company, it shall be removed and replaced with new equipment at no additional cost to Atlantic Richfield Company or Engineer.

END OF SECTION

SECTION 43 21 40
SUBMERSIBLE SOLIDS HANDLING PUMPS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide wet pit and dry-pit submersible solids handling pumps in accordance with this Section, Drawings, Pump Schedule, and applicable reference standards listed in Article 1.02.
   2. Pump Schedule: On the Drawings.

B. Related Requirements
   1. Section 05 50 00 – Metal Fabrications.
   2. Section 09 90 00 – Painting & Coating.
   3. Section 40 00 00 – Basic Process Materials and Methods.

1.02 REFERENCES

A. Reference Standards:
   1. American National Standards Institute (ANSI):
      a. ANSI/NEMA MG1 - Motors and Generators.
   2. ASTM International (ASTM):
      a. ASTM A48 - Standard Specification for Gray Iron Castings.
      b. ASTM A532 - Standard Specification for Abrasion-Resistant Cast Irons.
   3. American Water Works Association (AWWA).
   4. Hydraulic Institute (HI):
      a. ANSI/HI 11.6 - Rotodynamic Submersible Pumps for Hydraulic Performance, Hydrostatic Pressure, Mechanical, and Electrical Acceptance Tests.
   5. Institute of Electrical and Electronic Engineers (IEEE).
   6. International Electrotechnical Commission (IEC).
   7. National Electric Code (NEC).

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures:
   1. SD-01 Preconstruction Submittals:
      a. Design Data:
         1) Design calculations for custom stands, pedestals, and anchors, stamped by an engineer in the state of Montana.
   2. SD-03 Product Data:
      a. Manufacturer's product data, including parts listing, indicating compliance with requirements.
      b. Certified dimension prints showing fabrication, assembly, and installation, including anchorage details.

c. Characteristics and performance data for each pump including guaranteed performance curves based on actual test data of duplicate units demonstrating compliance with specified requirements. Variable speed units including capacity/head curves and best efficiency point (BEP) for minimum of 5 reduced speeds between minimum to maximum speed. Plot curves capacity versus head, net positive suction head (NPSH) required, pump efficiency, brake horsepower, and motor horsepower. Show BEP and all specified operating points. Tabulate data at all operating points.
d. Weight of each major component and total weight of equipment.
e. List of manufacturer's spare parts including gaskets, bearings, and seals.
f. Motor data including performance characteristics.
g. Wiring diagrams and control schematics.
h. Manufacturer's recommended shipping, unloading, storage, installation and testing procedures.

3. SD-05 Test Reports:
   a. Source and field quality control submittals.
   b. Manufacturer Reports:
      1) Factory Test Report: Include test pump curves for supplied units following fabrication and prior to shipment, demonstrating compliance with requirements.
      2) Field Test Report: Include all requirements of Division 01 General Requirements including but not limited to written certification of proper installation, initial adjustments, and satisfactory operations, dated and signed by a Manufacturer's representative. Each test report shall indicate the final position and set points of controls.
4. SD-06 Certificates:
   a. Qualification Statements:
      1) Installation lists with contact information demonstrating compliance with qualification requirements.
5. SD-07 Closeout Submittals:
   a. Per Division 01 General Requirements.
   b. Operation & Maintenance Data:
      1) Submit operation and maintenance data in accordance with Division 01 General Requirements. In addition to the requirements of Division 01, the manual shall include but is not limited to the following:
         (a) A complete bill of materials.
         (b) Startup, normal, shut down, and emergency operating instructions.
         (c) Lubrication and maintenance instructions.
         (d) Guides to troubleshooting.
         (e) A numbered parts list and predicted life of parts subject to wear
         (f) Test data and performance curves.
         (g) Installation instructions.
         (h) Written warranty statement.
      2) Operation and Maintenance Data shall also include all required cuts, drawings, equipment lists, descriptions, etc., which are required to instruct operation and maintenance personnel unfamiliar with such equipment.

1.05 QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Equipment specified in this section shall be from a single manufacturer that has been regularly engaged in the design and manufacture of submersible solids handling pumps for a minimum of ten (10) years and not less than ten (10) years of experience in the production of pump models equal or larger than the equipment specified herein.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.07 SITE CONDITIONS

A. Existing conditions: Per Division 01 General Requirements.

B. Examine the space that the equipment will be installed into for tight clearances and notify Engineer of any conflicts prior to placing order for equipment.

1.08 WARRANTY

A. Special warranty for pump equipment: 5-year pro-rated warranty.

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide pumps, motors, and bases as a single unit from the pump manufacturer.

B. The pump Manufacturer shall be ISO 9001 revision certified, with scope of registration including design, control, and service after sales activities.

C. Engineer and manufacture pumps under a written quality control program certified to ISO 9001:2000 Quality System Standard and conform to applicable requirements of ASTM, ANSI, AWWA, and HI.

D. Design and build equipment for 24-hour continuous service at all points within the specified range of operation, without overheating, without cavitation, and without excessive vibration.

E. Furnish complete pumping units. Design and proportion parts to have liberal strength, stability, and stiffness and adapted for the service to be performed.

F. Furnish working parts of pumps and motors, such as bearings, wearing rings, shaft, and sleeves of standard dimensions built to limit gauges or formed to templates so that parts are interchangeable between like units and that Atlantic Richfield Company may obtain replacement and repair parts.

G. Do not exceed the nameplate ratings of motors. Do not allow design service factor to be reduced when the pump is operating at any point on its characteristic curve at maximum speed.

H. Noise Level of Motors: Not to exceed 85 dBA measured 3 meters from the unit under free field conditions while operating on utility power.

I. Pump Operation: Capable of normal, continuous operation when flooded in water to a depth of 65 feet or greater.

2.02 MANUFACTURERS

A. Manufacturers:
   1. Xylem Inc. (Flygt).
   2. Sulzer.
   3. Grundfos.
   4. Or equal.

2.03 PUMP SIZING AND PERFORMANCE

A. Refer to the Pump Schedule for sizing and performance details and requirements for each pump.

2.04 PUMP

A. Provide ASTM A48, class 30, 35 or 40 single piece gray cast iron volute, non-concentric design with smooth passages sized to pass any solids entering impeller. Provide minimum inlet and discharge size as specified. Provide ANSI B16.1 Class 125 flanged discharge connection.

B. Provide volute and impeller equipped with replaceable and adjustable insert or wear rings.

C. Provide 420 or 431 stainless steel grade single piece motor/pump shaft. Shaft sleeves are not acceptable. Deflection at shaft seal within allowable operating range shall not be more than 0.002-inch.

D. Provide two independent mechanical shaft seal sets not requiring maintenance or adjustment, with stationary and positively driven parts.
   1. Contacting sliding surfaces: single-piece tungsten or silicon carbide.
   2. Other parts: stainless steel. Seal springs shall not contact pumped fluid.

E. Provide Buna-N O-rings for stationary parts.

F. Provide cable entry seal to ensure watertight, submersible seal up to depth specified, consisting of threaded gland, compressible grommets, and positive stop. Glands to provide strain relief independent of sealing function.

G. Provide NEC severe service “S”, type SJTO single cable with neoprene jacket for power and instrument conductors. Length: sufficient to reach termination point as shown on Drawings.

H. Hardware: 316 stainless steel.

I. Provide leak detection sensors indicating the need for seal inspection. Leak detection must be capable of providing ample warning of seal failure prior to damage incurred by the leak to the bearings, stator, or other motor components.

2.05 IMPELLERS

A. Impellers shall statically and dynamically balanced single piece impeller. Impellers shall be keyed and held in place with a single stainless-steel bolt.

B. Impeller Materials: Provide per Pump Schedule and as defined below.
   1. Gray Cast Iron: ASTM A48 Class 30 gray cast iron.

2. White Iron: ASTM A532 (Alloy III A) 25 percent chrome cast iron.
3. Duplex SS: Cast Duplex Stainless Steel ASTM A743 CD4MCu.

C. Impeller Types: Provide based on Pump Schedule and as defined below.
1. Enclosed Channel: Closed impeller capable of passing large solids. Impeller shall have single or multi-vane construction. Wear rings provided at the inlet shall be adjustable to allow for maintaining a tight clearance to reduce axial loads and maintain efficiency.
2. Semi-Open: Open-face impeller capable of handling raw domestic wastewater with fibrous materials including wet wipes and rags. Impeller shall have one or two vane construction. Blades on the open face of the impeller shall be self-cleaning upon each rotation as they pass across a sharp relief groove in the insert ring or bottom plate and shall keep the impeller blades clear of debris.
3. Tube: Enclosed channel impeller with smooth tube-shaped interior capable of handling raw domestic wastewater with fibrous materials including wet wipes and rags. Impeller shall have single vane construction. Impeller shall have smooth geometry with no leading edges and provide free passage of solids with minimal dead zones.
4. Recessed Vortex: Low-profile, multi-vane, semi-open impeller capable of handling sand and grit. Impeller shall be recessed from the path of flow from the pump suction to pump discharge. All flow paths shall be equal to or greater than the pump suction size.
5. Chopper/Grinder: Low-profile, multi-vane, semi-open impeller with sharpened edges. A cutter ring or bar mounted on the suction end of the pump works in conjunction with the sharpened impeller to shred fibrous materials including wet wipes and rags prior to entering the volute. An optional cutting tool mounted to the impeller shaft on the exterior of the pump inlet cutter ring or bar may be used to further break down large materials prior to entering the pump inlet.

2.06 MOTORS

A. Motor Unit:
1. Provide NEMA B motor, squirrel-cage induction motor. Motor shall be submersible according to IEC 60034 and protection class IP 68. Motor shall continue to operate while permanently submerged by a water column up to 65 feet. Motors with a protection class IP 67 only capable of being submerged for a limited time are not acceptable.
2. Horsepower rating shall not be less than maximum brake horsepower requirements of pumps over entire range of pump performance curve.
3. Service Factor: 1.15 over 40 degrees C ambient.
4. Thermal overload protection with automatic reset.
5. ANSI/NEMA MG1 Part 31 continuous or intermittent, inverter-duty.
6. Windings must be suitable for operation on VFDs.
7. Provide NEMA report of test form for tests conducted according to AIEE Test Code as specified in the ANSI Standard MG1 for Motors and Generators.

B. Motor Housing:
1. Air filled, watertight design housing.
2. Class H insulation.
3. Cooling system:
a. For motors less than 15 hp: Pumps shall be cooled by surrounding process water or air and not require supplemental cooling over entire range of specified operating conditions.
b. For motors 15 hp and greater: Provide integral closed-loop cooling system for motors. Stator housing enclosed by motor cooling jacket. Impeller integral to

cooling system driven by pump shaft, providing necessary circulation of cooling liquid through jacket with 1 fill port and 1 drain port. Design system to maximize heat transfer from motor to cooling fluid and cooling fluid to pumped fluid. Provide cooling system for continuous pump operation in liquid or ambient temperatures up to 104 degrees F without operational restrictions over entire range of operating conditions. Pumps cooled by process fluid, fans, blowers or auxiliary cooling systems mounted external to pump motor are not acceptable.

C. Radial and thrust bearings shall be factory pre-lubricated for life and suitable for all conditions within the allowable operating range. Provide protection for bearings from stray electrical current damage caused by operation on VFDs for the lifespan of the bearing.
   1. For motors less than 30 hp: bearings shall have a minimum L10 lifespan of 50,000 hours over allowable operating range.
   2. For motors 30 hp and greater: bearings shall have a minimum L10 lifespan of 100,000 hours over allowable operating range.

2.07 GUIDE RAIL BASE ASSEMBLY FOR WET-PIT INSTALLATIONS

A. Install pump on a discharge elbow and guide rail system mounted permanently to the structure and connected to the pump discharge piping. The base elbow shall support the entire weight of the pump and no portion of the pump shall rest on the wet well floor. Base elbow shall be anchored and grouted to the wet well per manufacturer recommendations. The pump shall engage and disengage the discharge elbow from above without entry into the structure. When lowered the pump shall make a tight seal with the base elbow.

B. Either a single or dual guide rail system extending from the base elbow to the top of the station shall be employed for guiding the pump out of the wet well. Guide rails shall be 316 stainless steel schedule 40 with a minimum diameter of two inches. Number and frequency of the intermediate brackets shall be in accordance with Manufacturer’s recommendations.

C. Provide pumps with a cast iron slide bracket that mates to the discharge elbow. Positive sealing of the slide bracket to the base elbow shall be accomplished with a field replaceable Nitrile (Buna-N) rubber profile gasket or O-ring or metal-to-metal contact between pump discharge flange and base elbow.

D. Pump lifting assembly shall consist of 316 stainless steel shackle, chain, wire rope, and steel grab link device. The pump lifting assembly shall allow for the removal of the pump in a single lift. Pump lifting assembly shall be rated for twice the weight of the pump.

2.08 RING STAND FOR WET-PIT INSTALLATIONS

A. Install pump on ring stand for portable installation in tank or for mounting on auxiliary platform. Ring stand shall elevate pump inlet above base elevation to allow for unobstructed path of flow into the pump inlet. Provide mounting holes in the base of the ring stand for permanently mounting the stand to a fixed location.

B. Provide hose coupling or flanged connection to the discharge pipe.

2.09 PUMP STANDS AND PEDESTALS FOR DRY INSTALLATIONS

A. Horizontally or vertically installed pumps shall be supported with either prefabricated stands or concrete pedestals based on the recommendation of the manufacturer. Stands and pedestal design shall aim to minimize overall footprint to allow for maximum working area around the pump.

B. Prefabricated Stands:
   1. Provide steel or cast-iron stands capable of supporting all anticipated static and dynamic loads generated during pump operation. Pump manufacturer shall provide anchoring requirements to mount the stand to the structure.
   2. Set and level steel stands to meet intended inlet and outlet pipe centerline elevations with a non-shrink grout pad or concrete equipment pad. Pad requirements shall be recommended by the manufacturer and designed and stamped by an engineer in the state that the project is located.

C. Concrete Pads/Pedestals:
   1. Concrete pads and pedestals shall be designed and stamped by an engineer in the state that the project is located. Pad and pedestal designs included as part of the Drawings are acceptable. All others shall be designed by either the manufacturer or independent engineer.
   2. Obtain concrete pedestal design and anchor requirements from manufacturer where concrete pedestals are used as pump equipment stands.
   3. Concrete pedestal and anchors shall be capable of supporting all anticipated static and dynamic loads generated during pump operation encountered at the Site.

2.10 HORIZONTAL PUMP CARTS AND SLEDS FOR DRY-PIT INSTALLATIONS

A. Pumps shall be installed on horizontal pump cart or sleds as indicated in the Pump Schedule.

B. Materials: Powder-coated or epoxy-coated carbon steel.

C. Carts and Sleds:
   1. Each pump motor and volute shall be fixed to a steel fabricated roll-back support frame to facilitate both the mounting and servicing of the pump unit. The roll-back of the complete drive motor and rotating assembly shall be done without the need to disconnect the pump volute, suction, or discharge piping. The roll-back shall expose the pump's impeller for inspection or adjustment and allow for the replacement and adjustment of the pump's insert ring. Support frame shall allow the height of the drive motor and rotating assembly to be adjusted for height and level.
   2. Movement along horizontal guide rails shall be accomplished with the use of wheels, rollers, or guides to facilitate the roll-back of the pump for safe maintenance.
      a. Carts using wheels or rollers may be used for pump assemblies weighing less than 3500 lbs. Wheels or rollers must be able to freely move to allow operating staff to safely move equipment without excessive bodily strain.
      b. Sleds using linear guides shall be used for heavier pump assemblies to prevent pump assemblies from rolling and being unable to be controlled by manual labor. Sleds using non-rolling guides shall be equipped with a double acting hydraulic actuator providing safe movement without additional handling required.
   3. Horizontal Guide Rails: Guide rails shall be mounted, leveled, and grouted to a concrete equipment pad.

2.11 CONCRETE ANCHORS

A. Pumps stands, bases, pedestals, and appurtenances shall be anchored to concrete using manufacturer-provided mounting holes. Concrete anchors shall allow for level adjustment of the pump prior to grouting.

B. Concrete anchors shall be provided in accordance with Section 05 50 00 – Metal Fabrications.

2.12 CONTROLS

A. Furnish relays for each pump to detect seal failure and motor over-temperature. Provide separate dry contacts for seal failure and motor over temperature.
   1. Contact Rating: 240 VAC 3A maximum.
   2. Indicator Lights: Power, seal failure, and motor over-temperature.
   3. Power: 24 VDC.

B. Provide separate relays for installation in control panel. Coordinate panel fabrication to accept relays provided by pump manufacturer.

2.13 LUBRICATION

A. Provide lubrication fittings readily accessible from the outside without the necessity of removing covers, plates, housings, or guards.

B. Provide required lubricants for initial operation, including startup and 6-months of operation. Provide grades and quantities of oil supplied as recommended by pump manufacturer, required lubricants for initial operation, including startup and 6-months of operation. Provide grades and quantities of oil supplied as recommended by pump manufacturer.

2.14 SURFACE PREPARATION AND PAINTING

A. All ferrous metallic surfaces including but not limited to pump, motors and slide brackets shall be thoroughly cleaned, dry and free from all mill-scale, rust, grease, dirt, and other foreign matter before exposure to weather and prior to shop painting. All items not manufactured from corrosion-resistant materials or otherwise protected shall be blast cleaned prior to painting. All nameplates shall be properly protected during painting.

B. All ferrous metallic surfaces shall be field applied with the manufacturer’s standard two-part epoxy coating. Coatings shall be resistant to sewage, high humidity, hydrogen sulfide and other chemicals normally found in wastewater. Galvanized, stainless steel, brass, bronze, aluminum, plastic and FRP components shall not be painted.

C. Provide touch-up paint as specified to restore integrity of coating system that may be damaged during construction.

2.15 NAMEPLATES

A. Provide nameplates in accordance with Section 40 00 00 – Basic Process Materials and Methods.

B. At minimum, nameplates shall have the Manufacturer's name, address, equipment type or style, model or serial number, catalog number, rated capacity, speed, and all other pertinent data.

C. The nameplate for each electric motor shall show at least the minimum information required by NEMA MG 1 standards.

2.16 SPARE PARTS

A. Furnish a total of one (1) set of the following spare parts for each size/model of pumping equipment specified in this section. At a minimum, a set of spare parts shall include the following:
   1. One (1) set of mechanical seals (upper and lower).
   2. One (1) set of gaskets, O-rings, and lip seals.
   3. One (1) set of insert/wear plates/rings.
   4. One (1) Cable entry grommet and elastomer assembly.
   5. Spares of any additional parts subject to wear, and as recommended by manufacturer.

B. Provide 1 set of special tools required for normal operation and maintenance of pumps.

2.17 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Test pump performance in accordance with HI 11.6 standards at manufacturer's facility prior to shipment.

C. Test pump performance at a minimum of five points spanning the full range of allowable operating conditions including all points within the allowable range specified in the Pump Schedule. Record capacity, head, motor speed, pump speed, efficiency, input horsepower, and vibration for each test point. Develop pump test curves to illustrate conformance with the specified performance. For variable speed units, test each pump at full speed plus 3 equally spaced speeds between maximum and minimum design conditions.

D. Hydrostatically test each pump to 1.5 times shutoff head.

E. Pump performance shall meet or exceed the HI acceptance tolerance grade specified in the Pump Schedule for the specified duty point. HI acceptance grades are in the table below for reference. If no acceptance tolerance grade is specified, pumps shall be evaluated in accordance with HI default acceptance grade criteria.

Test Parameter	Guarantee Requirement	Grade	Grade 1			Grade 2		Grade 3
		Δt_Q	10%			16%		18%
		Δt_H	6%			10%		14%
		Symbol	Acceptance Grade					
			1B	1E	1U	2B	2U	3B
Rate of flow	Mandatory	t_Q (%)	± 5%	± 5%	0% to + 10%	± 8%	0% to + 16%	± 9%
Total head	Mandatory	t_H (%)	± 3%	± 3%	0% to + 6%	± 5%	0% to + 10%	± 7%
Power [a]	Optional (either/or)	t_P (%)	+ 4%	+ 4%	+ 10%	+ 8%	+ 10%	+ 9%
Efficiency [a]		t_η (%)	− 3%	− 0%	− 0%	− 5%	− 5%	− 7%

[a] The power and efficiency tolerances are not the result of an exact calculation using the maximum values of a related column. They are instead reflecting real life experience. For grade 1E and 1U, no negative tolerance on efficiency is allowed.

NOTE: All tolerances are percentages of values guaranteed.

F. Test motors in accordance with IEEE standards and at no load running current, high potential, and winding resistance.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install each pump and motor in accordance with the written instructions of the manufacturer and under direct supervision of manufacturer's representative. Install and assemble pumps and other equipment in accordance with the Drawings and with the manufacturers' installation instruction manual. Furnish bolts, shims, tools, and other devices necessary for installing the pumping units. The manufacturer's representative familiar with equipment being installed shall supervise the handling, installation, start-up, and testing of the equipment.

B. Pipe flanges connected to the pump must be accurately aligned prior to tightening connecting hardware to ensure no strain is induced from adjoining piping. Surrounding pipes, valves, fittings, and appurtenances shall be independently supported without imposing any strain on the pump casing.

C. Obtain certificate from pump manufacturer stating installation of the pumping equipment is satisfactory, equipment is ready for operation, and operating personnel have been suitably instructed in the operation, lubrication and care of each type unit provided.

3.02 FIELD PAINTING

A. In accordance with Section 09 90 00 – Painting and Coating.

B. Do not paint stainless steel, galvanized steel, and nonferrous surfaces.

C. Clean factory painted items requiring touching up in the field of all foreign material. Prime and topcoat with manufacturer's standard factory finish.

3.03 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Site/Field Tests and Inspections:
   1. Confirm units and appurtenances have been installed correctly and that the assembly is free from undue stress imposed by the piping or mounting bolts. Construction Management General Contractor (CMGC) shall demonstrate that all hardware connecting suction and discharge piping to the pump can be removed and reinstalled by hand to ensure absence of pipe strain.
   2. After installation of the pumping units and appurtenances is complete, test pumping equipment for proper operation. Ensure manufacturer's representative is present during each test. Notify Engineer 1 week prior to test and confirm with Engineer 24 hours prior to test.
   3. Test pumping equipment in accordance with HI 11.6 standards using clean water or treated effluent.
      a. Process water may be used in lieu of clean water for field tests if the supply of clean water for testing is not feasible or practical at the discretion of the Engineer. At minimum, clean water is recommended for initial pressure tests of the system.
      b. If leaks are found using non-clean water, clean and disinfect the area prior to correcting the installation and retesting.
   4. Conduct a running field test on each pumping unit in the presence of the Engineer and manufacturer’s representative for a minimum of 2 hours. Operate each pumping unit at its rated capacity and the operating points specified.

a. Throttle discharge valves or run multiple pumps simultaneously to achieve specified heads. Use an accurate method of measuring the discharge flow and suction and discharge heads. Use of new, calibrated, and tested station flow meter and pressure gauges is acceptable.
b. Test to confirm units have no objectionable heating, vibration, or noise from any parts, and that manual and automatic controls function properly. If any deficiencies are revealed during any tests, correct such deficiencies and repeat testing.

5. Provide vibration testing by a qualified and independent testing company. Test each complete system with vibration measurement system installed at the top motor bearing location installed at a 45-degree angle radial to the shaft centerline. Conduct vibration testing in the presence of the manufacturer's representatives in accordance with tolerances and procedures outlined in HI 11.6.
   a. In the event vibration exceeds specified limits and cause of vibration is attributable to the pumping equipment, manufacturer shall make necessary balancing or alignment adjustments to bring equipment to within specified limits.
   b. In the event vibration exceeds specified limits and the cause of vibration is attributable to field conditions, work with the Engineer to remedy the installation.
6. Provide field test booklets for each unit showing field tests performed to adjust each component and field tests performed to prove compliance with the specified performance criteria, upon completion and testing of installed system. Indicate the final position of controls and data gathered during testing in field test booklets and ensure test booklets are signed by the manufacturer's representative, CMGC, and Engineer.

C. Manufacturer Field Services:
1. Obtain and pay for the travel and services of a factory trained service representative to assist in installation, field testing, startup, and checkout.
2. Trained service representative shall provide a minimum of 8 hours per pump system for on-site personnel training for operation and maintenance of the equipment.

3.04 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.05 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION