REPORT

SOLAR HEATING AND HOT WATER SYSTEM INSTALLED AT THE SENIOR CITIZEN CENTER, HUNTSVILLE, ALABAMA

Prepared by the

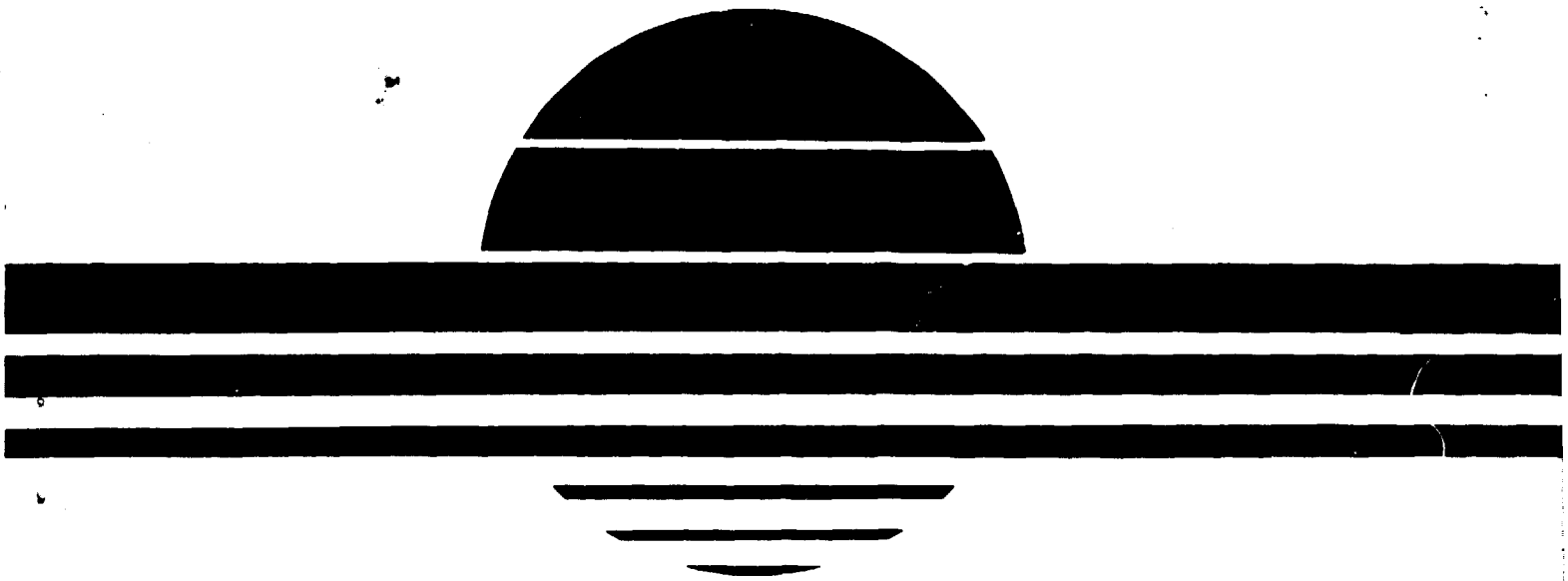
City of Huntsville
125 Earl Street
Huntsville, Alabama 35805

Under Contract EG-77-A-01-4071

Monitored by

National Aeronautics and Space Administration
George C. Marshall Space Flight Center, Alabama 35812

For the U. S. Department of Energy



U.S. Department of Energy

Solar Energy

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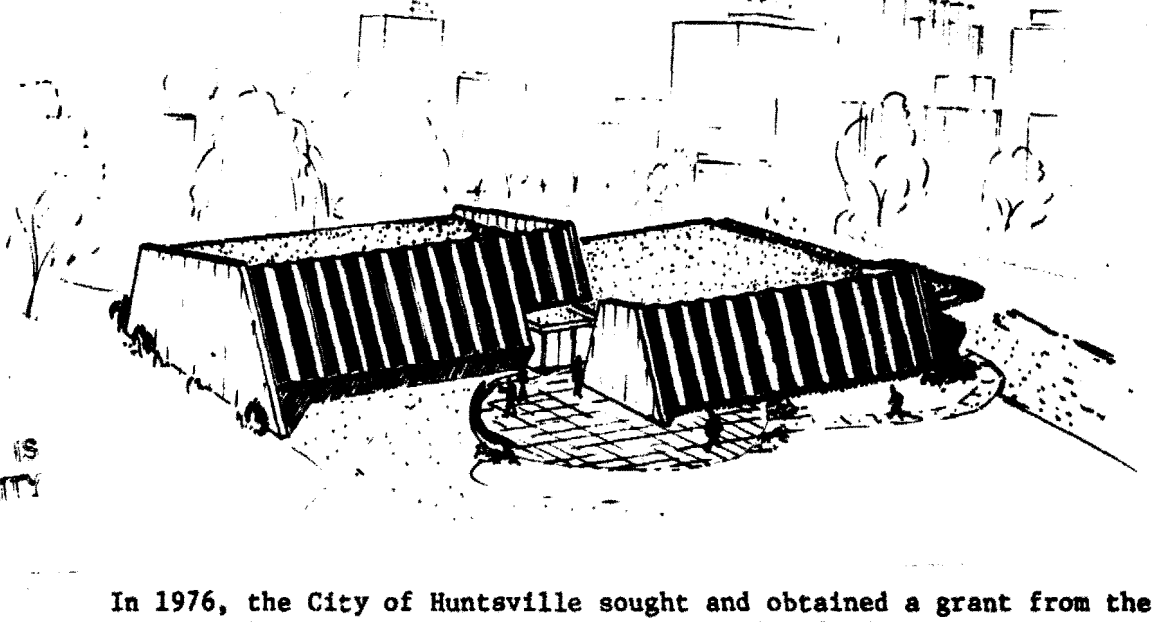
1.0 INTRODUCTION

This project is a retrofit solar system integrated with an existing building.

The original building was constructed in 1959 as a City of Huntsville central recreation facility. It included a gymnasium and other recreation program spaces totaling 12,000 sq. ft. of area. Subsequent municipal expansion required larger decentralized recreation centers which eventually relocated general recreation activities from this location.

In 1974, the original architect, W.R. Dickson, was commissioned to design an expansion and renovation project for the building to provide facilities for an active senior citizen's services and recreation program. The expanded total area completed in 1975 was 16,000 sq. ft. Concurrent with this design process, the City Council endorsed the architect's recommendations that the conversion project include heating and electrical modifications suitable for future interaction with a solar heating system and conservation modifications. These measures required an additional investment of about $25,000 at that time.



In 1976, the City of Huntsville sought and obtained a grant from the Energy Research and Development Administration for funding a solar demonstration project. The city provided necessary local funds. Total budget for the project from these combined funds was $188,210.

The existing building is of conventional concrete block and brick bearing wall construction with flat roofs and insulating deck plank on steel joist structure. High bearing walls are reinforced with masonry pilasters accentuated on the exterior as an architectural motif. Floor structure is concrete slab on grade. Existing heating is by gas-fired hot water boiler and cooling is by conventional air-cooled refrigeration for chilled water. Distribution is by hot or chilled water pumped throughout the building typically to zone-controlled fan coil cabinet units.

1.0 (cont.) The solar system was designed to provide 85% of the estimated annual space heating load and 85% of the estimated potable hot water requirement. The back-up hot water is provided by one 60 gallon gas hot water heater.

The solar energy architectural collection system consists of 1795 square feet of Halstead Mitchell fin tube absorber plates mounted in a box cast into Corotherm (prefabricated light weight concrete/fiberglas panel) with excellent thermal resistance. The absorber plate is covered with a single glaze, low iron, tempered glass pane. The 3,000 gallon water storage tank is located behind the Corotherm panels which are structurally self-supporting. The solar heat transfer fluid is Dow Corning Syltherm 444 Silicone Fluid which allows the fluid to be pumped at -121°F and generates essentially no vapor pressure at 600°F. This alleviates the need for freeze protection through the system draining procedures. The low vapor pressure allows for a simple closed loop design with no provisions for stagnation conditions. When the system load and storage capacity have been satisfied, the solar panels simply sit with the fluid in them.

The architectural solar collectors are grouped in two arrays. The solar collectors Array A consist of thirteen (13) collectors 26 feet in length mounted on a integral toe footing anchored with a continuous mounting angle. The solar collectors Array B consist of eleven (11) collectors 26 feet in length and four (4) collectors 19 feet in length mounted on angle stand-offs approximately eight feet above existing ground level grade. All of the solar collectors are facing due south at a fixed tilt angle of 60 degrees.

The project was initiated in May, 1978, and was operational in December, 1978, with the completion of the acceptance test. The solar project was dedicated December 19, 1978.

In addition to technological factors herein, the author places particular emphasis on architectural design considerations. The project is at the visual center point of the heart of Huntsville Civic Center park area, and the visual impact is significant.

2.0 SUMMARY OF PROJECT INFORMATION

Owner:	**City of Huntsville** **Huntsville, Alabama**
Project Manager:	**Glenn E. Wallace** **City of Huntsville, Alabama**
Designer:	**Project Architect - Dickson & Associates** **Huntsville, Alabama** **Solar System - Solar Unlimited, Inc.** **Huntsville, Alabama**
Contractor:	Parker Construction Company
DOE Technical Management:	NASA/Marshall Space Flight Center, Alabama
Operational Date:	December, 1978
Building:	Senior Citizens Center 16,000 square feet
Location:	City of Huntsville 300 Church Street Huntsville, Alabama 35801

CLIMATOLOGICAL DATA

Latitude:	34°-4'N
Heating Degree Days:	3070 yearly
Average Temperature:	60.8°F
Average Insulation:	1400 BTU/ft^2/day

SOLAR ENERGY SYSTEM

Solar Collector Type:	Flat Plate
Glazing:	1/8" Single Pane Tempered Water White Crystal
Absorber Description:	Fin & Tube
Absorber Coating:	3M Nextel
Transfer Fluid:	Dow Corning Silicone Oil
Tilt Angle:	60°
Total Area:	1795 $ft.^2$ Net
Manufacturer:	Solar Unlimited, Inc. Huntsville, Alabama
Application:	Heating - 85% Hot Water - 85%
Storage Medium:	Water
Container:	Above Grade Steel Tank
Capacity:	3,000 gallon

BACK-UP ENERGY SYSTEM

Space Heating:	Gas Fired Boiler - Hot Water Type
Hot Water:	One 60 gallon Gas Heater

2.1 SUMMARY OF PROJECT COST

Cost Element	Estimated Cost	Actual Cost
System Design	$ 12,000	$ 12,000
Solar Hardware	76,834	79,834
Construction	95,700	96,376
Total Project Cost	$184,534	$188,210

DOE FUNDING $121,937

3.0 PROJECT CHRONOLOGICAL

February, 1977 - The City of Huntsville was advised that its proposal in response to Program Opportunity Notice DSE-76-2 for a solar energy demonstration project had been selected for negotiation of a cooperative agreement.

September, 1977 - The City of Huntsville was awarded a contract which stipulated ERDA (DOE) would pay $121,937 of the estimated cost.

January, 1978 - The Final Design Review was held with Planning Research Company and Marshall Space Flight Center personnel.

February, 1978 - A Pre-advertisement Conference was held to acquaint interested contractors with the proposed solar demonstration project.

May, 1978 - A Pre-construction Conference was held with the General Contractor and his sub-contractors to discuss construction and scheduling.

May, 1978 - The Notice to Proceed was given to the General Contractor, Parker Construction Company, Inc., and the Contractor immediately started site preparation and concrete foundation work for the ground mounted solar collectors.

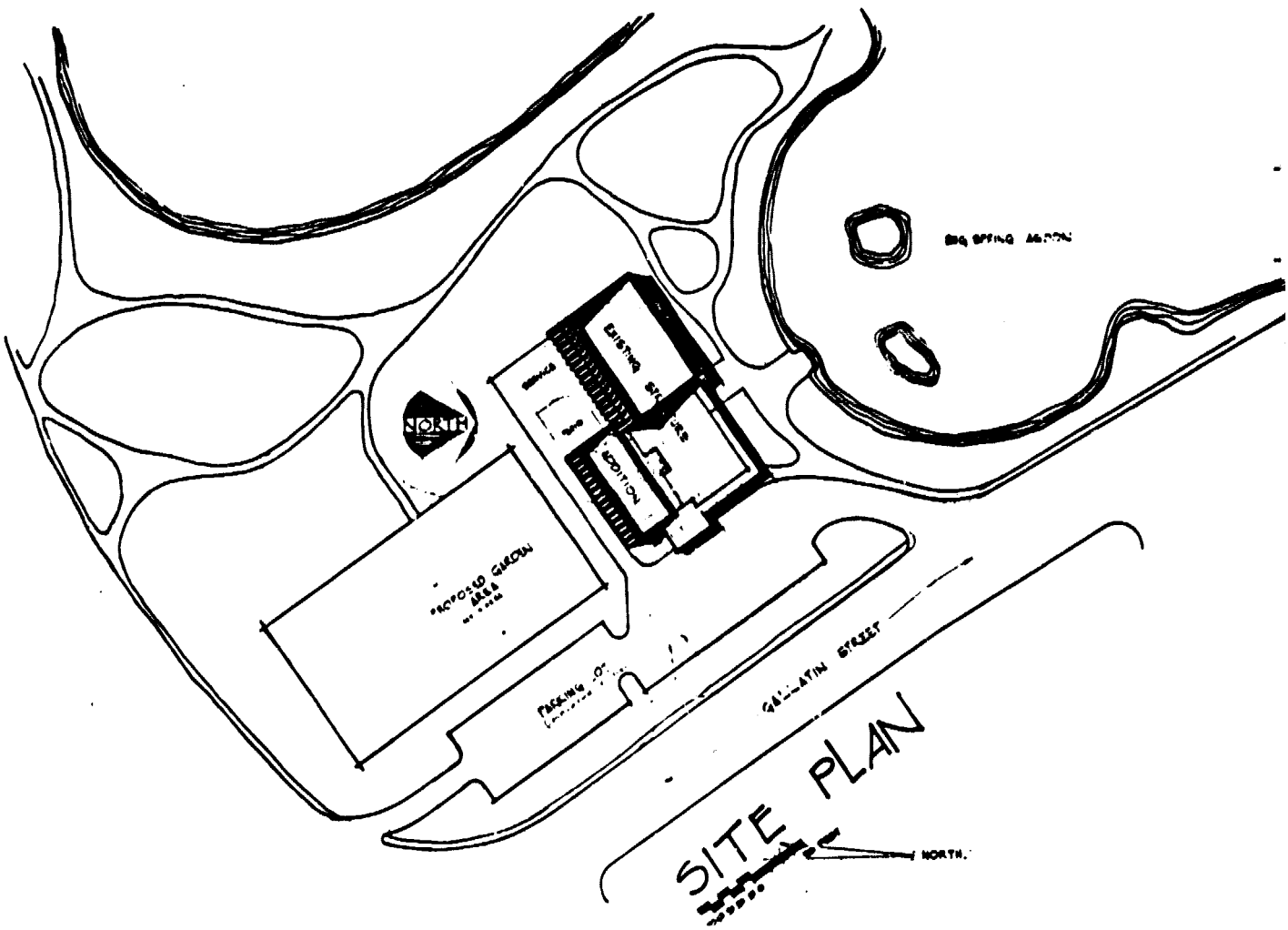
June, 1978 - The collector supports were installed and 100% of the concrete work was completed.

July, 1978 - 50% of the collectors were mounted to steel supports and the 3,000 gallon steel storage tank was installed.

September, 1978 - The solar collectors were pressure tested for possible leaks with no substantial pressure loss.

October, 1978 - The project was completed and the final inspection of the work was performed by the Owner, Architect and Solar Unlimited, Inc.

December, 1978 - All acceptance tests were completed and the system was operational. The Open House and the Dedication Ceremony were held on December 19. Dr. William Lucas, Director of the National Aeronautics and Space Administration/George C. Marshall Space Flight Center, was key note speaker to a group of approximately 125 guests.



4.0 DESIGN PHILOSOPHY

Basic requirements of the design criteria were to develop a cost effective solar system design to heat the building and its hot water supply with minimum back-up by the existing conventional gas-fired boiler system.

Criteria required 85% of heating to be provided by solar energy and solar preheating of hot water for 85% of requirement.

4.0 (cont.) Uniquely affecting the design criteria were two project location factors.

1. As a major space technology center, the City of Huntsville is a community devoted to a "fail safe" philosophy. The design criteria developed, therefore, included a "fail safe" design approach.

2. The project is located at the visual center point of the Heart of Huntsville Civic Center park area surrounded by monumental civic building developments and civic activity. This required that the solar design must be integrated with the existing building without an add-on appearance. The design required should enhance rather than detract from the original building and its surroundings.

A third factor unique to this project is compass orientation of the existing building. The nearest-to-southward face of the rectangular building actually faces approximately 30° to the east of due south. This is a common situation for building sites in Huntsville, Alabama, because the original streets were laid out in directions rotated similarly away from due north, south, east or west. There is some conjecture that this was deliberately planned to provide some sunshine exposure to all building facades. This project criteria, therefore, included a requirement for a solution to this problem of orientation.

5.0 SOLAR SYSTEM DESCRIPTION & HARDWARE

The basic solar system selected is an active system which combines flat plate absorbers with specialized collector fluid transfer loops through heat exchangers which transfer heat to hot water storage loops and the storage tanks.

Domestic hot water is preheated by a separate double-walled heat exchanger in the collector fluid loops by way of a domestic water supply loop with pump and a standard hot water storage tank which supplies preheated water to a standard gas hot water heater.

5.1 SOLAR ARCHITECTURAL PANELS

The manner in which architectural effects and solutions to orientation problems are integrated with this solar system is of special note.

The integrated pre-assembled solar architectural panel design incorporates cover glass, solar absorber plate and insulation backing, all integrated into a precast, thin shell, glass reinforced concrete solar architectural panel.

Panels are mounted on the side of the building which faces 30° to the east of due south according to the existing orientation. Panels are formed into a triangular section. The exposed face is in two planes each at 30° from the plane of the panel back, placed opposite and symmetrical to form a ridge at the centerline. Absorber plates and glass covers are mounted into a preformed recess in the westward of these plane faces. This arrangement tilts the absorber plate face toward the south. (See Figure 3)

The single sheet cover glass used is of standard size, 34" x 76", 1/8" thick, tempered, water white crystal. One face has a diffusing texture. Glass is furnished and installed by Solar Unlimited, Inc.

Absorber plates are furnished and installed by Solar Unlimited, Inc.

These are aluminum fin and single-row copper tube construction. Fins on the back side are folded over to close the back. The absorbing faces are spray painted with flat black solar absorbing paint.

The fin tube configuration entraps diffused radiation from a wide range of directions and, consequently, test results have indicated that these absorbers maintain a relatively higher solar absorption rate under light overcast conditions.

The insulation system behind the absorber plates is integrated into the panel sandwiched into the glass-reinforced, thin shell concrete structure during the casting process. This insulation consists of a honeycomb paper with polystyrene beads all encased in the thin shell concrete.

Each panel contains an absorber plate 32" x 300", each with total absorber surface area of 66.7 square feet per panel. Twenty-four typical panels are used and four panels which are one-quarter shorter are adapted

5.1 (cont.) over a building exit. Total absorber surface provided is 1,795 square feet.

The weight of each 26' long, typical, fully-assembled architectural solar panel is approximately 3,000 lbs. Each completed panel assembly, including cover glass and seals, absorber plates which were pressure-tested during assembly and integral insulation system, was installed as a complete unit. These completely assembled units were furnished to the site by Solar Unlimited, Inc.

Each unit was placed on pre-installed steel mounting angles with a boom crane. Panel delivery and crane time were coordinated and the total crane time required is estimated at about 6 days.

Typical panels are 6.5 feet wide and 26 feet long and are self-spanning. These are provided with integral steel weld plates at bottom and at 5'9" from the top. These are welded to continuous horizontal steel angle mounts, supported by steel angle struts, anchored to masonry bearing walls. The panel supplier provided a special lifting harness for built-in lifting loops. The tops of the panels rise above and overhang the existing flat roof (2.5 feet). The entire system thereby requires no penetration of the flat roofs. Weather flashings are installed on the backs of panels to overlap existing roof edge flashings without modification to the existing flashings. (See Figures 3 & 4)

The existing bearing walls of the building and footings were analyzed for additional vertical load-carrying capacity and for resistance to lateral thrust of stand-off struts. The existing structure proved to be more than adequate without further reinforcement. Some oversizing of the original building pilaster system for decorative purposes contributed some useful margins of safety evidenced in these analyses.

Two solar architectural panel collector arrays are installed on the southward side of the building.

The westward array is mounted to the original high gymnasium masonry bearing wall. The bottoms of these panels are seated into a horizontal steel mounting angle with horizontal steel stand-off struts eight feet above floor level. A flat plywood soffit is installed below. This array contains 15 panels.

The eastward array is mounted into the masonry bearing wall of the more recent addition to the building. The bottoms of these mount on a new concrete slab edge. The 6" reinforced concrete slab with turn-down slab edge footing extends 10'4" from the wall at 2" below building floor level. This mounted array provides a generous enclosed space triangular in section behind the panels. This space is the location for main hot water storage and major portions of manifold piping, pumps, exchangers and other mechanical equipment and controls. The eastward array contains 13 typical panels.

The overall assembly provides a unique and bold architectural motif on the southward building facades.

5.2 MANIFOLDS AND PIPING

Main solar heat collector fluid supply and return manifolds are suspended behind panels with tee connections located 30 inches behind each supply and return stub-out connection from absorbers through the panel backs. Final connections from absorbers to manifolds are made with soft copper tubing adapted with long sweep bends and soldered connections throughout.

The entire piping system, therefore, is provided with complete freedom for expansion without the use of special expansion joints or any type of rubber or synthetic type of coupling material. All piping is copper with high temperature solder joints. Copper expansion loops only are used where needed at collector manifolds. Valves and mechanical joints are minimized.

5.3 COLLECTOR LOOP TRANSFER FLUID

The collector loop transfer fluid merits special note. A total of 230 gallons of Dow Corning Syltherm 444 silicone fluid is installed into two separate solar absorber collector loops. The high boiling point (600° F) and the low freezing point (below -121° F) of this fluid are relied on to prevent problems with high stagnation temperatures and extreme freezing conditions. This fluid is virtually inert chemically, non-toxic and non-corrosive and is intended to be permanently enclosed within the collector fluid loops. These loops were completely sealed after the fluid installation. Thermal expansion of the fluid is absorbed by a sealed air chamber expansion tank at an appropriate point in the loop. (See Figure 6)

Pumps in these loops are in-line canned types or types which incorporate mechanical seals. It is believed that this system will prove to be "fail safe" with virtually no maintenance other than pump replacements relating to pump life cycle expectancy. Isolation valves are provided to facilitate pump replacement. Heat exchangers are tube-in-shell type. These transfer heat from silicone oil in collector loops to water in storage loops to storage tanks.

The high initial cost of the silicone fluid is offset by a smaller investment being required for freeze control, fluid replacement and maintenance, and other preventive maintenance measures.

5.4 PIPE INSULATION

All piping and components except pumps are fully insulated with standard jacketed fiberglass or foam rubber insulation systems.

5.5 HOT WATER STORAGE FOR HEATING

A 3,000 gallon cylindrical steel tank provides the required hot water storage for building heating. This tank is insulated with blocks of 4" thick urethane foam insulation banded in place and wrapped with

5.5 (cont.) a 2" wide aluminum foil tape. The overall "R" factor is 32. The tank is connected to the main building hot water distribution loop with supply and return mains. A controlled by-pass valve system provides for the occasional operation of supplementary gas-fired heating from the existing building boiler. The hot water heating distribution system has an atmospheric-vented expansion tank and contains only water.

5.6 CONTROL SYSTEM

The control system is a 24-volt system designed by Solar Unlimited, Inc. with sensors in each collector array and other components to operate pumps and valves in accordance with the control logic developed in their design. This system incorporates night set-back controls of the building thermostats.

6.0 PROJECT ENERGY CONSERVATION MEASURES

Previous conversion of the original gymnasium space for senior citizen's activities required subdivision of the space into numerous smaller rooms. New partition systems and a new suspended ceiling at 10' height was installed including four-inch batt insulation throughout. The combination of existing roof deck insulation factors, the remaining large volume of dead air space above the new rooms and new ceilings and insulation results in a much improved thermal barrier.

Included with this solar system project effort were other modifications to the building for energy conservation.

A continuous area of single-glazed existing windows totaling 945 square feet was reduced by half by applying 1" polystyrene bead board and interior and exterior facing panels and trim over alternate window units. The remaining window units were reglazed with thermopane glazing. In addition, 225 square feet of existing single 1/4 inch plate glass entry treatment was double glazed with the addition of another plate glass with a 1-inch air space between.

The exposure of the east and west walls was reduced by the installation of new screen wall architectural treatments. Although these are primarily architectural treatments, some thermal barrier assistance was calculated as a result.

Two inches of polystyrene board insulation was applied to a 12-foot height on the west end of the building behind new screen walls.

These combined conservation measures are calculated to reduce the building heat loss of 85,275 BTU/hour at standard design conditions.

7.0 SITE PLANNING

Within a two block radius and in direct line of site surrounding this project are a 12-story hotel, a modern 10-story bank building, a monumental antibellum Greek Revival bank building, a modern 10-story county courthouse complex, a 10-story city municipal building complex, a modern 4-story parking garage, a modern 3-story telephone company office building, a modern library, a modern chamber of commerce building, a large modern bank computer center, a major new office complex, a new Hilton Hotel and the recently completed $13,000,000 Von Braun Civic Center Auditorium complex. This project is the only building situated in a 16 acre open park area which includes a large lagoon. It is surrounded by major streets and buildings listed above.

The solar design team, therefore, required appropriate architectural values.

In addition to technological solutions required of them, the solar architectural panels were exploited to provide a bold sculptured treatment to the southward facade of the building. Careful attention was given to proportioning and positioning. Panel height determination, etc. were studied in relation to establishing dimensional modules of solar glazing and absorber plates. The solar engineering determinations which established panel slopes were fixed criteria to which other building lines and massing must relate.

Screen wall closures were developed to close the ends of the two solar architectural panel arrays and were extended as new screen wall facing treatments over existing east and west building wall faces. These were developed with a sloped parapet effect above existing roofs with the high point at the tops of solar panel arrays. Low points in the parapet effect are only slightly above existing roofs toward the north side of the building.

From most viewpoints, this effectively screens existing roof-mounted equipment and the backs of solar panels exposed above the roofs.

The massing effects of this treatment tends to harmonize the unchanged portions of the existing building with the imposing scale of the solar installation. (See Figures 1 & 5)

The original building brick which remains exposed is a warm buff color and overhanging cornices have a sandy buff-colored exposed aggregate treatment. The solar architectural panels were constructed with an intergrally-colored cement to produce a blending buff color. The end screen wall panels were surfaced with a sandy buff, exposed aggregate surface matching existing cornice treatments.

All window and door frame and trim work is painted dark brown to blend with the brown patina of existing weathered copper cornice flashings and trim. Copper, treated to develop this patina, was used as a cap flashing and trim for new screen walls.

8.0 CONTROL LOGIC AND MODES OF OPERATION

8.1 CONVENTIONAL BACKUP ENERGY SYSTEM

The existing system provides both heating and cooling. Since this project deals with solar heating, little explanation will be given to the cooling system.

Transport Between Systems

Water is the medium of heat transfer. All piping is type L copper insulated with 3/4 inch thick closed-cell expanded-foam insulation. Piping design consists of a low-velocity chilled water loop interconnected with a hot water loop. Required quantities of water to handle the heat load and/or cooling load are determined by the respective chilled-water pump and hot-water pump.

The building is zoned with each zone having a copper piping system, commonly referred to as a reverse-return system. The pressure drop of each zone and terminal unit is handled by its respective zone pump. This type of system is commonly referred to as a primary-secondary pumping system.

Cooling System

Cooling is accomplished with a conventional system which pumps water through an air cooled chiller and into a multi-loop circulating water system. The cooling system is not solar or solar assisted.

Heating System

The existing system was designed to be used as auxilliary system to a solar system.

It consists of a gas-fired-sectional-cast iron boiler, a 1/2 horsepower circulating in-line pump and related expansion unit and air removal devices. The boiler is manufactured by Weil McLain and has a wet rating of 591.3 M BTU/hr.

System Operation

Based on outdoor temperature, either the chilled-water pump or the hot water pump is placed in operation. An adjustable deadband precludes either the hot pump or the chiller pump from operating. This occurs when the ambient air temperature is such that the internal building loads balance the heat loss through the walls. It is adjustable since the internal load caused by people is subject to variation. Each zone, office, craft room or meeting room has its temperature controlled by an individual unit-mounted thermostat. These thermostats are in series and are controlled by an automatic changeover thermostat. Room units which are exposed on an outside wall have a motor-operated damper which allows 25 percent fresh air to be introduced into the room. The unit thermostats (controlling the room air temperature) have a two stage heating

8.1 (cont.) and single-stage cooling mode of operation. If the system is in a cooling mode, a temperature drop of one degree below the setting will cause a three-way valve to by-pass chilled water to the return line. A further drop in temperature causes a mild weather electric heating coil to turn on even though the system as a whole is in a cooling configuration. When the outdoor thermostat changes the system from the cooling mode to the heating mode, the electric coil no longer functions and the changeover thermostat reverses the action of the room thermostat so the entire area is heated by hot water.

8.2 CONTROLS

The addition of solar heating capability to the Senior Citizen's Center requires special consideration be given to the operational controls. These controls are designed to maximize the benefits made available by the addition of the solar system while maintaining the identity of the present conventional gas based system. This permits use of the solar heating system as the primary system retaining the present heating system for peak load requirements and back-up.

The design of the control system provides for five modes of operation. Each operational mode is configured to make best use of the thermal and mechanical resources available for use during its particular portion of system operation. The five modes of operation are:

Direct Solar Heat (DSH)
Domestic Hot Water (DHW)
Heat From Storage (HFS)
Store Solar Heat (SSH)
Back-up Heating System (BHS)

The present heating system utilizes a gas-fired boiler as the heat source for a multi-loop circulating water system. The boiler operates in an ON-OFF mode with the primary distribution loop temperature maintained by a thermal control valve. The excess temperature of the primary loop is set to a ratio of 1.5 times the difference between the interior temperature (70° F) and the outside ambient temperature. This variable operating temperature must be given proper consideration in this solar energy control system design.

The control system design is based upon the measurement of temperature at several points within the system, determining the requirements for heat transfer, and initiating the appropriate system actions. These actions take the form of selecting the proper paths through the system piping and turning on one or more pumps as appropriate. Provisions have been made to isolate the solar energy system from the current gas-fired heating system should this become necessary for back-up operation or system maintenance.

Before proceeding with the detail system discussion it seems appropriate to define the changes made to the current system. First, a 3-way valve, VE, was installed in the piping leading to the low temperature side of the gas fired boiler. (See Figure 6) This valve network permits the gas fired system to constructively aid the solar energy system in supplying the heat requirements for the building. During periods when the solar system cannot provide any useful heat, this valve network will

8.2 (cont.) allow the functional separation of the solar and conventional systems. Thus, the conventional system is not burdened with any thermal losses caused by the solar system equipment.

The control electronics package for the thermal control valve was modified to gain access to a control voltage which is proportional to the desired primary loop temperature. This signal is then compared with similar signals within the solar energy control system to determine if solar energy is available to supply a portion of all of the required building heat.

The remaining modification was accomplished by connecting the Hot Water Pre-Heat Tank in series with the supply side of the domestic hot water system. These three modifications are easily identified on the system diagram since they are located near the dashed line used to separate the solar system components from the currently installed system. The solar energy system components are arranged into three sub-systems: the collector loop, the hot water preheat loop and the primary heat transfer loop. Each of the system loops has its components arranged to perform one or more functions. These loops provide the transport mechanisms that are utilized to collect solar energy and move it to some useful point within the system. If the collected energy is not immediately useful, it is stored for later utilization. Each of the five operating modes will be discussed in detail and during these discussions the function of each component will be presented. The operational modes are shown in Figures 7, 8, 9 and 10.

The collector loop is enabled when the temperature measurements indicate that solar energy is available from the flat plate collectors. Pump PA provides the head pressure required to circulate the heat transfer fluid through the collector loop. The flow rate is approximately 100 GPM. After passing through the collector array the fluid passes through two series connected heat exchangers, HE1 and HE2. HE1 is a small diameter device, 1/2 inch piping, that serves to transfer heat to the domestic hot water preheat tank. The other exchanger, HE2, is a larger diameter device; 2 inch piping is used to transfer heat to the primary storage loop. A hand operated valve, VA, is used for controlled by-pass of HE1 for the major part of the flow in this loop. This particular configuration permits the use of a small size exchanger for HE1 that utilized double-wall construction for code compatability while allowing the use of a single-wall, large diameter device for the primary loop transfer. An expansion tank and air purge valve are installed at the highest point of this loop. The control system connection to this loop consists of a temperature comparison of collector outlet temperature with the storage tank temperature or the hot water preheat temperature to give a single control command to turn pump PA on or off.

8.3 DIRECT SOLAR HEAT (DSH)

During the time when sufficient solar energy is available to meet the total heating requirements of the building, the DSH mode of operation is initiated. (See Figure 7) The energy available in the collector loop is transferred to the primary heat transfer loop by HE2. Pump PC transfer circulates the heated water throughout the primary loop. The thermal control valve will provide any adjustment required to maintain the appropriate loop temperature.

8.3 (cont.) The DSH mode is activated when the collector temperature, TC, is 20° above the temperature set point, TD, of the thermal control valve. This mode is terminated when the temperature difference drops to 10°F. Precautions are taken against any overtemperature condition existing within this loop. The current system design limit of 19° F and an excess ratio of 1.5 against the building temperature of 70° F gives a maximum working fluid temperature of 146° F. In those cases where the primary supply temperature, TP, exceeds 160° F, the direct mode is modified by changing the position of valve VB to return the supply water through the storage tank. This will provide near optimum sharing of the available solar energy by supplying building needs while at the same time storing excess heat for future use.

8.4 DOMESTIC HOT WATER (DHW)

The solar energy system is used to supply domestic hot water. This mode is initiated when the collector temperature, TC, is 20° F greater than temperature of the water contained within the pre-heat tank, TH. The hot water preheat loop uses heat exchanger HE1, pump PB, and the preheat tank. (See Figure 8) This mode requires operation of the collector loop. The possibility of unsafe temperatures could be introduced in the DHW storage tank. To circumvent this problem, an independent thermal cut-out switch, TZ, is located near the pump inlet. This switch will open the power leads to pump PB when a temperature of 180° F is reached, and the DHW loop will be provided with an independent overtemperature control to prevent excessive temperature buildup.

8.5 HEAT FROM STORAGE (HFS)

The solar energy reserve in the primary storage tank is used to provide heat when the level of solar insulation does not permit direct heating. In this mode of operation, See Figure 9, the primary heat transfer loop is enabled to transfer heated water from the primary bulk storage tank to the main building supply loop. This is accomplished by opening valve VB, turning on pump PC, and closing valve VE. The bulk storage temperature, TS, is composed with the set point temperature as indicated by the thermal control valve electronics package. When the demand temperature is higher than the water temperature in the bulk storage, the gas fired boiler is enabled. This permits the boiler to be used as a "super heater" thus providing the peak heating demand. The use of heat from bulk storage is continued until the temperature of the building return water, TR, is greater than the temperature, TS, of the bulk storage.

8.6 STORED SOLAR HEAT

The excess solar energy available is stored in the primary bulk storage tank. This storage is accomplished by enabling the collector loop and certain components of the primary heat transfer loop. Pumps PA and PC are turned on and valve VB is opened along with closing valve VE. (See Figure 10) This mode of operation is enabled with the collector temperature, TC, is 20° F greater than the temperature of the bulk storage tank.

8.7 EQUIPMENT CONTROL SYSTEM

The control system proposed for operation of the solar energy system of the Senior Citizens Center gives due consideration to the optimization of the collection of solar energy, cost effective heat transfer operations and utilization of the existing investment in the current heating and cooling plant. The actual control signals required are derived from five temperature measurements and one control signal obtained from a thermal control valve in the existing equipment. An additional on-off thermal switch provides an over-temperature safety function for the domestic hot water preheat system. The control line leading to the gas valve on the gas-fired boiler is placed in series with a control output so that the boiler can be prevented from firing when sufficient solar energy is available to supply the building requirements.

Sensed temperatures will take the form of analog electrical signals. Electronic comparitor devices will be used to translate the several temperatures and delta-temperatures to relay-logic levels. Relay-logic will then be used to derive the appropriate control signals. A manually operated switch is provided so that the system can be forced to operate in the back-up, gas-fired mode only. The mechanical engineer is then given the option of using the automatic solar energy system or the currently installed gas-fired system.

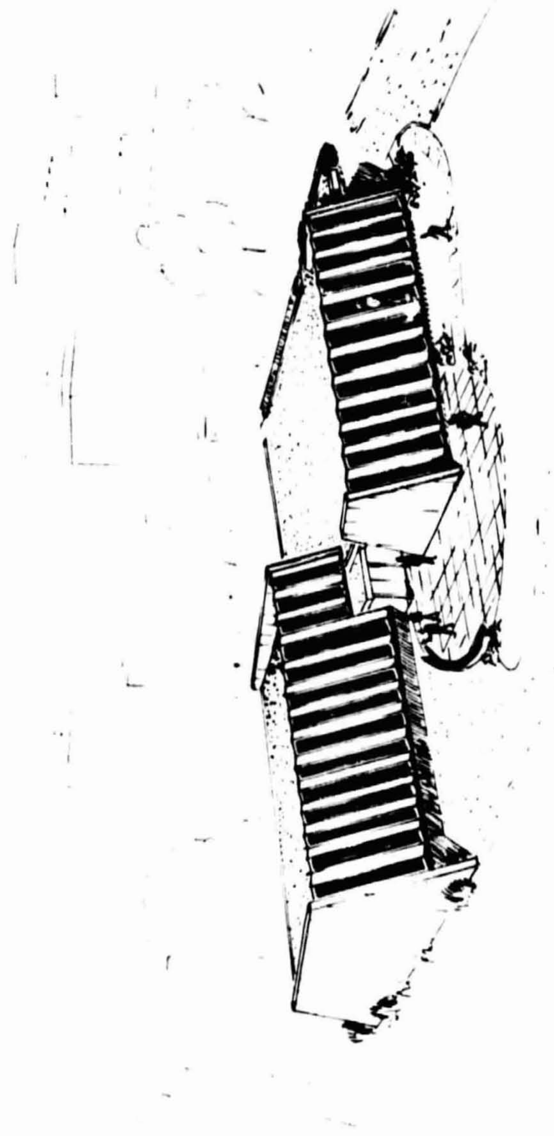


Figure 1

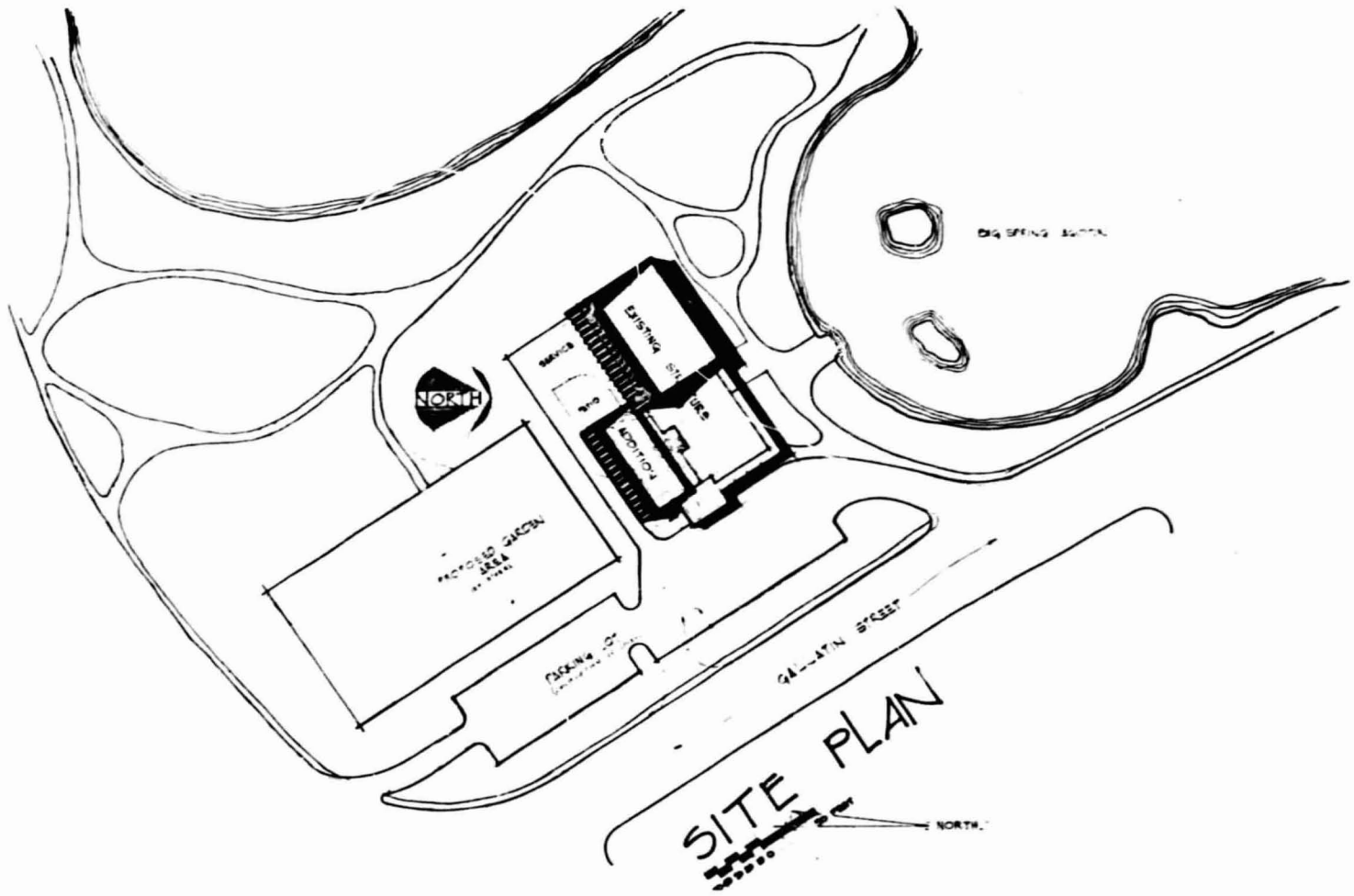
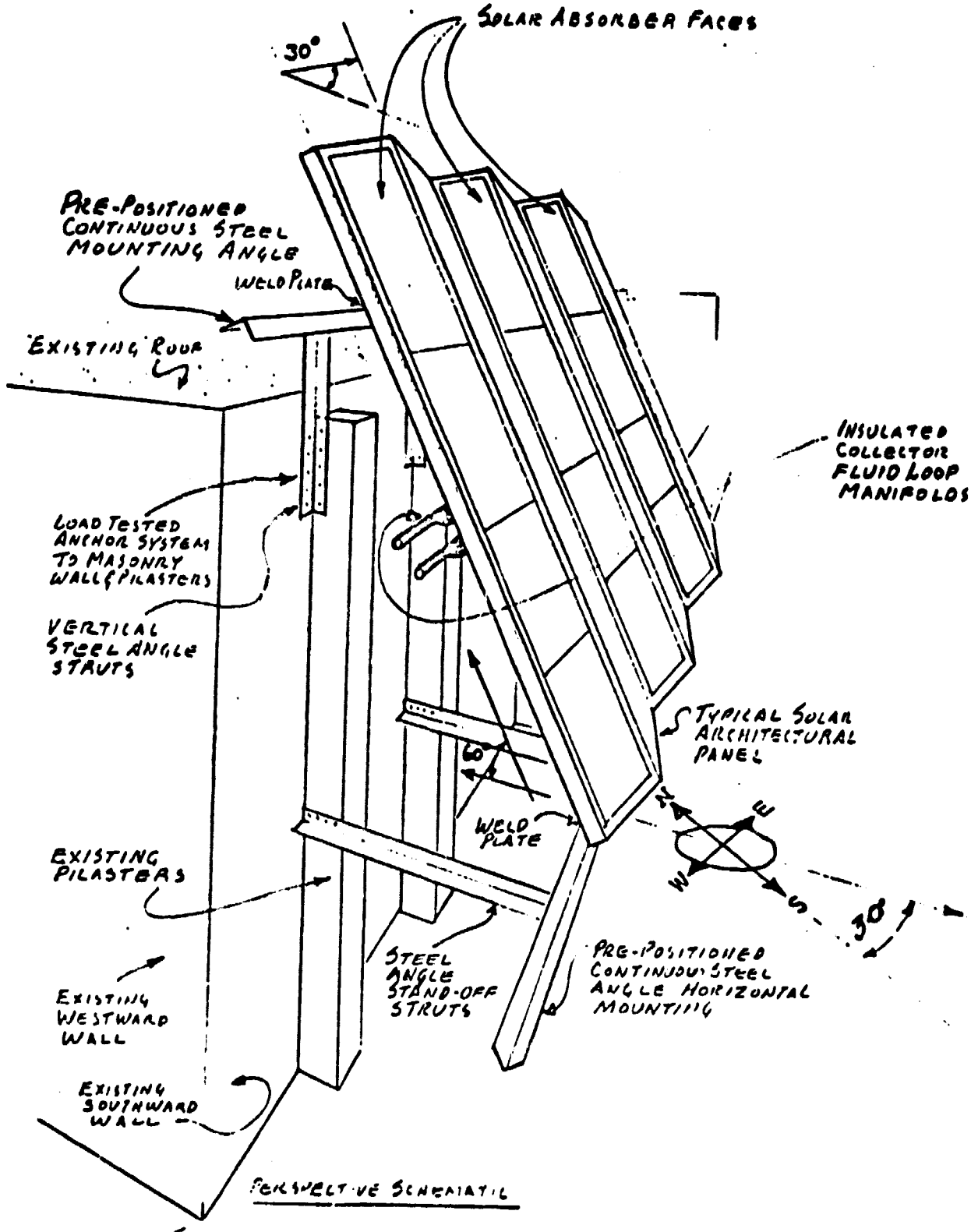
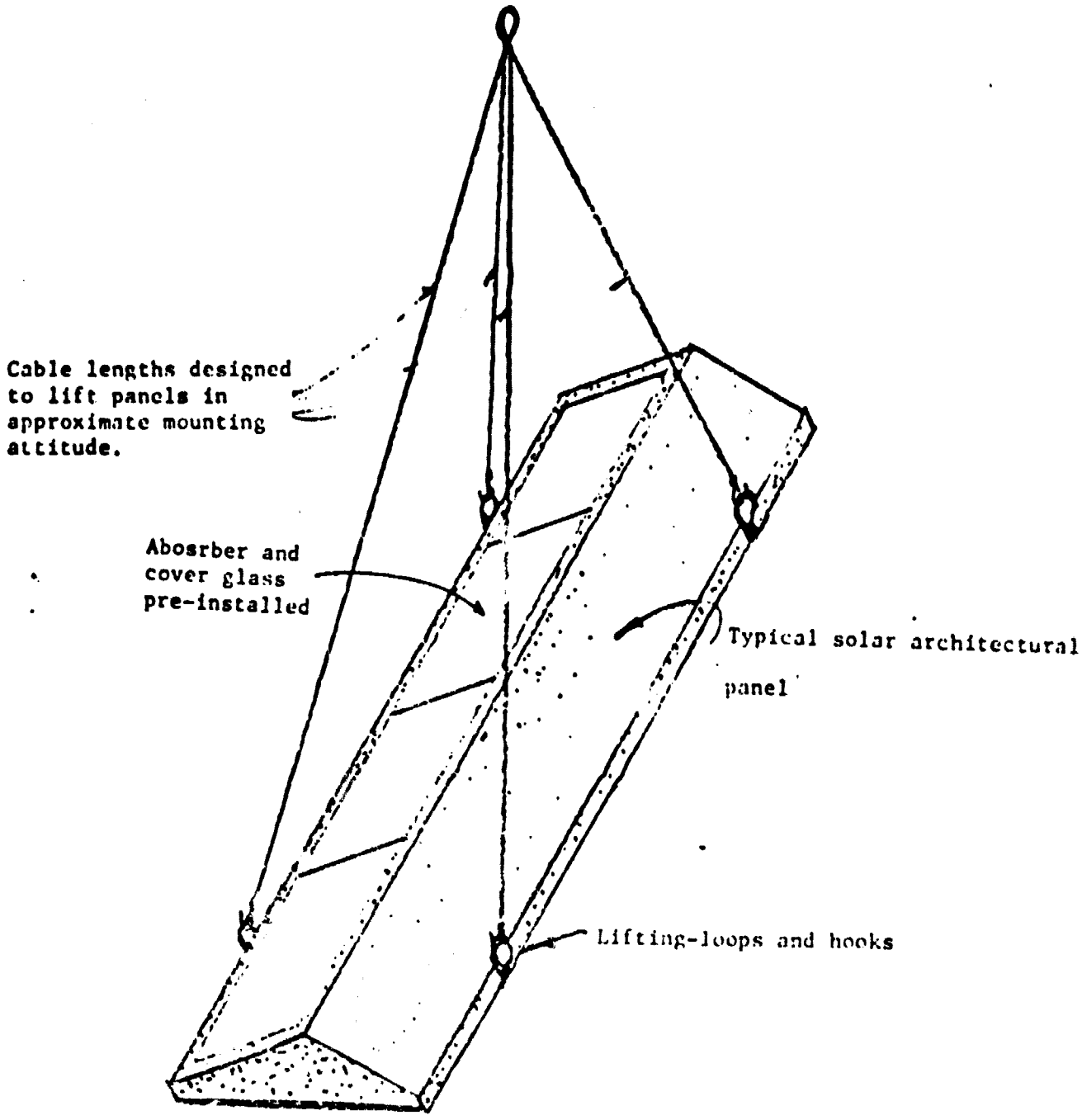


Figure 2
Site Plan



SOLAR ARCHITECTURAL PANELS
TYPICAL MOUNTING

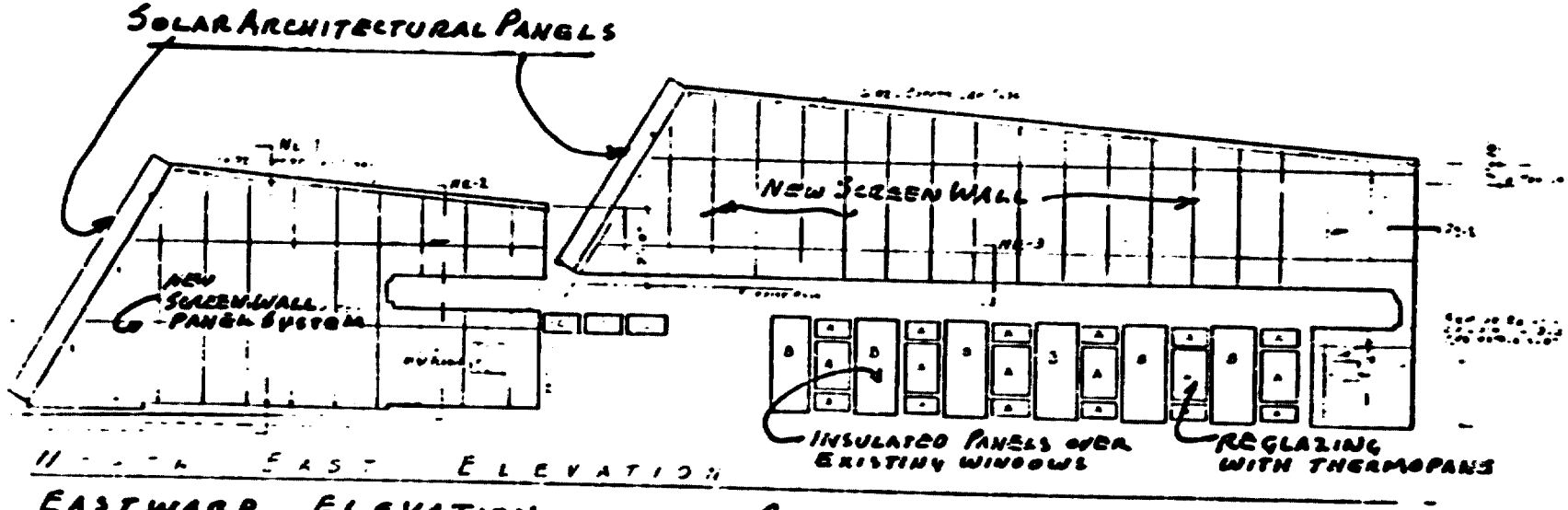
Figure 3



Isometric lifting harness

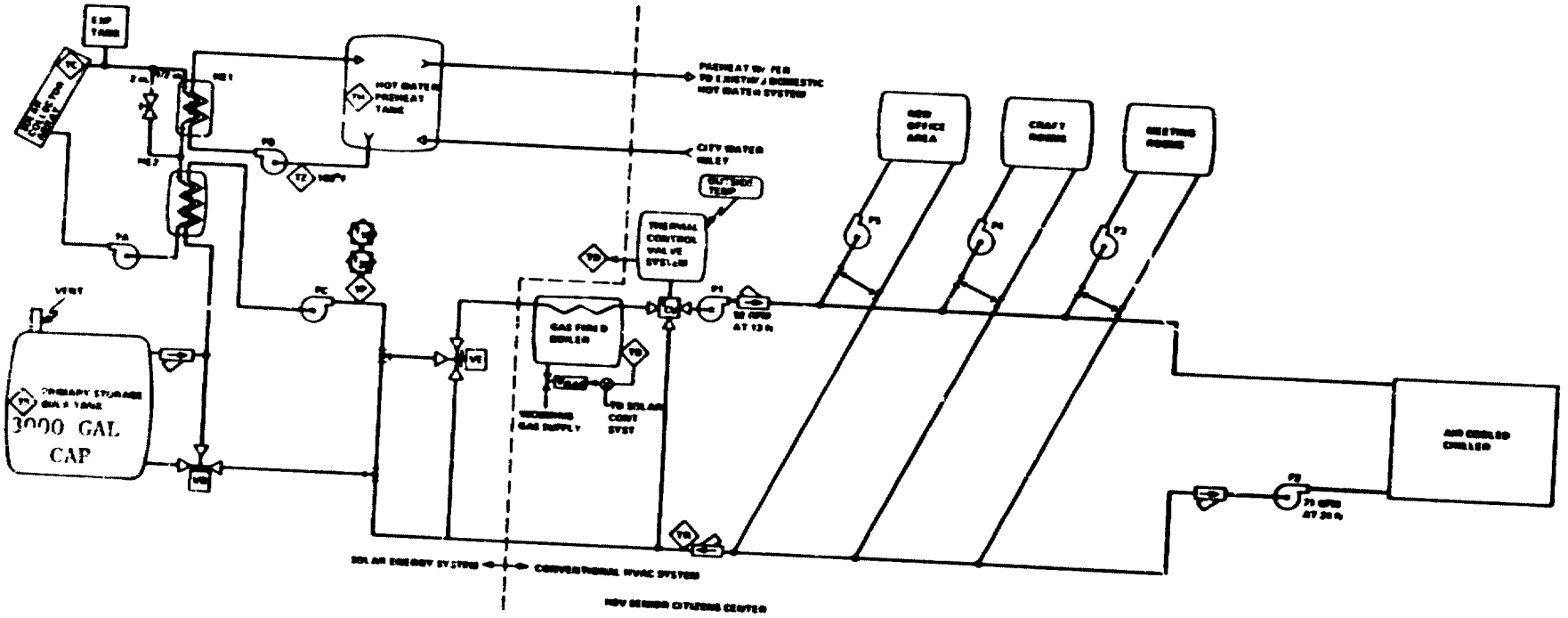
No Scale

Figure 4



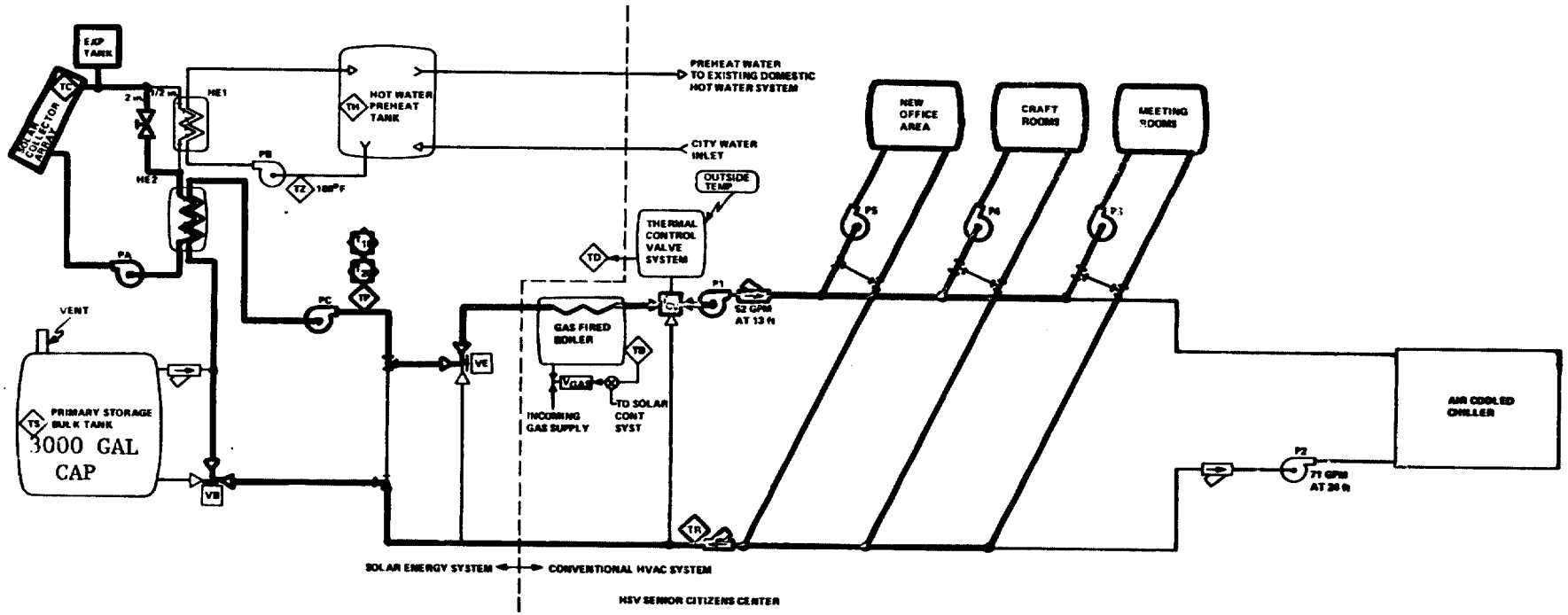
EASTWARD ELEVATION — CONSTRUCTION DRAWING SHOWING SCREEN WALL ADAPTATIONS OVER EXISTING AND MODIFICATIONS TO WINDOW-WALLS

Figure 5



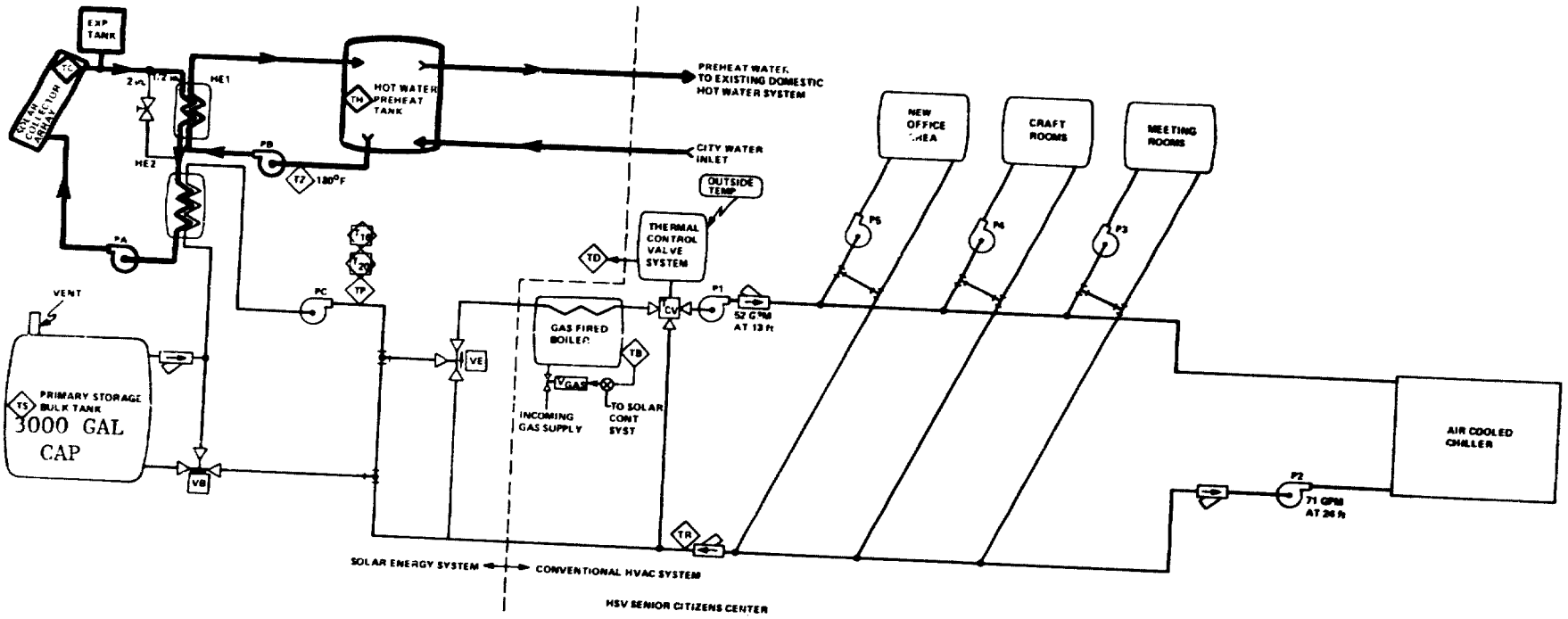
Total System Schematic

Figure 6



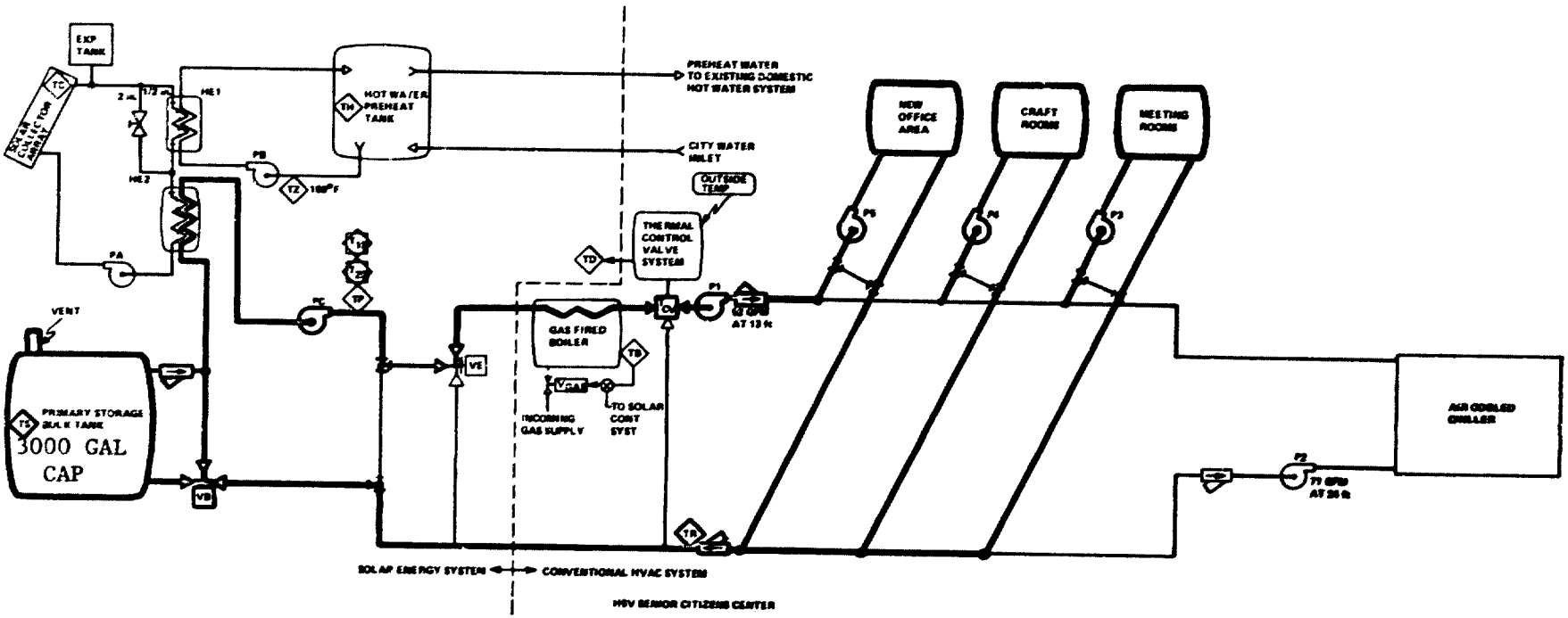
Direct Solar Heat Schematic

Figure 7



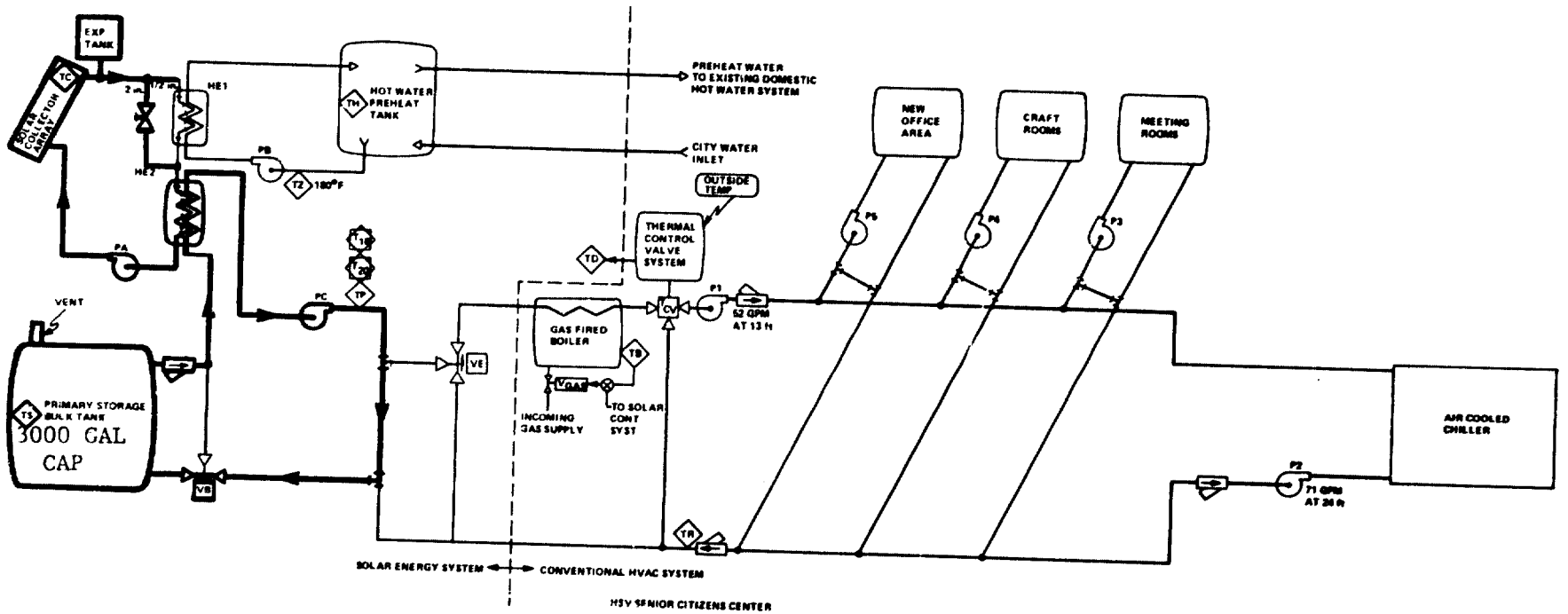
Domestic Hot Water Schematic

Figure 8



Heat From Storage Schematic

Figure 9



Store Solar Heat Schematic

Figure 10

9.0 ACCEPTANCE TEST PLAN

Test Objectives

The objectives of the acceptance test, through compliance with the acceptance test plan, are to 1) verify that each system component responds and functions within the manufacturer's specified limits; and 2) that the system responds and functions within the manufacturers' specified limits.

To achieve these objectives, each mechanical component and each electrical component was functionally inspected on site as an entity; and, finally, the system as a whole was inspected for function and for compliance with design specifications.

OPERATIONAL MODES OF THE SYSTEM

		Direct Solar Heat	Domestic Hot Water	Heat From Storage	Store Solar Heat	Back-up Heating System	Summer Cooling System
Solar System Equipment	Pump DHW1	-	ON	-	-	-	-
	Pump PDHW2	-	ON	-	-	-	-
	Pump PA1	ON	-	OFF	ON	-	OFF
	Pump PA2	ON	-	OFF	ON	-	OFF
	Pump PB1	ON	-	OFF	ON	-	OFF
	Pump PB2	ON	-	OFF	ON	-	OFF
	Pump PH	ON	-	ON	-	OFF	OFF
	Heat Exchanger HEDHW	-	ON	-	-	-	-
	Heat Exchanger HE1	ON	-	OFF	ON	-	OFF
	Heat Exchanger HE2	ON	-	OFF	ON	-	OFF
	3-Way Valve VE	THRU	-	THRU	BYPASS	BYPASS	BYPASS
Existing Conventional Equipment	Pump P1	ON	-	ON	OFF	ON	OFF
	Pump P2	OFF	-	OFF	OFF	OFF	ON
	Pump P3	ON	-	ON	OFF	ON	ON
	Pump P4	ON	-	ON	OFF	ON	ON
	Pump P5	ON	-	ON	OFF	ON	ON
	Boiler	OFF	-	OFF	OFF	ON	OFF
	Chiller	OFF	-	OFF	OFF	OFF	ON

9.1 ITEMS TO BE TESTED: PUMP PH, 1/2 HP AND VALVE VE1

TEST OBJECTIVE: Verify proper installation and operation

TEST PREREQUISITES:
a) Proper physical mounting
b) Prior piping pressure test
c) Verify proper pump orientation
d) Verify proper valve orientation and valve VE1 orientation for fluid flow direction
e) Open all water distribution line valves and isolation valves to assure free water flow path
f) Insure that water is in piping at or above pump level

PASSING:
1. Pumps
   a) Pump operates with proper water pressure
   b) Pump operates with proper electric voltage and current valves
   c) Pump operates with no leaks
2. Valve VE
   a) Valve VE operates in proper direction
   b) Valve does not leak or chatter

TEST PROCEDURE:

1. Turn off pump disconnecting device and verify that 120 volt ac is not present at motor starter contact terminals.

2. Turn off 10 amp circuit breaker which supplies 120 volt ac to 24 volt transformer T1 and T2.

3. Measure voltage at coil terminals for ph motor starter. Voltage should be 0.

4. Measure voltage at valve VE terminal. Voltage should be 0.

5. Disconnect solar heat available control connections from control RB-DCA-1 terminals SHA.

6. Turn on 10 amp circuit breaker which supplies 24 volt transformers T1 and T2. Zero voltage should be observed at points measured in 3 and 4.

7. To simulate solar heat available, place a jumper wire across RB-DCA-1 terminals SHA. Valve VE and PH motor starter should operate. Verify visually and audibly. Valve VE should, when no 24 volt power is applied to terminal, be in position that bypasses water fed from pump PH. When 24 volts is applied, valve should switch to accept vater from pump PH and flow to gas fired boiler intake.

8. Measure and record voltage at coil terminals for PH motor starter and for valve VE terminals. 24 volts ac should be present.

9. Temporarily remove jumper from SHA terminals on RB-DCA-1.

9.1 (cont.)

10. Turn on pump PH disconnect device, and verify that PH motor starter contact input terminals has 120 volt ac present. Measure and record.

11. Replace jumper SHA, which was removed in step 9.

12. Pump Ph should start.

13. Measure and record voltage and current at pump PH terminals. Running valves should be within 10% of name plate ratings.

14. By use of pressure gauge, verify that water downstream of valve VE is at least 8 psi greater than when measured with the pump off.

15. Verify after pump operates 10 minutes that no leaks occur in pump or valve VE.

16. Remove jumper from SHA terminals (step 11) and replace lead wires removed in step 5.

9.1 (cont.) TEST RESULTS

Procedure No.	Result
1.	Turned Off
2.	Turned Off
3.	0 Voltage Verified
4.	0 Voltage Verified
5.	Disconnnected
6.	0 Voltage Verified
7.	Verified
8.	24 Volts AC Verified
9.	Removed
10.	120 Volts AC Verified
11.	Replaced
12.	Pump Starts
13.	120 Volts Verified
14.	12 psi Verified
15.	No Leaks Occurred
16.	Accomplished

9.2 ITEMS TO BE TESTED: DISTRIBUTION CONTROL SYSTEM, INCLUDING RB-DCA-1 AND THERMOSTATS

TEST OBJECTIVE: To insure proper operation of distribution control system

TEST PREREQUISITES:
a) Installation of RB-DCA-1 control, associated thermostats and wiring
b) Installation and wiring of all distribution pumps and valves

TEST PROCEDURE:

1. Turn Off 10 amp breaker which supplies power to 24 volt transformer T1 and T2.

2. Turn off pump motor disconnect devices for pumps PH, P1, P2, PZ2, PZ1, PZ3.

3. Verify that no voltage exists at the following points:
   a) Between terminals "C" and "R" on the RB-DCA-1
   b) Between terminals "Cp" and "Rp" on the RB-DCA-1
   c) Starter coil terminals on each motor starter for pumps listed in step 2
   d) Input terminals for valve VE
   e) Input terminals for gas valve relay coil

4. Remove zone thermostat covers so that mercury switch operation can be observed.

5. Adjust all thermostats and the differential control "SHA" to the OFF position. This means:
   a) that the three zone thermostats will be set lower than room temperature
   b) the heat on thermostat will be set greater than 75°F
   c) the cool on thermostat will be set lower than 60°F

6. Turn on the 10 amp breaker which was turned off in step 1.

7. Measure and record voltage between RB-DCA-1 terminals "R" and "C" and between terminals "Rp" and "Cp". Voltages should be 24 volts ac $\pm$ 10%.

8. Install a temporary jumper (to remain in place for the remainder of this test) across terminal "TC". This simulates time clock "ON" conditions. Instead of using a jumper, the timeclock can be adjusted to insure an ON or contact closed condition.

9. Measure and record terminal input voltages at motor starters for P1, P2, PZ1, PZ2, PZ3, the relay coil input for the gas valve relay and the coil terminal for valve VE. These voltages should be 0.

10. Raise the "Heat-ON" thermostat to above room temperature to insure that it is calling for heat and its contacts are closed. A jumper across the HO terminals will simulate this condition.

9.2 (cont.)

11. Raise the thermostat setting of the Zone 1 thermostat to a setting above room temperature. Physically observe that the first stage mercury bulb only has made contact.

12. Measure and record the coil input voltage for the following controls:

Pump Motor Starter No. - Input Coil Voltage

	Should be
P1	24V ac
P2	0V ac
PZ1	24V ac
PZ2	0V ac
PZ3	0V ac
Valves	
VE	0V ac
Gas Valve Relay Coil	24V ac

13. Increase the thermostat setting of the zone 2 thermostat to above the room temperature. Verify that only the first stage mercury bulb has made contact.

14. Measure and record the pump PZ2 coil input terminal voltage. This voltage should be 24V ac ± 10%.

15. Increase the setting of the zone 3 thermostat to insure that only the first stage mercury bulb has made contact.

16. Measure and record the starter coil terminal input voltage for pump PZ3. This should read 24V ac ± 10%.

17. Turn the solar heat available (SHA) differential temperature control to Manual On.

18. Measure and record the coil input voltages at the following points:

	INPUT COIL VOLTAGE
Control	Should Read
Pump PH Starter	24V ac
Valve "VE"	24V ac
Gas Valve Relay Coil	0V ac
Pump P1	24V ac

19. Increase the zone 1 thermostat to insure that the first and second stage heat mercury bulbs make contact.

20. Measure and record voltage input at gas valve relay coil input terminals. This voltage should now be 24V ac ± 10%.

21. Readjust all controls and thermostats as set in Step 5.

22. Turn on pump motor disconnect devices.

9.2 (cont.) 23. Verify that motor starter contact input terminals have proper input voltage; measure and record:

Starter For	Specified Voltage
P1	208V ac *1Ø
PZ1	208V ac *1Ø
PZ2	208V ac *1Ø
PZ3	208V ac *1Ø
P2	208V ac 3Ø
PH	120V ac 1Ø

24. Lower the "cooling" thermostat to below room temperature to insure its contacts close. This can be simulated with a jumper across the "CO" terminals.

25. Verify that pumps P2, PZ1, PZ2, and PZ3 start. No other distribution pumps should operate.

26. Raise the cooling thermostat to above room temperature and verify that the pumps stop.

27. Turn the solar heat available (SHA) control to "Manual On". No pump should start.

28. Adjust the zone 1 thermostat to a temperature setting that will close only the first stage mercury bulb. The following pumps should start: a) P1; b) PH; c) PZ1. Valve "VE" should be energized and in the solar heating distribution position.

29. Increase the zone 1 thermostat setting to close the second stage mercury bulb.

30. The gas boiler should operate and the pumps in step 28 should continue to operate.

31. Reduce the zone 1 thermostat to turn off both stages of heat. Pumps and boiler should be off.

32. Increase the zone 2 thermostat setting to close the first stage only mercury bulb. Pumps P1, PH and PZ2 should start. Valve VE will be energized.

33. Increase the zone 3 thermostat setting to close the first stage only mercury bulb. Pump PZ3 should start.

34. Turn off the "SHA" control.

35. Pump PH should stop. Valve VE should deenergize; the gas boiler should start.

36. Adjust all thermostats and controls to normal settings and remove the jumper across terminals TC and any other jumper installed.

* Existing pump motors are rated at 230V ac; however, existing power is 120/208 volts 3 phase.

9.2 (cont.) **TEST RESULTS**

Procedure No.	Results
1.	Turned Off
2.	Turned Off
3.	0 Voltage Verified at All Points
4.	Removed
5.	All thermostats adjusted
6.	Turned Off
7.	24V ac Verified
8.	Accomplished
9.	0 Voltage Verified
10.	Verified
11.	Verified
12.	P1 - 24V ac P2 - 0V ac PZ1 - 24V ac PZ2 - 0V ac PZ3 - 0V ac Valves VE - 0V ac Gas Valve Relay Coil - 24V ac
13.	Verified
14.	24V ac
15.	Verified
16.	24V ac
17.	Accomplished
18.	Pump PH Starter - 24V ac Valve "VE" - 24V ac Gas Valve Relay Coil- 0V ac Pump P1 - 24V ac
19.	Verified
20.	24V ac
21.	Accomplished

9.2 (cont.) TEST RESULTS CONTINUED

Procedure	Results
22.	Accomplished
23.	P1 - 208V ac PZ1 - 208V ac PZ2 - 208V ac PZ3 - 208V ac P2 - 208V ac PH - 120V ac
24.	Accomplished
25.	Verified
26.	Verified
27.	Verified
28.	Verified
29.	Accomplished
30.	Verified
31.	Accomplished
32.	Accomplished
33.	Verified
34.	Accomplished
35.	Verified
36.	Accomplished.

9.3 ITEMS TO BE TESTED: MECHANICAL COLLECTOR ARRAY A AND B PLUMBING LINES

TEST OBJECTIVE: Test pressure integrity of all components and joints.

TEST PREREQUISITES: All components and connections must be attached and ready for filling, including collector, heat exchanger, pump, pressure and temperature gauges.

PASSING: Collector loop plumbing holds 150 psi pressure for 24 hours with a pressure loss of less than 5 psi.

FAILING: Collector loop A plumbing drops more than 5 psi when 150 psi is applied and held for 24 hours.

TEST PROCEDURE:

1. All connections to the collector Array A plumbing loop have been made and joints sealed, including collectors, heat exchanger, pump, manifold, supply and return pipe, expansion tank, and pressure and temperature gauges. This test should be performed before the pipe insulation is applied.

2. Close and plug 1" drain valve on mechanical platform.

3. Thread a bushing or elbow with a gas schrader valve into the 1" female end of the fill valve, sealing the threads with teflon pipe tape.

4. Open the fill valve and apply nitrogen pressure to the collector lines through the schrader valve until the pressure in the line is 150 psi as indicated by collector loop pressure gauge located on the mechanical platform.

5. It is desirable to apply the pressure test in the early morning when sun on the collectors will not create temperature pressure effects.

6. The person performing the test should record the pressure shown on the collector loop gauge, time, date and his name, and also the witness representing the owner should confirm the data recorded and sign the test report.

7. After allowing 24 hours to pass, recheck the pressure indicated on the same collector loop pressure gauge. Record the pressure indicated on this gauge along with the time, date, name of person performing the test, The witness should verify this information and sign the report.

8. If the pressure on the gauge is not less than 145 psi, then the collector loop pressure integrity is acceptable. Otherwise, the contractor should inspect all the loop joints to find any leaks.

9.3 (cont.) TEST RESULTS

Procedure	Results
1 - 8	Pressure test on Mechanical Collector Array A & B plumping lines at 150 psi pressure for 24 hours was accomplished with minor pressure loss not greater than 5 psi.

9.4 ITEMS TO BE TESTED: MECHANICAL HEAT DISTRIBUTION WATER PIPE LOOP

TEST OBJECTIVE: Test pressure integrity of all components and joints

TEST PREREQUISITES: All pipes and components must be connected and sealed ready for filling without insulation.

PASSING: Holds 5 psi of water pressure for 24 hours without pressure loss.

FAILING: Plumbing line pressure drops to below 5 psi after 24 hours from the initial 5 psi pressure.

TEST PROCEDURE:

1. All collector Array A water line components are connected, but not insulated, including heat exchangers, heating storage tank with water pumps, lines, water expansion tank, 3-way valve.

2. Heating storage tank is filled from the makeup water supply line until the pressure gauge at pump PH indicates 5 psi. Close the makeup water supply valve.

3. Visually inspect all plumbing lines and component connections for obvious water leakage.

4. Turn off the boiler make-up water supply.

5. Record the gauge pressure, time and date, along with the name of the person performing the test, and with a witness verifying this information.

6. After 24 hours, recheck the pressure at the pump PH pressure gauge and record the pressure indicated along with the time, date, and name of test operators and witness.

7. If the pressure indicated on this gauge shows 5 psi or greater, then the water line plumbing is acceptable.

8. If the pressure indicated on the gauge is less than 5 psi, the water piping loop is rejected.

9. Inspect all water line components and connections for evidence of water leakage.

10. Repair and retest.

11. Open the boiler water make-up line valve and set the makeup water control to 5 psi.

9.4 (cont.) TEST RESULTS

Procedure	Results
1 - 11	Mechanical heat distribution water pipe loop pressure tested at 5 psi for 24 hours without pressure loss.

9.5 ITEMS TO BE TESTED: SOLAR COLLECTION PUMPS PA1 and PB1 (1HP pumps)

TEST OBJECTIVE: Verify proper installation and operation.

TEST PREREQUISITES:

a) Proper physical mounting
b) Prior piping pressure testing to verify all connections tight
c) Verify pump orientation for proper fluid flow direction
d) Verify that all valves are in proper position (open in flow path)
e) All tubing must be filled with silicone heat transfer fluid

PASSING:

a) Pump operates with proper pressure
b) Pump operates with proper current and voltage requirements (name plate data)
c) Pump operates with no silicone oil leaks at any pump part or connection to pump

TEST PROCEDURE:

1. With pump disconnecting device (breaker) off, verify that 120 volts is not supplied to pump electrical terminal or motor starter terminals.

2. Activate (turn on) solar differential control (manual on). This should supply 24 volts ac to motor starter. Measure motor starter coil input voltage. Verify and record 24 volt ac input.

3. Deactivate differential control (manual off) starter coil input voltage should be 0.

4. Measure and record silicone oil line pressures with no silicone pumps running.

5. Turn on pump motor disconnecting device. Verify and record that 120 volts ac is supplied to motor starter input terminals.

6. Turn solar differential control to manual ON. Motor starter should activate and pump start.

7. Measure and record pump input voltage and current. Voltage and current should be within 10% of running nameplate ratings.

8. Measure and record silicone pump output side pressure with 1 hp pump running. A pressure of about 13 psi greater than that recorded in step 4 should be attained.

9. Operate pumps at least 10 minutes and verify that no pump connection or pump part leaks.

9.5 (cont.) TEST RESULTS

Procedure	Results
1.	Verified
2.	Verified; 24V ac supplied
3.	0 Voltage Verified
4.	PA1 - 8 psi PB1 -13 psi
5.	124V at both
6.	Verified
7.	PA1 - 120V - 11 amps PB1 - 124V - 12 amps
8.	PA1 - 9 psi Delta PB1 -10 psi Delta
9.	No leaks verified

9.6 ITEMS TO BE TESTED: PUMPS PDHW1, PDHW2, 1/12 HP PUMPS

TEST OBJECTIVE: Verify proper installation and operation

TEST PREREQUISITES:

a) Proper physical mounting
b) Prior piping pressure test
c) Verify proper pump orientation for fluid flow direction
d) Verify that all valves are open (check pump isolation valves)
e) Place pump flow rate control in maximum position
f) Verify that piping is filled with fluid

PASSING:

a) Audible verification of pump operation
b) Verification of proper electric operating current
c) Absence of leaks
d) Quiet operation

TEST PROCEDURE:

1. With pump disconnecting device off, verify that the 120 volt supply is not present at relay (starting device) or pump terminals.

2. Activate (turn on) solar differential control manual. This should supply 24 volts ac to coils of pump starting relay. Verify and record relay coil voltage.

3. Deactivate solar control (manual off) and verify that no voltage is supplied to pump starter relay coils.

4. Turn on pump disconnecting device (breaker). Verify that 120 volts ac is supplied to pump starter relay contact terminal input.

5. Turn on solar differential control to activate pump relays. Pumps should start.

6. Measure and record pump input voltage and current. Voltage and current readings should be within 10% of running name plate ratings.

7. Measure and record silicone pump (PDHW2) output side pressure with 1/12 hp pump off and with it running. An increase of about 4 psi should be observed with PDHW2 running.

8. Verify that no pump connection or bearing leaks after 10 minutes of operation.

9.6 (cont.) TEST RESULTS

Procedure	Results
1.	Verified
2.	26 volts ac Verified
3.	Verified
4.	Verified
5.	Verified
6.	Verified
7.	Delta 5 psi Verified
8.	Verified No Leaks

9.7 ITEMS TO BE TESTED: PUMPS PA2 AND PB2; 1/3 HP WATER PUMPS (SOLAR STORAGE)

TEST OBJECTIVE: Verify proper installation and operation

TEST PREREQUISITES:
a) Proper physical mounting
b) Prior piping pressure test
c) Verify pump orientation for proper flow direction
d) Verify all valves open in flow path
e) Verify that water is in pipes above pump level

PASSING:
a) Pump operates with proper fluid flow pressure
b) Pump operates with proper electric voltage and current requirements
c) Pump operates with no leaks

TEST PROCEDURE: (Note: first three steps can be done simultaneously with test for PA1 and PB1)

1. With pump disconnecting device (breaker) off, verify that 120 volts is not supplied to motor starter terminals.

2. Activate (turn on) solar differential control (manual on). This should supply 24 volts ac to motor starter coil. Measure and record motor starter input voltage.

3. Deactivate differential control (manual off). Starter coil input voltage should be 0.

4. Measure and record down pump side of water pressure (pump off).

5. Turn on pump motor disconnecting device. Verify and record that 120 volts ac is supplied to motor starter contact input terminals.

6. Turn solar differential control to manual On. Motor starter should activate and pumps start.

7. Measure and record pump input voltage and current. These valves should be within 10% of running nameplate ratings.

8. Measure and record downstream water pressure with 1/3 hp pump running. A pressure of about 10 psi greater than that recorded in step 4 should be attained.

9. Measure and record water flow for each loop - a flow of at least 15 gpm should be read.

9.7 (cont.) TEST RESULTS

Procedure	Results
1.	Verified
2.	24V ac Verified
3.	0 Voltage Verified
4.	PA2 - 5 psi PB2 - 4 psi
5.	Verified
6.	Verified
7.	PA2 - 8 amps - 124V PB2 - 9 amps - 124V
8.	PA2 - 20 psi PB2 - 15 psi
9.	35 gpm

9.8 ITEMS TO BE TESTED: SENSOR INSTALLATIONS FOR SOLAR DIFFERENTIAL TEMPERATURE CONTROLLERS: Sensors TCA1, TCB, TSA, TSB, TCA2, TH, TSC, TR

TEST OBJECTIVE: To insure that sensor installations work properly

TEST PREREQUISITES: All sensors to be tested must be installed with wires attached and run to controller location.

TEST PROCEDURE:

1. Measure and record resistances at controller location sensor wire terminals for each sensor listed. The following values will be considered acceptable:

Sensor		Resistance in OHMS		
TCA1	With Sunlight	3600	to	5000
TCA2	With Sunlight	3600	to	5000
TCB	With Sunlight	3600	to	5000
TSA		3300	to	3900
TSB		3300	to	3600
TH		3300	to	3900
TSC		3300	to	3900
TR		3300	to	3900

9.8 (cont.) **TEST RESULTS**

Procedure No.	Results
1.	TCA1 - 4200 TCA2 - 4200 TCB - 4000 TSA - 3900 TSB - 3600 TH - 3800 TSC - 3900 TR - 3900

10.0 DEVIATIONS FROM BASELINE CONFIGURATIONS

1. The original construction documents of the solar system design specified three 1,000 gallon insulated fiberglass storage tanks. After much effort and a number of manufacturing attempts, Solar Unlimited, Inc. was not able to procure tanks of this design that would pass Solar Unlimited's stringent leak test criteria. Resulting in a decision to procure one 3,000 gallon steel tank fully insulated with 4" of urethane foam and a 2" fiberglass foil backed blanket to substitute for the three fiberglass tanks.

2. The proposed one 80 gallon expansion tank to be located in the solar mechanical storage area was replaced with two 40 gallon expansion tanks because of procurement problems with the manufacturing company that was to supply the 80 gallon expansion tanks.

3. The horizontal joints on the apoxy aggregate end walls were not installed as originally designed due to moisture problems recognized by the sub-contractor, Acounti Engineering. This resulted in the modifying of the end walls to be constructed only with vertical joints.

4. In the final system design, the heat distribution operated with three possible heat distribution modes, boiler to load; solar to load and solar preheat to boiler to load. The control function that determined the switch over between heat supplied from the solar storage or the boiler is determined by the two-stage room thermostats in the three zones. That is if any of the three thermostats were calling for 1st stage heat then the load will be supplied by solar. If any of the three zone thermostats were calling for 2nd stage heat then the solar storage is not sufficiently carrying the load and the heat distribution is switched to supply heat from the boiler. In addition, the final design included a mode that would direct the building distribution return water into the solar storage and provide solar preheated water to the boiler which would then boost the temperature and heat the load. This mode was initiated when the building distribution return water (measured by Sensor TR) was cooler than the solar storage tank temperature (measured by Sensor TS) and any building zone was calling for 2nd stage heat.

   However, after the system had been installed, checked out and was operating, it was found that the system rarely switched to the solar to load or solar preheat to boiler mode. It was discovered that the return distribution water was usually above 140° F due to the nature of the cabinet unit heaters and the building hot water distribution system.

   Further, the control logic in the solar to load mode also uses the comparison of the temperatures of the return distribution water (TR) and the solar storage water (TS) to determine whether the solar storage is warm enough to heat the building in 1st stage heating. This combination of control logic resulted in the heat distribution staying

10.0 (cont.) in the conventional boiler to load mode a majority of the time. Because the building return water was warmer than the solar storage water when the boiler was heating, the building and the solar mode never got a chance to try to carry the load.

To rectify these problems, the building distribution return sensor, TR was moved into the fan room adjacent to the boiler room, so that the TR sensor now senses the temperature of the building ambient air. This allows the solar system to try to supply the load in the first stage heat condition whenever the solar storage tank is warmer than the building (nearly always). Then if the load is not being carried by the solar system and the building temperature begins to drop further when it reaches the 2nd stage thermostat setpoint, the distribution system switches to supply heat from the boiler. When the boiler brings the building temperature up to 1st stage heat again, then the solar continues to supply heat to the building. The solar preheat to boiler mode was disabled in favor of alternative heating by solar and the boiler so that when the solar was supplying the heat the boiler was off.

This control function has a particular advantage with regard to night setback and early morning startup. Since the control logic gives solar the first chance at heating the building and since the building is cooler than 65° F after night setback, the solar can both warm the building early in the morning and at the same time reduce the solar storage tank temperature immediately for solar collection. This allows the solar system to start collecting earlier than it would otherwise and allows slightly improved collection efficiency due to lower collector inlet temperature. In the early morning warmup period, the 2nd stage (boiler) heat is inhilated for a period by a time delay relay to allow the solar to chance to warmup the building before occupancy.

11.0 PROBLEMS ENCOUNTERED

1. Bidders interest was a point of concern with members of the solar design team because local construction contractors had limited or no experience in the construction of solar space heating and domestic hot water systems. Therefore, the design team made special efforts to inform and educate the construction trades through the cooperation of F.W. Dodge reports and builders associations. The design team constructed scale models of the project and separate models detailing typical solar hardware material and its mounting system.

   Also, a pre-bid conference was held to acquaint approximately 60 persons of the construction industry with the proposed solar project which we believed gave us a realistic bid on the project.

2. Scheduling and coordination of subcontract activities and delivery of materials and equipment were common problems but these were not greater than is normal to general construction practice and no serious delays resulted.

3. Some minor disputes arose between general contractor, subcontractors, and solar hardware suppliers relative to responsibility for furnishing certain items of labor and material. These were resolved amicably through frequently-called meetings to clarify and negotiate points in question.

4. During the installation of the first pre-assembled architectural solar panel, a lifting hook swung free and broke two cover glasses. Light control lines were attached to the lifting harness hooks by the general contractor to prevent this and more care was exercised. This accident did not recur.

5. Several improvements in the automatic distribution control have also been implemented to further enhance energy conservation, and solar utilization by taking full advantage of a night setback time clock.

6. We had poor joint seals between the architectural solar panels due to ratio of joint width and depth of backer rod. This was corrected by the Contractor by replacing the backer rod at the proper depth and recaulking.

7. Care was not taken on assuring that the interior side of the pre-installed cover glass on the architectural solar panels was clean; therefore, we are having to remove, clean and install all glass.

12.0 RECOMMENDATIONS

This project has progressed from the very beginning very smoothly. The people and the organizations involved worked very well together and responded to their responsibilities as were originally outlined in the proposal. The system has so far proved to be well designed and is working even better than was anticipated. The total project costs remained within budget limits and the project was completed essentially on schedule. A number of things appear to be responsible for the overall recommendations for similar type projects in the future:

A. That specific responsibilities for all participating organizations be identified at the very beginning of a project.

B. That a formal Pre-Bid Conference be held after the publication of the plans and specifications to increase interests and in the case of solar energy to eliminate the scare factor of constructing something new.

C. That the advantages of Silicone Oil as a heat transfer fluid be considered in the design of future solar systems.

D. The system should be instrumented so as to show energy savings from this design.

13.0 Maintenance Plan

I. Scope

This plan covers the maintenance and inspection requirements for the electrical and mechanical equipment used in the Huntsville Senior Citizens Center for solar heat collecting and solar heat distribution. Previously existing mechanical equipment used in connection with the conventional gas boiler and chiller system is not affected by this plan, although certain mutual use of this interfacing mechanical equipment is involved. Previously existing maintenance procedures should continue to be used for such equipment.

The solar heating mechanical equipment affected by this plan is:

A. Solar Collector Group A (west bank collector group)
   1. Silicone solar heat transfer fluid system.
      a. Copper tubing piping system
      b. Expansion tank A
      c. 1 h.p. Model 3196 Gould pump (PA-1)*
      d. 1/12 h.p. Grudfos pump (PDHW-2)*
      e. Heat exchangers (2)

      * Located in attic over kitchen area
   2. Domestic water preheat system
      a. Copper tubing pipe system
      b. Domestic hot water storage tank
      c. 1/12 h.p. Grudfos water pump (PDHW-1) (located in domestic water tank closet)
   3. Bulk heat storage piping system
      a. Copper tubing pipe system
      b. 1/3 h.p. Bell and Gossett water pump (PA2) (located under east bank collectors)

B. Solar Collector Group B (East Bank Collector Group)
   1. Silicone solar heat transfer fluid system
      a. Copper tube piping
      b. Expansion tank
      c. 1 h.p. Model 3196 Gould Pump (PB1)
      d. Heat exchanger

2. Bulk heat storage piping system
   a. Copper tube piping
   b. 1/3 h.p. Bell and Gossett water pump (PB2)

C. Heat Distribution System
   1. Heating water piping system
      a. 1/2 h.p. Bell and Gossett pump (PH) (east end of storage tank)
      b. Three-way motorized valve (VE) (located in gas boiler mechanical room)

II. General Maintenance Requirements

The solar heating system selected for this center is virtually maintenance free. However, due to the requirement for larger than normal silicone fluid pumps, it is recommended that a monthly inspection program be implemented to insure that no silicone fluid leak occurs around the pump seal. Less frequent inspections can be scheduled after adequate operating experience with this type pump using a silicone fluid has been obtained. A summary outline of maintenance and inspection requirements is as follows:

A. Gould pumps (PA1 and PB1) - monthly -
   1. Inspect to insure no silicone heat transfer fluid leaks.
   2. Inspect lubricating oil reservoir. Add SAE #20 premium grade, non-detergent oil when oiler is less than 1/3 full.

B. Bell and Gossett 1/2 h.p. pump (PH) each October - add SAE #20 premium grade, non-detergent oil

C. Other pumps; quarterly during operating season. Inspect for normal operation.

D. Piping and tanks - quarterly during operating season. Inspect to insure leak-free operation.

E. Electrical controls require no maintenance inspection.

III. Maintenance and Inspection Requirement

A. Monthly Inspection
   1. Inspect the two 1 h.p. Gould pumps (PA1 and PB1) to make sure that there are no visible signs of silicone heat transfer oil leaks. Any sign of leak should be reported to the solar heating equipment supplier.
   2. Check lubricating oil reservoir. Oil should be visible in the reservoir; if not, immediately add #20 SAE premium, non-detergent oil. Oil level in reservoir should be maintained at least 1/3 full. Normally,

Normally, extra oil should not be required more frequently than four times per year.

3. Using the Honeywell Controller, turn "ON" the heat transfer fluid pump. The pump should operate smoothly with no significant noise or vibration present. Any unusual noise or vibration should be reported to the supplier of the solar equipment. Record the pressure reading of the 0-100 PSI gauge. This reading should normally be from 15 to 30 psi.
4. Turn the pumps OFF and record the pressure reading. Depending upon heat transfer fluid temperatures, the pressure should normally be between 5 lbs. and 10 lbs.

Note: The first year's record of pressures can be used in the future to detect system deviations or pending failures.

B. Quarterly Inspections (January, April, July, October)

1. Inspect heat transfer fluid piping where connections are made to:
   a. Pumps
   b. Valves
   c. Gauges, and
   d. Expansion tanks. Verify that no silicone fluid leaks exist. Any sign of leaks should be reported and actions taken for repair.
2. Check the Grundfos 1/12 h.p. pump in the attic (pump PDWH2) and the 1/12 h.p. Grundfos water pump located in the closet with the domestic water heater. These pumps should operate quietly. These two pumps may be manually started by turning the differential control in the domestic water heater closet to "ON". Place the control to "AUTO" after the check is completed.
3. The two Bell and Gossett 1/2 h.p. water pumps should be checked for vibration-free, leak-free operation during the October, January, and April inspection. Any vibration or water leaks should be investigated and/or repaired.

Note: The Bell and Gossett pumps (PA2 and PB2) can be manually started by switching the Honeywell differential controller to "ON". Return the switch to "AUTO" after inspections are completed.

4. The Bell and Gossett 1/2 h.p. water pump (PH) located to the east of the 3,000-gallon storage tank should be visually inspected during the October, January, and April inspection. This pump also requires annual servicing during the October inspection. This pump is turned on by fully automatic system interface controls and cannot be manually

turned on and off for inspection purposes at this level of maintenance. Records should be kept of the pumps' condition of operation, i.e. that it was or was not running during inspection, and if running whether any noise or vibration was detected. Output pressure readings should be recorded and notation made as to whether or not the pump was running at the time of the reading. Pressure readings of from 0 to 8 psi may be expected with the pump off and from 12 to 18 psi with the pump on.

C. Annual Maintenance

1. The 1/2 h.p. Bell and Gossett water pump "PH" should have oil added at the beginning of each heating season. During the October inspection, this pump should have #20 SAE premium grade, non-detergent oil added through the flip cap in the top of the bearing frame. Add oil until oil is indicated at the overflow hole on the side of the frame.

14.0 MAJOR COMPONENTS AND MANUFACTURERS' LITERATURE

Honeywell

THE S4005 AND S6005 ENERGY MANAGEMENT TIMERS PROVIDE AUTOMATICALLY TIMED, ELECTRICAL SWITCHING.

- S4005A provides spst switching; S6005A,B, and C provide spdt switching; S6005D provides dpdt switching.
- S4005A and S6005A,B have a 24 hour dial.
- S6005C and D have a 7 day dial.
- S6005B has skip-a-day feature which allows you to omit operation on any selected day or days of the week.
- S6005D has a spring wound carry-over mechanism to keep the timer on schedule during a power failure of up to 10 hours; mechanism automatically rewinds itself when power is restored.
- 120 volt or 208-240 volt models available.
- Settings can be changed as desired.
- Snap-out, replaceable time clock mechanism.
- Heavy duty, synchronous, quiet, self-lubricating motors do not require service or attention.
- Drawn steel case has hinged door with spring hasp and hole for lock. NEMA Type 1 enclosure.
- Large terminal screws for fast, easy wiring.
- Switch contact electrically isolated from clock motor terminals.

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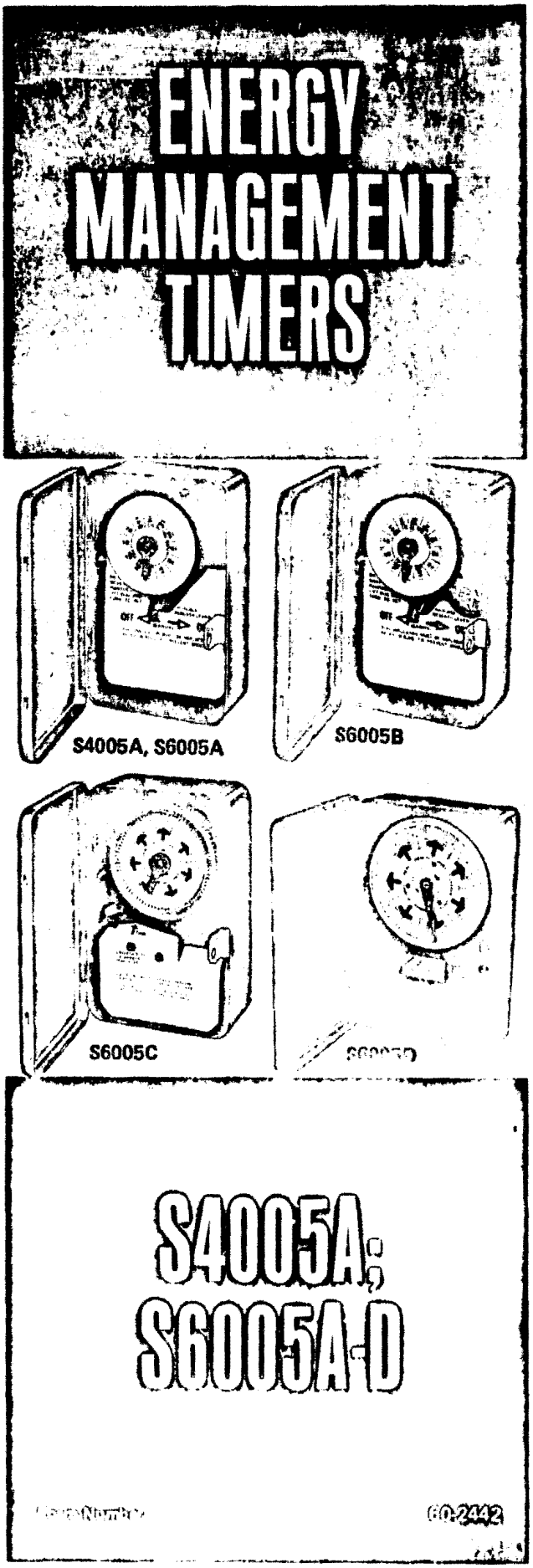

SPECIFICATIONS

IMPORTANT

THE SPECIFICATIONS GIVEN IN THIS PUBLICATION DO NOT INCLUDE NORMAL MANUFACTURING TOLERANCES. THEREFORE, THIS UNIT MAY NOT MATCH THE LISTED SPECIFICATIONS EXACTLY. ALSO, THIS PRODUCT IS TESTED AND CALIBRATED UNDER CLOSELY CONTROLLED CONDITIONS, AND SOME MINOR DIFFERENCES IN PERFORMANCE CAN BE EXPECTED IF THOSE CONDITIONS ARE CHANGED.

TRADELINE MODELS

TRADELINE models are selected and packaged to provide ease of stocking, ease of handling, and maximum replacement value.

TRADELINE MODELS AVAILABLE:

MODEL NO.	DIAL DURATION	TIMING RANGE (HOURS) "ON" TIME MIN	TIMING RANGE (HOURS) "ON" TIME MAX	TIMING RANGE (HOURS) "OFF" TIME MIN	TIMING RANGE (HOURS) "OFF" TIME MAX	MAX ON-OFF OPERATIONS PER DAY	MAX ON-OFF OPERATIONS PER WEEK	SKIP-A-DAY FEATURE[d]	10-HOUR SPRING CARRY-OVER[e]	SWITCH ACTION
S4005A	24 Hr	1	23	1	23	12[a]	–	No	No	spst
S6005A	24 Hr	1	23	1	23	12[a]	–	No	No	spdt
S6005B	24 Hr	1	23	1	23	12[a]	–	Yes	No	spdt
S6005C	7 Days	2	22	2	22	6	42[b]	–	No	spdt
S6005D	7 Days	6	166	2	162	3	21[c]	–	Yes	dpdt

[a]The basic timer includes only 1 set of trippers to provide 1 ON-OFF operation. A set of trippers must be added for each additional ON-OFF operation. See Accessories.

[b]The basic timer includes 84 permanent trippers; no additional trippers are needed.

[c]The basic timer includes 7 sets of trippers to provide 7 ON-OFF operations per week. A set of trippers must be added for each additional ON-OFF operation. See Accessories.

[d]Skip-a-day feature locks out automatic "ON" or manual "ON" switch operation on selected days of the week.

[e]A spring wound carry-over mechanism keeps the timer on schedule during a power failure of up to 10 hours. When power is restored, the mechanism automatically rewinds itself.

TIMER MOTOR VOLTAGE AND FREQUENCY: Separate models for 120 volts ac, or for 208-240 volts ac; 60 Hz.
SWITCH CONTACT RATINGS PER POLE (approved by Underwriters Laboratories Inc.):

MODEL NO.	PILOT DUTY[a] (VOLT-AMPERES)	LIGHTING (AMPERES)		MOTOR AT 120V			MOTOR AT 240V		
	AT 120V OR 240V	INDUCTIVE	TUNGSTEN	hp	FULL LOAD (AMP)	LOCKED ROTOR (AMP)	hp	FULL LOAD (AMP)	LOCKED ROTOR (AMP)
S4005A; S6005A,B	690	40	35	2	24	144	3	20	102
S6005C	345	20	20	1/2	8	48	1	8	48
S6005D	690	40	40	1	16	96	1	8	48

[a]At 24 volts ac: 125 VA maximum; 4 VA minimum for the S4005A, S6005A,B,D; 1 VA minimum for the S6005C.

(continued on page 3)

ORDERING INFORMATION

WHEN PURCHASING REPLACEMENT AND MODERNIZATION PRODUCTS FROM YOUR TRADELINE WHOLESALER OR YOUR DISTRIBUTOR, REFER TO THE TRADELINE CATALOG OR PRICE SHEETS FOR COMPLETE ORDERING NUMBER, OR SPECIFY–

1. **Order number; specify TRADELINE model.**
2. **Timer motor voltage and frequency.**
3. **Replacement parts, if desired.**
4. **Accessories, if desired.**

IF YOU HAVE ADDITIONAL QUESTIONS, NEED FURTHER INFORMATION, OR WOULD LIKE TO COMMENT ON OUR PRODUCTS OR SERVICES, PLEASE WRITE OR PHONE:

1. **YOUR LOCAL HONEYWELL RESIDENTIAL DIVISION SALES OFFICE (CHECK WHITE PAGES OF PHONE DIRECTORY).**
2. **RESIDENTIAL DIVISION CUSTOMER SERVICE**
   HONEYWELL INC., 1885 DOUGLAS DRIVE NORTH
   MINNEAPOLIS, MINNESOTA 55422 (612) 542-7500

   (IN CANADA–HONEYWELL CONTROLS LIMITED, 740 ELLESMERE ROAD, SCARBOROUGH, ONTARIO M1P 2V9)
   INTERNATIONAL SALES AND SERVICE OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD.

SKIP-A-DAY FEATURE (S6005B only): Locks out automatic "ON" or manual "ON" switch operation on any selected day or days of the week. Insert skipping screws (3 included) into proper holes in the dial for the days you wish to omit.

SPRING WOUND CARRY-OVER MECHANISM (S6005D only): Keeps the timer on schedule during a power failure of up to 10 hours. When power is restored, the mechanism automatically rewinds itself. Ideal in areas where frequent power breakdowns occur; eliminates costly resetting.

CASE: NEMA TYPE 1 (general purpose) enclosure; drawn steel with gray finish; spring hasp with hole for lock; side-hinged door.

KNOCKOUTS: Combination 1/2 to 3/4 inch [12.7 to 19.1 mm]; 5 knockouts in the S4005A and S6005A-C (1 in back, 1 in each side, 2 in bottom); 5 knockouts in the S6005D (1 in each side, 3 in bottom).

MOUNTING: Surface mounted in any position; 3 or 5 mounting holes in back of case (see Fig. 1 or 2).

FIELD WIRING: Screw terminals in spacious wiring compartment inside case; motor power and electrical contacts are isolated.

DIMENSIONS: See Figs. 1 and 2.

SHIPPING WEIGHT:

MODEL	lb	kg
S4005A; S6005A,B	2-1/2	1.13
S6005C	2-3/4	1.25
S6005D	7	3.18

ADDITIONAL FEATURES:

TRADELINE Pack with cross reference label and special instruction sheet.

APPROVALS:

UNDERWRITERS LABORATORIES INC. LISTED: File No. E10694.

CANADIAN STANDARDS ASSOCIATION CERTIFIED: File No. LR3730.

REPLACEMENT PARTS:

1. Timer Motor.
   For the S4005A and S6005A,B–192512 (120V ac), 192513 (208/240V ac).
   For the S6005C–192514 (120V ac), 192515 (208/240V ac).
   For the S6005D–192607 (120V ac), 192608 (208/240V ac).
2. Mechanism without motor.
   S4005A–192518.
   S6005A–192519.
   S6005B–192520.
   S6005C–192517.
   S6005D–192516.

ACCESSORIES:

1. Set of trippers.
   For the S4005A and S6005A,B (1 ON and 1 OFF)–192543.
   For the S6005D (16 trippers)–192546.
2. Skipping screws for the S6005B (3 per package)–192544.

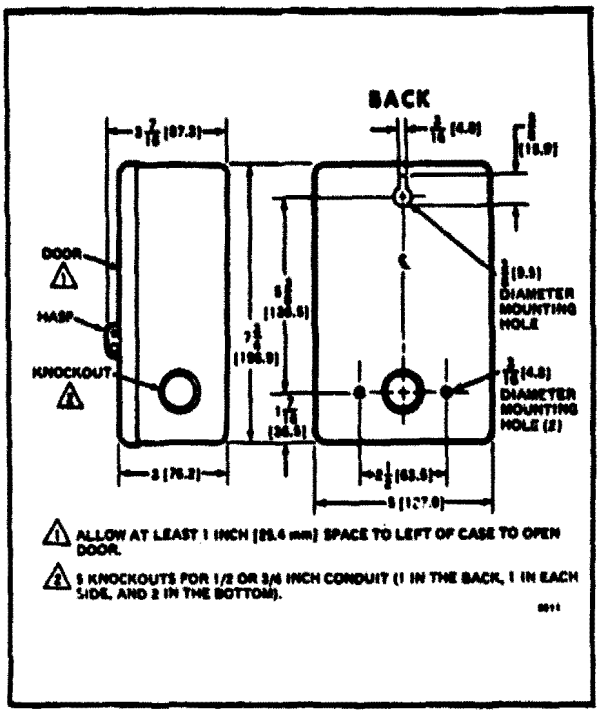

FIG. 1–APPROXIMATE DIMENSIONS OF THE CASE FOR THE S4005A AND S6005A,B, AND C MODELS, IN INCHES [MILLIMETRES IN BRACKETS].

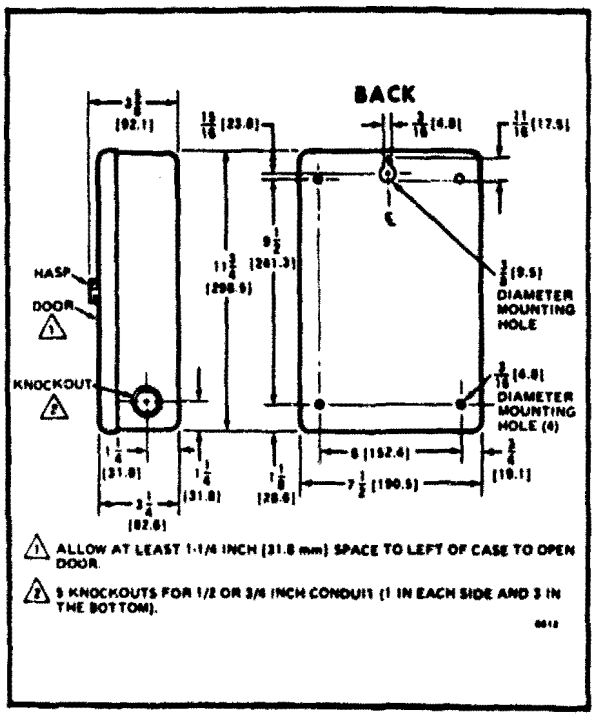

FIG. 2–APPROXIMATE DIMENSIONS OF THE CASE FOR THE S6005D MODEL, IN INCHES [MILLIMETRES IN BRACKETS].

INSTALLATION

CAUTION

1. Disconnect power supply before beginning installation to prevent electrical shock and equipment damage.
2. All wiring must comply with applicable local electrical codes, ordinances, and regulations.
3. Voltage and frequency of the power supply connected to the timer motor must match the electrical ratings of the motor.
4. Loads connected to the switch terminals must not exceed those listed in the SPECIFICATIONS section.
5. Replace the insulator covering the terminal board when wiring is completed.
6. Perform all required checkout tests after installation is complete.

LOCATION

The case is designed for indoor mounting. If the S4005 or S6005 is installed outdoors, it must be protected. Do not install the S4005 or S6005 where it could be subject to extreme vibration. Vibration could loosen the trippers and cause erratic switch operation.

MOUNTING

The S4005 or S6005 Timer can be mounted on any flat surface in any position. The case has 3 or 5 mounting holes in its back (see Fig. 1 or 2).

WIRING

Make sure all power is disconnected from the timer. As the timer motor and load contacts are isolated, more than one disconnect switch may be required. Open the door on the case and remove the insulator covering the terminal board. (On the S4005A, S6005A, and S6005B, tabs on the white insulator snap into 2 slots, one at each end of the terminal board. On the S6005C, the white insulator is held in by 2 nuts. On the S6005D, the gray insulator snaps over 2 posts on the terminal board.) Use copper wire suitable for at least 167 F [75 C]. Connect the wires to the proper screw terminals on the terminal board and tighten the screws securely. (Wiring diagrams are shown in Figs. 3-6.) Run the wires out through an appropriate knockout (or knockouts) provided in the case. *Replace the* insulator and set the timer (see the next section).

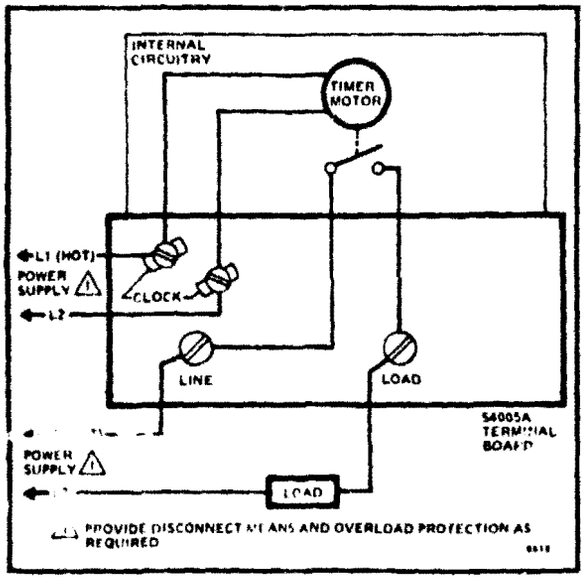

FIG. 3–WIRING DIAGRAM FOR AN S4005A TIMER.

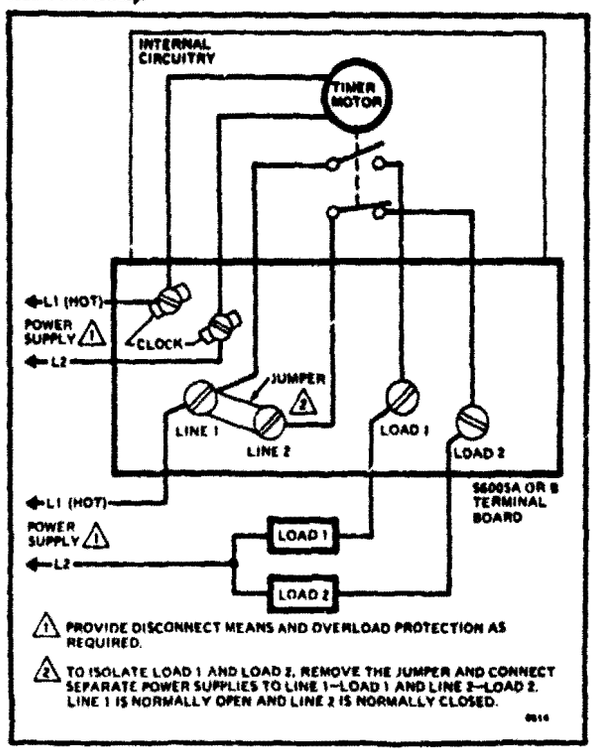

FIG. 4–WIRING DIAGRAM FOR AN S6005A OR B TIMER.

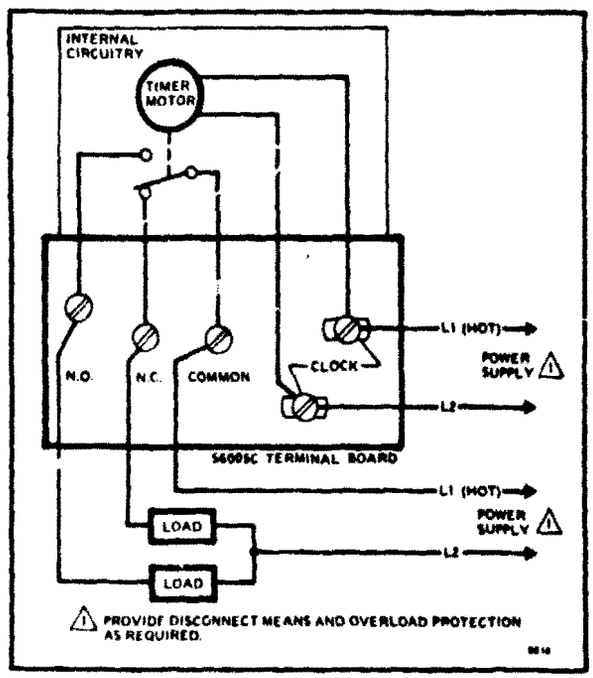

FIG. 5–WIRING DIAGRAM FOR AN S6005C TIMER.

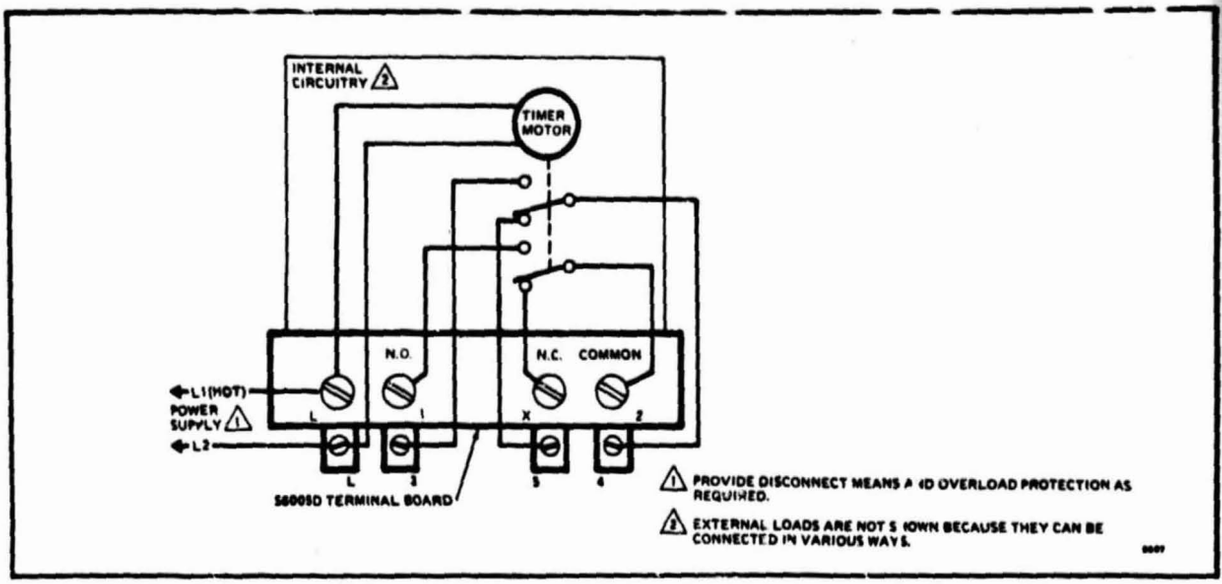

FIG. 6—WIRING DIAGRAM FOR AN S6005D TIMER.

SETTING

CAUTION

1. Do not move the TIME pointer; turn the dial to set clock to correct time of day.
2. On the S6005C:
   a. All trippers not used to set an operation must be in the maximum OUT position. Be careful not to pull them all the way out of the dial.
   b. Do not turn the dial counterclockwise ↶.
3. On the S6005D:
   a. Do not use pliers to tighten the knurled setting screws; tighten them by hand.
   b. Do not place an OFF tripper less than 6 hours after an ON tripper; minimum time from ON to OFF is 6 hours.
   c. Do not turn the dial clockwise ↷

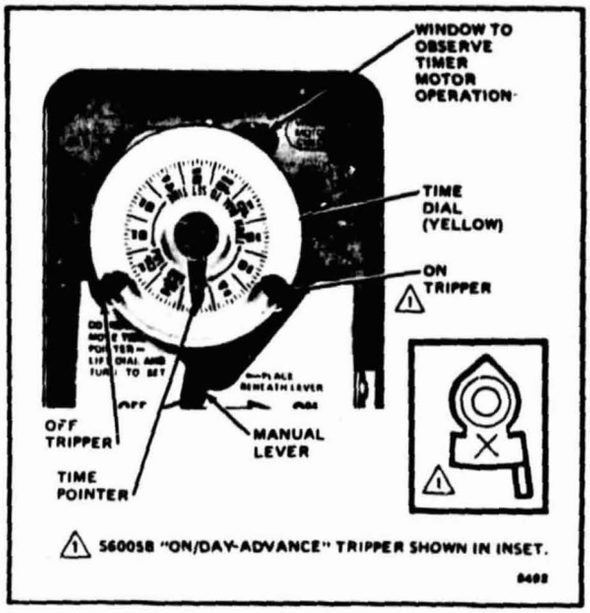

FIG. 7—SETTING 24 HOUR TIMERS (S4005A; S6005A,B).

24 HOUR TIMERS (S4005A; S6005A,B)

SETTING "ON" AND "OFF" TIMES (FIG. 7)

NOTE: 2 trippers (1 set) are included with the S4005A and S6005A and B. If more than 1 daily ON-OFF operation is required, additional trippers can be ordered (see Accessories in the SPECIFICATIONS section).

1. Loosen the screw in the tripper labeled ON (or X for the S6005B).

2. Move the ON tripper (or X tripper for the S6005B) around the edge of the time dial until it points to the time (AM or PM) you desire the switch to turn on. (When the switch is turned on, the normally open contacts will close, and the normally closed contacts will open.)

NOTE: The dial will turn clockwise ↷ when power is connected.

3. Hold the tripper firmly against the edge of the dial, and tighten the screw securely.

4. Repeat steps 1 through 3 for the OFF tripper and the time you desire the switch to turn off (normally open contacts will open, and normally closed contacts will close).

5. You can set the S4005A or S6005A or B for up to 12 ON-OFF operations per day. Place additional tripper pairs around the edge of the dial at the desired times of operation and tighten their screws securely.

(continued on next page)

IMPORTANT

a. **The minimum time between ON and OFF operations is limited to 1 hour by the width of the trippers; they cannot be set any closer together.**

b. **For the S6006B with the Skip-A-Day feature, use the ON/DAY-ADVANCE tripper (labeled X, furnished with the S6005B) for the first ON operation of the day.**

SETTING THE SKIP-A-DAY FEATURE (S6006B ONLY—FIG. 8)

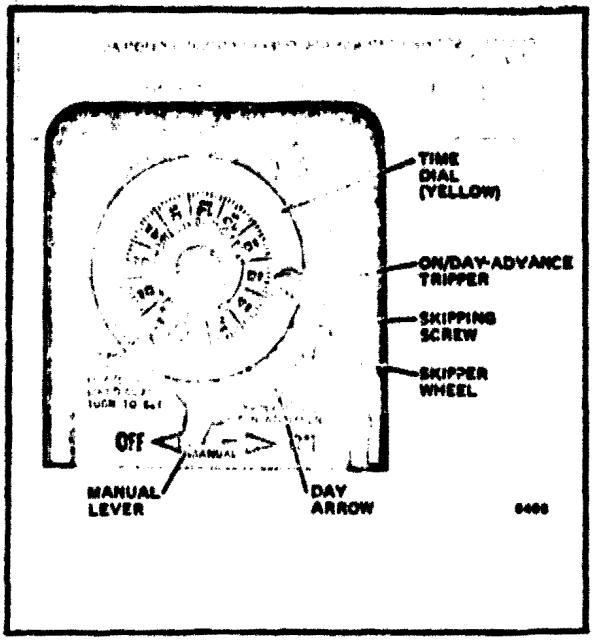

FIG. 8—SETTING THE SKIP-A-DAY FEATURE (S6005B ONLY).

1. *Manual lever* should be in the OFF position.
2. Insert a skipping screw (or screws) in the *skipper wheel* for the day (or days) on which automatic switch operation is not required. (The skipper wheel has 1 hole marked for each day of the week.)
3. Tighten the screw(s) firmly.
4. Rotate the skipper wheel until the *day arrow* points to the correct day of the week on the skipper wheel. (If the ON/DAY-ADVANCE tripper has not yet advanced the skipper wheel, the day arrow should point to the previous day. For example, if the day is Saturday, the arrow should point to Friday.)
5. Move the manual lever to the desired position.

SETTING THE TIME OF DAY (FIG. 7)

1. Apply power to the timer motor.
2. Pull the time dial outward, turn it *in either direction* until the TIME pointer is aligned with the correct time of day, and let the dial snap back into position. *Do not turn the TIME pointer.*

S6005C—7 DAY TIMER

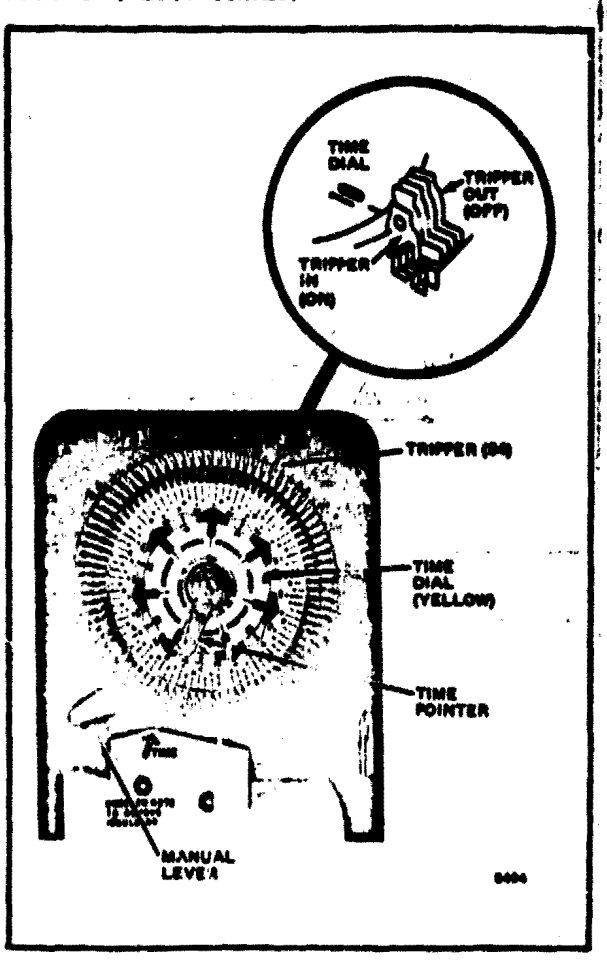

FIG. 9—SETTING THE 7 DAY S6005C TIMER.

SETTING "ON" AND "OFF" TIMES (FIG. 9)

NOTE: There are 84 permanent trippers included with the S6005C. No additional trippers are needed. The dial will turn clockwise ↷ when power is connected.

1. For an ON operation, push in the tripper opposite the desired time. Each tripper will turn the switch on for 2 hours.
2. For an OFF operation, leave the tripper in the OUT position. *Do not pull the tripper all the way out of the dial.* All trippers not pushed in will result in the switch being off (normally open contacts open, and normally closed contacts closed).
3. You can set the S6005C for up to 6 ON-OFF operations per day or 42 per week.

SETTING THE TIME OF DAY (FIG. 9)

1. Apply power to the timer motor.
2. Turn the time dial clockwise ↷ until the TIME pointer is aligned with correct time and day. *Do not turn the time dial counterclockwise ↶, and do not move the TIME pointer.*

S6005D–7 DAY TIMER

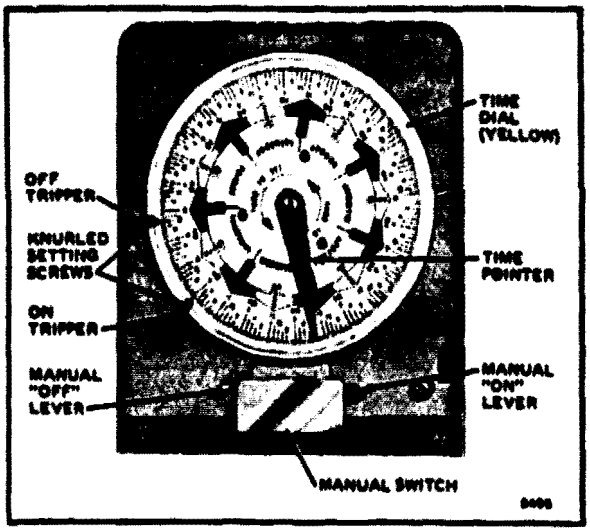

FIG. 10–SETTING THE 7 DAY S6005D TIMER.

SETTING "ON" AND "OFF" TIMES (FIG. 10)

NOTE: 14 trippers (7 sets, 1 set for each day) are included with the S6005D. If more than 7 ON-OFF operations per week are required, additional trippers can be ordered (see Accessories in the SPECIFICATIONS section).

1. For setting an ON time, hold a tripper so you can read the ON label. Insert a knurled setting screw into the tapped hole and screw it a few turns into the tripper.

2. Slip the ON tripper over the edge of the time dial, and move it around the edge of the dial until it points to the day *of the week* and the *time of the day* (AM or PM) you desire the switch to turn on. (When the switch is turned on, the normally open contacts will close, and the normally closed contacts will open.)

NOTE: The dial will turn counterclockwise ↶ when power is connected.

3. Hold the tripper firmly against the edge of the dial, and tighten the knurled screw securely by hand. *(Do not use a pliers.)*

4. For an OFF operation, hold a tripper so you can read the OFF label, and repeat steps 1 through 3 for the time you desire the switch to turn off (normally open contacts will open, and normally closed contacts will close).

5. You can set the S6005D for up to 3 ON-OFF operations per day or 21 per week. To omit operation on any day(s), don't put any trippers on the dial for that day(s).

IMPORTANT

a. The minimum time from an ON operation to an OFF operation is 6 hours; do not place an OFF tripper less than 6 hours after an ON tripper.
b. The minimum time from an OFF operation to an ON operation is limited to 2 hours by the width of the trippers; they can't be set any closer together.

SETTING THE TIME OF DAY (FIG. 10)

1. Apply power to the timer motor.

2. Turn the time dial counterclockwise ↶ until the TIME pointer is aligned with the correct time and day. *Do not turn the time dial clockwise ↷, and do not move the TIME pointer.*

OPERATION AND CHECKOUT

OPERATION

AUTOMATIC SWITCHING

When the ON tripper actuates the timer switch, the normally open contacts close and the normally closed contacts open. The contacts will stay in this position until the OFF tripper actuates the timer switch. Then the normally open contacts again open and the normally closed contacts again close. The switching times can be changed as desired (see the SETTING section).

The S4005A has an spst (single-pole, single-throw) switch. The S6005A,B, and C have an spdt (single-pole, double-throw) switch. The S6005D has a dpdt (double-pole, double-throw) switch.

MANUAL SWITCHING

The S4005's and S6005's can be switched manually by moving the *manual lever* under the time dial. The manual lever operates the timer switch the same way the ON and OFF trippers do during automatic switching.

On the S4005A, S6005A, and S6005B (Fig. 7), move the lever to the right to switch to the ON position, and to the left to the OFF position (as indicated by arrows on the lever). The timer resumes automatic operation after completion of that cycle.

On the S6005C (Fig. 9), move the lever up to the permanent ON position (indicated by an arrowhead on the mechanism plate), and down to the AUTOMATIC position.

On the S6005D (Fig. 10), move down the lever on the right of the manual switch for the ON position, and move down the lever on the left of the manual switch for the OFF position. The timer resumes automatic operation after completion of that cycle.

SKIP-A-DAY

The S6005B has a skipping wheel which allows you to omit automatic operation on any selected day or days of the week (see SETTING section). On the S6005C and D (7 day models), skipping a day or days can be accomplished by simply omitting trippers for the selected day(s).

POWER FAILURE

The S6005D has a spring wound carry-over mechanism which will keep the timer on schedule during a power failure of up to 10 hours. When power is restored, the mechanism automatically rewinds.

For the other models, in case of power failure, reset the time dial to the correct time and day after power has been restored. (See SETTING section.)

CAUTION

1. Make sure the insulator has been installed over the terminal board.
2. Use utmost care while testing or troubleshooting the timer; line voltage is present on contacts when power is on.
3. Disconnect power before removing or replacing the mechanism or timer motor.

S4005A, S6005A, AND S6005B

1. Observe the motor gears through the window in the mechanism plate to make sure the motor is operating.
2. Move the *manual lever* to its ON and OFF positions and observe that the loads are being switched properly.

S6005C AND S6005D

Manually rotate the yellow time dial (clockwise ↷ on the S6005C and counterclockwise ↶ on the S6005D) and observe that the loads are being switched properly.

If the Energy Management Timer does not operate properly during Checkout, refer to the following TROUBLESHOOTING CHART.

TROUBLESHOOTING CHART

PROBLEM	CHECK	SOLUTION
TIME DIAL DOES NOT ADVANCE	1. Is timer motor running? 2. Is proper power supply connected to the CLOCK terminals (L terminals on the S6005D)?	1. If motor is not running, check power supply. 2. If power supply is connected properly but timer motor is still not running, replace the motor.[a]
TIME DIAL ADVANCES, BUT LOADS ARE NOT SWITCHED PROPERLY	——	Replace the mechanism.[a]

[a]If the timer motor or mechanism has to be replaced, refer to the following SERVICE section.

SERVICE

CAUTION

1. Disconnect power before removing or replacing the mechanism or timer motor.
2. Replace the insulator covering the terminal board before reconnecting power, to prevent electrical shock.

REPLACING THE MECHANISM

Before replacing the mechanism, disconnect all power from the timer, remove the insulator covering the terminal board, and remove the wires from the terminal board.

The mechanism in each timer is held in place by a spring clip. To remove the mechanism, depress the spring, grasp the time dial, and pull the mechanism outward.

To avoid jamming the mechanism in the case when replacing it, make sure the notches in the terminal board (or mechanism plate on the S6005C) fit over the ears in the case. (In the S6005D, the 2 tabs on the mechanism plate should fit into the 2 slots in the left side of the case).

After replacement, connect the wires to the terminal board, replace the insulator over the terminal board, and reconnect the power.

REPLACING THE TIMER MOTOR

S4005A, S6005A,B,C

The timer motor in each timer is attached to the back of the mechanism plate by 2 screws. To remove the timer motor, first remove the mechanism as described previously. Then disconnect the 2 motor wires from the CLOCK terminals on the terminal board, and remove the 2 mounting screws from the motor. Mount the new motor using the 2 mounting screws, and connect the 2 motor wires to the CLOCK terminals on the terminal board. Then replace the mechanism.

S6005D

The spring carry-over and motor assembly is attached to the mechanism plate by 3 screws that protrude through the mechanism plate and are secured with 3 nuts. To remove the carry-over assembly, first remove the mechanism as described previously. Then proceed as follows:

1. Make a mark on the manual switch right at the end of the TIME pointer. (The pointer must be lined up with this mark later.)
2. Unscrew the Phillips screw in the middle of the yellow time dial, and remove the dial.
3. Cut the 2 yellow leadwires that go from the spring carry-over and motor assembly to the "L" terminals on the terminal board.
4. Remove the 3 nuts from the screws that hold the assembly to the mechanism, and remove the assembly.
5. Mount the new assembly, replace the 3 nuts on the mounting screws, and tighten them securely.
6. Splice the 2 yellow leadwires on the new assembly to the 2 yellow leadwires still connected to the "L" terminals on the terminal board.
7. Replace the yellow time dial. Make sure the TIME pointer is lined up with the mark on the manual switch, and then tighten the Phillips screw in the center of the dial.

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type V90CA

THREE-WAY VALVES FOR DIVERTING SERVICE

APPLICATION

These three-way valve bodies are to be used for diverting service. They have 1-inlet and 2-outlets and are recommended for two position (on/off) service. Common applications are summer-winter changeover, cooling tower by-pass, etc.

The diverting valves have a quick opening flow characteristic. Because of this, they will have a tendency to "hunt" when applied to proportional control modes.

We recommend the V90DB mixing valves listed in Bulletin 3626 be used on proportional control application. These valves must be piped for mixing service (2-inlets and 1-outlet).

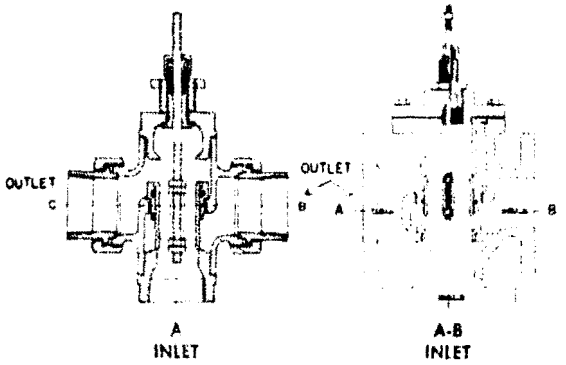
GENERAL DESCRIPTION

Motor Actuators and Linkage

These valves are positioned by Penn Series M40A or M81 motor actuators. The actuators are adapted to the valve bodies by a linkage which not only fastens the valve body and actuator together, but also transforms the angular movement of the actuator output shaft to the straight-line motion required to position the inner valve plug of the valve body. A pinion gear on the actuator output shaft drives a gear rack that is connected to the valve stem. This construction maintains the designed flow characteristics of the valve body. Clockwise motor rotation drives valve stem down.

SPECIFICATIONS

Sizes ½" to 2" have 150 lb. ASA bodies with bronze trim. Cylinder shaped inner valve plug gives a quick opening flow characteristic. They have union type pipe connections on the two side ports "C" and "B" and a screwed end connection on bottom port "A", metal-to-metal seating and asbestos rope packing.



Cross section view of typical Three-Way Valve in sizes ½" to 2".

Cross section view of typical Three-Way Valve in sizes 2½" to 6".

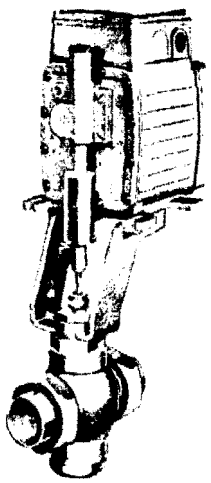


Fig. 1 — Motor Actuated Valve

Sizes 2½" to 6" are the same as above except 125 lb. ASA flanged semi-steel body with bronze trim. All diverting valves have a maximum media temperature of 281° F.

VALVE SIZING

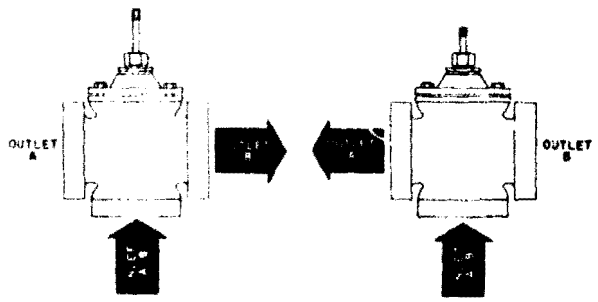
For liquid applications, see Bulletin 3334 (valve size selection chart).

ORDERING INFORMATION

To order, specify:

1. Valve Body Product Number.
2. Valve Linkage Product Number.
3. Motor Actuator Product Number.
4. Factory assembled, if required.
5. Water temperature and pressure.

Example: One V90CA-1 Valve Body, one Y20AAA-1 Valve Linkage and one M81AAA-12 Motor Actuator with 60 sec. timing completely factory assembled; for 180° F. water at 25 psi.



Direction of flow with stem up.

Direction of flow with stem down.

SPECIFICATIONS

Valve Body Number	Valve Body Size (Inches)	C_v	Linkage Required (Order separately to match valve and motor selected)			Max. Pressure Difference Outlet "A" to Outlet "B"	Valve Lift (Inches)	Shipping Wt. - Lbs. (Valve Only)
			Standard Series M81	Spring Return Series M81	Series M40A			
V90CA-1	½	5.5	Y20AAA-1	Y20ABA-1	Y20EAA-1	50	⅜	3.5
V90CA-2	¾	9.0	Y20AAA-1	Y20ABA-1	Y20EAA-1	50	⅜	3.8
V90CA-3	1	18.0	Y20AAA-1	Y20ABA-1	Y20EAA-1	50	⅜	5.3
V90CA-4	1¼	27.0	Y20AAA-1	Y20ABA-1	Y20EAA-1	50	⅜	7.4
V90CA-5	1½	32.0	Y20AAA-1	Y20ABA-1	Y20EAA-1	50	⅜	9.8
V90CA-6	2	50.0	Y20AAA-1	Y20ABA-1	Y20EAA-1	50	⅜	15.8
V90CA-7	2½	51.0	Y20AAB-2	Y20ABB-1	None	50	⅜	63
V90CA-8	3	75.0	Y20AAB-2	Y20ABB-1	None	50	¾	70
V90CA-9	4	152.0	Y20AAB-2	None	None	50	1	75
V90CA-10	5	220.0	Y20AAB-2	None	None	50	1 1/16	140
V90CA-11	6	302.0	Y20AAB-2	None	None	50	1 1/16	160

INSTALLATION

Upright mounting is recommended but valve assemblies can be mounted in other positions provided the output shaft is horizontal.

Ambient temperature plus heat transferred from the valve through the linkage must not cause the motor temperature to exceed its limit of 135° F.

Motor-actuated valves are available either completely factory assembled and tested or as individual components; valve body, valve linkage, and motor actuator.

CHECKOUT PROCEDURE

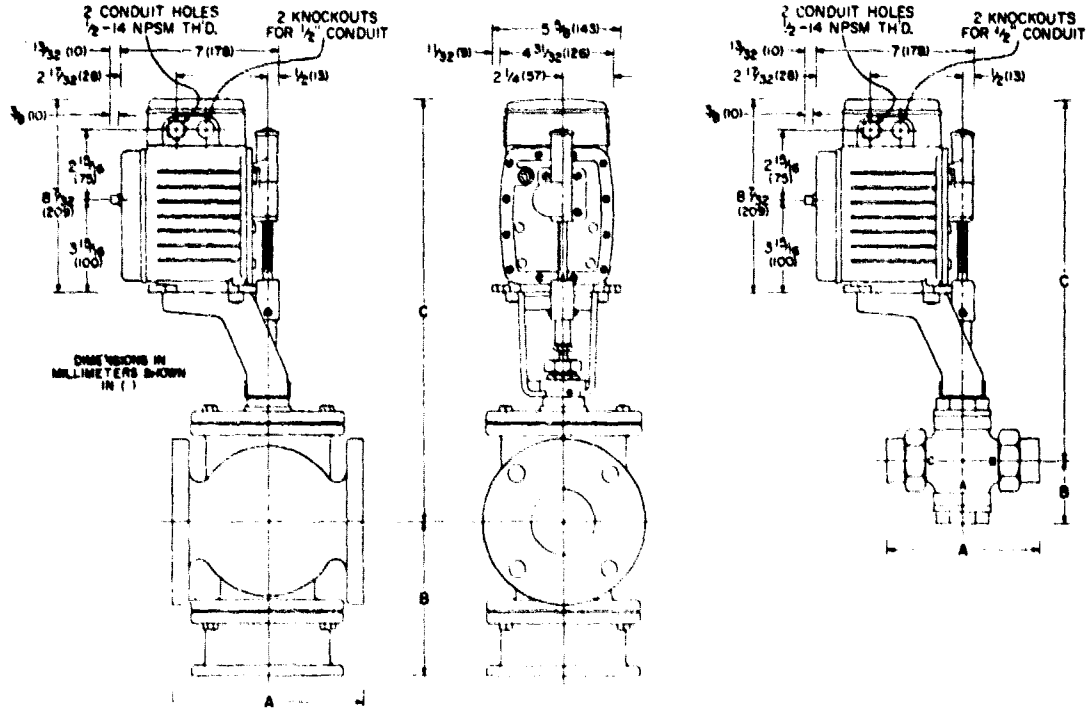
Make sure valve stem moves freely after valve is installed. The valve joints and seals should be checked to be sure there are no leaks.

After linkage and motor actuator are assembled to the valve, a complete operating cycle should be observed to be sure all components are functioning properly.

REPAIRS AND REPLACEMENT

Replacement of valve stem, valve plug and packing may be made in the field. When ordering replacement parts, give Valve Body Number and complete description of the part required.

DIMENSIONS



Valve Size	A	B	C	Valve Size	A	B	C
½"	4 7/8" (124)	2" (51)	14 5/8" (371)	2½"	9" (229)	7 1/16" (179)	17 1/4" (438)
¾"	5 1/4" (133)	2 3/16" (56)	14 13/16" (376)	3"	10" (254)	7 15/16" (202)	18" (457)
1"	5 1/2" (140)	2 5/16" (59)	14 15/16" (379)	4"	13" (330)	10 1/8" (257)	18 7/8" (479)
1¼"	6 3/4" (171)	2 5/8" (67)	15 1/4" (387)	5"	12" (305)	10 11/16" (271)	19 3/8" (492)
1½"	7 7/16" (189)	3 1/8" (79)	15 1/2" (394)	6"	14 1/8" (359)	11 1/4" (286)	20 3/8" (518)
2"	8 7/16" (214)	3 3/16" (81)	15 3/4" (400)				

Performance specifications appearing herein are nominal and are subject to accepted manufacturing tolerances and application variables.

Litho in U.S.A.

8 5-75

series Y20

AUTOMATIC HEATING-COOLING

Change-over Linkage
(Was Series MV)

APPLICATION

This linkage set, used with a proportional motor actuator and selected auxiliary switch kit operates a heating valve and up to four stages of mechanical cooling in sequence. The room thermostat should be a proportional electronic or electric (135 ohm) type.

A typical application is sequencing a steam coil control valve with travel through a given dead band and then actuating (with an auxiliary switch kit) one, two, three or four compressors or refrigerant solenoid valves.

Figure 1 illustrates the assembly of the automatic change-over linkage set to the motor and valve.

GENERAL DESCRIPTION

The linkage fastens the valve body and a 60 second speed motor actuator together and also provides the means for transforming the angular movement of the actuator output shaft to the straight-line motion required to position the inner valve of the valve body.

LINKAGE SELECTION TABLE

Valve Bodies *	Valve Linkage Number	Remarks
V90CA-1 thru V90CA-6	Y20ADA-1 (Was MV1036)	½" to 2" 3-way bodies For Diverting service
V90AA-10 thru V90AA-15	Y20ADA-2 (Was MV1043)	½" to 2" 2-way bodies
V90DB-1 thru V90DB-6		½" to 2" 3-way bodies For Mixing service
V90AA-7 thru V90AA-9	Y20ADB-1 (Was MV1042)	2½" to 4" 2-way bodies
V90DB-7 thru V90DB-9		2½" to 4" 3-way bodies For Mixing service

* The max. close-off ratings are ⅓ of that specified in Bulletins 3624, 3626, 3627 and 3690.

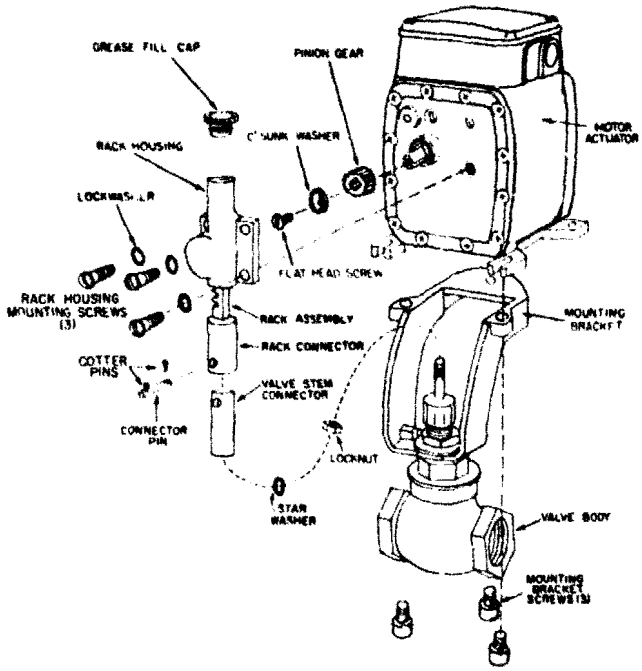


Fig. 1 — Diagram showing assembly of valve linkage set connecting valve body to motor actuator.

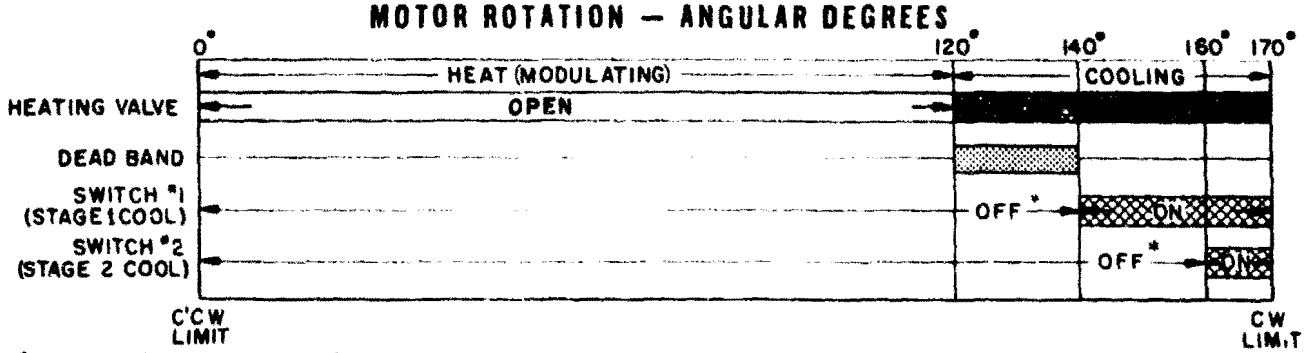
ORDERING INFORMATION

To order specify:

1. Linkage Number (see Specification Table.)
2. Motor actuator (see Series M80, M81 Bulletins.)
3. Valve body (see Series V90 Bulletin.)
4. Auxiliary switch kit (see Series S91 Bulletin.)
5. Factory assembly, if required.

Example: One V90CA-3 Valve Body, one Y20ADA-1 Valve Linkage, one M80BAA Motor Actuator and one S91BA Switch Kit.

MOTOR ROTATION — ANGULAR DEGREES



* NOTE: (1) If two or more stages of cooling are used, increase motor stroke to 170°. (2) Readjust auxiliary switch differentials to 10°.

INSTALLATION AND MOUNTING

WHEN INSTALLING TO A SERIES M81 WITH SNAP-ACTING TRAVEL LIMIT SWITCHES OR SERIES M80F MOTOR ACTUATOR, FOLLOW THE INSTRUCTIONS PACKED WITH THE MOTOR.

Install the motor-actuated valve in a location where the ambient temperature does not exceed 125° F. Valve medium temperatures above 250° F. are permissible only if the maximum ambient temperature at the motor is reduced to 105° F. Valve controlling mediums exceeding 320° F. must be equipped with cooling fins or extension bonnets to reduce the motor housing temperature to 160° F. maximum.

The motor-actuated valve should be mounted in an upright position. Positions other than upright are acceptable if the motor actuator output shaft is kept horizontal.

Two-way globe valves should be intalled with pressure under the seat unless a direction arrow on the valve body indicates otherwise. Refer to three-way valve installation instructions for proper valve body installation.

To field assemble this valve linkage:

1. Assemble the pinion gear to the main shaft of the motor actuator with screw and washer provided.

   Liberally apply a heavy transmission grease to the pinion gear. Remove the position indicator cover.
2. *Electrically power motor actuator to clockwise limit by connecting 24 V. A.C. to terminals 2 and 7.*

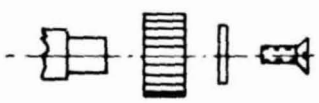


Fig. 2 — Pinion gear and screw.

3. Slide the rack assembly into the rack housing with the first scribe mark on rack flush with lower edge of rack housing.
4. Assemble rack housing to motor (holding the rack scribe line position as shown in Figure 3) to mesh the pinion and rack teeth.

   NOTE: The scribe lines may disappear into the rack housing *or* both lines may just be visible depending upon the teeth engagement. *The lower scribe mark should be visible.*

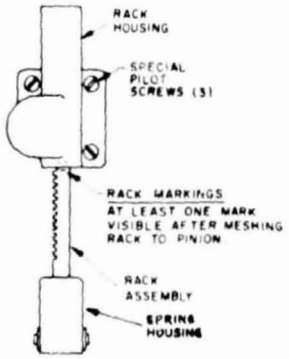


Fig. 3 — Rack assembly and rack housing. Note rack marking position.

Fig. 4 — Interior close-up of motor actuator showing travel adjusting screw.

5. Lock the assembly to the motor housing using the three rack housing mounting screws supplied in the linkage kit.
6. *Adjust motor travel to minimum by rotating travel adjustment screw (Fig. 4) 10 complete turns clockwise.*
7. Assemble parts as shown in Figure 5. Tighten the valve jam nut (not the packing nut).
8. Assemble valve and mounting bracket assembly to

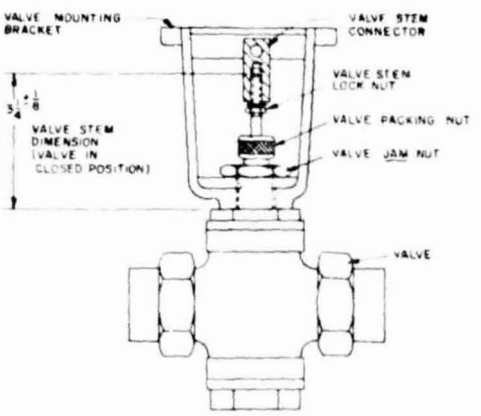


Fig. 5 — Valve body mounted to bracket.

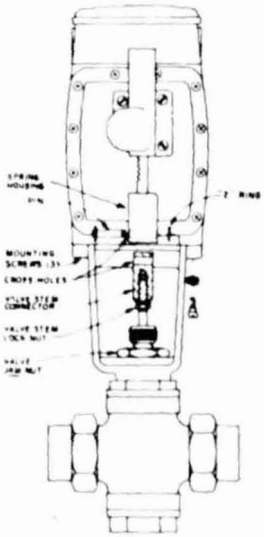


Fig. 6 — Motor assembled to valve body.

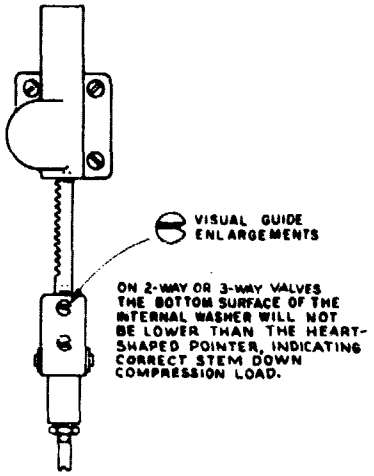


Fig. 7 – Properly assembled linkage will have the visual guide in the position shown.

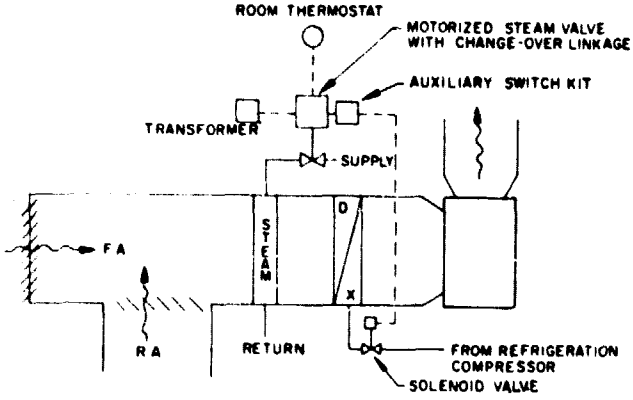
the motor actuator housing with the three mounting bracket screws.

9. Motor travel adjustment.
   a. *Determine valve stem travel of valve — Pull valve stem up and then push down as far as possible and measure the amount of valve stem movement that is available.*
   b. Single stage cooling — the amount of rack "lift" required equals the actual valve travel + .250 inches.
   c. Two or more stages of cooling — the amount of rack "lift" required equals the *actual valve travel + .325 inches.*
10. Electrically power the motor actuator to the "rack up" position by connecting 24 V. A.C. to terminals 3 and 7. Allow it to run until it stops itself. (Measure this movement.)
11. *Slowly rotate the travel adjustment screw counter-clockwise until the rack has moved up the same total distance as determined in paragraphs 9b or 9c.*
12. *Pull the valve stem up.* Rotate the valve stem connector until the crosshole of the connector lines up with the cross-hole in the spring housing. Insert the pin in place with the snap rings.
13. *Three-way valves* — Rotate travel adjustment an additional revolution counter-clockwise. This assures tight closure on both the upper and lower valve seats.
14. Replace the position indicator cover.
15. Re-apply 24 V. A.C. power to terminals 2 and 7 until motor stops. See Figure 7 for visual means to denote properly assembled units.

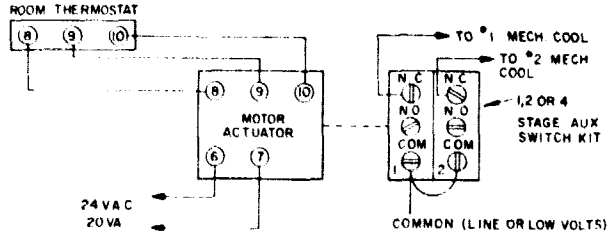
SEQUENCE OF OPERATION

Room thermostat modulates a steam valve to maintain temperature. A rise in room temperature causes the valve to close. On a continued temperature rise, motor actuator continues to rotate and turns on mechanical cooling. When room temperature drops reverse procedure occurs.

TYPICAL APPLICATION DIAGRAM



TYPICAL WIRING DIAGRAM



NOTE: If a low limit is required, select a proportional controller with two 135 ohm potentiometers in series and wire as a 270 ohm control. Wire in series with the room thermostat in the number 9 leg. The low limit must be removed from circuit during cooling cycle.

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PENN PRODUCTS DIVISION PENN CONTROLS, INC.

INSTALLATION AND OPERATION INSTRUCTIONS

SERIES Y20

FORM 997-739

ADJUSTMENT INSTRUCTIONS FOR NORMALLY CLOSED SPRING RETURN VALVE ACTUATOR

Use Linkage Y20ABA-1, -2, Y20ABB-1, -2
(Was Series MV)

APPLICATION

Valve Linkage sets are used with a Series M80 or M81 Motor Actuator and selected valve bodies to electrically control steam, water, gas, etc. Valve bodies are single seat, double seat, three-way, pilot balanced, or other similar construction.

DESCRIPTION

The linkage sets include the parts necessary to mount motor actuators directly to valve bodies.

The motor actuator is secured to the valve body by a die cast mounting bracket (see Fig. 3). Usually the bonnet or stuffing box of the valve body is threaded and a jam nut secures the bracket to the body. Each bracket has the proper hole size to accommodate the bonnet of the specific valve body being used.

A rack and pinion gear arrangement transforms the rotary movement of the motor actuator output shaft to the straight-line movement necessary to position the valve stem. On one end of the rack assembly is a threaded valve stem adapter which secures the mechanism to the valve stem. A series of disc type springs insure positive valve closure.

NOTE: The rack assembly movement can easily be changed from ½" to ⅞" by adjusting the motor actuator travel limits (see Fig. 2). Since the valve stem travel varies with valve size and type, this feature allows the use of one motor actuator on almost any valve body.

The motor is factory set for a valve stroke of ⅞".

LOCATING AND MOUNTING

WHEN INSTALLING TO A SERIES M81 WITH SNAP-ACTING TRAVEL LIMIT SWITCHES OR SERIES M80F MOTOR ACTUATOR, FOLLOW THE INSTRUCTIONS PACKED WITH THE MOTOR.

Install the motor-actuated valve in a location where the ambient temperature does not exceed 125° F. Valve

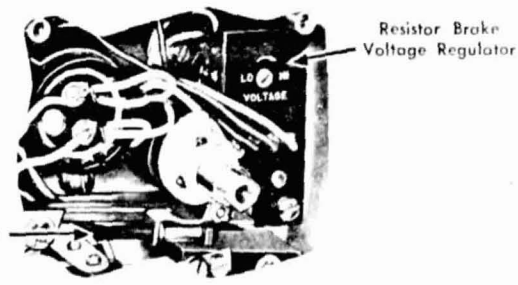


Fig. 2 — Interior of motor actuator showing travel adjusting screw.

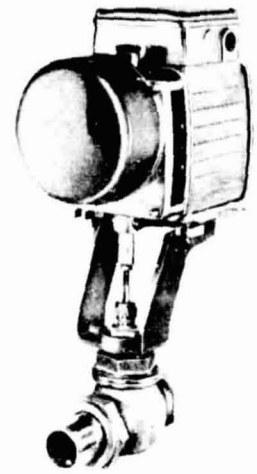


Fig. 1 — Valve linkage set fully assembled to motor actuator and valve body.

medium temperatures above 250° F. are permissible only if the maximum ambient temperature at the motor is reduced to 105° F. Valve controlling mediums exceeding 320° F. must be equipped with cooling fins or extension bonnets to reduce the motor housing temperature to 160° F. maximum.

Upright mounting is recommended, but valve assemblies can be mounted in other positions if the motor actuator output shaft is kept horizontal.

Two-way globe valves should be installed with pressure under the seat unless a directional arrow on the valve body indicates otherwise. Three-way valves should be installed as mixing valves; namely, two inlets and one outlet whenever possible.

Motor-actuated valves are available either factory assembled and tested or as individual components; valve body, valve linkage, and motor actuator. If shipped "knocked down" or if for any reason the motor actuator must be field assembled to the valve body, refer to assembly diagram (Fig. 3) and proceed as follows.

1. Assemble mounting bracket to valve body.
   Valves with threaded bonnets — Remove jam nut and, where necessary, packing nut from valve body. Slip mounting bracket on valve bonnet and insert tool "A" between bottom of bracket and top of valve mounting surface. Tool "A" should be inserted so its two fingers lie flat on valve mounting surface with one finger on each side of the threaded bonnet. Secure mounting bracket to valve body with the jam nut with tool "A" in place. Replace packing nut (if it was necessary to remove).

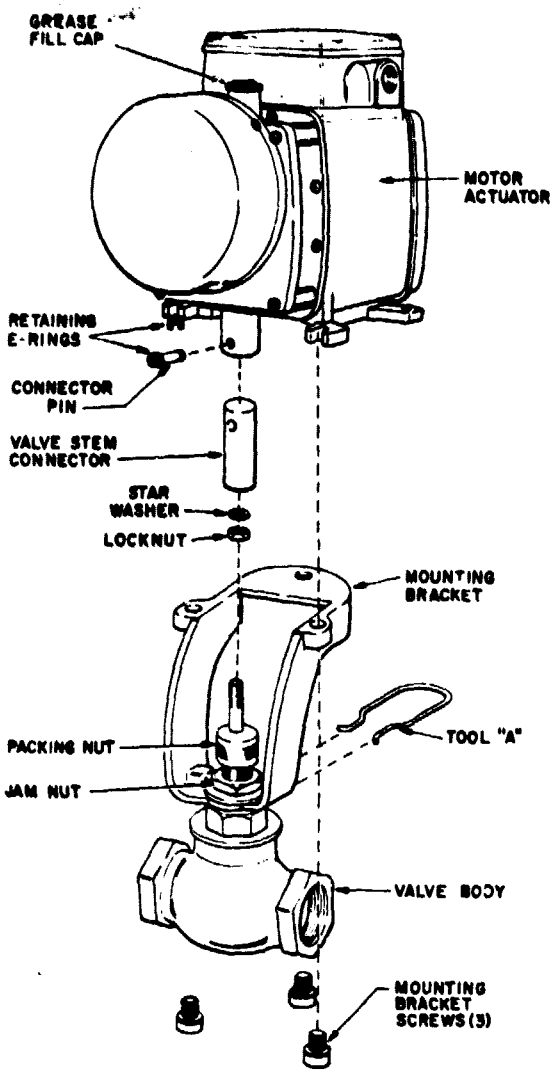


Fig. 3 — Drawing showing assembly sequence.

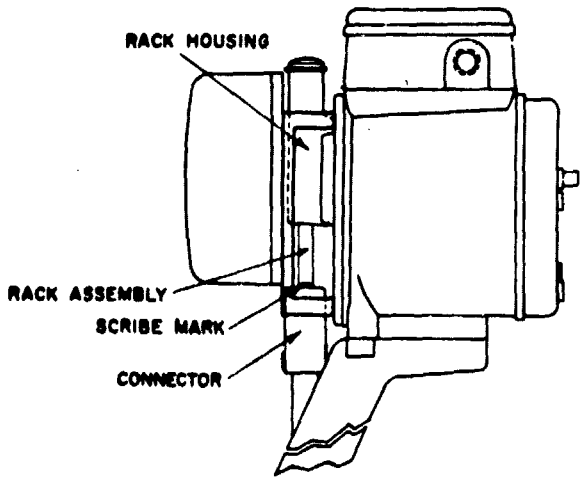


Fig. 4 — Drawing showing scribe mark.

2. Pull valve stem up and then push down as far as possible and measure the physical stem travel that is available.
3. Thread connector lock nut and valve stem connector as far down the valve stem as possible. Secure the motor actuator to the mounting bracket with the three screws provided. Next, start turning the valve stem connector counterclockwise while keeping the valve stem from moving. As soon as the through hole of the connector lines up with the mating hole of the rack assembly, insert the connecting pin and snap in the retaining E-rings. Now tighten the connector lock nut up against the valve stem connector.
4. Apply 24 V. A.C. power to terminals 6 and 7, apply a jumper between terminals 1 and 3 until valve stem rises approximately ¼ inch. Loosen the valve bonnet jam nut and remove tool "A." Re-tighten valve bonnet jam nut against valve mounting bracket. Re-apply the jumper to terminals 1 and 2 until motor stops running. **NOTE:** At this point if all settings have been properly made, the bottom scribe mark will be in line with the top of the spring housing.
5. Remove back cover from motor actuator and refer to the "limits of travel adjusting screw" (Fig. 2). If, from step 2, the available valve stem travel was found to be less than ⅞ inch, turn travel adjusting screw clockwise approximately 8 complete turns.
6. Connect a jumper to terminals 1 and 3 on motor actuator and allow it to run until it stops itself. Measure the distance the valve stem has traveled. If additional stem travel is required, slowly turn adjusting screw counter-clockwise until the exact amount of valve stem travel occurs. **NOTE:** On three-way valves, an additional .040 of an inch movement in the rack assembly should be provided for, when setting the travel adjusting screw. This assures positive valve closure in the stem-up as well as the stem-down position.
7. Replace cover on motor actuator.

RESISTOR BRAKE VOLTAGE REGULATOR

Occasionally, incoming voltage to the transformer will be above or below the normal 10% allowance on line voltages. When this occurs, the valve stem will oscillate up and down continuously on either the CW or C'CW electrical travel limit.

A brake voltage regulation potentiometer is built into the motor actuator. Place a volt meter across terminals 6 and 7. Read the *operating voltage*. If this voltage is above 26.5 V. A.C., rotate the regulator potentiometer towards "HI" until oscillation stops. The opposite is done if the voltage on terminals 6 and 7 is less than 22.5 V. A.C.

Bulletin No. 3801-B Catalog Section M
Supersedes 3801-A Series M81

JOHNSON CONTROLS

Johnson Controls, Inc.
Penn Division

2221 Camden Court
Oak Brook, IL 60521

Series M81 Motor Actuator On-Off and Floating Control Action

APPLICATION

These motor actuators position air dampers, control valves, programming devices, burner fuel valves, and similar equipment in heating, air conditioning and industrial applications.

FEATURES

- Enclosed, snap acting travel limit switches.
- Travel limits are field adjustable by adjusting internal cam.
- All motor actuators have weather-resistant enclosure as standard.
- Models available with an internal, adjustable differential auxiliary switch.
- Oil immersed gear train provides minimum maintenance, quiet operation and long life.

GENERAL DESCRIPTION

These motor actuators have a capacitor-run motor enclosed in a gasketed die cast case with mounting feet. An output shaft actuates cam-operated, snap acting switches which stop the shaft rotation at predetermined limits of travel.

There are three basic Series M81 motor actuators; standard on-off, spring return damper and spring return valve.

The spring return damper model has a heavy gauge built-in spring mechanism to return the motor shaft to its full CCW limit on power failure or interruption. An electrical holding circuit prevents the return spring from driving the motor actuator towards its normal position unless the power is interrupted. The external spring housing and optional internal auxiliary switch are installed on opposite sides of the motor actuator. At no time is it necessary to disconnect the damper and remove the spring housing for access to the auxiliary switch.

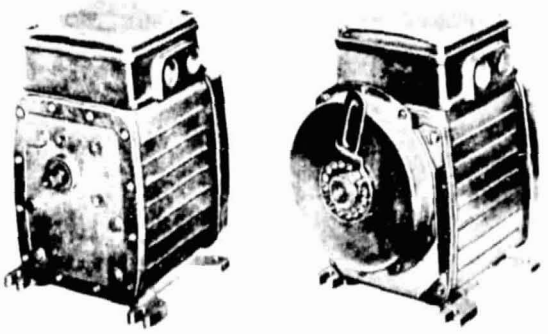


Fig. 2 — Load end view of non-spring return motor actuator (left) and spring return damper motor actuator (right).

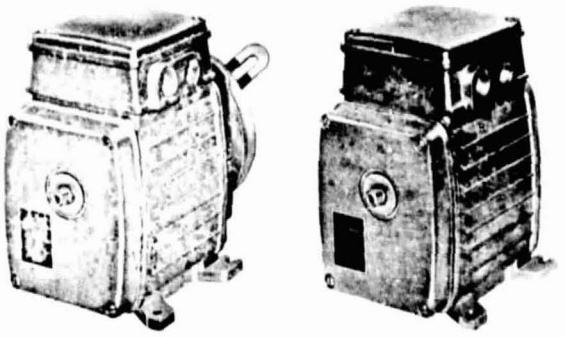


Fig. 1 — Back view of motor actuator. Spring return damper (left) and non-spring return (right).

An adjustable crank arm on the output shaft for easy connection is standard on the spring return damper motor. It is slotted to allow an adjustable radius from 1 11/16" to 2 7/8". The crank arm can be secured to the motor actuator shaft in position increments of 22½ angular degrees.

The spring return valve model has a heavy gauge built-in spring mechanism to return the valve to its normal position on power failure or interruption. It has the same holding circuit as the spring return damper motor actuator.

The spring return valve motor actuator is available for normally open (N.O.) and normally closed (N.C.) valve operation. The field adjustable travel is from 0.4" to 1.3" valve stem movement for both spring return and non-spring return valve applications.

The motor actuator can be mounted in any position except upside down. However, mounting with the output shaft horizontal is recommended, and upright mounting is preferred. Spring return actuators must be mounted within 30° of upright.

The motor should travel through its full stroke (determined by its limit switches) while performing its function, even though the motor's full range may not be employed. Motor may be *damaged* if it is not free to complete its full stroke. The motor should be stopped at the end of its stroke by the limit switch, *not* stalled by the damper or valve.

SPECIFICATIONS

Shaft Specifications: Double ended, 3/8" square.

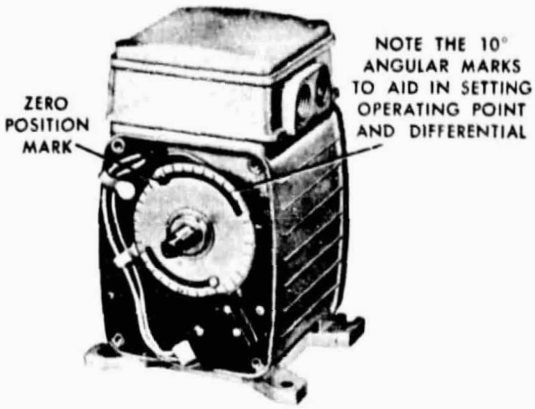


Fig. 3 — Interior view showing auxiliary switch adjusting cam.

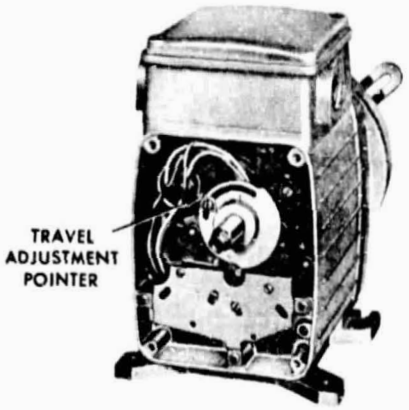


Fig. 4 — Interior view showing travel limit cam on spring return damper actuator.

Control Requirements: SPDT On-Off or floating control with minimum three-wire rating of 1 amp. at 24 V. A.C.

Power Requirement: 20 VA., 24 Volts A.C., 50/60 Hz. Spring return damper models with internal heater require 50 VA.

Enclosure: Die cast natural aluminum provides a light and rugged case. This time proven construction is used in all models.

Built-in Auxiliary Switch: SPDT, adjustable range from 0 to 160°, adjustable differential from 5 to 90°.

Internal Heater (M81AFA Spring Return Damper Motor): The thermostat control closes circuit to heater when ambient temperature drops below 20° F (−7° C) and opens circuit when temperature rises above 50° F (10° C). It cannot be field installed.

Conduit Openings: Two threaded openings for ½" conduit.

Electrical Ratings at 131° F (55° C) Ambient

Volts A.C.	120 V.	240 V.	277 V.
Full Load Amps.	5.8	2.9	2.6
Locked Rotor Amps.	34.8	17.4	15.6
Non-Inductive Amps.	10.0	8.3	7.2
Pilot Duty 125 VA. at 24 to 300 V. A.C.			
Maximum Connected Load 2000 VA.			

Ambient Temperature

Type Number	Minimum		Maximum	
	°F	°C	°F	°C
M81AAA, M81AAB, M81AFA*	−40	−40	+131	+55
M81ACA, M81ACB, M81ADA, M81AEA	+10	−12	+131	+55

*Includes internal heater.

PRODUCT NUMBER SELECTION

Product Number	Timing (1) Secs./160°	Travel Standard Factory Setting	Auxiliary Switches	Internal Heater	Application
*M81AAA-12	60	90°	None	No	Valve or damper
*M81AAB-5 (2)	60	90°	1	No	Valve or damper
*M81ACA-3	60	90°	None	No	Spring return damper CCW
*M81ACB-1 (2)	60	90°	1	No	Spring return damper CCW
*M81ADA-2	60	0.4" lift	None	No	Valve stem normally down Spring return valve
*M81AEA-2	60	0.4" lift	None	No	Valve stem normally up Spring return valve
*M81AFA-2	60	90°	None	Yes	Spring return damper CCW

(1) See Specification Table for additional timing information.
(2) U.L. Listed.
*Models available from stock.

SPECIFICATIONS

Type Number	Timing in seconds (Nominal) Angular travel 160° (2.8 rad)	Torque (1) lb.-inches Newton Meters in ( )	Damper (3) Rating - Sq. ft. Sq. Meters in ( )	Field Adjustable Rotational Travel
M81AAA, M81AAB	15	40 (4.5)	17.5 (1.6)	65° to 270° (1.1 to 4.7 rad)
	30	80 (9)	35 (3)	
	60	150 (17)	70 (6.5)	
M81ACA, M81ACB, M81AFA	60	30 (3.4)	35 (3)	65° to 180° (1.1 to 3.2 rad)
M81ADA, M81AEA	60 seconds for 1" valve lift	75 lb. valve stem thrust	—	0.4" to 1.3" (2)

(1) Torque ratings are for load end of shaft.
(2) Includes 0.1" overtravel for seating of 2-way valves or 0.2" overtravel for 3-way valves.
(3) For dampers incorporating extensive seals for low leakage, these figures should be reduced to as much as ¼. Contact damper manufacturer. Auxiliary output shaft is limited to a maximum dead weight of 25 lbs.

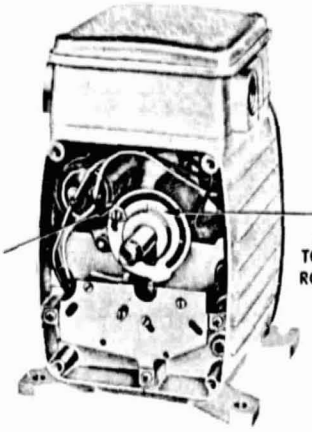


Fig. 5 — Interior view showing travel limit cam on non-spring return actuator.

OPTIONAL CONSTRUCTION

Position Indicator: Kit No. PTR11A-600 is available, if required. It contains an indicator pointer and two pressure sensitive mylar decals. For field installation only. Available no charge when ordered with motor actuator.

Travel Limit Setting: Standard setting is 90 angular degrees. Other factory settings are available at increased cost. Consult Customer Service.

ACCESSORIES

Damper Linkage Components: A variety of crank arms, ball joint connectors, push rods and a right angle mounting bracket provide easy connection of the motor actuator to a damper. Two complete sets are offered to simplify selection of proper components.

Description	Part No.	Application or Construction
Damper Linkage Set	Y20DAA-2	For mounting of actuator to top of duct or any flat surface. Contains LVR27A-602, LVR27A-600, SWL10A-601 (2 ea.), and ROD16-3.
	Y20DAB-2	For mounting of actuator to side of duct or wall. Contains LVR27A-602, LVR27A-600, SWL10A-601 (2 ea.), ROD16-3, and BKT22A-602.
Crank Arms	LVR27A-600	For use on $\frac{1}{2}$" or $\frac{7}{16}$" diameter damper shafts. Adjustable radius from $\frac{3}{4}$" to $4\frac{1}{2}$".
	LVR27A-602	For use on motor actuator. Adjustable radius from $1\frac{11}{16}$" to $2\frac{7}{8}$".
	BKT19A-600	Damper angle bracket to connect linkage to damper blade.
Ball Joint Connector	SWL10A-601	With $\frac{1}{4}$"-28 diameter stud — use with LVR27A-602, LVR27A-600, and BKT19A-600 crank arms.
Push Rods	ROD16-2	$\frac{5}{16}$" diameter x 48" long plated steel shaft.
	ROD16-3	$\frac{5}{16}$" diameter x 24" long plated steel shaft.
Mounting Bracket	BKT22A-602	Right angle mounting bracket.

RIGHT ANGLE BRACKET
BKT22A-602

CRANK ARM ASSEMBLY
LVR27A-602

DAMPER BRACKET
BKT19A-600

BALL-JOINT CONNECTOR
SWL10A-601

CRANK ARM
LVR27A-600

Externally Mounted Auxiliary Switch Kits: Use Penn Series S91 switch kit. These kits are available with one, two or four SPDT snap acting switches. They can be mounted on either shaft end of the motor actuator and incorporate the time proven, reliable, Pennswitch construction.

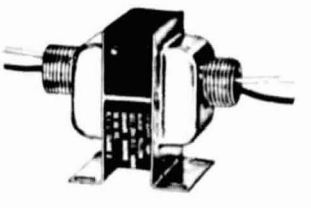
Contacts are rated at 9.8 amps. at 120 V. A.C. and 8.0 amps. at 240 V. A.C. at 125° F. (52° C.) ambient.

For complete information, refer to Penn Series S91 Bulletin No. 3650.

Transformers: A transformer is required to provide motor actuators with the necessary 24 Volt A.C. power supply. Plate mounted transformers mount on a 4" electrical box. Transformers No. Y65AS-1, Y65BS-1 and Y65CS-1 have a $\frac{1}{2}$" conduit fitting on the primary and secondary to permit direct mounting into the conduit opening in the motor wiring compartment. See Penn Series Y63, Y64 and Y65 Bulletin No. 3742 for additional information.

Transformer Capacity	Type Mounting	Primary Power Supply (V. A.C.)	Transformer Part No.
40 VA.	Plate	120	Y65AJ-1
		208	Y65CS-1
		240	Y65BJ-1
	Foot	120	Y65AS-1
		208	Y65CJ-1
		240	Y65BS-1
50 VA.	Plate	120	Y63AJB-1
		480	Y63KJB-1
		208/240	Y63SJB-1
	Foot	120	Y63ALB-2
		208/240	Y63SLB-2
100 VA.	Plate	120	Y64AJ-1
		208/240	Y64SJ-1
	Foot	120	Y64AL-2
		208/240	Y64SL-1

Plate mounted transformer



Foot mounted 40 VA. transformer.

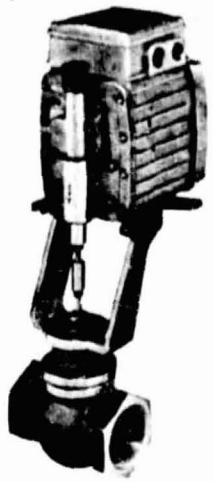


Fig. 6 — Motor actuator assembled to a two-way valve.

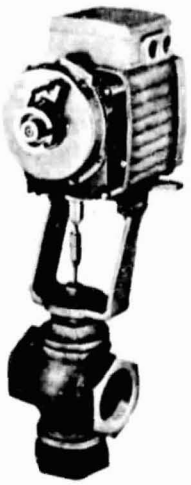


Fig. 7 — Spring return motor actuator assembled to a three-way valve.

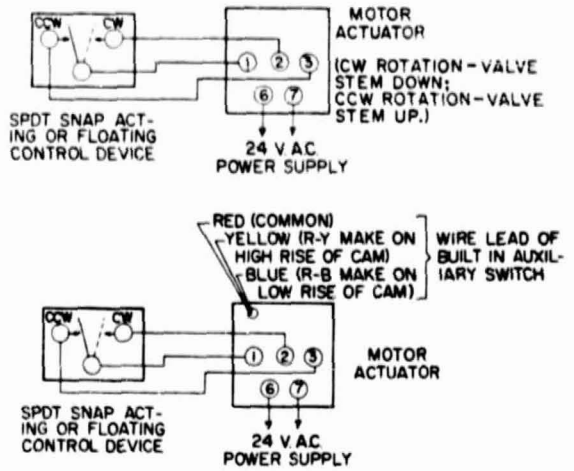


Fig. 8 — Typical wiring diagrams.

Valves: Penn provides a complete line of two-way single seat and double seat, three-way diverting and mixing valves to meet your control application.

Refer to the following bulletins to select the valve and linkage required:

Valve Number	Description	Bulletin Number
V90AA, V90AD	2-way, single seat globe	4283
V90BA	2-way, double seat	3625
V90CA	3-way, diverting	3627
V90DB, V90DD	3-way, mixing	4284
V90SA	Butterfly	3428

SHIPPING WEIGHTS (Approx.)

Type Number	Individual Pack
M81AAA, M81AAB	11.0 lbs (5 kg)
M81ACA, M81ACB, M81AFA, M81ADA, M81AEA	15.1 lbs (6.8 kg)

ORDERING INFORMATION

To order specify:

1. Complete Product Number, if available.
2. Position indicator Kit No. PTR11A-600, if desired.
3. If complete Product Number is not available, specify Type Number and the following:
   a. Torque (40, 80 or 150 lb.-inches) if model is other than spring return valve or damper actuator.
   b. Travel setting, if other than standard 90°.
4. Accessories required.

Example: M81AAA
150 lb.-inches
160° travel
Y65AJ-1 transformer
Y20DAB-2 damper linkage set
PTR11A-600 position indicator kit.

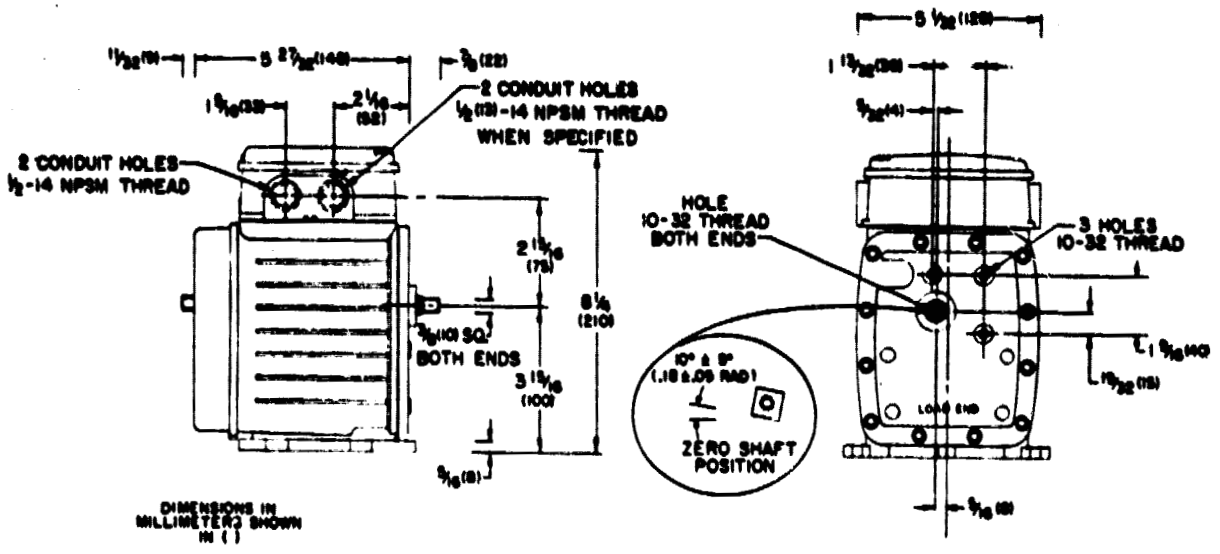
REPAIRS AND REPLACEMENT

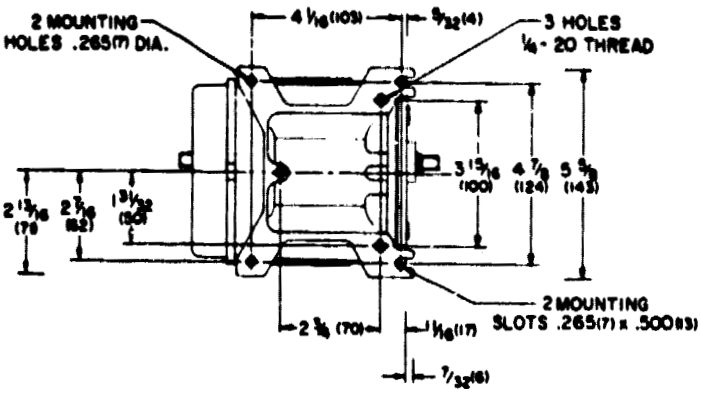
As the drive motor and gear train are immersed in oil and sealed in a die cast case, periodic maintenance is not required.

Field repairs must not be made. Replacement actuators may be obtained through the nearest Penn Commercial Wholesaler. When ordering a replacement actuator, specify Product Number and Serial Number shown on the actuator.

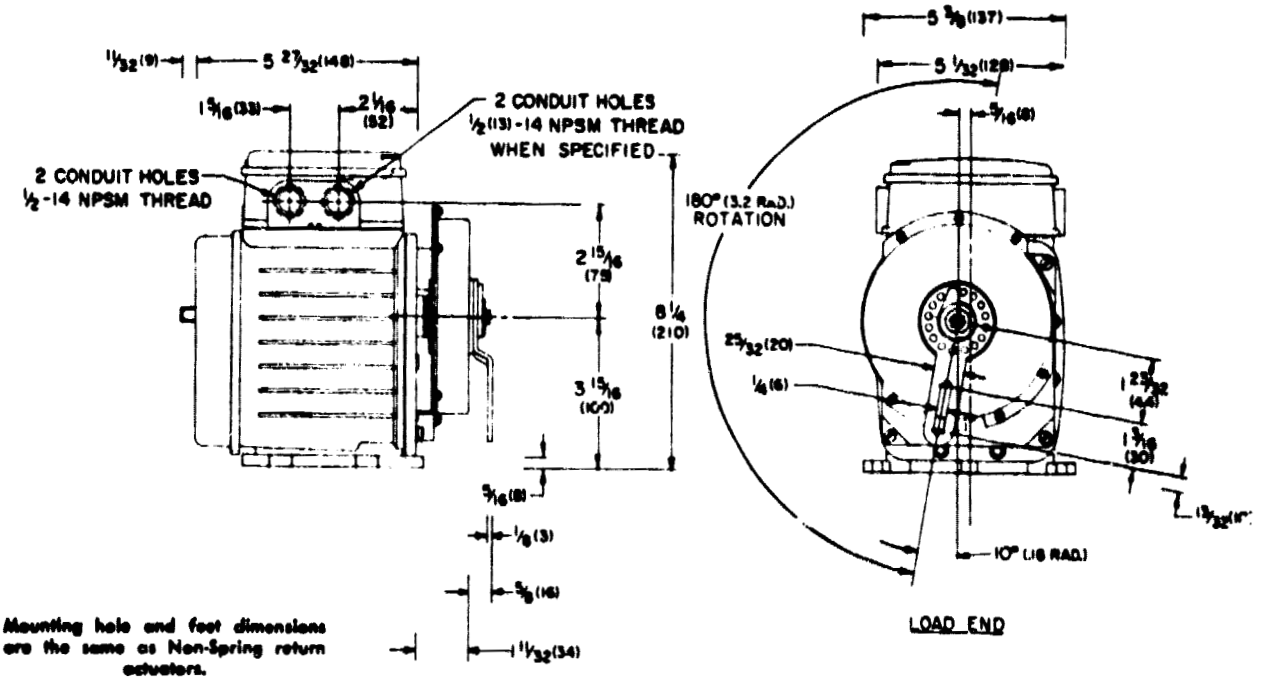
SEE PAGES 5 AND 6 FOR DIMENSIONS

DIMENSIONS





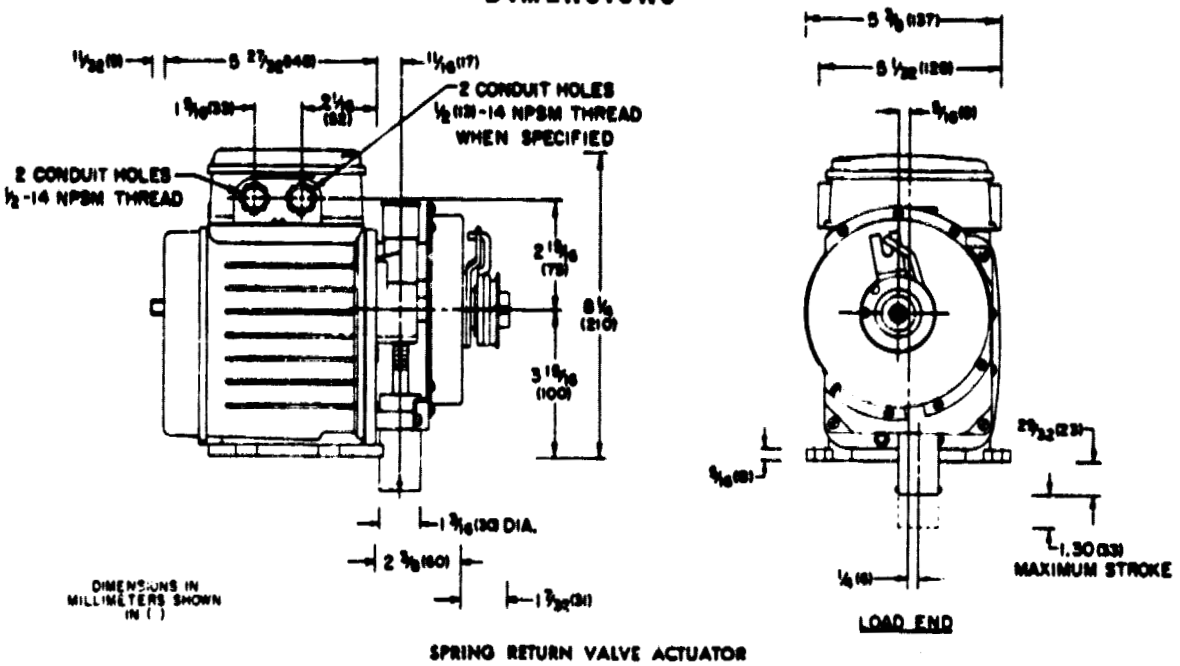
NON-SPRING RETURN VALVE AND DAMPER ACTUATOR



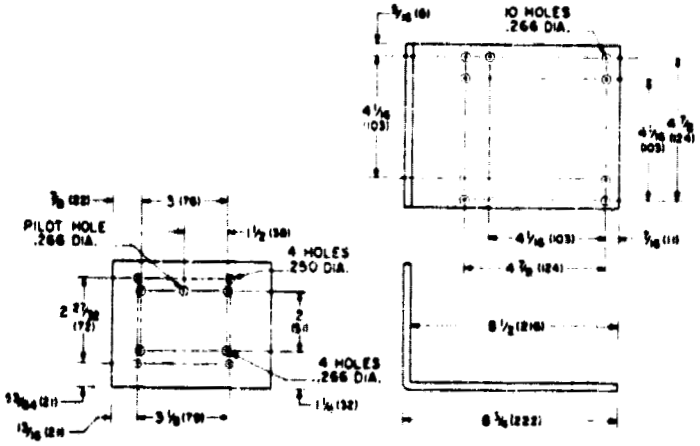
Mounting hole and foot dimensions are the same as Non-Spring return actuators.

SPRING RETURN DAMPER ACTUATOR

DIMENSIONS



SPRING RETURN VALVE ACTUATOR



RIGHT ANGLE BRACKET

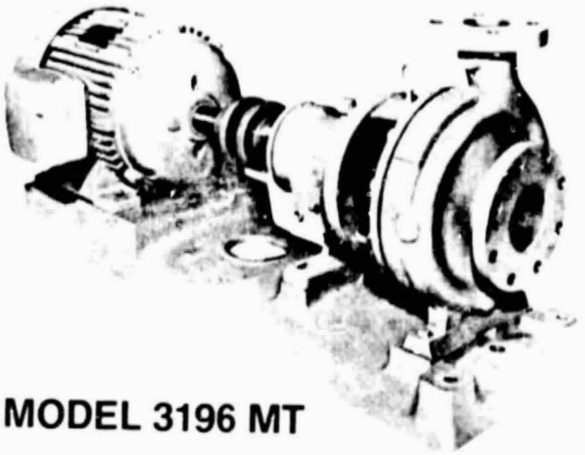
Performance specifications appearing herein are nominal and are subject to accepted manufacturing tolerances and application variables.

MS1AAB, MS1ACB: U.L. Guide No. XAPX
File E6688

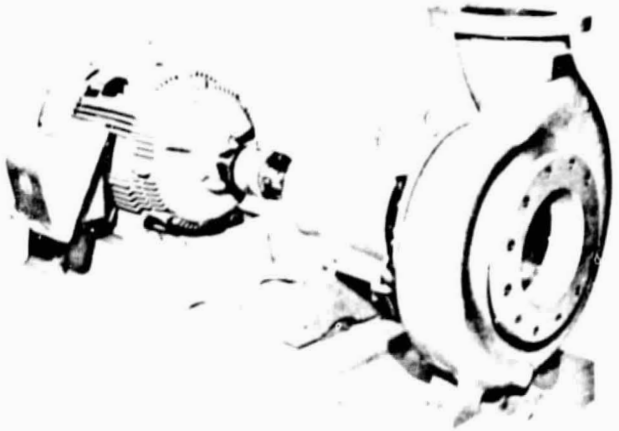
GOULDS PUMPS

Installation, Operation and Maintenance Instructions

MODEL 3196 ST



MODEL 3196 MT



MODEL 3196 XLT

TABLE OF CONTENTS

P20637 GOULDS PUMPS, INC. REPLACEMENT PARTS DATA SHEET

ORDER NUMBER 782280 3196ST 1X1-1/2-6 CONST. DI

IMP. DIAMETER 5-5/8

CUST. P.O. NUMBER 703 ITEM

Solar UnLimited

HunTsville AL

NO	PUMP	PART NAME	JULDS PART NO.	MATL	NET PRICE EACH	MANUFACTURERS IDENTIFICATION
100	1	CASING	104-421	1012	209.25	
101	1	IMPLR W/O-RG	R76777	1013	85.25	
112A	1*	BALL BRG OB	8055 30600		20.54	MRC-5306
113A	1	BREATHER	9008 31365		3.10	ALEMITE 313650
119A	1	BRG END COV	76771	2210	6.98	
122	1*	SHAFT ASSY	R104-435	2238	128.65	
123	1	DEFLECTOR	76776 1		3.88	
126	1*	SHAFT SLEEVE	76772X	2229	77.50	
134A	1	BRG HOUSING	104-433	1001	46.50	
136	1*	BRG LK NUT	8601 0006		1.40	MRC N-06
168A	1*	BALL BRG 1.B	8050 20760		5.19	MRC-207S
184	1	SB COV ASSY	R104-429	1012	116.25	
228A	1	FRAME	259- 57	1000	240.25	
250	1	GLAND MS	077231 1	2229	.00	
251	1	SIGHT OILER	072531 5	8683	32.55	TRICO=3
332A	1	OIL SEAL	8690 62020		2.09	VICTOR 63647K5
333A	1	OIL SEAL	8690 62019		2.09	VICTOR 64448K3
351	1	GASKET CASE	70782 81	5128	2.17	
353	4	GLAND STUD	27177 604	2229	4.65	
.355	4	HEX NUT	49507 104	2228	.00	
361A	1	RTNG RING	58101 281		2.02	N002-281
.370	4	H CAP SCREW	49511 252	2210	.39	
370C	3	H TAP BOLT	49521 104	2210	.16	
370D	3	H TAP BOLT	49521 104	2210	.16	
370H	2	STUD	27177 663	2228	2.33	
382	1*	BRG LK WSHR	8910 0006		.70	MRC W-06
.383R	/*	RTRY UNIT	90890 1137		.00	
.383S	/*	STA SEAT	90890 0201		.00	
412A	1	O-RING IMPLR	70721 137		2.02	ARP 568-023TEFLON
469D	1	ROLL PIN	80860 5		.16	
496	1	O-RING	70721 144		.78	ARP 568-236BUNA-N
.600		SECTIONAL	259-55		.00	

* RECOMMENDED SPARE PARTS

RUN DATE 07/12/78

PAGE 1

GOULDS PUMPS, INC.

P.O. Box 3393-A
Birmingham, Alabama 35205
205-939-0533

April 17, 1978

Solar Unlimited
4310 Governors Drive S.W.
Huntsville, Alabama 35805

Attn: Bruce Noval RE: Proposal BP4141B

Dear Mr. Noval:

Enclosed is the quotation which you requested for the Silcon Oil Service. Both pumps quoted are model 3196ST groups. These pumps have a mechanical seal which will be mounted inside and require no flushing at all. However we have supplied a special vent and drain gland so as, to prevent any leakage into the mechanical seal while in operation or, in case of failure. The drain off of this gland should go back to the reservoir or to the collection basin.

Inspection of both the pump and the mechanical seal may be done on a monthly basis. Inspection of the mechanical should be done visually. Signs of mechanical seal failure would be leakage to the mechanical seal. During normal operation mechanical seals should have zero leakage. Only at the time of failure will it start to leak.

This quote will be valid for 30 days, with all standard terms as stated on the reverse side of this quotation form.

Yours very truly,

Robert G Bloom

Robert G. Bloom
District Engineer

RGB:ls

GOULDS PUMPS, INC.
SENECA FALLS, NEW YORK 13148

CENTRIFUGAL PUMP
QUOTATION

REPLY TO:

GOULDS PUMPS, INC.
P.O. Box 8398-A
Birmingham, AL 35205
Phone: 205-989-0588

All quotations subject to terms and conditions on the reverse side except as noted on Page _____ attached.

SHIPMENT: Our best estimate at this time is 6 weeks after complete engineering and manufacturing information and full approval to proceed with work.

To: Solar Unlimited
4310 Governors Drive West
Huntsville, Alabama 35805

Date: 4/14/78 Page: 1 of 2
Proposal No.: BP4141B
Revision No.:
Copies: Mobile, Seneca Falls

Attention: Bruce Noval
Inquiry Date:
Inquiry No.:

In answer to your inquiry, we propose to furnish GOULDS PUMPS as described below:

ITEM NO.
EQUIP. NO.
SERVICE

Quantity	Model	Size	Rotation
2	3196	1x1½-6	CW
Casing	**Impeller**	**Shaft**	**Sleeve**
DI	DI	STEEL	316SS
Wear Plate	**Lubrication**	**Base Plate**	**Coupling**
-	Oil	CI	Woods
Mechanical Seal -- Packing			**Imp. Type**
Dura. Seal ROTT EU5EVTT			Open

OPERATING CONDITIONS AND PERFORMANCE

Liquid		Temp. °F	Sp. Gr. @ P.T
Dow Chem. Silicon Q21132		350	1.0
G.P.M.	**T.D.H.**	**V.P.**	**Visc.**
40	30	12 CS	
Eff.	**Rated B.H.P.**	**Max. B.H.P.**	**Suct. Press**
46	.66	.86	
Disch. Press	**Perf. Curve**	**$NPSH_R$**	**$NPSH_A$**
	C1-2075-2	2.25'	

Impeller Diameter			Bulletin
Rated	Min.	Max.	
5½	3½	6 1/16	725.1

DRIVER -

H.P.	R.P.M.	Enclosure	Frame	S.F. Insulation
1	1780	TEFC OPDP Pr. T	143T	
Phase	**Hertz**	**Voltage**	**Furnished By**	

WITH THE FOLLOWING ADDITIONS, MODIFICATIONS AND/OR REQUIREMENTS

ITEM	*PRICE	WEIGHT
Pump	$926.ea	160
Driver	65.00 76.ea	45
Total Unit Price & Weight	$1002.ea	205

PRICE BEING REVIEW BY ROBERT BLOOM BASED ON TAG LIST BID.

THIS QUOTATION VALID FOR 30 DAYS FROM DATE OF PROPOSAL SHOWN ABOVE.
* PRICES SHOWN ARE F.O.B. SHIPPING POINT
TERMS: NET 30 DAYS

Robert Bloom

GOULDS PUMPS, INC.

STANDARD TERMS AND CONDITIONS

GOULDS PUMPS, Inc., Seneca Falls, N.Y., U.S.A.

All Sales and Transactions with Goulds Pumps, Inc., are subject to its Standard Terms and Conditions

1. Warranty: The Company warrants that its pumps, when properly installed and cared for as stated in the appropriate instruction manual issued by the Company, will operate in accordance with its proposal.

Goulds Pumps are warranted to be made of first-class material, and in a skillful and workmanlike manner. They are additionally warranted against any defective material or workmanship and any part proven defective within one year from the date of shipment, after inspection by and to the satisfaction of the Company, will be replaced free of charge F.O.B. Shipping Point, on return of such defective part to the Company, transportation charges prepaid. No parts, however, shall be returned without the express authority of the Company so to do.

There are no warranties, express or implied, except such warranties as are definitely set forth herein. The Company shall not be liable for damage or wear to pump caused by abnormal conditions, vibration, failure to properly prime or to operate pump without flow or caused by corrosives, abrasives or foreign objects. No obligations other than those herein set forth shall be binding upon the Company. No warranties apply to other than the original user.

The Company shall in no event be held liable for damages or delay caused by defective material and no allowance will be made for repairs or alterations, unless made by its written consent or approval. In the event the pumps are altered or repaired by others without prior written approval by the Company all warranties are void. Equipment and accessories not manufactured by the Company are warranted only to the extent of and by the original manufacturer's warranty.

Under no circumstances shall the Company be held liable for any consequential or other damages, losses or expenses arising from installation, use, or any other causes, regardless of advices or recommendations that may have been rendered concerning such installation or use of its products, nor shall the Company be liable for penalties of any description.

2. Shipment: Promised shipping dates are approximate, and are from point of manufacture. Such dates are estimated from (a) the date of receipt of order with complete manufacturing information at Company's factory, and (b) the date of entry of such order by the Company. Shipping dates are subject to revision at the time of the entry of order and the shipping schedule then given is approximate and subject to any action Company must take in connection with priorities or other orders or regulations issued by the United States Government, or any department thereof.

The Company will not be liable for loss, damage, detention, or delay in manufacture or delivery or necessity to substitute materials, resulting from causes beyond its reasonable control, including but not limited to casting failures, war, fire, strikes, lockouts, or other labor difficulties, civil or military authority, insurrection or riot, embargoes, car or ship shortages, acts of governments, wrecks or delays in transportation, including any delays caused by inability to obtain necessary labor, materials or manufacturing facilities due to such causes, or from action taken by the Company in connection with priorities or preference orders or other production [illegible] issued by the United States Government or any department thereof, or from delay in obtaining or failure to obtain manufacturing, financing, export or other licenses required by the United States Government or any department thereof, or in any event for consequential damages.

STC 1070

Acceptance of material by common carrier constitutes a waiver of any claim against the Company for delay or damage in transit, or for lost goods.

When quotation includes equipment not of Company's manufacture, Company's promise of shipment is based on manufacturer's promise to Company and shipment is contingent on the fulfillment of their promise.

3. Prices: All prices are subject to change without notice and are subject to any increase which may be in effect on the date of shipment of the goods, such increase, if any, to be within any applicable government regulations. Prices are F.O.B. Shipping Point, unless otherwise specified. When price includes transportation and other charges pertaining to the shipment of the goods, any increase in transportation rates and other charges will be for the account of the purchaser. There will be an extra charge for any test other than that which may be normally run by the Company, or for any test performed to suit the convenience of the purchaser.

4. Terms of Payment: Terms and conditions of payment will be shown on invoices rendered by the Company at time of shipment or as may be otherwise stated in writing by an officer of the Company.

5. Orders: All illustrations and specifications are descriptive and are not intended as warranties. The acceptance of all orders taken by the Company's sales representatives or branches is subject to approval by Company's office at Seneca Falls, New York, U.S.A., or City of Industry, California, U.S.A.

6. Cancellation of Orders: Orders once placed with and accepted by Company can be cancelled only with Company's consent and upon terms that will indemnify Company against loss.

I. Company may forthwith cancel the order or contract without recourse

(a) if conditions are such that shipment from Company's factory may be delayed beyond the date estimated at the time of entry of order or contract;

(b) if the Purchaser is in default with the Company on this or any other order or contract;

(c) if Purchaser is or becomes insolvent, or if at any time Company is not fully satisfied with the credit of Purchaser, it may at any time after the order has been entered, or during the manufacturing period, or at the time the goods are ready for shipment, require payment in advance of shipping regardless of original terms, or if after shipment has been made and before actual delivery and acceptance at destination, (regardless of F.O.B. point), it may recall the shipment and cancel this and any and all other orders and contracts which may be outstanding, and shall be entitled to receive reimbursement for its reasonable and proper cancellation charges;

(d) if the order or contract is for the direct account of one of its sales representatives, distributors or dealers, and Company terminates or alters such relationship.

II. The Company shall have at all times a right of set-off as to any and all accounts between it and Purchaser.

7. Claims: No claims for allowances will be entertained unless presented immediately on receipt of goods; nor will Company be held responsible for breakage or shortage after goods are delivered to and accepted by the common carrier.

8. Equipment Returned: Goods can be returned for credit only after receiving Company's authorization and shipping instructions. Consignor's name and address must be plainly written on the shipping tag.

9. Taxes: All Federal, State, Local and Municipal taxes now in effect or hereafter enacted that are applicable to this transaction shall be paid for the account of the Purchaser, and if paid or required to be paid by the Company, the amount thereof shall be added to and become a part of the price payable by the Purchaser hereunder.

10. Minimum Charge: A minimum charge of $20.00 will be made in the case of any order, the items on which at the net prices total less than this amount.

11. General: All sales and transactions are subject to Company's Standard Terms and Conditions, and they shall prevail in the event of any conflict or variance with those of the Purchaser's, unless otherwise agreed to in writing.

All previous agreements, either written or oral, which are subject matter hereof, are hereby cancelled.

Stenographic or clerical errors are subject to correction.

If this transaction involves EXPORT, the following additional terms and conditions shall apply:

12. Packing: Equipment will be packed, boxed or crated in accordance with the Company's standard commercial practice, for underdeck export shipment, unless otherwise agreed.

13. Payment: Unless otherwise specified in writing, payment shall be made by irrevocable letter of credit in form acceptable to Company, confirmed by a New York or Los Angeles Bank acceptable to Company, and providing for payment in full in United States dollars in New York or Los Angeles against presentation of United States inland shipping documents and invoices, such letter of credit to be established prior to Company's acceptance of the order. The letter of credit shall provide also that in the event Company is, for any reason beyond its control, prevented from making shipment from Company's factory or delivery at the port of embarkation, a certificate of manufacture of the whole or any part of the goods shall constitute delivery of such whole or any part of the goods and payment in full of any and all drafts drawn against the letter of credit for the goods so "delivered" shall be made upon presentation of such certificate of manufacture in lieu of United States inland shipping documents. In the event that Company is prevented by law, or otherwise, from making shipment from Company's factory or delivery at port of embarkation of the goods or any part thereof, on completion of manufacture, Company reserves the right to place the goods in storage for the purchaser's account and risk. Any charges incurred in this connection will be for the account of the purchaser at cost and will be payable upon demand.

14. Company as Agent: If Company makes or arranges for ocean shipment, Company shall act as agent for the purchaser and reserves the right to procure full insurance coverage, including war risk insurance, at the expense of the purchaser. All expenses incurred in this connection will be payable upon demand to the Company.

If Company applies for or secures manufacturing, financing, exporting or other licenses required by the United States Government, or any department thereof, Company shall make such applications or secure such licenses solely as agent for the purchaser, and assumes no responsibility therefor.

PRINTED IN U.S.A.

GOULDS PUMPS, INC.
SENECA FALLS NEW YORK 13148

CENTRIFUGAL PUMP
QUOTATION

REPLY TO:

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P.O. Box 8398-A
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Phone: 205-939-0588

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ITEM NO.
EQUIP. NO.
SERVICE

Quantity	Model	Size	Rotation
	3196	1x1½-8	CW
Casing	**Impeller**	**Shaft**	**Sleeve**
DI	DI	Steel	316SS
Wear Plate	**Lubrication**	**Base Plate**	**Coupling**
-	Oil	CI	Woods

Mechanical Seal -- Packing: DuraMetallic
ROTT EU5EVT/T

Imp. Type: Open

OPERATING CONDITIONS AND PERFORMANCE

Liquid	Temp. °F	Sp. Gr. @ P.T.
Dow Chem. Silicon Q21132	350	1.0

G.P.M.	T.D.H.	V.P.	Visc.
70	40	12 CS	
Eff.	**Rated B.H.P.**	**Max. B.H.P.**	**Suct. Press**
51	1.39	1.6	
Disch. Press	**Perf. Curve**	**$NPSH_R$**	**$NPSH_A$**
	C1-2101	4.5	

Impeller Diameter Rated	Min.	Max.	Bulletin
7"	5½"	8	725.1

DRIVER—

H.P.	R.P.M.	Enclosure	Frame	S.F./Insulation
2	1800	TEFC	145T	
Phase	**Hertz**	**Voltage**	**Furnished By**	

WITH THE FOLLOWING ADDITIONS, MODIFICATIONS AND/OR REQUIREMENTS

ITEM	*PRICE	WEIGHT
Pump	$997.ea	180
Driver	94.ea	50
Total Unit Price & Weight	$1091.ea	230

THIS QUOTATION VALID FOR 30 DAYS FROM DATE OF PROPOSAL SHOWN ABOVE.
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TERMS: NET 30 DAYS

Robert Bloom

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There are no warranties, express or implied, except such warranties as are definitely set forth herein. The Company shall not be liable for damage or wear to pump caused by abnormal conditions, vibration, failure to properly prime or to operate pump without flow or caused by corrosives, abrasives or foreign objects. No obligations other than those herein set forth shall be binding upon the Company. No warranties apply to other than the original user.

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Under no circumstances shall the Company be held liable for any consequential or other damages, losses or expenses arising from installation, use, or any other causes, regardless of advices or recommendations that may have been rendered concerning such installation or use of its products, nor shall the Company be liable for penalties of any description.

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The Company will not be liable for loss, damage, detention, or delay in manufacture or delivery or necessity to substitute materials, resulting from causes beyond its reasonable control, including but not limited to casting failures, war, fire, strikes, lockouts, or other labor difficulties, civil or military authority, insurrection or riot, embargoes, car or ship shortages, acts of governments, wrecks or delays in transportation, including any delays caused by inability to obtain necessary labor, materials or manufacturing facilities due to such causes, or from action taken by the Company in connection with priorities or preference orders or other procurement permits issued by the United States Government or any department thereof, or from delay in obtaining or failure to obtain manufacturing, financing, export or other licenses required by the United States Government or any department thereof, or in any event for consequential damages.

Acceptance of material by common carrier constitutes a waiver of any claim against the Company for delay or damage in transit, or for lost goods.

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(c) if Purchaser is or becomes insolvent, or if at any time Company is not fully satisfied with the credit of Purchaser, it may at any time after the order has been entered, or during the manufacturing period, or at the time the goods are ready for shipment, require payment in advance of shipping regardless of original terms, or if after shipment has been made and before actual delivery and acceptance at destination (regardless of F.O.B. point), it may recall the shipment and cancel this and any and all other orders and contracts which may be outstanding, and shall be entitled to reimbursement for its reasonable and proper cancellation charges.

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10. Minimum Charge: A minimum charge of $20.00 will be made in the case of any order, the items on which at the net prices total less than this amount.

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14. Company as Agent: If Company makes or arranges for ocean shipment, Company shall act as agent for the purchaser and reserves the right to procure full insurance coverage, including war risk insurance, at the expense of the purchaser. All expenses incurred in this connection will be payable upon demand to the Company.

If Company applies for or secures manufacturing, financing, exporting or other licenses required by the United States Government, or any department thereof, Company shall make such applications or secure such licenses solely as agent for the purchaser, and assumes no responsibility therefor.

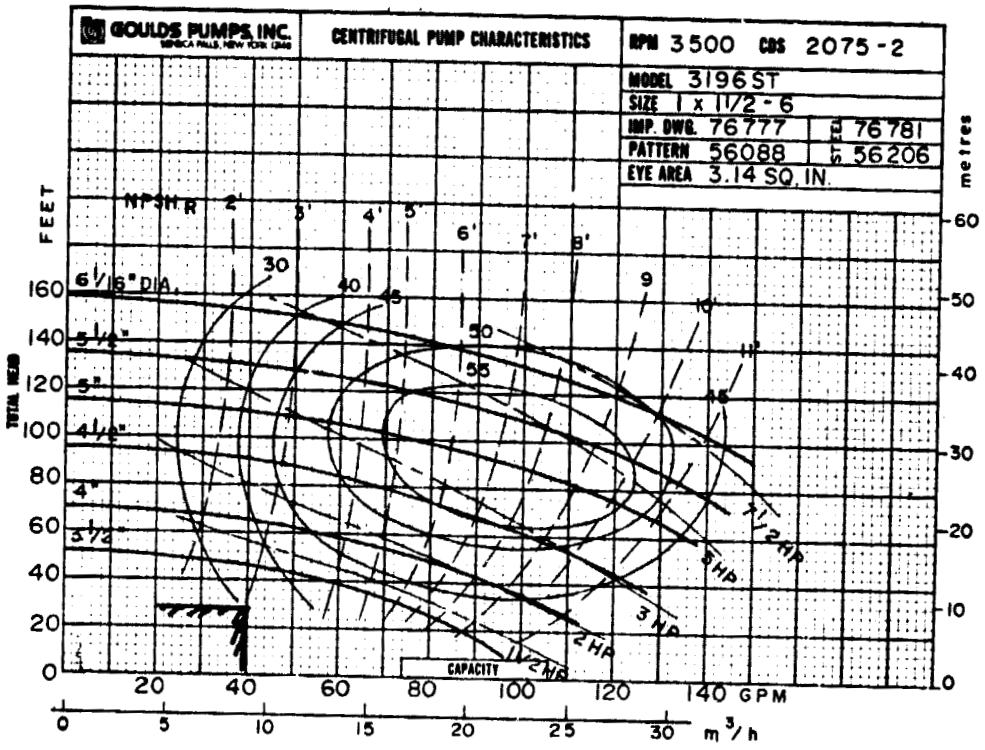
STC 1070

PRINTED IN U.S.A.

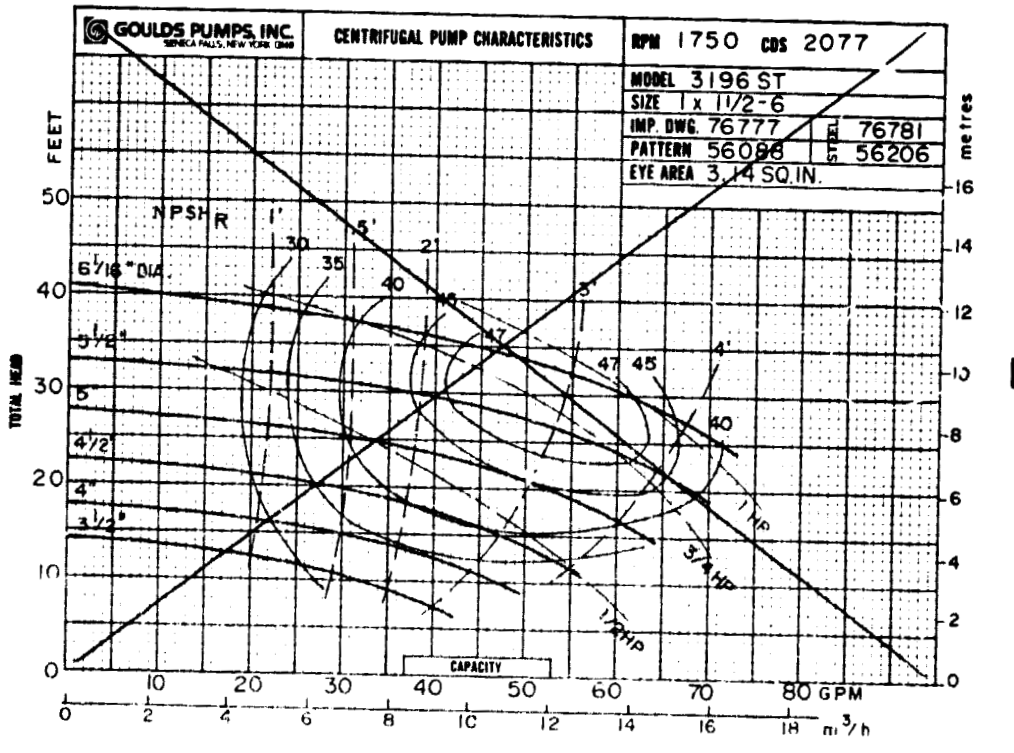
Goulds Model 3196 ST
60 Hz Performance Curves

725.1C1
June 2, 1976
(Sup. 8/4/72)

Customer Solar Unlimited Inquiry No. _____ Date 4/14/78
Service _____ Item No. _____ P.O. No. _____ Date _____
F.O. No. _____ ; 40 GPM; 30 TDH; 1780 RPM; 46 % Eff.; CDS No. _____



3500 R.P.M.



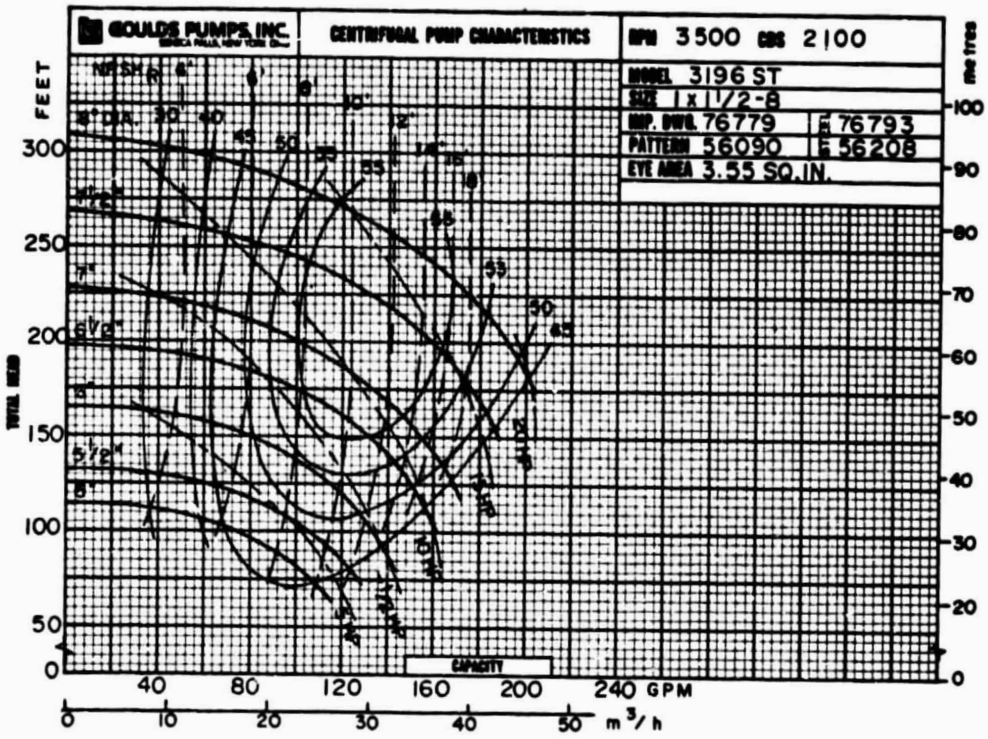
1750 R.P.M.

Customer _____ Inquiry No. _____ Date _____

Service _____ Item No. _____ P.O. No. _____ Date _____

F.O. No. _____ ; _____GPM; _____ TDH;_____RPM; _____ % Eff.; CDS No._____

3500 R.P.M.



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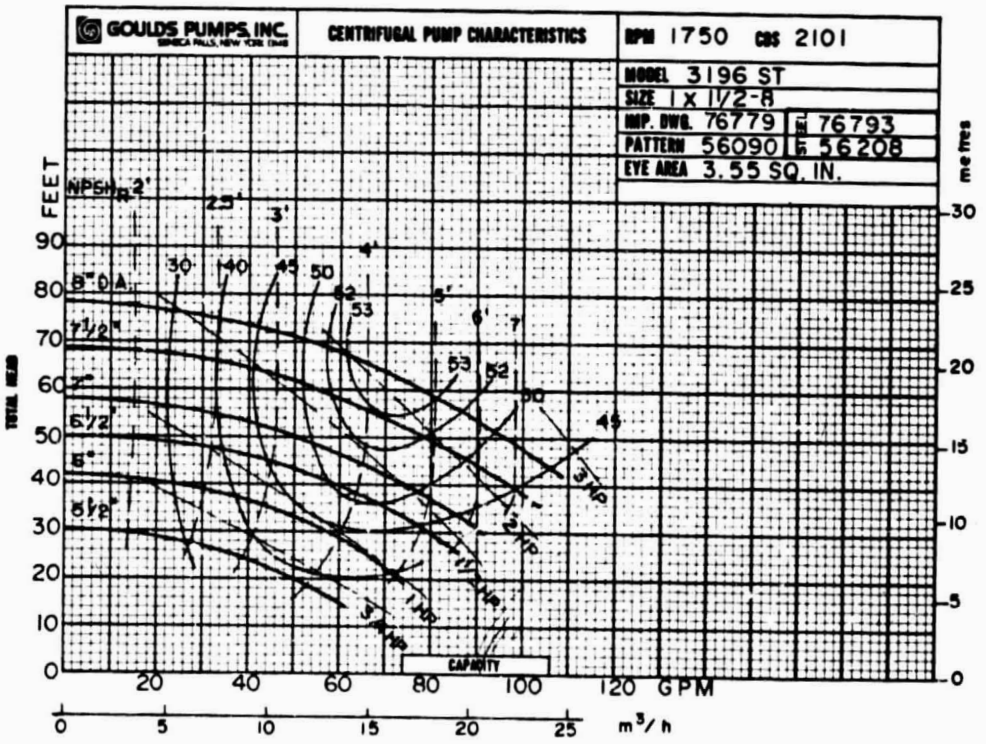


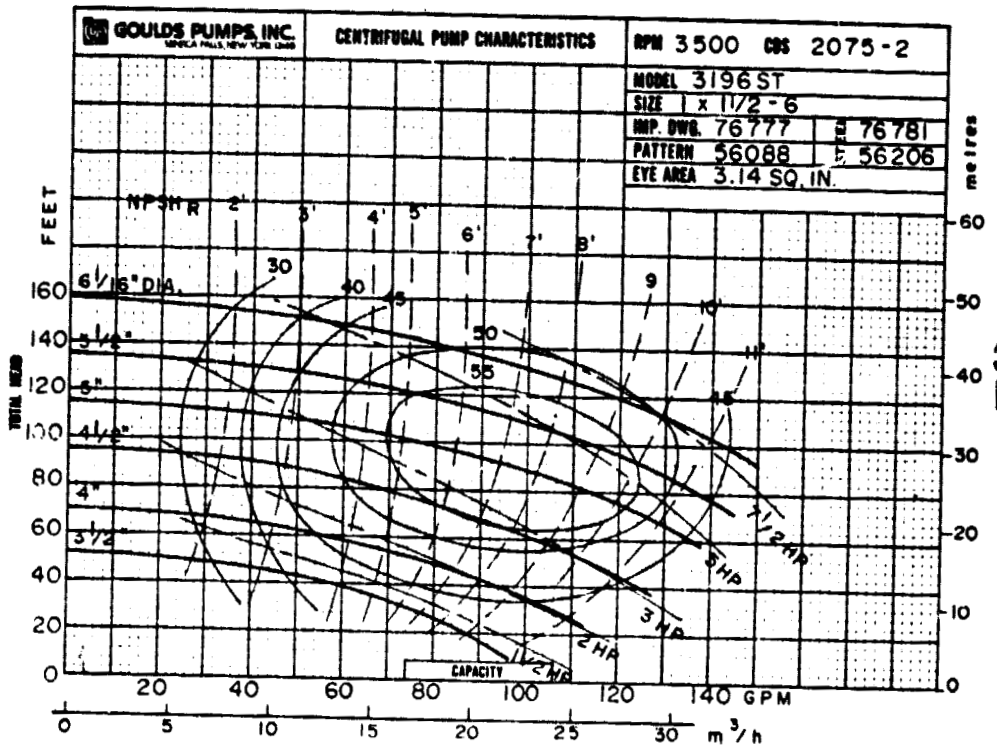
GOULDS PUMPS, INC.
SENECA FALLS, NEW YORK 13148

PRINTED IN U.S.A.

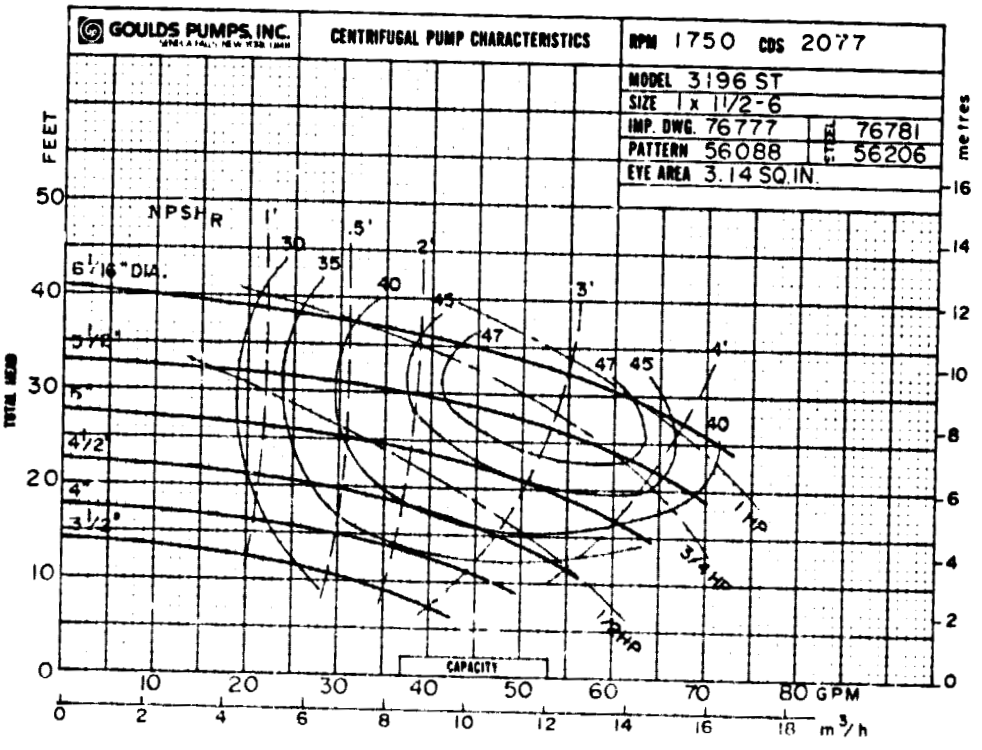
Goulds Model 3196 ST
60 Hz Performance Curves

725.1C
June 2, 1
(Sup. 8/4/72

Customer Solar Inquiry No. _____ Date _____
Service _____ Item No. _____ P.O. No. _____ Date _____
F.O. No. _____ _____GPM; _____ TDH;_____RPM; _____ % Eff.; CDS No._____



3500 R.P.M.



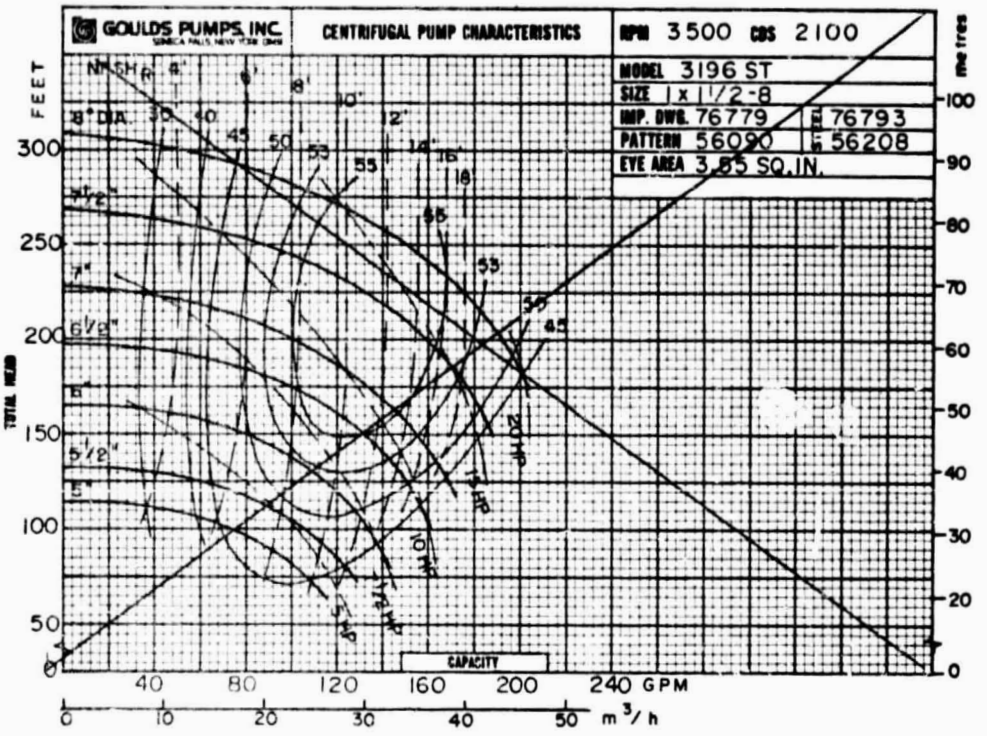
1750 R.P.M.

Customer Solar Unlimited Inquiry No. _____ Date 4-14-78

Service _____ Item No. _____ P.O. No. _____ Date _____

F.O. No. _____ : 70 GPM, 40 TDH, 1800 RPM, 51 % Eff.; CDS No. 2101

3500 R.P.M.



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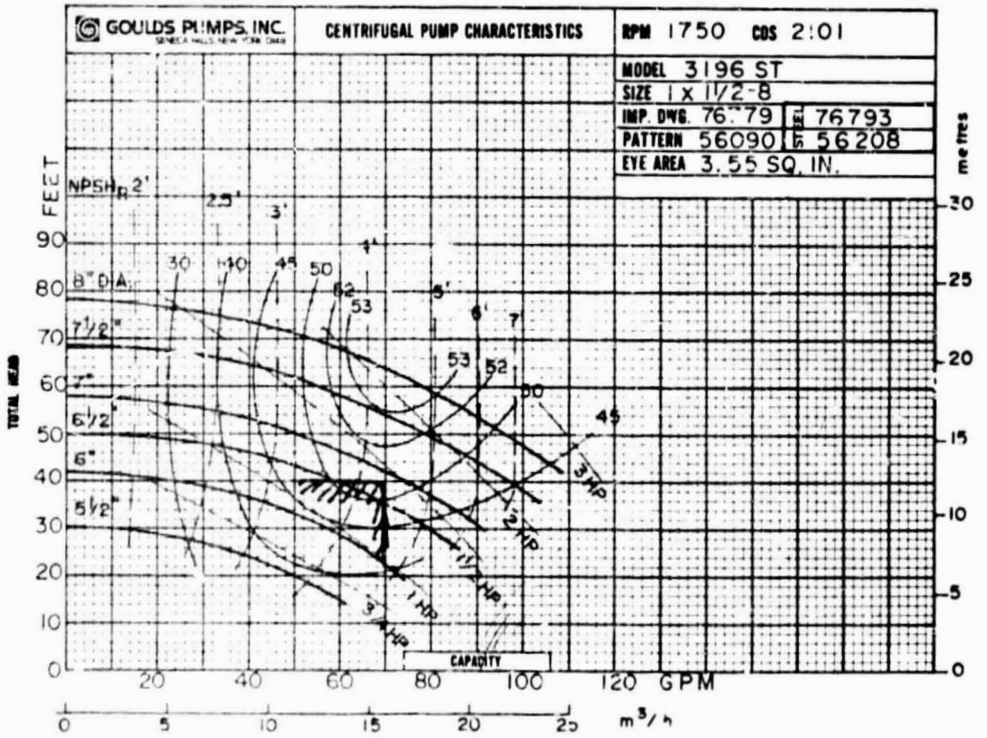


GOULDS PUMPS, INC.
ITT A FALLS, NEW YORK 13148

PRINTED IN U.S.A.

SECTION I—GENERAL

Introduction

This instruction manual is intended to assist those involved with the installation, operation and maintenance of Goulds' Model 3196 pumps. It is recommended that this manual be thoroughly reviewed prior to installing or performing any work on the pump or motor.

I-A. Importance of Instructions

The design, material and workmanship incorporated in the construction of Goulds' pumps make them capable of giving long, trouble-free service. The life and satisfactory service of any mechanical unit, however, is enhanced and extended by periodic inspection and careful maintenance. This instruction manual was prepared to assist operators in understanding the construction and correct methods of installing, operating, and maintaining these pumps.

Study thoroughly Sections I, II, III, and carefully follow the instructions for installation and operation. Sections IV, V, VI, VII, and VIII are answers to trouble and maintenance questions. Keep this instruction manual handy for reference. Further information can be obtained by contacting the Engineered Products Division, Goulds Pumps, Inc., Seneca Falls, N.Y. 13148 or your local branch office.

I-B. Special Warnings

Goulds Pumps, Inc will not be liable for any damages or delay caused by failure to comply with the provisions of this instruction manual. This pump is not to be operated at speeds, working pressures, discharge pressures, or temperatures higher than, nor used with liquids other than, stated in the original order acknowledgment without written permission of Goulds Pumps, Inc.

I-C. Receiving Inspection—Shortages

Care should be taken when unloading pumps. If shipment is not delivered in good order and in accordance with the Bill-of-Lading, note the damage or shortage on both receipt and freight bill. MAKE ANY CLAIMS TO THE TRANSPORATION COMPANY PROMPTLY.

Instruction sheets on various components as well as the Instruction Book for the pump are included in the shipment. DO NOT DISCARD!

I-D. Preservation and Storage

Goulds' normal domestic shipping and storage preparation is suitable for protecting the pump during shipment in covered trucks. It also provides protection during covered storage at the jobsite, and for a short period between installation and start-up. If the pump is to be idle and exposed to the elements for an extended period, either before or after installation, special precautions are required. One approach is to provide special preservatives and wrapping before shipment. However, after installation the protective wrappings will have been removed. Therefore, application of preservatives after installation is considered a good practice. Information about various long term perservation and storage options available can be obtained from your local Goulds' representative.

The driver, coupling, and mechanical seal manufacturers should be contacted for their recommendations on preservations and protection procedures.

I-E. Handling Techniques

Care should be used in moving pumps. Pumps should *not* be hoisted by eyebolts. These eyebolts are intended for removing the back pull-out assembly for maintenance and inspection. An assembled pump should be hoisted using a sling under suction flange *and* under rear of bearing frame. Bedplate mounted units should be hoisted using slings under bedplate below both pump and driver.

SECTION II—INSTALLATION

II-A. Location

Pumping unit should be placed as close as practical to the source of supply. Floor space and head room allotted to the unit must be sufficient for inspection and maintenance. Be sure to allow for crane or hoist service.

II-B. Foundations

1. Grouted—Bedplate mounted units are normally grouted-in on a concrete foundation, which has been poured on a solid footing. This allows a permanent, vibration absorbing base for the unit. The location and size of foundation bolts are shown on the outline assembly drawings supplied for the unit. Fig. 1 illustrates a typical foundation bolt installation.

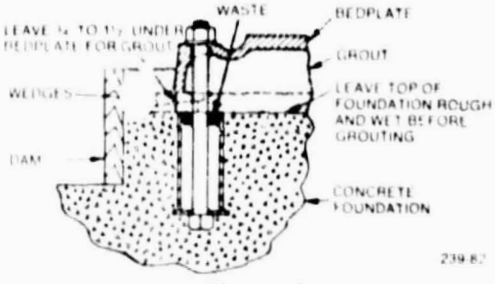


Figure 1

2. Flexibly Mounted –Installation and leveling of the optional flexibly-mounted bedplate should be carried out in accordance with assembly drawings supplied in the data package for the unit.

II-C. Leveling and Grouting of Baseplate—Initial Alignment Check

1. Put the unit in place on wedges located at four points as shown in Fig. 2. Some long installations may require additional wedges near center of bedplate.

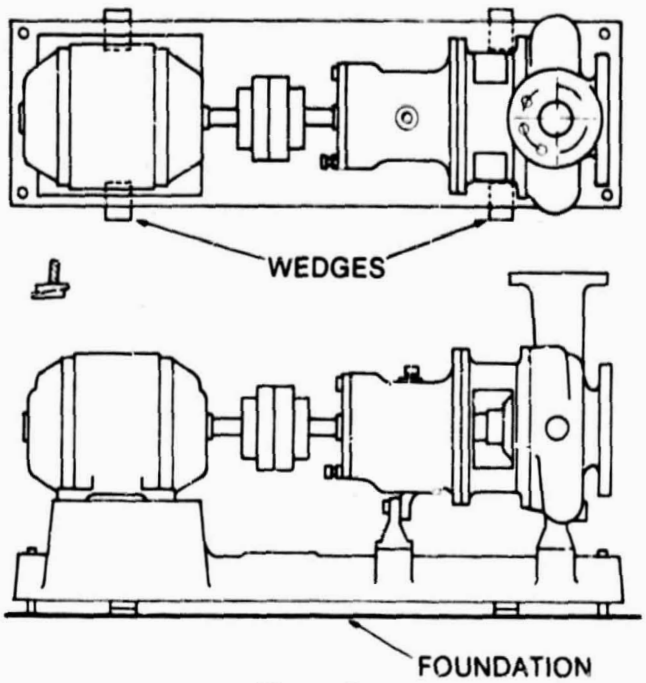


Figure 2

2. Adjust wedges to level unit (approximately), placing unit between ¾" and 1½" above foundation. Level or plumb suction and discharge flanges. Then, bring the coupling halves into reasonable alignment by adjusting the wedges as needed.

3. Make sure that the baseplate is not distorted and that final accurate coupling alignment can be established within the limits of movement of motor and by shimming motor if necessary.

4. Tighten foundation bolts finger tight. Build dam around foundation and pour grout through hole provided in top of bedplate. Fill to level of grout hole making sure that the areas under the pump and motor feet are filled solid. Allow grout to harden at least 48 hours before further tightening foundation bolts. Tighten pump hold down bolts.

II-D. Piping Practices

Guidelines for piping are given in the "Hydraulic Institute Standards" and should be reviewed prior to pump installation. All piping should be supported independently of, and line up naturally with, the pump flanges. NEVER DRAW PIPING INTO PLACE BY USE OF FORCE AT THE FLANGED CONNECTIONS OF THE PUMP.

Both suction and discharge piping should be as short and direct as possible to minimize friction losses.

Foundation, pump and driver hold-down bolts should be tightened prior to connecting suction or discharge piping to the pump.

On units handling corrosives, the piping can be arranged to allow flushing of the pump prior to opening of the unit for servicing. After connecting suction and discharge piping to the pump, rotate pump by hand to be sure that there is no binding.

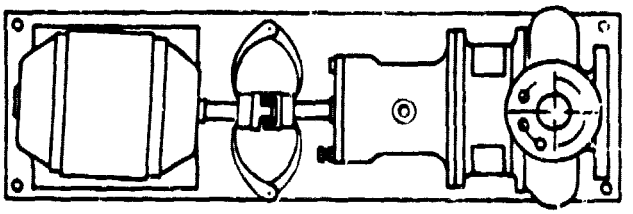
II-E. Alignment—Preliminary

Alignment of the pump and driver is of extreme importance for trouble-free mechanical operation. Alignment should be obtained by adding or removing shims from under the motor feet. The pump bearing frame foot should never be adjusted to obtain alignment. The proper shimming is installed under the bearing frame foot at the factory on units shipped with bedplates. Changing the pump casing or bearing frame in the field will require a reshimming of the frame foot. The proper number of shims is installed when the pump shaft is level and parallel to the bedplate surface. Proper shimming is achieved by loosening frame foot and tightening casing foot. This should create a gap between the frame foot and and bedplate between 0 and .040 inches (1mm). This must be filled with shims and the frame foot retightened. If this procedure is not followed, mechanical problems can result. The final alignment is done after the unit has been run under actual operating conditions. The following are suggested steps for aligning the unit, prior to initial startup.

1. Parallel Alignment: The unit is in parallel misalignment when the shaft axes are parallel, but not concentric. During initial alignment, vertical parallel alignment may be different, due to thermal expansion of the unit at actual operating conditions. The following is a suggested cold setting for motor driven units:

Pumpage Temperature Above Ambient	Set Motor Shaft
Ambient	.002-.004" low (.05-.10 mm)
100° F.	.000-.002" high (.00-.05 mm)
200° F.	.004-.006" high (.10-.15 mm)
300° F.	.008-.010" high (.20-.25 mm)
400° F.	.012-.014" high (.30-.35 mm)
500° F.	.016-.018" high (.40-.45 mm)

2. To check the parallel alignment of "spider-insert" couplings, place a straight edge across both hubs at four points, 90° apart (see Fig. 3). To check the parallel alignment of flexible spacer couplings, place a dial indicator on one hub and rotate that hub 360° while taking readings on the outside diameter of the other hub. Alignment occurs when indicator deflection does not exceed .002" T.I.R. (see Fig. 4) of the recommended cold setting in elevation and not more than .002" T.I.R. side to side.



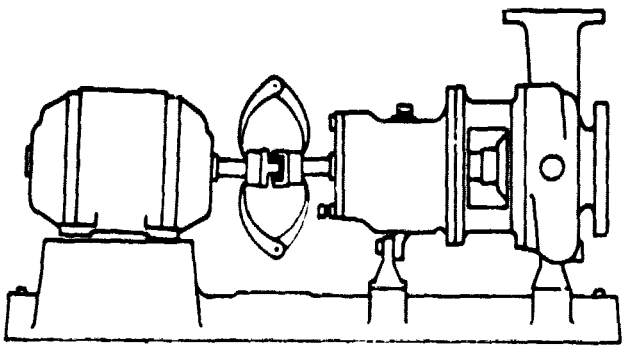


Figure 3

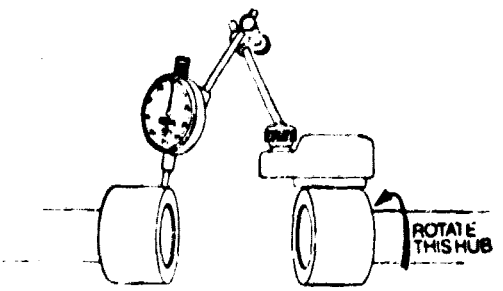


Figure 4

To check angular alignment of a "spider-insert" coupling, use calipers at 90° intervals on the circumference on the outer end of hubs. When caliper measurements are identical, the unit is in angular alignment. The correct gap between the hub and insert will be given in the coupling manufacturer's instructions supplied for the pump.

To check angular alignment of flexible spacer couplings, place a dial indicator on one shaft hub and rotate the hub 360°. Take readings from the face of the other hub. Alignment is achieved when deflection does not exceed .002" (see Fig. 5).

PRIOR TO COUPLING DRIVER TO PUMP, ROTATION OF DRIVER SHOULD BE CHECKED! ***Serious damage can result if pump is rotated in wrong direction.*** **Once motor rotation is checked, connect coupling, following the manufacturer's instructions. If a coupling guard is furnished with the unit, ensure that it is securely fastened in place.**

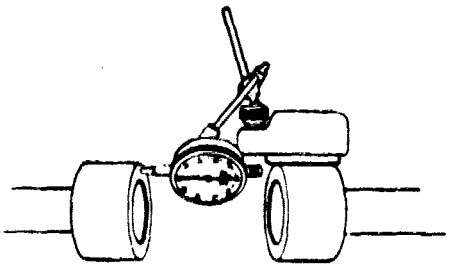


Figure 5

II-F. Stuffing Box

1. Packing: Stuffing box packing, lantern ring and gland are in box of fittings supplied with the pump. Install in proper sequence as shown in drawing in Part VI. Twist rings sideways to place them over shaft—never spread rings straight out. Seat each ring firmly as it is installed, staggering joints 90°. Gland should be installed finger tight only.

Packing cannot run dry, it must be lubricated. If the pumpage is clean, cool fluid, it may be used through a bypass off the discharge to the lantern ring connection to lubricate the packing.

If the pumpage is dirty or hot, it is not suitable to lubricate the packing. An external source must be utilized, unless the bypass is equipped with proper separator, filter, and/or cooling system. This must be piped into the lantern ring connection, also (refer to packing recommendations).

2. Mechanical Seals: When mechanical seals are supplied, they are installed and adjusted at the factory. They must not run dry or in abrasives. Connect recirculation, flush and/or cooling lines as required, following instructions on the seal print supplied for the unit.

SECTION III—OPERATION

III-A. Startup

1. Check List

a. Lubrication—Pump bearings are normally oil lubricated. (THE BEARINGS ARE *NOT* LUBRICATED AT THE FACTORY.) These pumps are supplied with an oiler which maintains a constant oil level in the bearing frame. Locate oiler as shown on the outline drawings supplied for the unit. See Fig. 6 for correct adjustment of oiler.

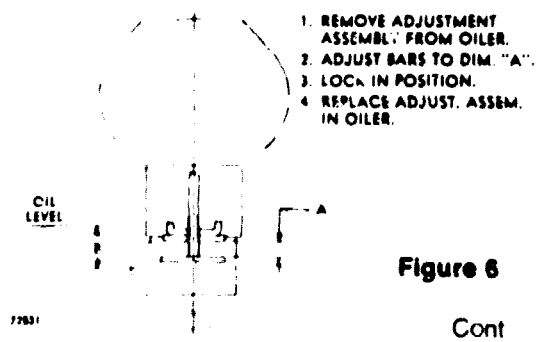


Figure 6

Cont

GROUP	OILER SIZE	A	B
ST, MT, LT	#3 (4 Oz.)	19/32" (15 mm)	1/2" (13 mm)
XLT	#5 (8 Oz.)	9/16" (14 mm)	1/2" (13 mm)

b. A high quality turbine type oil with rust and oxidation inhibitors should be used. Under normal operating conditions, an oil of 300 SSU viscosity at 100° F. (approximately SAE 20) should be used. Fill oiler bottle and replace in oiler housing. Repeat until oil remains visible in bottle. Do not add oil through the vent or breather. Optional grease lubricated bearings are lubricated at the factory and need lubrication only after 2,000 hours of operation, or every 3 months, which ever occurs first. On pumps supplied with greased-for-life bearings, no additional lubrication is required for the life of the bearing.

c. Priming—Pump and suction piping must be full of liquid before pump is started. Usually suction supply will be primed when shutoff valves are opened, if pump is below suction supply. If suction supply is below pump, priming by other means, such as a foot valve or ejector, will be required.

d. Free Rotation—Rotate shaft by hand to make sure it is free. Drag from packing or seal is normal but, if pump cannot be rotated by hand or binding or rubbing is noticed, correct before starting pump.

2. Startup

a. Valves—Be sure suction valve is fully open. Normally, discharge valve should be at least partially closed for flow control.

b. Rotation Check—If not already done, uncouple the unit and jog the motor to check for proper rotation (refer to Section II-E-2, page 5).

III-B. Operation Checks

Inspect pump carefully and frequently during the first few hours of operation. If packing runs hot, shut pump down, allow box to cool, loosen gland if necessary. (Do not loosen gland until packing has cooled.) Mechanical seal may weep slightly, but should "run-in" in a few hours. Be sure all auxiliary lines (cooling, flushing, sealing, etc.) are functioning properly. Check pump bearings for excessive heating. Check complete unit for excessive vibration and unusual noises. Do not run pump at greatly reduced flow because damage can result.

III-C. Shutdown Procedure

Back flow through pump will cause reverse rotation. If backflow is excessive, and there is a possibility of the pump being turned on during this period of reverse rotation, then precautions should be taken to prevent the backflow. This can be done by installing a check valve in the discharge line, or by closing a discharge valve immediately prior to shutting down the pump. NOTE: IT IS NOT RECOMMENDED THAT THE PUMP RUN LONGER THAN ABSOLUTELY NECESSARY AGAINST A CLOSED DISCHARGE VALVE.

SECTION IV—PREVENTIVE AND CORRECTIVE MAINTENANCE

IV-A. Lubrication

Oil lubricated units require only that oil be visible in reservoir or the oiler. Grease lubricated units should be regreased every 2,000 hours or 3 month intervals, whichever occurs first. Use a sodium or lithium grease and fill until grease comes out grease relief fittings. Follow motor and coupling manufacturers' lubrication instructions.

IV-B. Stuffing Box

1. Packing Stuffing Box: Periodically inspect stuffing box to see that there is sufficient leakage to lubricate the packing and maintain a cool box. Never restrict the leakage from the packing as this will cause damage to both packing and shaft sleeve. Draw up gland nuts slowly and evenly and only while pump is running.

After pump has been in operation for some time and the packing has been completely "run-in", a leakage of 40 to 60 drops per minute of the liquid should be allowed to flow from the stuffing box at all times for cooling and lubricating the packing and shaft sleeve.

2. Stuffing Boxes with Mechanical Seal: This type of box requires no attention other than to make sure that the circulating lines do not become clogged.

IV-C. Vibration

It is a good practice to periodically monitor vibration of the pump. Normally, the vibration level will be well within accepted standards. Of equal importance is that the vibration level not increase. If a problem with vibration is encountered, refer to Trouble Shooting, Section VII.

IV-D. Alignment—Final

Alignment should be checked after unit has reached operating temperature, following startup. Repeat alignment procedures outlined in Section II-E. Check alignment again after one week of operation.

IV-E. Performance

If performance deteriorates, refer to Trouble Shooting, Section VII.

SECTION V—DISASSEMBLY AND REASSEMBLY

V-A. Disassembly (refer to Sectional Views in Part VI)

1. Prepare pump for disassembly as follow:

a. Lock out power supply to motor.
b. Shut off valves controlling flow to and from pump.
c. Flush pump of all corrosive or toxic liquid, if required.
d. Remove all auxiliary tubing and piping.
e. Disconnect coupling and remove coupling spacer.
f. Drain oil.
g. On units with packed stuffing box, unbolt and remove split gland (107).

2. Disassemble pump as follows:

a. Place sling from hoist through eyebolt (132). On ST units, place sling through frame (228A) above shaft (122).
b. Remove frame foot hold down bolts.
c. Remove bolts (370) holding frame (228A) or frame adapter (108) to casing (100).
d. Slide back pull-out assembly from casing, using jacking bolts (418) provided.
e. Remove casing gasket (351).
f. Unscrew impeller (101) from shaft (122). The threads are right hand. Remove O-ring (412A) which seals between the impeller and shaft or sleeve.
g. (1) On units with inside mechanical seal, remove gland stud nuts (355) and carefully slide gland toward bearing frame (228A).
   (2) On units with outside mechanical seal, loosen set screws holding rotary portion of seal to shaft and slide seal toward bearing frame. Remove gland stud nuts and carefully slide gland off studs.
h. Remove stud nuts (370H) which hold stuffing box cover (184) to frame adapter. Pull stuffing box cover from frame or adapter. Slide sleeve (if any) off shaft.
i. On units with mechanical seal, loosen set screws holding rotary portion of seal to shaft, and carefully slide seal and gland assembly off shaft. On units having a shaft sleeve, it is not necessary to remove rotary portion of seal from sleeve unless replacement of seal is required.
j. Slide deflector (123) off shaft.
k. Scribe shaft at coupling hub for proper positioning of hub during reassembly and remove hub.
l. Remove bearing housing bolts (370C). Using impeller adjustment bolts (370D) for jacking, remove shaft and bearing assembly from frame. This will include the shaft, both bearings (112A) and (168A), and bearing housing (134A). Do not lose or damage O-ring (496).
m. Remove inboard bearing (168A) using a bearing puller. Never use a hammer to drive shaft through bearing! Protect bearing from contamination.
n. On ST and MT models, remove bearing housing retaining ring (361A) and slide bearing housing off ball bearing. Do not damage oil seal (332A). On XLT units, remove bearing end cover bolts (109A) and slide cover off shaft. Do not damage oil seal (332A). Slide bearing housing off shaft.
o. Straighten tang in lockwasher and remove bearing locknut (136) and lockwasher. Remove ball bearing (112A) using a bearing puller. Protect bearing from contamination.
p. On units with stuffing boxes, remove lantern ring (105) and packing rings (106) from stuffing box cover (184).

V-B. Inspection and Parts Replacement Guidelines

1. Impeller—Replace if impeller shows excessive erosion, corrosion, extreme wear, or vane breakage. O-ring groove and impeller hub must be in good condition. Check impeller balance if possible. Reduction in hydraulic performance and reduced mechanical seal, packing or thrust bearing life may be caused by excessive impeller wear.

2. Shaft—Check for runout (.005" max) to see that shaft has not been bent. On pumps without shaft sleeves, shaft surface in stuffing box area must be smooth and free of grooves. Bearing seats and oil seal area must be smooth and free of scratches or grooves. Shaft threads must be in good conditions. Metalize or replace shaft if necessary.

3. Shaft Sleeve—Sleeve surface in stuffing box must be smooth. If grooved, replace.

4. Mechanical Seal—Seal faces, gaskets, and shaft sealing members must be in perfect condition or leakage may result. Replace worn or damaged parts.

5. Ball Bearings—Replace if worn, loose or rough and noisy when rotated.

6. Oil Seals—Replace if worn or otherwise damaged.

7. General—All parts should be clean before assembly. All burrs should be removed.

V-C. Reassembly Procedures

This procedure covers reassembly of pump after complete disassembly. Make sure all directions outlined in Section V-B have been followed.

1. Oil shaft at thrust bearing fit on coupling end of shaft (122). Slide thrust (coupling end) bearing (112A) on shaft as far as possible by hand. Place pipe or driving sleeve over shaft, making sure it rests against inner face only. Make sure bearing is "square" on shaft. Tap or press evenly until bearing is seated firmly against shaft shoulder. Do not mar the shaft.

2. Place lockwasher and bearing locknut (136) on shaft and tighten firmly. Bend "tang" of lockwasher into slot in locknut.

3. Slide bearing housing (134A), with O-ring (496) in place, on shaft and over bearing (112A) as far as possible. Do not damage oil seal (332A) on ST and MT models.

4. On ST and MT models, insert retaining ring (361A) into groove in bearing housing (134A). Flat side of retaining ring must be against bearing (112A). On XLT units, slide bearing end cover (109A) and gasket (360C) on shaft. Ensure the "top" of end cover (109A) lines up with the "top" of bearing housing (134A). Bolt end cover to housing.

5. Oil inboard bearing seat on shaft. Slide inboard ball bearing (168A) on shaft (122) as far as possible by hand. Continue as in Step 1 above.

6. Place a small amount of O-ring lubricant on inside of bearing frame (228A) at bearing housing (134A), at inboard bearing seats (168A), on O-ring (496), and on inboard oil seal (333A). Carefully slide shaft assembly into bearing frame. Do not damage inboard oil seal (333A). Screw bearing housing bolts (370C) about ½" into bearing frame (228A).

7. Slide deflector (123) on shaft (122).

8. If unit has packed stuffing box, place stuffing box cover (184) against adapter (108), making sure that studs (370H) align with proper holes in adapter. Replace nuts and firmly tighten. Slide sleeve (if any) on shaft. Make sure grooves in end of sleeve engage drive pin on shaft. Continue assembly at Step 10.

9. If unit has mechanical seal:

The following instructions refer to pumps equipped with mechanical seals, either with or without sleeves.

If the unit has a single inside or double seal, a preliminary impeller adjustment must be performed to assure proper positioning of mechanical seal.

(1) Position sleeve (126), if any, on shaft (122) and engage groove in sleeve with drive pin (469) on shaft. Place stuffing box cover (184) against frame (228). Make sure studs (370H) align with proper holes in frame. Firmly tighten nuts or bolts.
(2) Screw impeller (101) with O-ring (412A) in place on shaft. Make sure that shaft assembly extends through stuffing box cover (184) so that the impeller will NOT contact face of stuffing box cover.
(3) Using impeller adjusting bolts (370C and 370D), adjust the impeller clearance until a .020" (0.51mm) feeler gauge can be inserted between the back of the impeller and the face of the stuffing box cover.

The following instructions are for three basic seal types: Single Inside, Single Outside, and Double Seals. Refer to seal manufacturer's drawing seal type and positioning dimension. Follow pertinent procedures.

a. **Single Inside Seal**
(1) Scribe the shaft (122) or shaft sleeve (126) lightly at the face of the stuffing box.
(2) Remove the impeller and stuffing box.
(3) Assemble the gland (250) with gaskets and stationary seat and slide the assembly over the shaft (122) or shaft sleeve (126).
(4) Slide the rotary portion of the seal on the shaft (122) (or shaft sleeve) (126) establishing its location from the scribe line to the dimension as shown on the seal manufacturer's drawing. Tighten set screws.
(5) Reinstall the stuffing box cover and tighten. Do not damage the seal parts.
(6) Reinstall the impeller with O-ring.
(7) Slide the gland assembly against the stuffing box and tighten the nuts evenly. Do not damage the seal parts.
(8) Refer to step 12 for further assembly details.

b. **Double Seals**
(1) Scribe the shaft (122) or shaft sleeve (126) lightly at the face of the stuffing box.
(2) Remove the impeller and stuffing box.
(3) Assemble the gland (250) with gaskets and stationary seat and slide the assembly over the shaft (122) or shaft sleeve (126).
(4) Slide the rotary portion of the seal on the shaft (122) or shaft sleeve (126) establishing its location from the scribe line to the dimension as shown on the seal manufacturer's drawings. Tighten set screws.
(5) Place inboard stationary seat and gaskets into bottom of stuffing box.
(6) Reinstall the stuffing box cover and tighten. Do not damage seal parts.
(7) Reinstall the impeller with O-ring.
(8) Slide the gland assembly against the stuffing box and tighten the nuts evenly. Do not damage seal parts.
(9) Refer to step 12 for further assembly details.

c. **Single Outside Seal**
Preliminary impeller adjustment is not necessary with this type of mechanical seal.
(1) If unit has shaft sleeve (126), slide on shaft (122) and engage groove in sleeve with drive pin (469) on shaft.
(2) Lubricate rotary portion of seal and slide on shaft sleeve. Do not tighten set screws.
(3) Assemble gland (250), gaskets, and stationary seat and slide assembly on shaft or sleeve.
(4) Place stuffing box cover (184) against frame making sure that the studs (370H) align with the proper holes in frame. Firmly tighten nuts.
(5) Screw impeller with O-ring on shaft making sure impeller does not make contact with stuffing box cover. If the impeller does hit, use impeller adjusting cap screws to correct.
(6) Place gland assembly against face of stuffing box and firmly tighten stud nuts.
(7) Slide rotary portion toward gland until it contacts stationary seat. Compress the rotary. Tighten screws.

10. Screw impeller (101) with O-ring (412A) in place, on the shaft (122).

11. On units with stuffing box packing (106), repack stuffing box as outlined in Section II-F. Assemble gland stud nuts finger tight.

12. Install and position coupling hub at scribe mark on shaft.

13. Place casing gasket (351) against shoulder in casing.

14. Slide the pullout assembly into the casing (100). Drain slot in stuffing box cover (184) should line up with drain connection in casing. Install frame-to-casing bolts (370) and tighten evenly while rotating shaft (122) by hand. If impeller ceases to turn freely, stop tightening operation and adjust the impeller setting with the adjusting bolts (370C and 370D) before resuming tightening of frame-to-casing bolts (370).

15. Impeller Clearance

The impeller clearance is an important factor in maintaining optimum pump performance. The nominal clearance is .015" with the recommended minimum being .008". The actual clearance setting is dependent on the specific operating conditions, taking into account temperature, solids, etc. For maximum service flexibility pumps are shipped from the factory with the clearance set at .015".

The desired clearance is obtained in the following manner:

a. Loosen bolts (370C and 370D).
b. Tighten bolts (370C) while turning shaft until impeller starts to rub against casing.
c. Loosen bolts (370C) until a feeler gauge, corresponding to the desired clearance, can be placed between the bolt head and bearing housing.
d. Tighten bolts (370D) evenly. Bearing housing shaft and impeller will be jacked to proper clearance from casing. Tighten bolts (370C) and jam nuts on bolts (370D).
e. If desired, a dial indicator can be used instead of a feeler gauge to check that the bearing housing has been moved the correct distance.

V-D. Additional Details

An alternate method for setting inside mechanical seals is the "Modified Visegrip Method".

1. Follow assembly up to step 7.
2. Assemble the gland with stationary seat and gaskets.
3. Install the shaft sleeve, if used on the shaft, and engage groove in sleeve with drive pin (469) on shaft.
4. Slide gland assembly over the shaft or shaft sleeve.
5. Install the stuffing box cover and impeller. Establish a preliminary rotor adjustment (refer to Section V-C-9).
6. Slide gland assembly against stuffing box. Do not bolt the gland to the stuffing box.
7. Clamp the modified visegrip on the shaft or sleeve directly behind and against the gland.
8. Leave the visegrip in place and remove the impeller and stuffing box cover.
9. Lubricate the rotary portion of seal and slide it on the shaft until it comes in contact with the stationary seat in the gland.
10. Compress rotary portion of seal to correct dimension as shown on seal manufacturer's drawing. Tighten set screws.
11. Remove visegrip and reinstall stuffing box cover and tighten.
12. Reinstall impeller with O-ring.
13. Slide the gland assembly against the stuffing box and tighten nuts evenly.
14. Refer to Step 12, etc.

SECTION VI—PRODUCT DESCRIPTION

See pages 10 & 11 for
Sectional Views, Parts List
and Materials of Construction.

Parts List and Interchangeability List

Part No.	Req'd per Pump	Part Name	Material: All Ductile Iron	All 316SS	All CD4MI	All GA-20	All Monel	All Nickel	**All Hast	All Titanium
100	1	Casing	D I	316	CD4M	GA-20	Monel	Nickel	Hast	Titanium
101	1	Impeller	C I	316	CD4M	GA-20	Monel	Nickel	Hast	Titanium
105	1	Lantern Ring	Glass Filled Teflon
106	1 Set	Stuffing Box Packing	White Afr Asbes [3]	White African Asbestos[4]
107	1	Gland Packed Box	316	CA-20	GA-20	Monel	Nickel	Hast	Titanium
108	1	Frame Adapter	Cast Iron
109A	1	Bearing End Cover—Coupling End	Cast Iron
112A	1	Ball Bearing—Outboard End	Steel
113A	1	Bearing Frame Breather	Steel
119A	1	Bearing End Cover—Inboard	Steel
122	1	Pump Shaft (Less Sleeve)	SAE4150[3]	316	C-20	Monel	Nickel	Hast	Titanium
122A	1	Pump Shaft (with Sleeve)	SAE4140	316
123	1	Deflector	Glass Reinforced Nylon
126*	1	Shaft Sleeve	420[3]	316	CD4M	C-20	Monel	Nickel	Hast	Titanium
131	1	Casing Foot	Cast Iron
132	1	Eye Bolt	Steel
134A	1	Bearing Housing	Cast Iron
136	1	Bearing Locknut	Steel
168A	1	Ball Bearing—Inboard	Steel
184	1	Stuffing Box Cover—Standard	D I	316	CD4M	GA 20	Monel	Nickel	Hast	Titanium
184A	1	Stuffing Box Cover—Water Jacketed	D I	316	CD4M	GA 20	Monel	Nickel	Hast	Titanium
210	1	Gland Packing	White Asbestos[5]
228A	1	Bearing Frame	Cast Iron
241	1	Bearing Frame Foot	Cast Iron
247	1	Drip Basin	—	316
251	1	Constant Level Oiler (Not Illustrated)	Glass and White Metal
261	1	Gasket—Adapter to Stuffing Box	Manila Paper
332A	1	Oil Seal—Coupling End	Buna Rubber
333A	1	Oil Seal—Inboard End	Buna Rubber
351	1	Gasket—Casing	White Asbestos[5]
353	2	Gland Stud	316	Monel
355	2	Gland Stud Nut	304	Monel
360C	1	Gasket—Brg End Cover to Brg Hsg	Manila Paper
360D	1	Gasket—Bearing Frame to Adapter	Vellumoid
360U	1	Gasket—Jacket Cover	Asbestos
361A	1	Retaining Ring—Bearing Housing	Steel
370	4-24	Cap Screw—Frame/Adapt to Casing	Steel	304
370B	4	Cap Screw—Adpt /Adapt Ring to Frame	Steel
370C	3-4	Tap Bolt—Bearing Housing	Steel
370D	3-4	Tap Bolt—w/Jam Nut—Impeller Adjust	Steel
370E	2	Cap Screw—Casing Foot	Steel
370F	1-2	Cap Screw—Frame Foot	Steel
370H	2	Stud & Nut—Cover to Adapter	304
371D	8	Cap Screw	Steel
412A	1	"O" Ring—Impeller	Teflon
418	2-3	Tap Bolt—Jacking	Steel
469B	2	Dowel Pin—Frame to Adapter	Steel
469D	1	Drive Pin—Shaft Sleeve	420
490*	1	Water Jacket Cover	Cast Iron
492	1	Plug	Steel
496	1	"O" Ring—Bearing Housing	Buna Rubber
503	1	Adapter Ring	D I

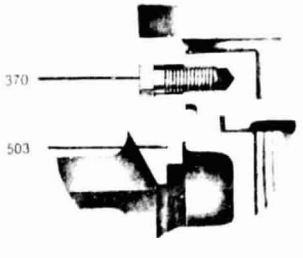
Part No.	Req'd per Pump	Part Name	INTERCHANGEABILITY BY SIZE & CASING CLASS: MODEL 3196 ST	MODEL 3196 MT*	MODEL 3196 XLT
100	1	Casing	1 x 1½ - 6 1½ x 3 - 6 2 x 1½ - 8 1½ x 3 - 8	2 x 3 - 6 2 x 3 - 8 3 x 4 - 86 1 x 2 - 10 1½ x 3 - 10 2 x 3 - 10 3 x 4 - 10 4 x 6 - 10 1½ x 3 - 13 2 x 3 - 13 3 x 4 - 13 4 x 6 - 13 6 x 8 - 13 8 x 10 - 13 6 x 8 - 15 8 x 10 - 15 8 x 10 - 156	
101	1	Impeller			
105	1	Lantern Ring	ST	MT	XLT
106	1 Set	Stuffing Box Packing	ST	MT	XLT
107	1	Gland Packed Box	ST	MT	XLT
108	1	Frame Adapter	NR	6 8 10 13	13A 15
109A	1	Bearing End Cover—Coupling End	NR	NR	XLT
112A	1	Ball Bearing—Outboard End	ST	MT	XLT
113A	1	Bearing Frame Breather	ST	MT	MT
119A	1	Bearing End Cover—Inboard	ST	NR	NR
122	1	Pump Shaft (Less Sleeve)	ST	MT	XLT
122A	1	Pump Shaft (with Sleeve)	ST	MT	XLT
123	1	Deflector	ST	MT	XLT
126*	1	Shaft Sleeve	ST	MT	XLT
131	1	Casing Foot	†	6 8 10 13 †	†
132	1	Eye Bolt	NR	MT	XLT
134A	1	Bearing Housing	ST	MT	XLT
136	1	Bearing Locknut	ST	MT	XLT
168A	1	Ball Bearing—Inboard	ST	MT	XLT
184	1	Stuffing Box Cover—Standard	6ST 8ST	6 8 10 13	13A 15
184A	1	Stuffing Box Cover—Water Jacketed	6ST 8ST	6 8 10 13	13A 15
210	1	Gland Packing	ST	MT	XLT
228A	1	Bearing Frame	ST	MT	XLT
241	1	Bearing Frame Foot	‡	MT	XLT
247	1	Drip Basin	—	MT	XLT
251	1	Constant Level Oiler (Not Illustrated)	MT	MT	XLT
261	1	Gasket—Adapter to Stuffing Box	NR	NR	XLT
332A	1	Oil Seal—Coupling End	ST	MT	XLT
333A	1	Oil Seal—Inboard End	ST	MT	XLT
351	1	Gasket—Casing	6ST 8ST	6 8 10 13	13A 15
353	2	Gland Stud	ST	MT	XLT
355	2	Gland Stud Nut	ST	MT	XLT
360C	1	Gasket—Brg End Cover to Brg Hsg	NR	NR	XLT
360D	1	Gasket—Bearing Frame to Adapter	NR	MT	XLT
360U	1	Gasket—Jacket Cover	NR	NR	XLT
361A	1	Retaining Ring—Bearing Housing	ST	MT	NR
370	4-24	Cap Screw—Frame/Adapt to Casing	ST	MT	XLT
370B	4	Cap Screw—Adpt /Adapt Ring to Frame	ST	MT	XLT
370C	3-4	Tap Bolt—Bearing Housing	ST	MT	XLT
370D	3-4	Tap Bolt—w/Jam Nut—Impeller Adjust	ST	MT	XLT
370E	2	Cap Screw—Casing Foot	NR	MT NR	#
370F	1-2	Cap Screw—Frame Foot	NR	MT	XLT
370H	2	Stud & Nut—Cover to Adapter	ST	MT	XLT
371D	8	Cap Screw	NR	NR	XLT
412A	1	"O" Ring—Impeller	ST	MT	XLT
418	2-3	Tap Bolt—Jacking	ST	MT	XLT
469B	2	Dowel Pin—Frame to Adapter	NR	MT	XLT
469D	1	Drive Pin—Shaft Sleeve	ST	ST	ST
490*	1	Water Jacket Cover	NR	NR	XLT
492	1	Plug	NR	NR	XLT
496	1	"O" Ring—Bearing Housing	ST	MT	XLT
503	1	Adapter Ring	NR 8ST	NR	NR

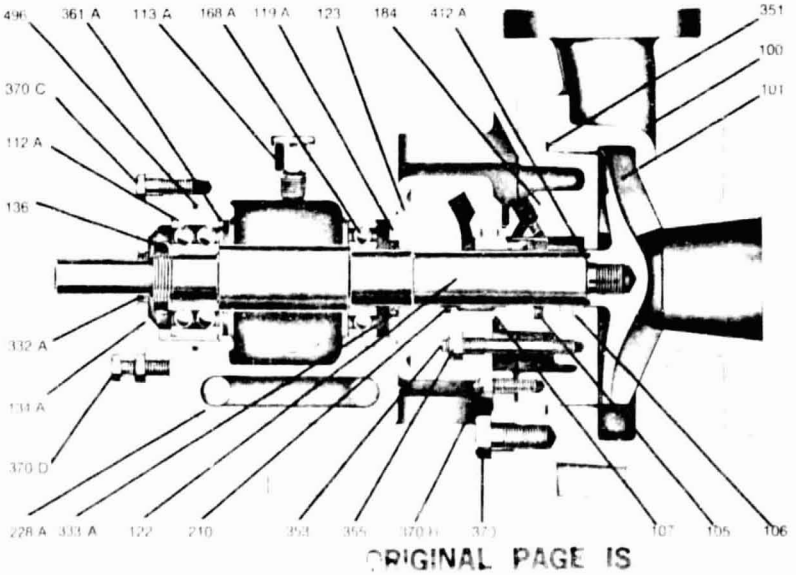
†Cast integral with casing
‡Cast integral with frame
*Optional
#Not required except on 300# flange casings and titanium construction

**Available in Hast-B or Hast-C Material
NR—Not required

NOTES: Not available on all sizes.
[2]Model 3196 LTC with 2-1.8 shaft available on 10" and 13" pumps. LTC standard on 3 x 4-13 at 3500 RPM and 2900 RPM. 2 x 3-13 at 3500 RPM. LTC would then replace MT on interchangeability chart.
[3]Graphite impregnated white African asbestos
[4]Teflon impregnated white African asbestos
[5]Flame hardened to 500 Brinell through stuffing box
[6]White chrysotile asbestos with acid resistant binders

Sectional View
Model 3196 ST

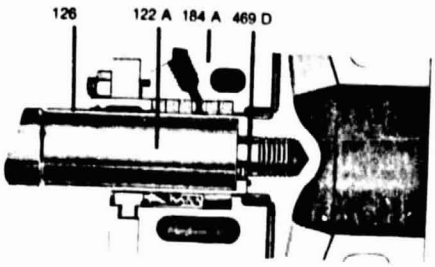




Assembly View of 1x1½-8 & 1½x3-6

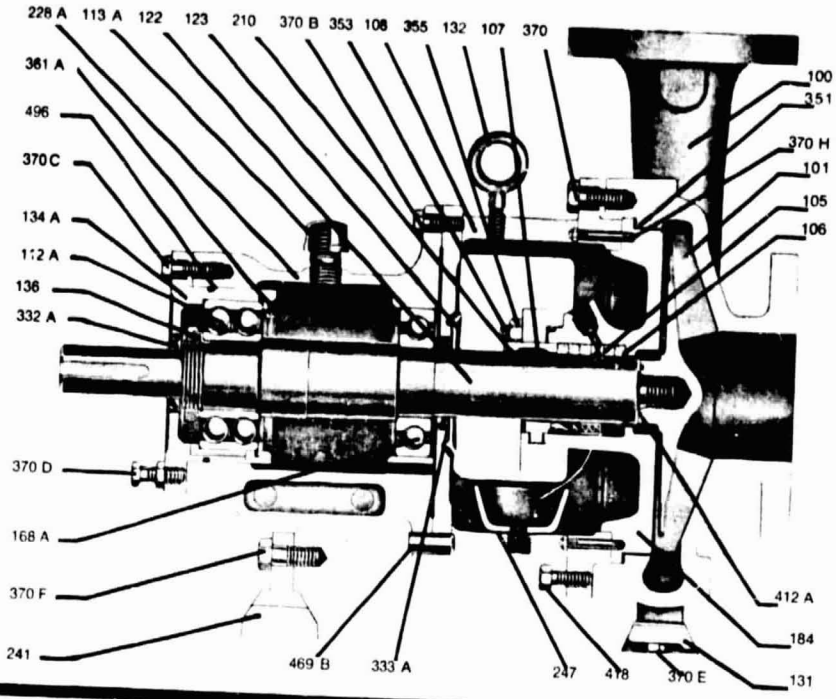
259-55

Model 3196 MT



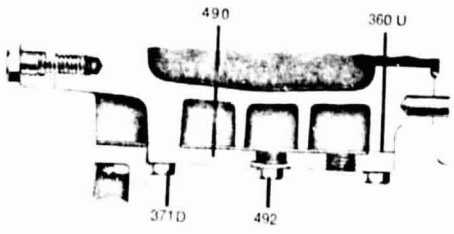
Optional Jacketed Stuffing Box
Optional Shaft Sleeve

Available on all Model 3196 pumps

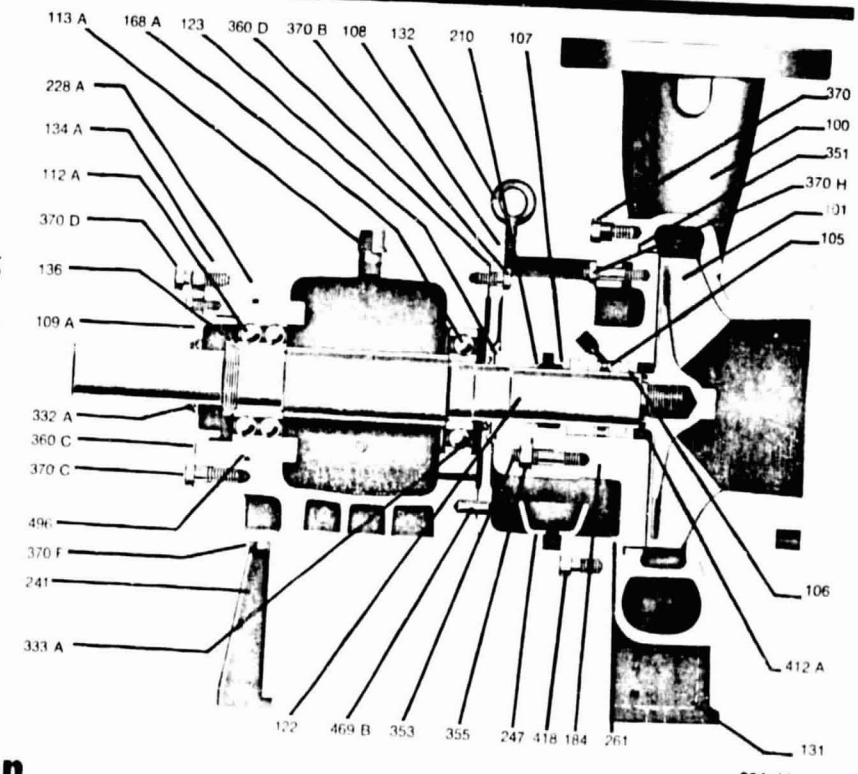


248-95 #3

Model 3196 XLT



Optional Water Cooled Bearing Frame



256-46

Materials of Construction

Code	Material and Specification
D-1	Cast Ductile Iron, Heat Treated — ASTM A536
316	Cast Stainless ASTM A296 Gr. CF 8M Wrought Stainless ASTM A276 Type 316
CD4M	Cast Chrome – Nickel Alloy A.C.I. CD4MCu, 250 270 Brinell
GA 20	Cast Gould A Loy 20 ASTM A296 Gr. CN 7M
Monel	Cast Monel ASTM A296 Gr. M 35 Wrought Monel ASTM B164 Cl. A
Nickel	Cast Nickel ASTM A296 Gr. CZ 100 Wrought Nickel ASTM B160
Hast C	Cast Hast C ASTM A296 Gr. CW 12M — Wrought Hast C ASTM B336
Hast B	Cast Hast B ASTM A296 Gr. N 12M — Wrought Hast B ASTM B335

Code	Material and Specification
Titanium	Cast Titanium ASTM B367 Gr. C 4 Wrought Titanium ASTM B348 Gr. 4
Cast Iron (C.I.)	Cast Iron ASTM A48 Class 25
SAE 4150	Wrought Steel ASTM A322 Gr. 4150
SAE 4140	Wrought Steel ASTM A322 Gr. 4140
420	Wrought Stainless ASTM A276 Type 420
C 20	Wrought Carpenter 20 CB3 ASTM B473
304	Wrought Stainless ASTM A276 Type 304

SECTION VII—TROUBLE SHOOTING

Problem	Possible Causes & Corrections
A. No liquid delivered, not enough liquid delivered, or not enough pressure	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 18, 19, 20.
B. Pump works a while and then quits	4, 5, 7, 8, 9, 11, 12, 20.
C. Pump takes too much power	6, 13, 14, 15, 16, 21, 22, 23. 24, 31.
D. Pump is noisy or vibrates	15, 16, 17, 28, 31.
E. Pump leaks excessively at stuffing box	8, 24, 25, 26, 27.
F. High bearing temperature	15, 16, 17, 29, 30, 31.
G. Stuffing box overheating	8, 24, 25, 26, 27.

Causes & Corrective Measures

1. Pump not primed or properly vented—check that casing and suction pipe are completely filled with liquid.
2. Speed too low—check whether motor wiring is correct and receives full voltage or turbine receives full steam pressure.
3. System discharge head too high—check system head (particularly friction losses).
4. Suction lift too high—check NPSH available (suction piping too small or long may cause excessive friction losses). Check with vacuum or compound gauge.
5. Impeller or piping obstructed—check for obstructions.
6. Wrong direction of rotation—check rotation.
7. Air pocket or leak in suction line—check suction piping for air pockets and/or air leaks.
8. Stuffing box packing or seal worn allowing leakage of air into pump casing—check packing or seal and replace as required. Check for proper lubrication.
9. Not enough suction head for hot or volatile liquids—increase suction head, consult factory.
10. Foot valve too small—install correct size foot valve.
11. Foot valve or suction pipe not immersed deep enough—consult factory for proper depth. Use baffle to eliminate vortices.
12. Entrained air or gases in liquid—consult factory.
13. Impeller clearance too great—check for proper clearance.
14. Impeller damaged—inspect and replace as required.
15. Rotating parts bind—check internal wearing parts for proper clearances.
16. Shaft bent—straighten or replace as required.
17. Coupling or pump and driver misaligned—check alignment and realign if required.
18. Impeller diameter too small—consult factory for proper impeller diameter.
19. Improper pressure gauge location—check correct position and discharge nozzle or pipe.
20. Casing gasket damaged—check gaskets and replace as required.
21. Speed too high—check motor winding voltage or steam pressure received by turbine.
22. Head lower than rating; pumps too much liquid—consult factory. Install throttle valve, cut impeller.
23. Liquid heavier than anticipated—check specific gravity and viscosity.
24. Stuffing box not properly packed (insufficient packing, not properly inserted or run in, packing too tight)—check packing and repack stuffing box.
25. Incorrect packing or mechanical seal—consult factory.
26. Damaged mechanical seal—inspect and replace as required. Consult factory.
27. Shaft sleeve scored—remachine or replace as required.
28. Cavitation—increase NPSH available. Consult factory.
29. Pump capacity too low—consult factory for minimum continuous flow.
30. Excessive vibration—See Section D.
31. Improper bearing lubrication or bearings worn out—inspect and replace as required.

SECTION VIII—ORDERING SPARE PARTS

VIII-A. Spare Parts

To insure against possible long and costly down-time periods, especially on critical services, it is advisable to have spare parts on hand.

1. For critical services: It is recommended that a "back pull-out assembly" be kept on hand. This is a group of assembled parts which includes all parts except the casing and the coupling.
   a. If this unit is equipped with stuffing box packing, the following parts should be on hand:
      (1) Stuffing box packing (item 106)—one set.
      (2) Stuffing box gland packing (item 210)—one set.

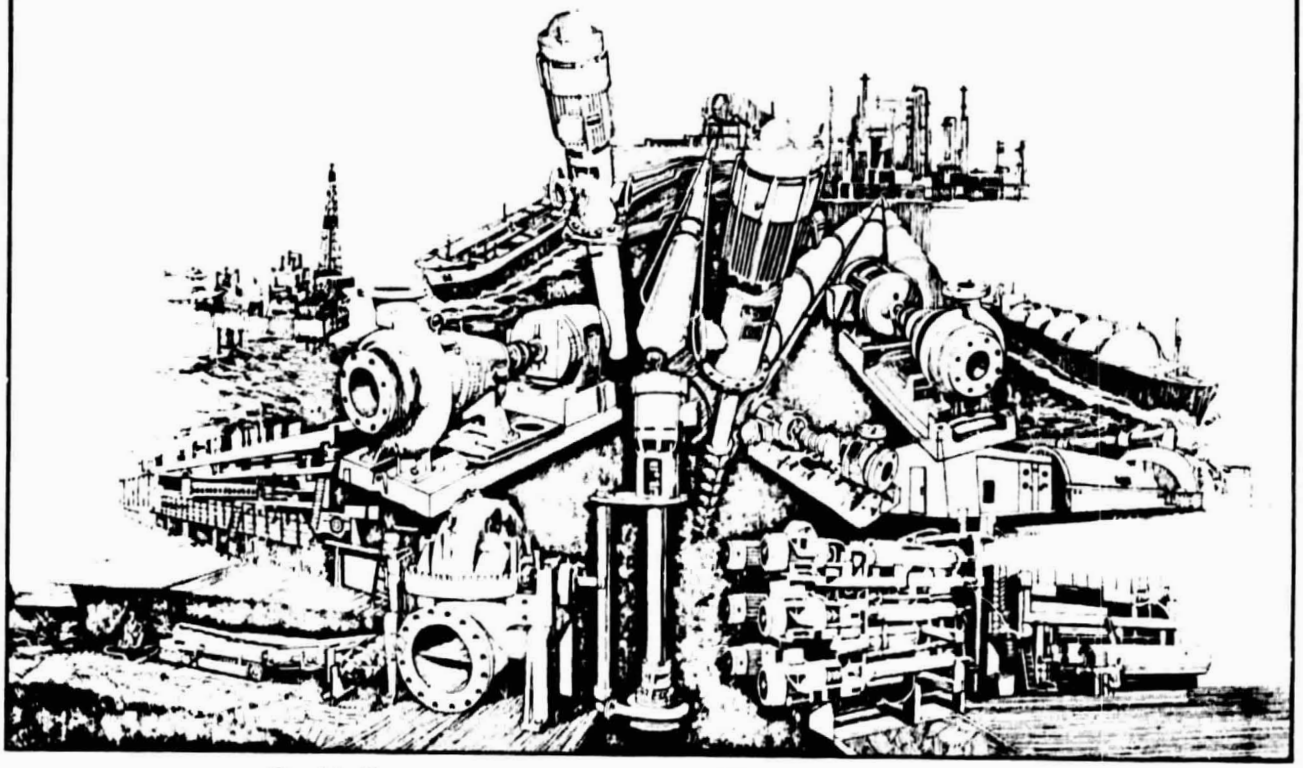
2. An alternative, though not as desirable as that stated above, can be used on non-critical services. This involves having on hand parts that are most likely to wear and can be used as needed. See Section VI-A, Parts List, for these recommended spares.

VIII-B. Instructions for Ordering Spare Parts

Repair orders will be handled with the minimum of delay if the following directions are followed:

1. Give model number, size of pump, and serial number. These can be obtained from the name-plate on the pump.
2. Write plainly the name, part number, and material of each part required. These names and numbers should agree with those on the sectional drawing in Section VI.
3. Give the number (quantity) of parts required.
4. Give complete shipping instructions.

Pumps, and nothing but.



Goulds Pumps built its first pump in 1851 and has since grown to the largest manufacturer dealing exclusively with centrifugal pumps.

Branch Sales Offices

*Atlanta—3406 Oakcliff Rd., Atlanta, Georgia 30340
Baltimore—2701 Cresmont Ave., Baltimore, Maryland 21211
Baton Rouge—6506 Airway Drive, Baton Rouge, Louisiana 70806
Beaumont—2360 Calder Ave., Rooms 232-233, Beaumont, Texas 77702
Birmingham—2112 11th Ave. South, Suite 400, Birmingham, Alabama 35205
Boston—One Washington St., Suite 203, Wellesley, Massachusetts 02181
Buffalo—3435 Harlem Rd., Cheektowaga, New York 14225
Charleston—54 MacCorkle Ave., S.W., St. Albans, West Virginia 25177
Charlotte—4108 Park Road, Charlotte, North Carolina 28209
*Chicago—2439 Crescent Dr., Broadview, Illinois 60153
Cincinnati—8901 Wooster Pike, Cincinnati, Ohio 45227
Cleveland—24700 Center Ridge Road, Westlake, Ohio 44145
Dallas—845 E. Arapaho Rd., Richardson, Texas 75081
Denver—300 East Hampden Ave., Suite 402, Englewood, Colorado 80150
Detroit—26437 Greenfield Road, Southfield, Michigan 48076
*Houston—5630 Star Lane, Houston, Texas 77057
Jacksonville—1919 Beachway Drive, Suite 4A, Jacksonville, Florida 32207
Kansas City—100 East Red Bridge Road, Suite 113, Kansas City, Missouri 64131
*Los Angeles—3537 Santa Fe River Pkwy., W. Hwy., California 90601
Memphis—3050 Poplar Ave., Suite 414, Memphis, Tennessee 38111
Mobile—4001 Airport Boulevard, Mobile, Alabama 36609
Monroe—2021 Tenney St., Monroe, Louisiana 71201
*New York—259 Fairfield Avenue, Fairfield, New Jersey 07006
Philadelphia—3605 Chapel Road, Newtown Square, Pennsylvania 19073
Pittsburgh—Two Parkway Center, Suite 117, Pittsburgh, Pennsylvania 15220
*Portland—10400 S.W. 5th St., Suite 140, Beaverton, Oregon 97005
St. Louis—14175 Manchester Blvd., Ballwin, Missouri 63011
San Francisco—1740 Suite 150, Mt. Diablo Blvd., Lafayette, California 94549
Seattle—Suite 201 Northwest Bldg., 19400 44th Avenue West, Lynnwood, Washington 98036
Tampa—1402 North 56th St., Tampa, Florida 33619
Tulsa—8175 East 46th St., Tulsa, Oklahoma 74145
Wilmington—17 Penny Drive, Hockessin Corner, Hockessin, Delaware 19707

*Stocking Warehouses

International Sales Offices

Goulds Pumps Inc.—Export Dept., Seneca Falls, New York 13148
Goulds Pumps Southeast Asia Office—P.O. Box 144, Makati, Rizal 3117, Philippines
Goulds Pumps European Office—Morgartenstrasse 6, CH-6003 Luzerne, Switzerland
Regional Office—Western Europe & North Africa—Schoolstraat 1, B 2230 Schilde (Antwerpen), Belgium
Regional Office—Middle East—P.O. Box 3391, Kolonaki, Athens 139, Greece
Goulds Pumps Latin American Office—Apartado Aereo 90316, Bogota, Colombia
Goulds Pumps Central American Office—41 E. Monte Mall, Hato Rey, Puerto Rico 00918

Manufacturing Plants

Main Plant and Headquarters—Seneca Falls, New York 13148
Vertical Pump Division—City of Industry, California 91747
*Texas Division—Lubbock, Texas 79417
Bombas Goulds de Mexico, S.A. de C.V.—Condor 96, Mexico 20, D.F.
Goulds Bombas e Equipamentos LTDA.—Avenida Bem Te Vi, 184 Indianopolis, Sao Paulo, S.P., Brazil
Goulds Pumps (Phil.) Inc.—P.O. Box 7157, Manila International Airport, Philippines
Goulds Pumps Europe AG.—CH-4800 Zofingen, Switzerland

Manufacturing Licensees

Allen Gwynnes Pumps LTD.—Queens Engineering Works, Bedford, England
Beloit Canada Ltee Ltd.—Goulds Pumps Division—189 Hymus, Pointe Claire, Quebec, Canada
Goulds Hidraven, Hidraven Comercial C.A.—Apartado 5C 451, Caracas, Venezuela
Goulds D.P. Drakos Polemis Pumps Manufacturers Inc.—P.O. Box 24, Kifissia, Greece
Celtic Engineering Co. Ltd.—25 Great Strand Street, Dublin 1, Ireland
Miguel Schmitt & Cia. S.R.L.—Beruti-y 5459-69, Buenos Aires, Argentina

Pump Service Facility

Goulds Lexington Division—Ferry and Main Streets, Newark, New Jersey 07105

*Stocking Warehouses

GOULDS PUMPS, INC. Main Plant and Headquarters, Seneca Falls, N.Y. 13148

Form No. A348-E.L. 6-77 Sup. 8788-E.L.

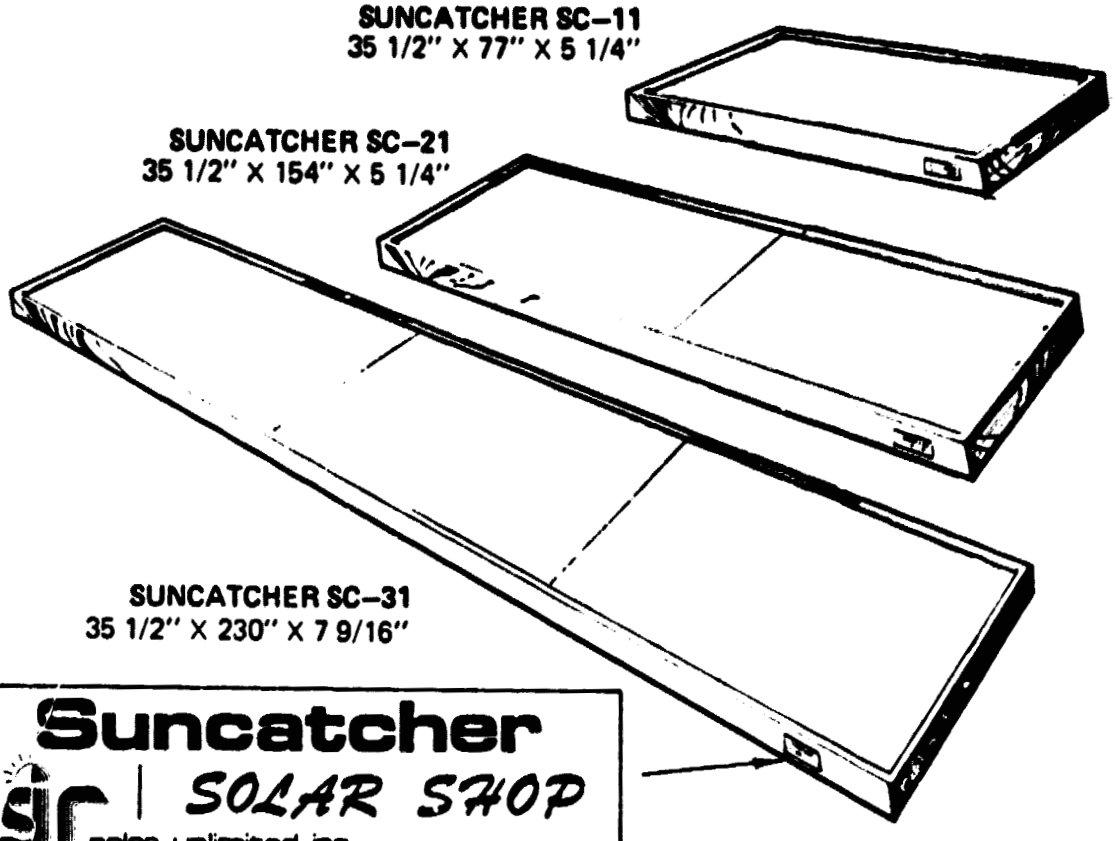
Printed in U.S.A.

STANDARD SOLAR COLLECTOR PANELS

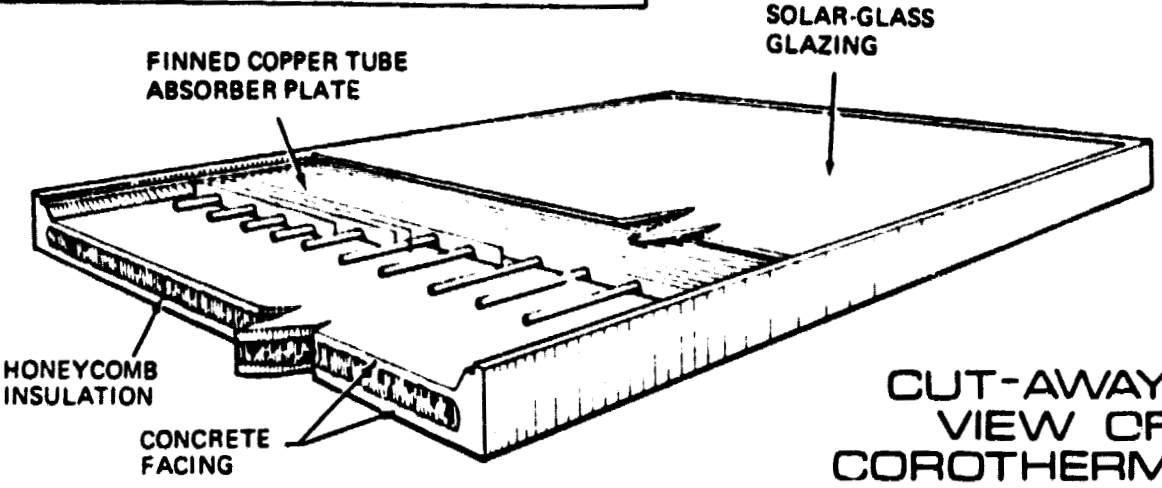
SUNCATCHER SC–11
35 1/2" X 77" X 5 1/4"

SUNCATCHER SC–21
35 1/2" X 154" X 5 1/4"

SUNCATCHER SC–31
35 1/2" X 230" X 7 9/16"



Suncatcher
SOLAR SHOP
solar unlimited inc
4310 Governors Drive West • Huntsville, Alabama 35805

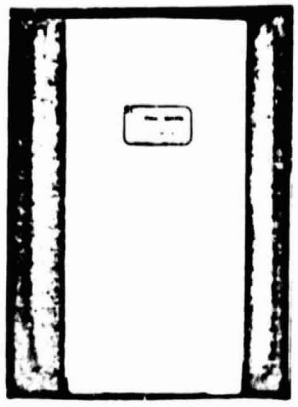


CUT-AWAY VIEW OF COROTHERM
(PATENT PENDING)

solar unlimited incorporated

HEAT EXCHANGER ASSEMBLY

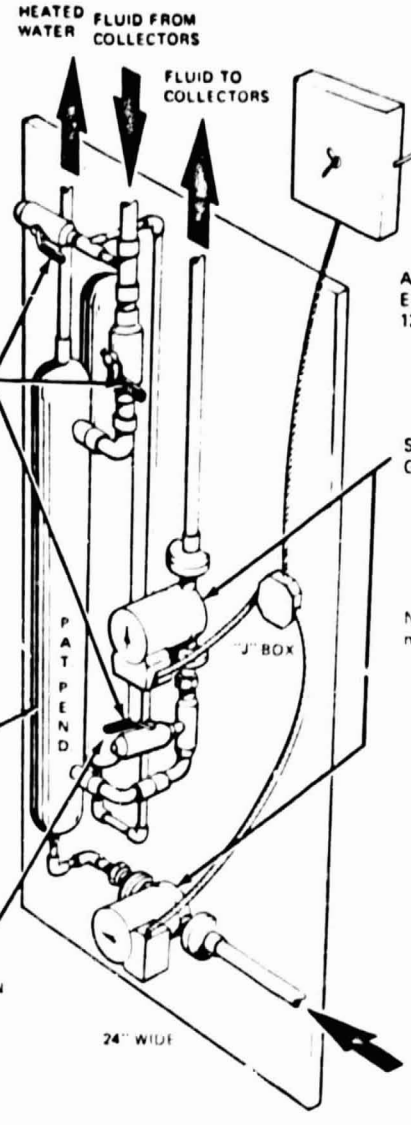
MODEL HEA-01



BEAUTIFUL FIBERGLASS COVER MAKES THIS AN ATTRACTIVE APPLIANCE TO THE MOST DISCRIMINATING HOMEOWNER.

PLYWOOD COVER IS STANDARD-
FIBERGLASS IS OPTIONAL

- **COMPACT**
- **EFFICIENT**
- **VERSATILE**
- **PROVEN**
- **ATTRACTIVE**



U.L. listed differential controller

All power completely pre-wired to National Electric Code, ready to plug into standard 120-volt outlet.

Self-lubricating, 1/12 h.p. U.L. listed Grundfos pumps, "can" type extra reliable

NOTE THIS !!

Quickly fill entire system, including collectors, using these three convenient valves and two ports. Just connect a service pump to 1/2" NPT and follow a simple procedure. Not necessary to fill from on top of roof.

!! SIMPLE !!

No solenoids, no relief valves, and no motorized valves to stick or fail.

EXCLUSIVE !!

All-copper counterflow high-efficiency heat exchanger. Double wall with an external vent path between walls gives absolute protection from contamination of drinking water by fluid in collector loop!! Don't settle for less!!

NOW HIGH EFFICIENCY CAN BE OBTAINED USING LOW SPECIFIC HEAT FLUIDS.

- **SAFE**
- **SAFE**
- **SAFE**

Stainless steel water pump that will not rust.

Chrome plated ball valves

Model HEA 01	Stock # 13111
Fiberglass cover for model above (white)	Stock # 13109

SOLAR SHOP HEAT EXCHANGERS

PATENT PENDING

DOUBLE-WALL HEAT EXCHANGERS

- Operates efficiently with low-specific-heat fluids
- Designed and built specifically for solar water heating systems
- All-copper construction ensures corrosion-free long life and efficient heat transfer
- Double-wall construction completely protects domestic hot water from heat transfer fluid
- External vent between tube walls gives positive leak detection and eliminates contamination in either direction in case of failure of either tube.
- Large shell side heat transfer area and low pressure drop
- Meets all U.S. plumbing codes
- Satisfies HUD Intermediate Minimum Property Standards, 4930.2 requiring double-wall contamination protection between potable water and nonpotable liquid
- Sized to operate efficiently with up to 100 sq. ft. of solar collectors
- Designed for use with viscous heat-transfer fluids such as silicone fluid
- Operates efficiently with water and antifreeze solutions
- Water connections are 1/2" nominal standard copper tubing
- Heat transfer fluid connection 1 1/4" nominal copper tubing
- Water loop pressure tested to 250 PSI
- PATENT PENDING Model No. HE 332D . . . . . Stock No. 13205

SINGLE-WALL HEAT EXCHANGERS

Solar Shop also manufactures a single wall heat exchanger similar in construction (except for the double wall) to the heat exchanger above. It is all copper construction, has a large shell side heat transfer area and low pressure drop, and operates efficiently with high-viscosity and low-specific-heat fluids.

Single wall heat exchanger – Model HE 332S . . . . . Stock No. 13204

. . . Non-Solar Applications . . .

Solar Shop's Heat Exchangers can also be used in heat recovery systems to transfer heat from toxic fluids (including gases) to water. The double wall heat exchanger provides a safe means of transferring heat from such fluids to potable water.

EXPANSION TANKS FOR SOLAR

DESIGNED FOR CLOSED SYSTEMS

- All Copper construction for corrosion free long life
- Compact size 3" OD x 31"
- 1 gallon capacity
- Connection size 1/2" Nominal Standard Copper Tubing
- Rated for Pressures up to 150 PSIG

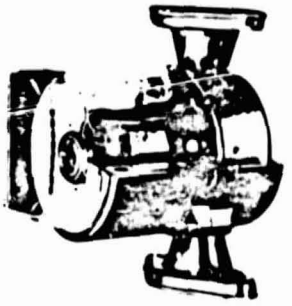
Stock No. 13301

solar unlimited incorporated

Domestic Circulators from GRUNDFOS

Versatile, Efficient and Reliable

Here's why over 2,000,000 Grundfos Domestic Circulators were purchased last year alone by contractors and manufacturers all over the world...



Stainless Steel Construction...
All vital motor and pump components, including shafts and impellers, are constructed of high-grade stainless steel. Grundfos open system pumps also feature an all stainless steel volute, so that water passing through the pump touches nothing but corrosion-resistant stainless.

18 Month Warranty...
Each Grundfos pump is warranted for continuous circulation of water up to 230°F. We are able to make this guarantee because we test *each and every* pump we make under extreme operating conditions. But, if for some reason, one of our pumps should fail, we'll give you a new one to replace it. We don't expect you to spend valuable time and money fixing up our mistake.

Variable Speed Motors...
You no longer have to stock a wide range of pumps. The Grundfos UPS 20-42 with its variable-speed motor, for example, does the job in the majority of residential and light commercial applications.

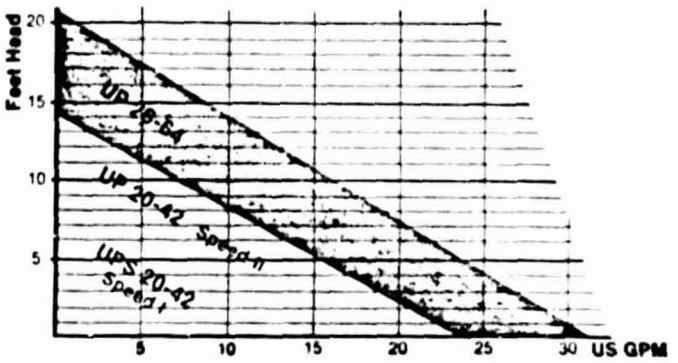
Fast, Easy Installation...
Grundfos pumps can be easily matched to the individual requirements of most heating and solar systems, and their light weight and small size make them a cinch to install.

Efficient and Quiet...
Our largest selling model the UPS 20-42 uses less power than it takes to run a 100-watt lightbulb! And due to the Grundfos patented self-lubrication system, and ceramic bearings, Grundfos circulators are the quietest-running pumps available today.

Competitively Priced...
Check with your Distributor or Grundfos Representative today. You'll find it hard to believe that a pump with all these features could cost so little.

GRUNDFOS

Closed System Circulators

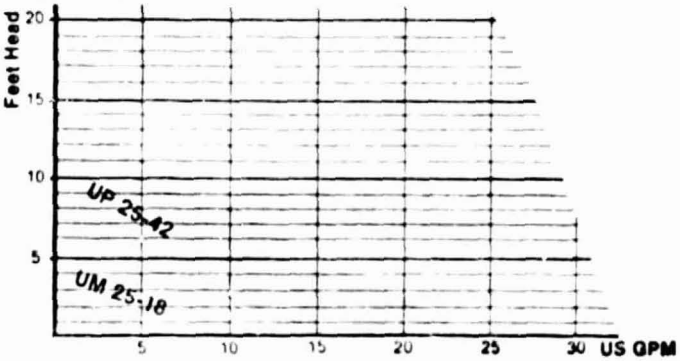


UP 26-64 1/12 HP

UPS 20-42 1/20 HP

For domestic hydronic heating, and closed system solar water and space heating systems...
Designed for easy pump selection, reduced stocking problems, fast installation and total reliability and efficiency, Grundfos Closed System Circulators produce heads to 21 feet or flows to 31 GPM using energy efficient 1/12th or 1/20th HP motors.

Open System Circulators



UP 25-42 1/20 HP

UM 25-18 1/35 HP

For domestic open system solar water and space heating and "Instant Heat" hot water loop systems.
Water passing through Grundfos Open System Circulators touches *only* high grade, corrosion resistant stainless steel. These pumps produce heads to 14 feet or flows to 23 GPM using energy efficient 1/20th or 1/35th HP motors.

SOLAR CONTROLS AND INSTRUMENTATION

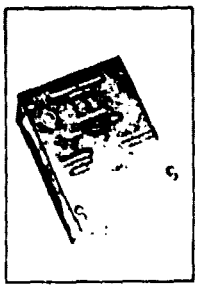
solar unlimited incorporated

CONTROLS AND INSTRUMENTATION MANUFACTURED BY RHO SIGMA

Control Systems
For regulation of liquid and air flows in solar systems designed for heating and cooling. UL Listed.

Sensors
Compatible with standard plumbing fittings. Designed to withstand solar collector stagnation temperature. Designed for easy installation.

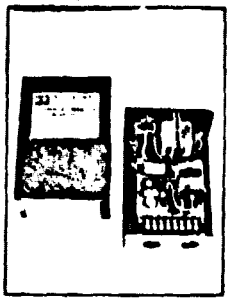
RS 106



Differential Thermostat
Input 120 VAC
Standard Output:
SPDT Relay rated at 10 amps
1/3 hp at 120 VAC
1/2 hp at 240 VAC
Switch with manual ON OFF AUTO positions
Relay contacts make when
ΔT on = T(collector) – T(storage) > 20 ± 3°F
Relay contacts break when
ΔT off = T(collector) – T(storage) < 3 ± 1°F
Housed in standard NEMA box to ensure compatibility with standard electrical trade hardware
Wiring connections made by standard electrical trade procedures

U L Listed
RS 106 – Stock #14103

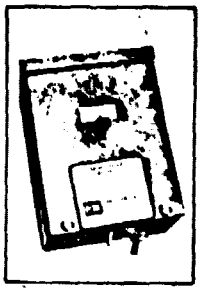
RS 12



Provides differential control identical to the RS 106 Relay switches 120 VAC at 10 amps directly to the pumps.

(Not U L Listed)
RS 12 – Stock #14102

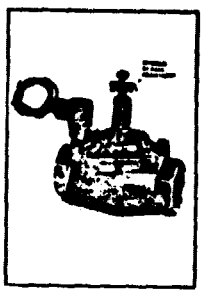
RS 240



Swimming Pool Solar Control
Input: 220 VAC Standard 120 VAC (optional)
Output: 12 VDC, 5 amps continuous
Thermostatic setting to prevent pool overheating (adjustable 56°F-120°F)
Turns on solar heater when solar collectors are 5°F hotter than pool temperature when pool temperature is below thermostatic setting. When pool temperature is above the thermostatic setting, then water by passes the solar collectors
Easily wired into pump timers so that the control unit functions only when the pump is operating. Rain tight enclosure
Easy retrofit installation into existing pool filtration systems
Optional configurations available for normally open valves and 24 VAC solenoids

U L Listed
RS 240 – Stock #14150

RS 950



Material: Brass
Port Diameters: 1 1/2" and 2"
Low voltage solenoid
Pressure drop: 1 psi and 40 gpm (1 1/2" valve)
Internal Bypass: Valve modified to Rho Sigma's specifications. Unique adjustment on stem enables installer to conveniently limit the amount of valve closure. Thus, high back-pressure (developed within the collector array) on the pump may be relieved through the internal by-pass of the valve. Internal bypass also provides a drain-down path for the collector supply line when the pump turns off.
The valve may also be effectively used in gravity return systems.
Positive opening ensured by connection to suction side of pump.

RS 950 – Stock #16301

SENSORS

All Rho Sigma sensors are electrically identical and interchangeable and are designed to withstand stagnation temperatures of solar collectors. Two and only two sensors are required with each differential thermostat.

The **SA Sensor** is the temperature sensing element encased in epoxy.

The **ST Sensor** has a copper housing with a hole punched in it for bolting directly to the collector plate or suspending inside air ducts. Alternatively, a radiator hose pipe clamp may be used to secure the rugged sensor to the surface of a pipe. Or it may be slipped inside the insulation of the storage tank.

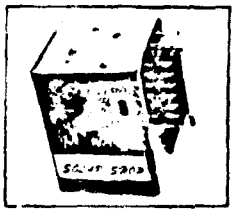
The **SF Sensor** is a 1" X 1" X 2", sandblasted and black anodized aluminum sensor designed for use with unglazed solar collectors or in high flow rate, low delta T systems. The screw provided with the sensor may be used to mount the sensor near the collector where it will sense the temperature and availability of solar energy at the collector.

The **SP Sensor** is epoxied into a rugged brass housing with standard 1/2" pipe threads for easy installation into standard plumbing fixtures.

SA Sensor – Stock #14205
ST Sensor – Stock #14201
SP Sensor – Stock #14202
SF Sensor – Stock #14204

These controllers turn the solar collection system on when solar energy is available and turn the system off when solar energy is not available. This ensures maximum efficiency of the solar heating system.

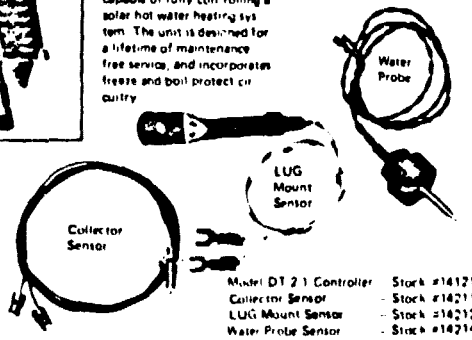
MODEL DT-2-1 SOLID-STATE SOLAR HOT WATER CONTROLLER



U L Listed

Description
The model DT-2-1 is a solid-state differential thermostat capable of fully controlling a solar hot water heating system. The unit is designed for a lifetime of maintenance free service, and incorporates freeze and boil protect circuitry.

Water probes have 1/2" NPC thread, in lengths from 2 3/4" to 28".



Model DT-2-1 Controller	Stock #14121
Collector Sensor	Stock #14211
LUG Mount Sensor	Stock #14212
Water Probe Sensor	Stock #14214

Specifications

Input Voltage	Either 120 VAC ± 10V or 24 VAC ± 4V.
Input Power	3 watts, no load
Control Relay	SPDT, 10A (resistive) at 28 VDC or 120 VAC. Higher ratings available.
Output Voltage	Either 120 VAC or 24 VAC
Sensors	Matched thermistors (±1°C over range from 0°C to +100°C) in a metal housing, with high-temperature teflon leads
Differential Turn-off Offset	Typically 4 ± 2°F @ 100°F (can be adjusted by a resistor change).
Differential Turn on Offset	Typically 20 ± 2°F @ 100°F (can be adjusted by a resistor change)
Temperature Range	Controller chassis –40°F to 140°F Sensors –40°F to +300°F
Tracking Accuracy	±5°F over entire operating range
Isolation Protection	1500 V
Size	4" x 4" x 3 1/2"
Weight	2 lbs
Mounting	Mounts on 4" x 4" J box

Q2-1132 SILICONE HEAT TRANSFER FLUID

Design Choices

Three general classes of materials can be considered as potential heat transfer candidates:

1. Water and Water/Glycol Mixtures
2. Hydrocarbon Oils
3. Silicone Liquids

1. Water and Water Glycol Mixtures

Water is usually the first choice for a heat transfer fluid. It has the inherent property of being extremely inexpensive, readily available and having no adverse biological, environmental, or building material effects.

The liquid range of water (32°F-212°F) is too narrow, it is easily contaminated with ionic minerals and is a poor dielectric.

To overcome these deficiencies propylene or ethylene glycols and corrosion inhibitors are added. These do not solve the vapor pressure problem. At 400°F pressures ove 150 psi are generated. As the inhibitors are sacrificial, a regular maintenance schedule is required to maintain the system. Draindown systems or waste heat dumping hardware must be added to the collection loop increasing the overall capital cost. Water and water/organic mixtures are not premium solar heat transfer fluids.

The superior thermal properties of water are of marginal value as the low heat flux levels of flat plate collectors result in very low fluid flow rates. Increased flow rates for less efficient fluids result in negligible increased pumping costs.

2. Hydrocarbon Oils

In industrial use, hydrocarbon oils are normally considered as a second choice for a heat transfer fluid. While there are many mixtures of "hot oils" to choose from, a typical example of a premium hydrocarbon would be mineral oil such as that used in outdoor transformers as a dielectric coolant.

Mineral oils of this type are excellent dielectric materials, are non-ionic, exhibit only minor biological, environmental, and building material problems and are non corrosive at temperatures up to 220°F. While parafinic-based mineral oils freeze at relatively high temperatures, naphthanic stocks can be formulated to operate down to the −20°F range provided that high viscosity increases can be coped with in the pumping loop.

Unfortunately, most mineral oils have flash- and fire-points in the 300-330°F range. In addition, at elevated temperatures they readily oxidize forming tars which can coat the collector panel walls reducing both heat transfer characteristics and flow rates. Oxidation is quite frequently accompanied by the formation of acid by-products which can attack and corrode copper, aluminum, and steel. The acceptance of hydrocarbon oils under general residential building codes and fire insurance regulations is unknown.

A napthanic-based transformer-grade mineral oil would appear to be a superior product to water and water/glycols, provided that panel stagnation temperatures could be kept below 220°F and oxidation inhibitors could be added to prevent tar and acid buildup.

Specialized aromatic and terphenyl organic heat transfer fluids used at temperatures up to 650°F in industrial heat transfer loops are the premium fluids of the hydrocarbon class. These offer acceptable viscosities at temperatures as low as 0°F, exhibit excellent thermal stability in a closed system up to 400°F and are, in themselves, non-corrosive to common engineering materials. They tend to oxidize at 400°F even with limited oxygen exposure, and tars and/or acids can be generated, and they can adversely affect house construction materials. The flashpoints are in the general range of 310-360°F.

3. Q2-1132 Silicone Fluid

Dow Corning Q2-1132 Silicone Heat Transfer Liquid comfortably exceeds each of the basic design parameters as they relate to freezing, vapor pressure, corrosion, flashpoint, long term stability, toxicity, and compatibility with materials of house construction.

Silicone fluids have extremely wide liquid ranges with a flat temperature-viscosity slope. They are non-freezing and have very low vapor pressures.

Current evidence indicates that Dow Corning Q2-1132 Silicone Heat Transfer Liquid is non-corrosive leaving the designer free to use a variety of metals in designing his system.

It has a high flash- and fire-point, 460°F & 500°F, respectively.

Both laboratory testing and field experience indicate that silicone fluids such as Q2-1132 do not attack common building materials. They are one of the least toxic chemicals sold in industry.

At operating temperatures of 150-200°F with occasional exposure to 400°F in closed loops, silicone fluids should last for the life of the solar system. Periodic maintenance and replacement of the fluid should not be required.

Dow Corning Q2-1132 Silicone Heat Transfer Liquid is designed to operate in closed-loop medium temperature collector systems which do not normally operate over 250°F and stagnate below 400°F.

1 Gallon	Stock No. 16101
5 Gallon Container	Stock No. 16105
55 Gallon Drum	Stock No. 16115

ABOUT COROTHERM

It is apparent that a construction material and building system serving both for solar energy collection and as the primary building material would greatly reduce the cost and complexity of new construction. Corotherm, which Solar Unlimited, Inc. is now marketing, satisfies these requirements.

The primary goals in this product development were to reduce cost while maintaining a high standard of building quality. Consideration had to be given to important features such as type of materials, production methods, thermal qualities, construction techniques, weight and strength.

There are other products now on the market that offer one or two outstanding characteristics, but none that can offer all in one versatile product like Corotherm.

Corotherm is a patent-pending product made by sandwiching a layer of structural honeycomb filled with sound and thermal insulation between layers of reinforced concrete.

The list below reveals why Corotherm is, in reality, a new and beautiful way to construct solar facilities and building components.

corotherm features

- Lightweight – Honeycomb core eliminates heavy internal weight while maintaining structural strength.
- Low Thermal Conductivity – Honeycomb core filled with insulation greatly reduces heat-transfer losses.
- Low Material Cost – Unique and precast manufacturing methods combine low-cost materials into a completed integral building panel.
- Low Construction Cost – Complete building panel arrives at job site ready for quick installation thus eliminating costly and time-consuming job site construction activities.
- Reduced Shipping Costs – Light-weight panels permit shipment of large square foot quantities on one truck load.
- Unlimited Architectural Flexibility – Shape, thickness, interior and exterior facings are all features that can be widely varied to suit the designer.
- Fire Resistant – Non-combustible concrete facings provide effective fire resistance.
- High Durability – Concrete virtually unaffected by weather, salt air, wind and blowing sand.
- Low Sound Conductivity – Concrete facings separated by insulated honeycomb provide excellent sound barrier.
- Low Maintenance – Natural facing materials require no periodic painting or coatings.

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DOUBLE-WALL HEAT EXCHANGER

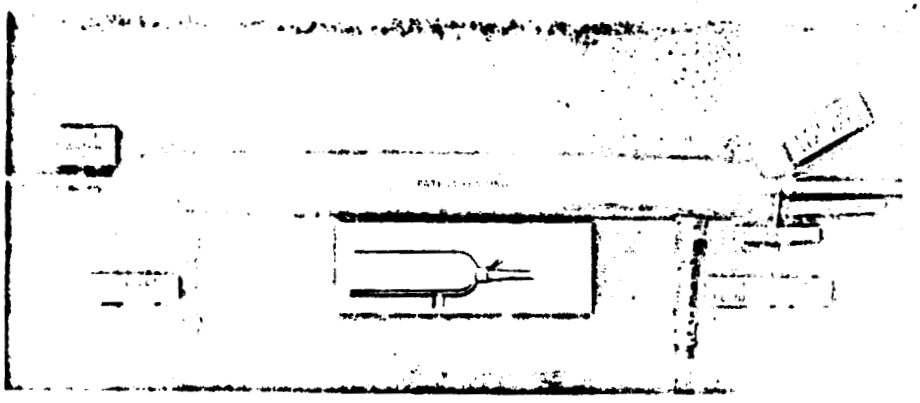
ABSOLUTE PROTECTION

Absolute protection of your water supply from collector fluid contamination is assured by using an external leak path between dual tubes inside heat exchanger.

HIGH EFFICIENCY

High-efficiency heat transfer using high surface area counterflow patent pending design. This all-copper unit efficient even with low-specific-heat fluids such as silicone.

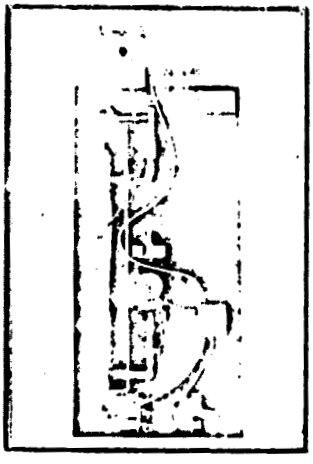
PHOTO DEMONSTRATES EXTERNAL LEAKAGE PATH IF EITHER TUBE FAILS*



*A hole was drilled through the outer wall of the dual water tube to prove that the external leakage path works.

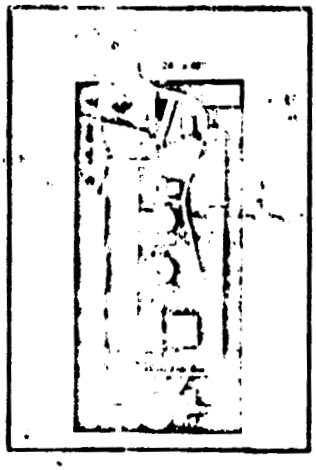
HEAT EXCHANGER ASSEMBLIES

COMPLETELY ASSEMBLED, TESTED AND READY TO PLUG IN



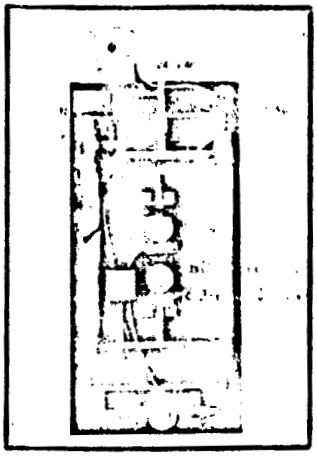
HEA-01

Water Heater



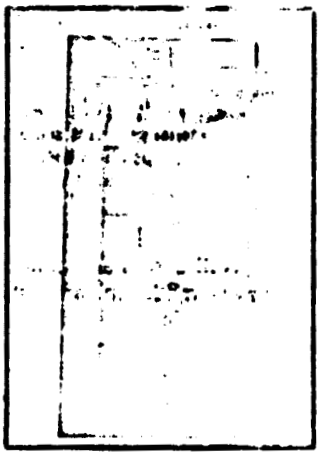
HEA-02

Solar Room Heater



HEA-03

Multi Room Solar Heater

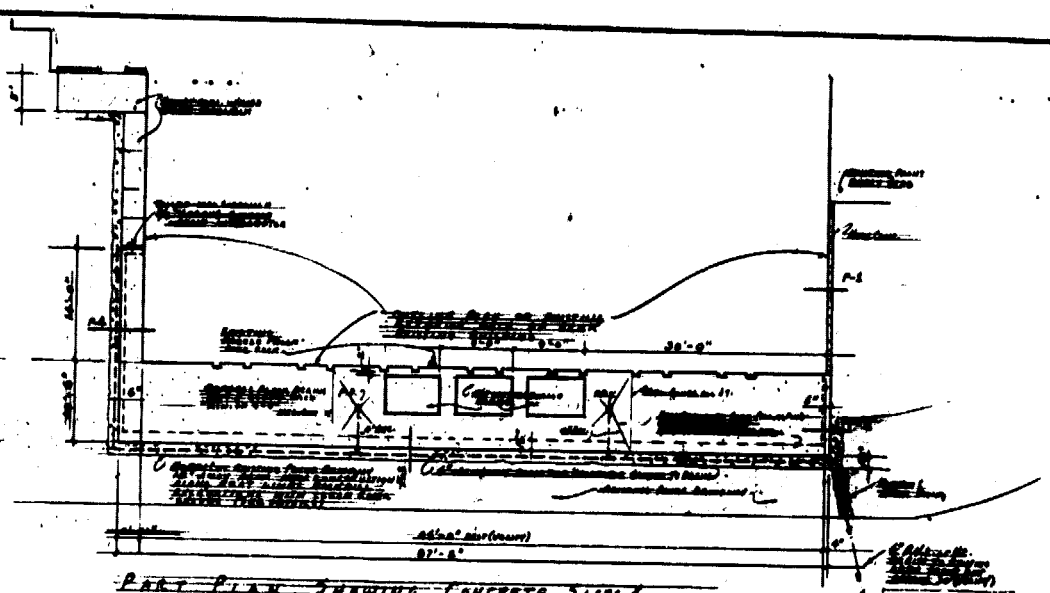


HEA-31

Central Solar Heater

15.0 AS-BUILT DRAWINGS

(Pages 1 through 8 comprise the drawings for this project.)

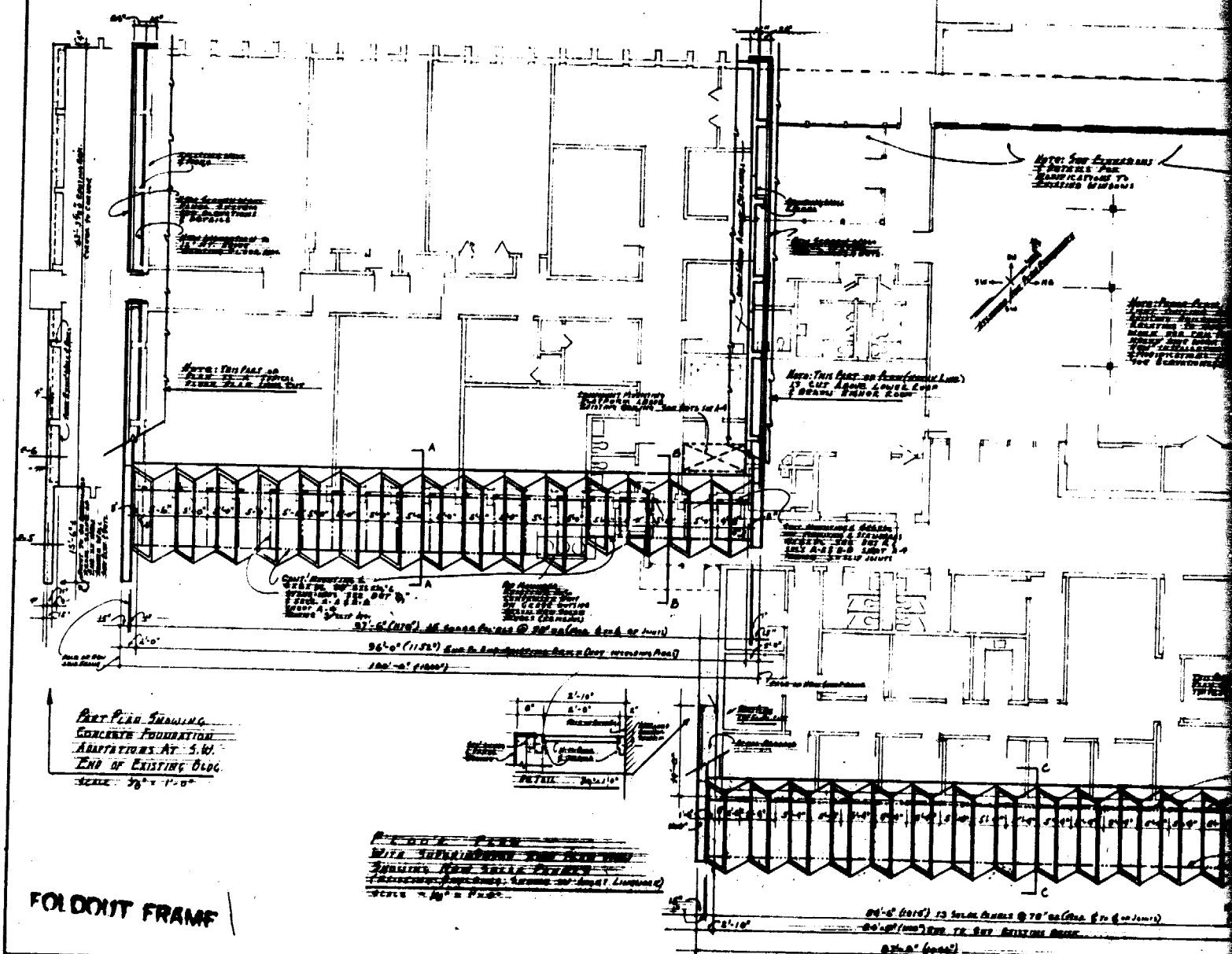


PART PLAN SHOWING CONCRETE SLABS & FOUNDATION ARRETATIONS FOR SOLAR PROJECT AT SOUTH EAST SIDE OF EXISTING BUILDING

INDEX TO SHEETS

Sheet No.	Title
A-1	
A-2	
A-3	
A-4	
A-5	
A-6	
M-1	
E-1	

ORIGINAL PAGE IS OF POOR QUALITY



PART PLAN SHOWING CONCRETE FOUNDATION ARRETATIONS AT S.W. END OF EXISTING BLDG.

FOLDOUT FRAME

...RATIONS FIRST PLANS & DETAILS
...DETAILS
...TECTURAL PANEL DETAILS
...PANEL ADAPTATION TO EXISTING BUILDING
...WALL PANEL ADAPTATION TO EXISTING BUILDING
...NICAL PLANS & DETAILS
...NICAL DETAILS
...TRICAL PLANS & DETAILS

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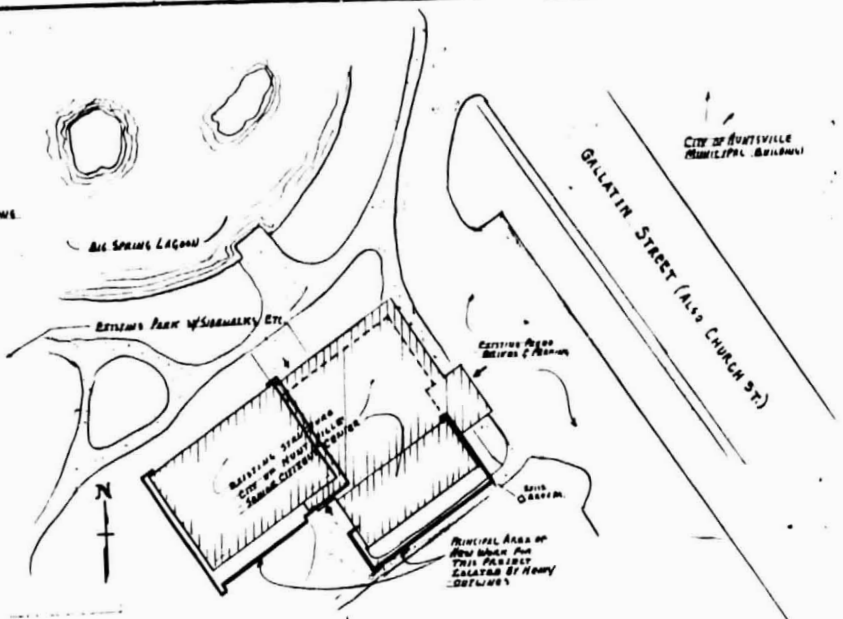
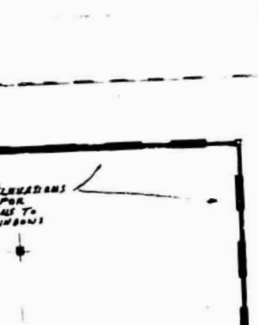
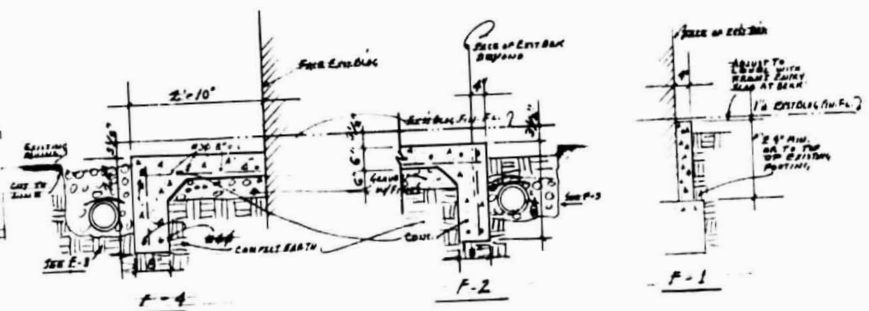
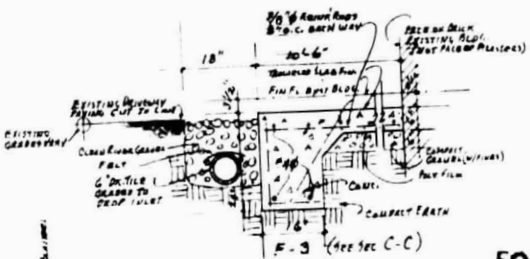
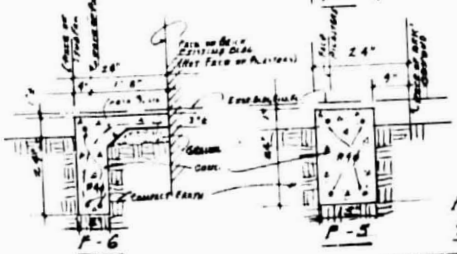


PROJECT LOCATION & PARTIAL SITE PLAN SCALE 1" = 40'



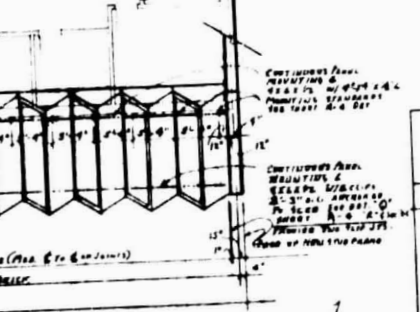






FOUNDATION DETAILS F-
SECTIONS SCALE 3/4" = 1'-0"

FOLDOUT FRAME 2



CITY OF HUNTSVILLE SENIOR CITIZEN'S CENTER
SOLAR HEATING AND HOT WATER SYSTEM
PROJECT EG-77-A-01-6071 HUNTSVILLE, ALABAMA
FLOOR PLAN & FOUNDATION PART PLANS & DETAILS

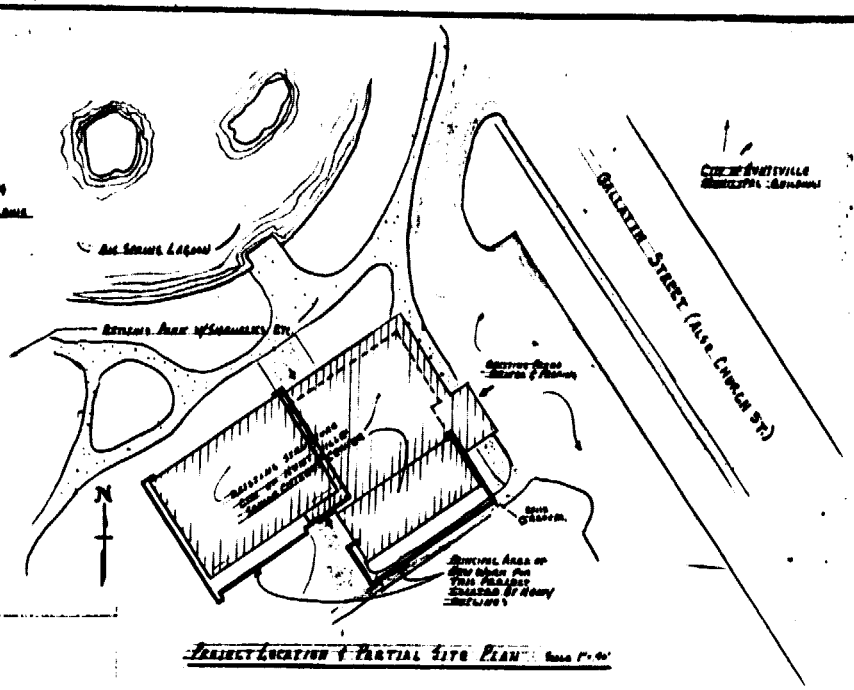
DICKSON AND ASSOCIATES ARCHITECTS
HUNTSVILLE ALABAMA

STATE OF ALABAMA REGISTERED ARCHITECTS 336 1710

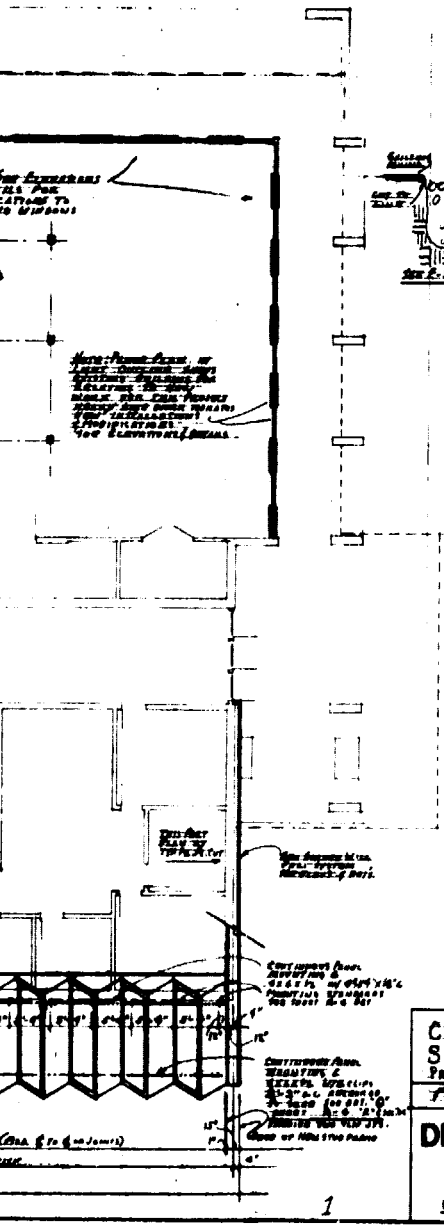
SHEET	DRAWN	REVISED	JOB NO.
A-1	CHECKED		
OF 8	DATE 1/25/78		

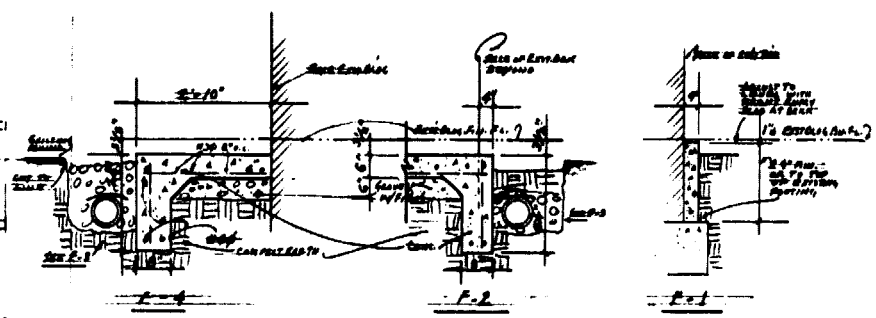
HEETS

- Foundation & Floor Plans & Details
- Details & Sections
- Architectural Plans & Details
- Solar Heating Installation To Existing Building
- Structural Notes & Details
- Mechanical Details
- Electrical Plans & Details

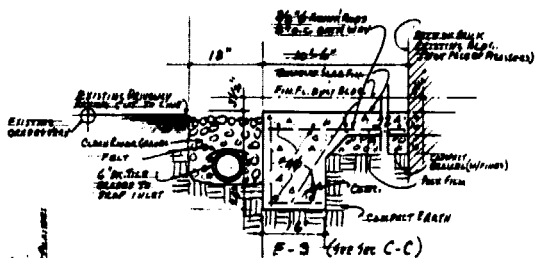


Project Location & Partial Site Plan

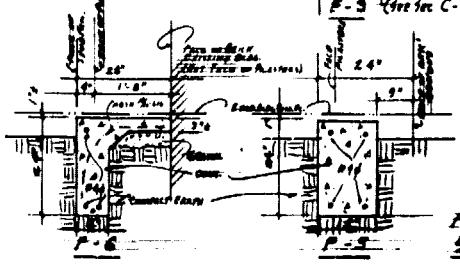




F-4 F-2 F-1



F-3 (See Sec C-C)



F-6 F-5

Foundation Details F-
Sections

FOLDOUT FRAME 2

City of Huntsville Senior Citizen's Center
Solar Heating and Hot Water System
Project #6-77-A-01-0471 Huntsville, Alabama

Floor Plan & Foundation Part Plans & Details

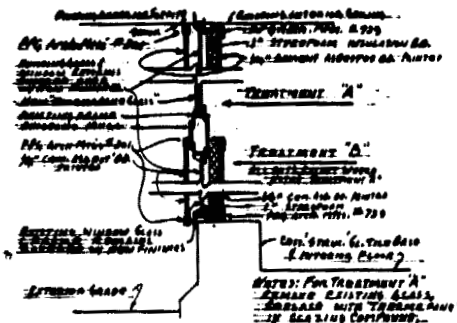
DICKSON AND ASSOCIATES
ARCHITECTS
Huntsville Alabama

Sheet A-1 of 8
Drawn RWS
Checked
Date 1/25/78
Revised 4/4/78
Job No. 77-9

1

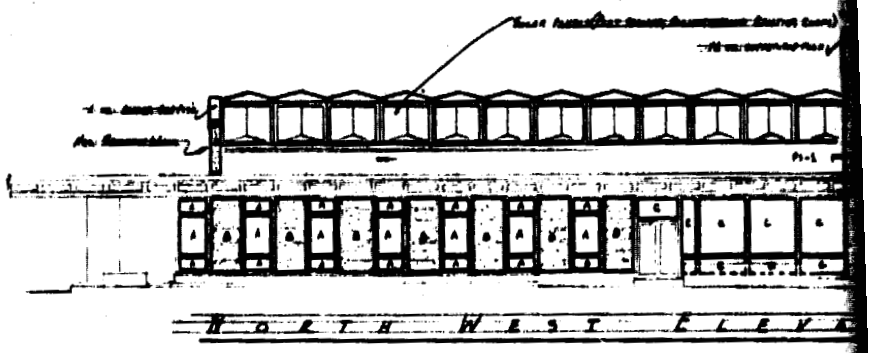
Glass & Glazing Schedule & Notes

Mark	Treatment	Remarks
A	[illegible]	See Specifications
B	[illegible]	See Details & Specifications
C	[illegible]	See Specifications

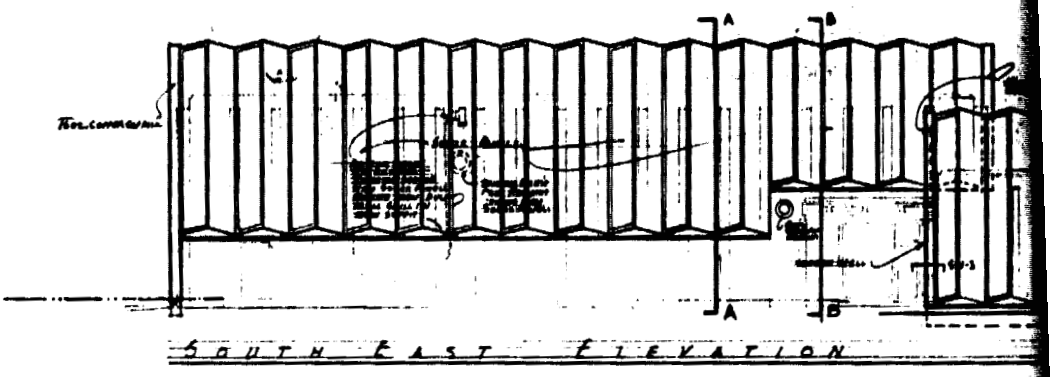


Details - New Glazing & Modifications to Existing Window Walls - See A-8

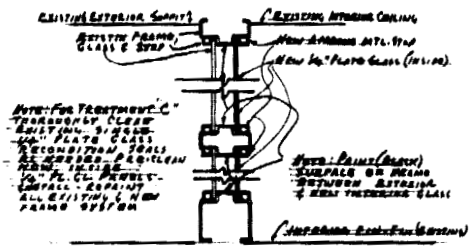
Scale: 1½" = 1'-0"



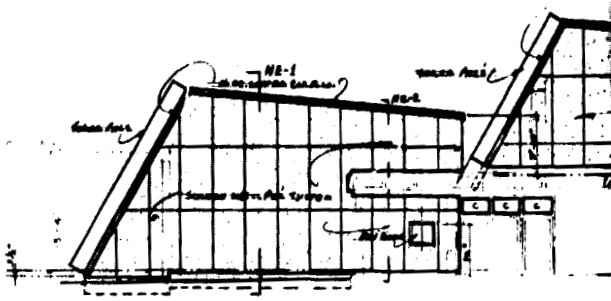
North West Elevation



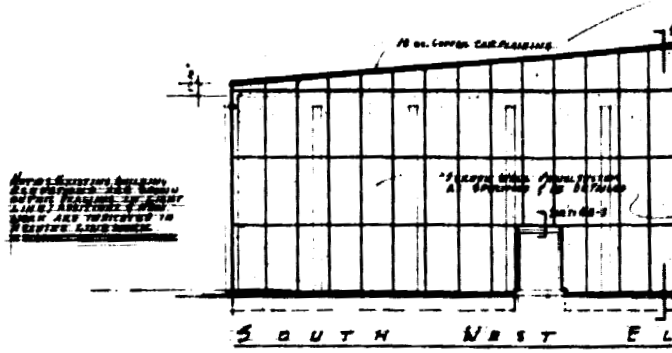
South East Elevation



Details - New (Supplementary) Glazing Treatment "C" - Scale 1½" = 1'-0"

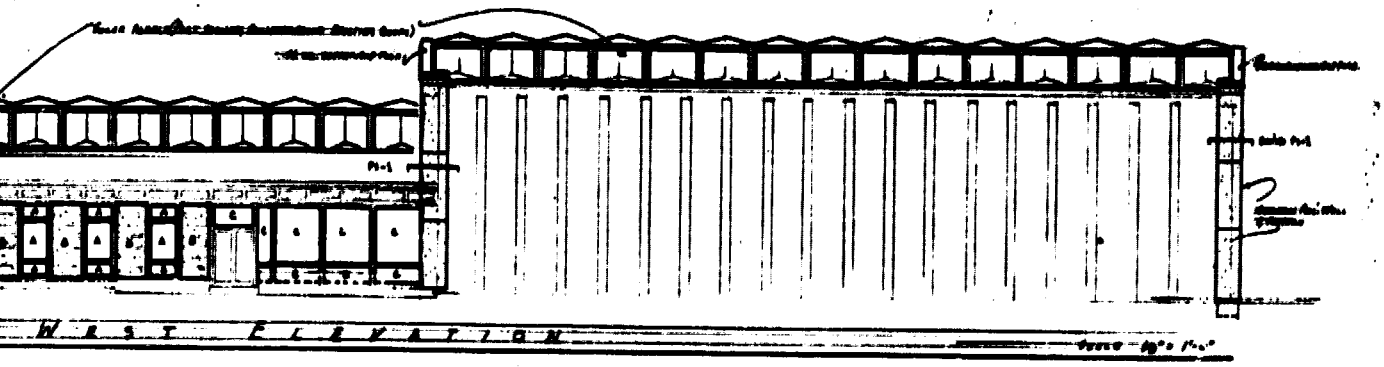


North East Elevation

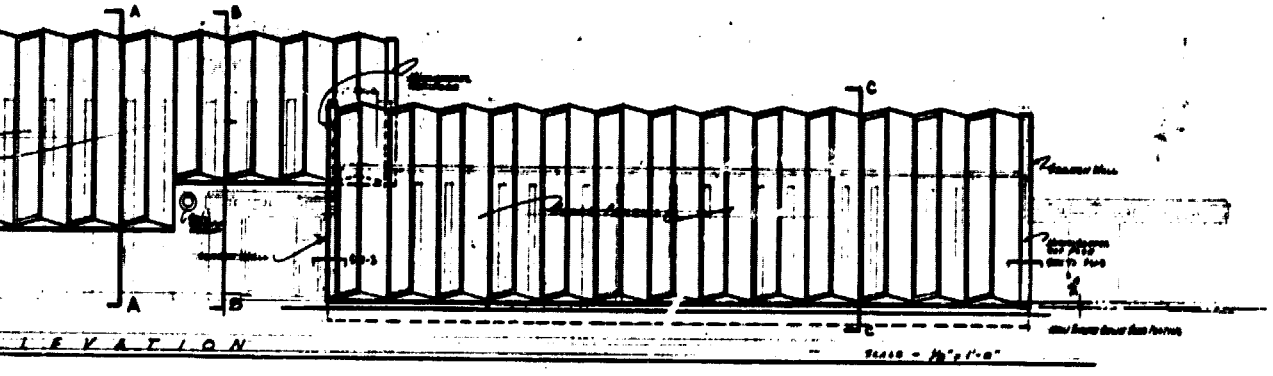


South West El

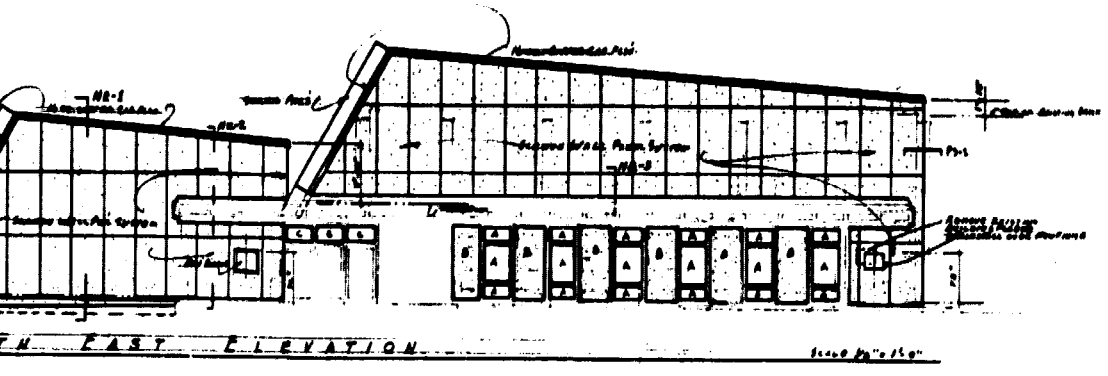
FOLDOUT FRAME



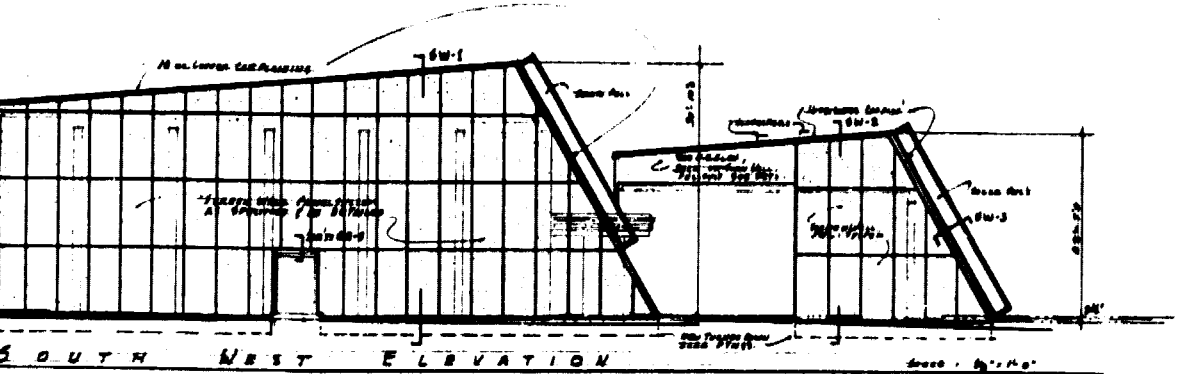
W E S T E L E V A T I O N



E L E V A T I O N



T H E A S T E L E V A T I O N



S O U T H W E S T E L E V A T I O N

HOLDOUT FRAME 2

CITY OF HUNTSVILLE SENIOR CITIZEN'S CENTER
SOLAR HEATING AND HOT WATER SYSTEM
PROJECT 65-77-A101-0071 HUNTSVILLE, ALABAMA

ELEVATION & DETAILS

DICKSON AND ASSOCIATES
ARCHITECTS
HUNTSVILLE ALABAMA

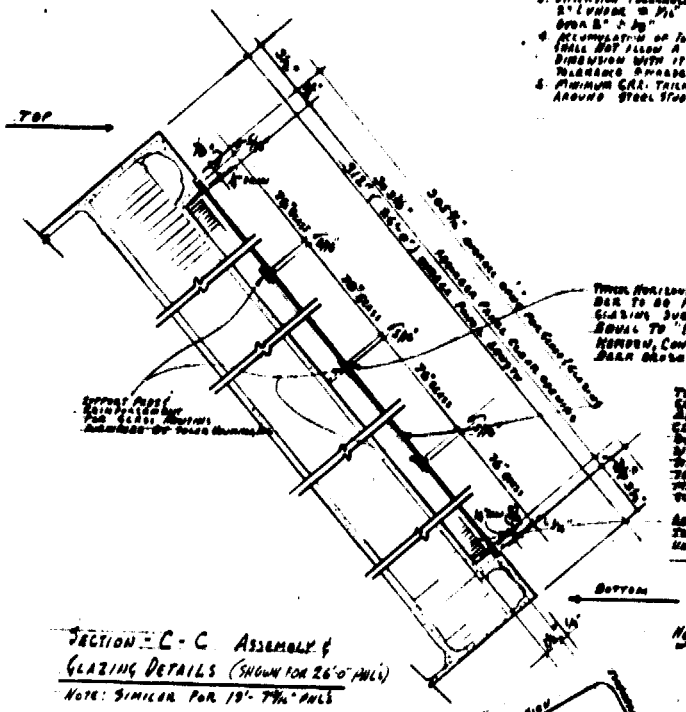
STATE OF ALABAMA REGISTERED ARCHITECT 534 1716

SHEET A-2 OF 8

DRAWN [illegible]
CHECKED [illegible]
DATE 1/65/70

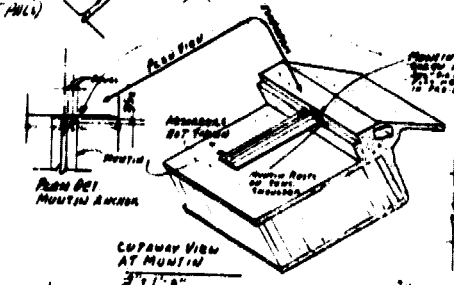
REVISED Aug 5 [illegible]

JOB NO. 71-9



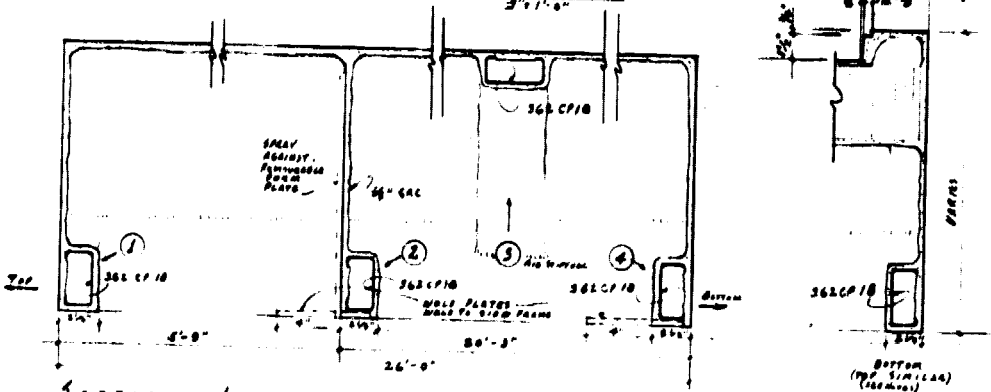
SECTION C-C ASSEMBLY & GLAZING DETAILS (SHOWN FOR 26'-0" PULL)

NOTE: SIMILAR FOR 19'-7 7/16" PULL

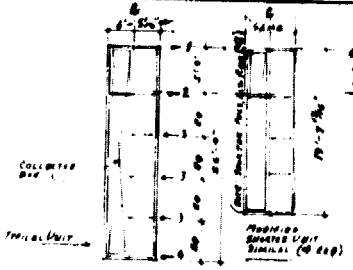


PLAN DET MOUNTING ANCHOR

CUTAWAY VIEW AT MUNTIN 3" = 1'-0"



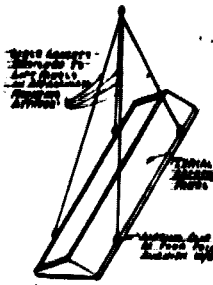
SECTION LONGITUDINAL — A-A SCALE 3/4" = 1'-0" B-B

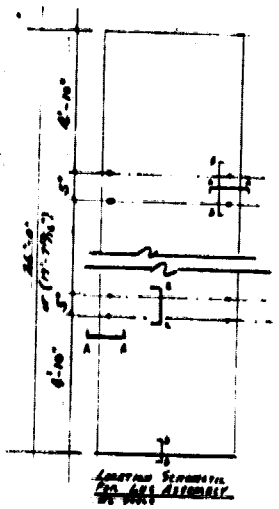


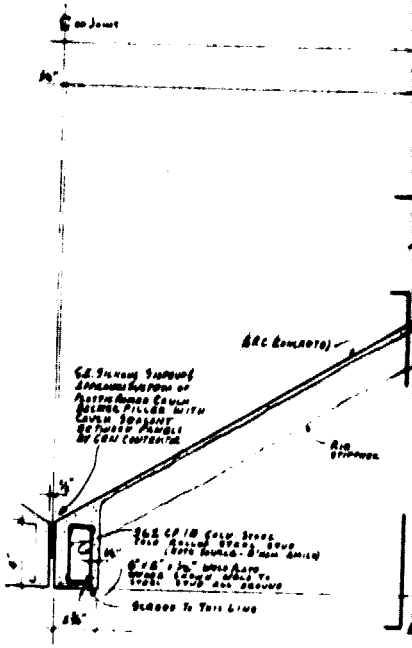
PANEL ELEVATIONS 1/4" = 1'-0" SHOWING REINFORCING LOCATIONS

QUANTITIES
26'-0" LONG PANELS - 84 UNITS
19'-7 7/16" LONG PANELS - 4 UNITS

NOTE: SOLAR COLLECTOR UNITS SHOWN ON THIS DRAWING ARE TO BE FURNISHED BY SOLAR UNLIMITED INC. & INSTALLED AT THE PROJECT SITE BY THE GENERAL CONTRACTOR (SEE NOTES RE: ASSEMBLY OF OTHER RELATED ITEMS AS NOTED & AS SPECIFIED)







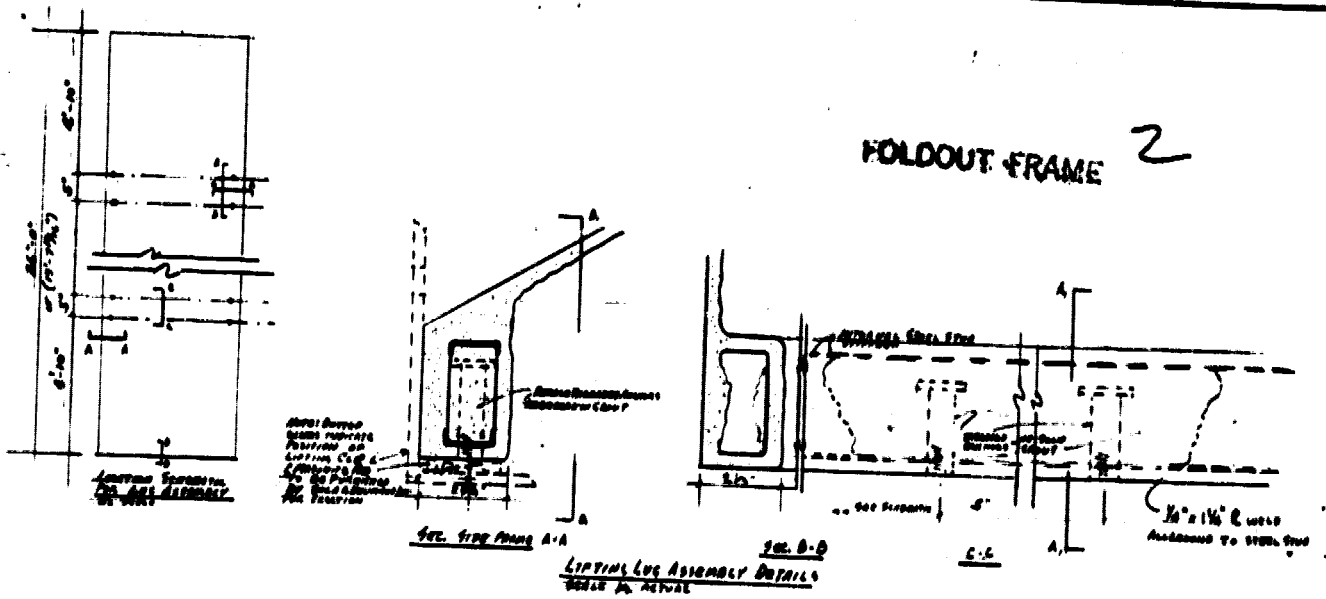
PLAN SECTION SCALE -

NOTE: COLD ROLLED STEEL STUD DESIGNATIONS ARE STANDARD WITH SIMILAR FROM CATALOGUE OF AMICO - BIRMINGHAM, ALA.

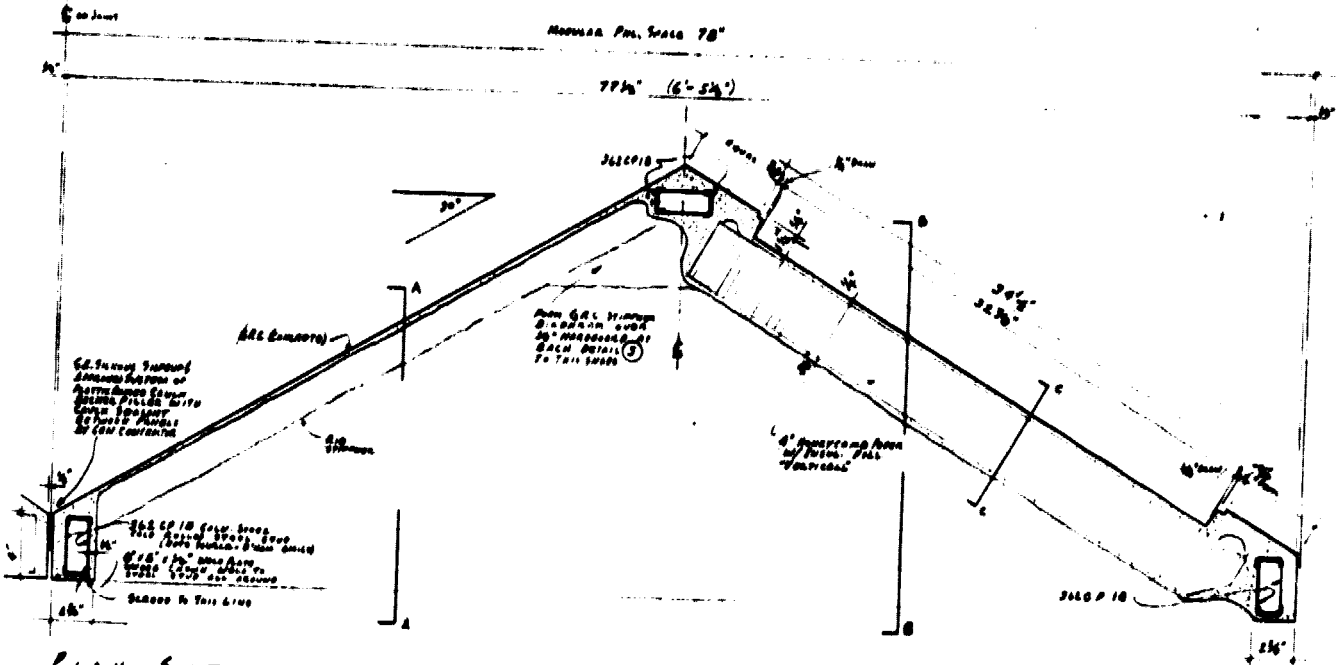
NOTE: SOLAR ARCHITECTURAL PANELS ARE TO BE FABRICATED TO FINAL DETAILS PER FABRICATORS SHOP DRAWINGS SUBJECT TO FINAL APPROVAL BY SOLAR UNLIMITED OR THE ARCHITECT. FABRICATORS SHOP DRAWINGS ARE TO INCLUDE ANY PROPOSED VARIATIONS FROM DETAILS HEREON & ADDITIONAL DETAILS OF MOUNTING WALL & LIFTING & HANDLING SYSTEM.

FOLDOUT FRAME

FOLDOUT FRAME 2



LIFTING LUG ASSEMBLY DETAILS



PLAN SECTION SCALE - 3"=1'-0"

NOTE: COLD ROLLED STEEL STUD DESIGNATIONS ARE STEINBERG VERIFY SELECTION FROM CATALOGUE USE AMICO - BIRMINGHAM, ALA.

SOLAR ARCHITECTURAL PANEL DETAILS

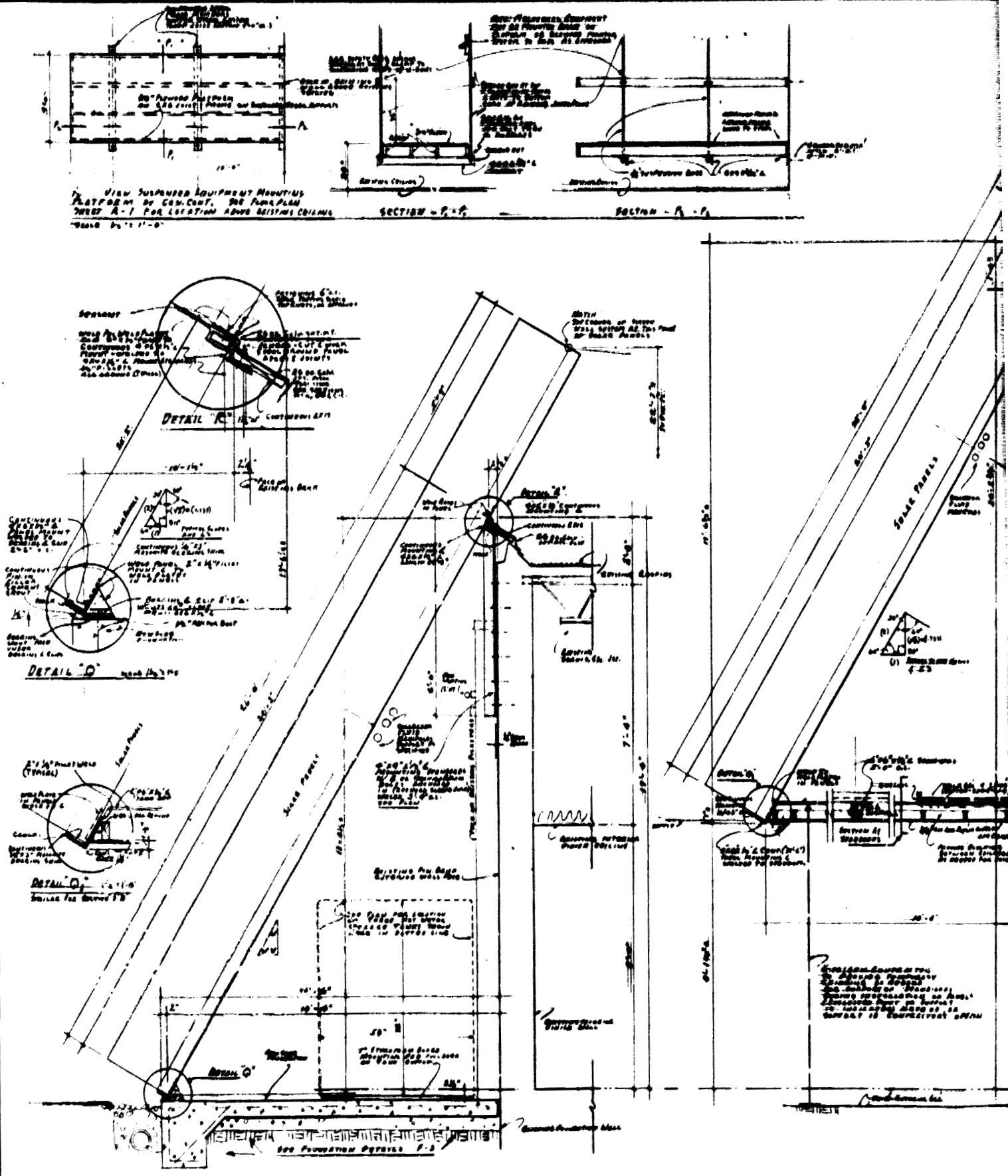
ORIGINAL PAGE IS OF POOR QUALITY

NOTE: SOLAR ARCHITECTURAL PANELS ARE TO BE FABRICATED TO PANEL DETAILS FOR FABRICATOR SHOP DRAWING SUBMIT TO FINAL APPROVAL BY SOLAR CONSULTANT BY THE ARCHITECT. FABRICATOR SHOP DRAWINGS ARE TO INCLUDE ANY PROPOSED VARIATIONS FROM DETAILS SHOWN & ADDITIONAL DETAILS OF MOUNTING WALL PLATES & LIFTING / HANDLING SYSTEM.

CITY OF HUNTSVILLE SENIOR CITIZEN'S CENTER
SOLAR HEATING AND HOT WATER SYSTEM
PROJECT E6-77-A-01-4091 HUNTSVILLE, ALABAMA
SOLAR ARCHITECTURAL PANEL DETAILS

DICKSON AND ASSOCIATES ARCHITECTS
HUNTSVILLE ALABAMA

SHEET A-3 OF 8 DATE 1/25/78



FOLDOUT FRAME

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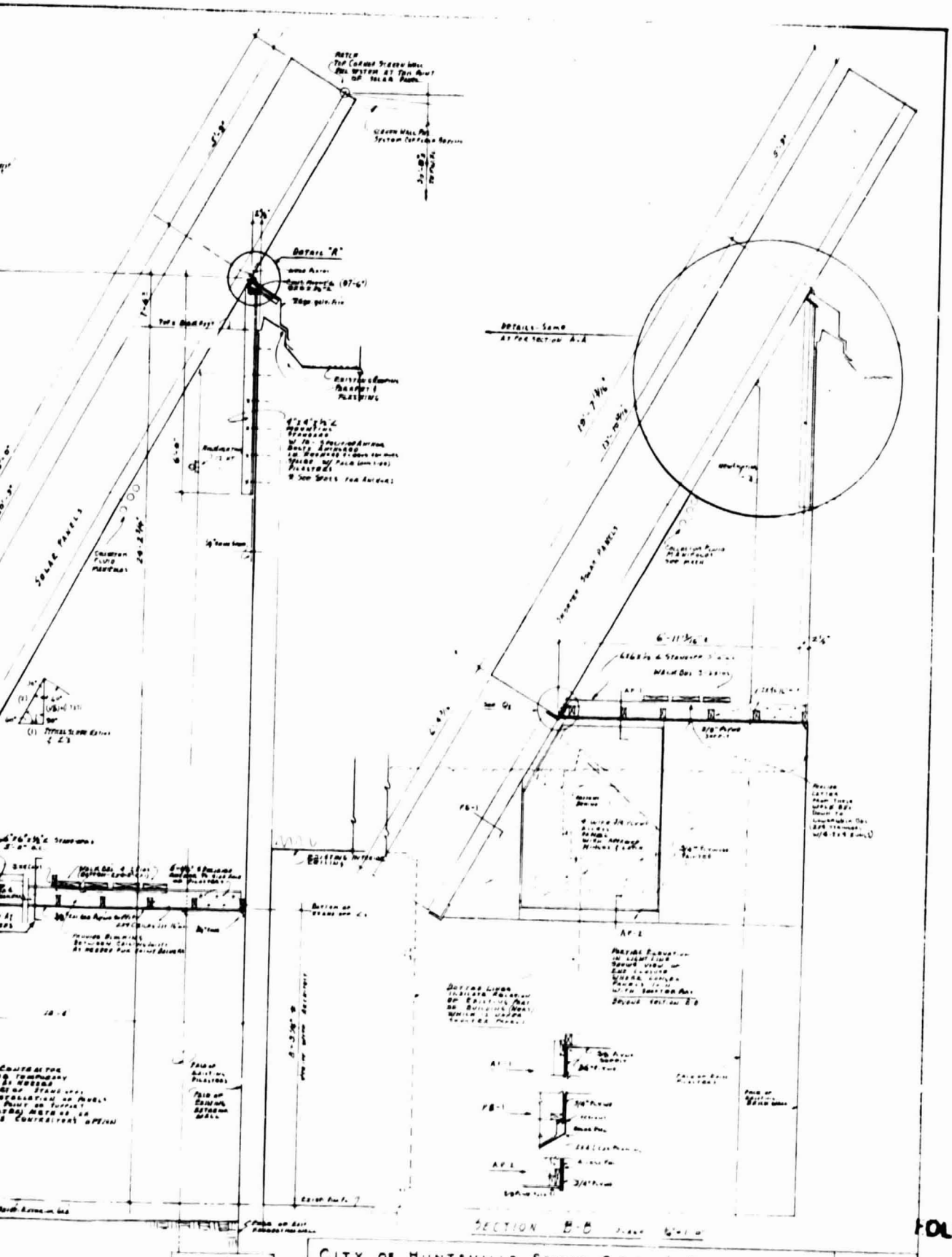
OF POOR QUALITY



CITY OF HUNTSVILLE SENIOR CITIZEN'S CENTER
SOLAR HEATING AND HOT WATER SYSTEM
PROJECT EG 77-A-01-4071 HUNTSVILLE, ALABAMA

DETAILS - SOLAR PANEL ABATATION TO EXISTING BUILDING

DICKSON AND ASSOCIATES ARCHITECTS

HUNTSVILLE ALABAMA

STATE OF ALABAMA REGISTERED ARCHITECTS 3716

SHEET A-4 OF 8

DRAWN

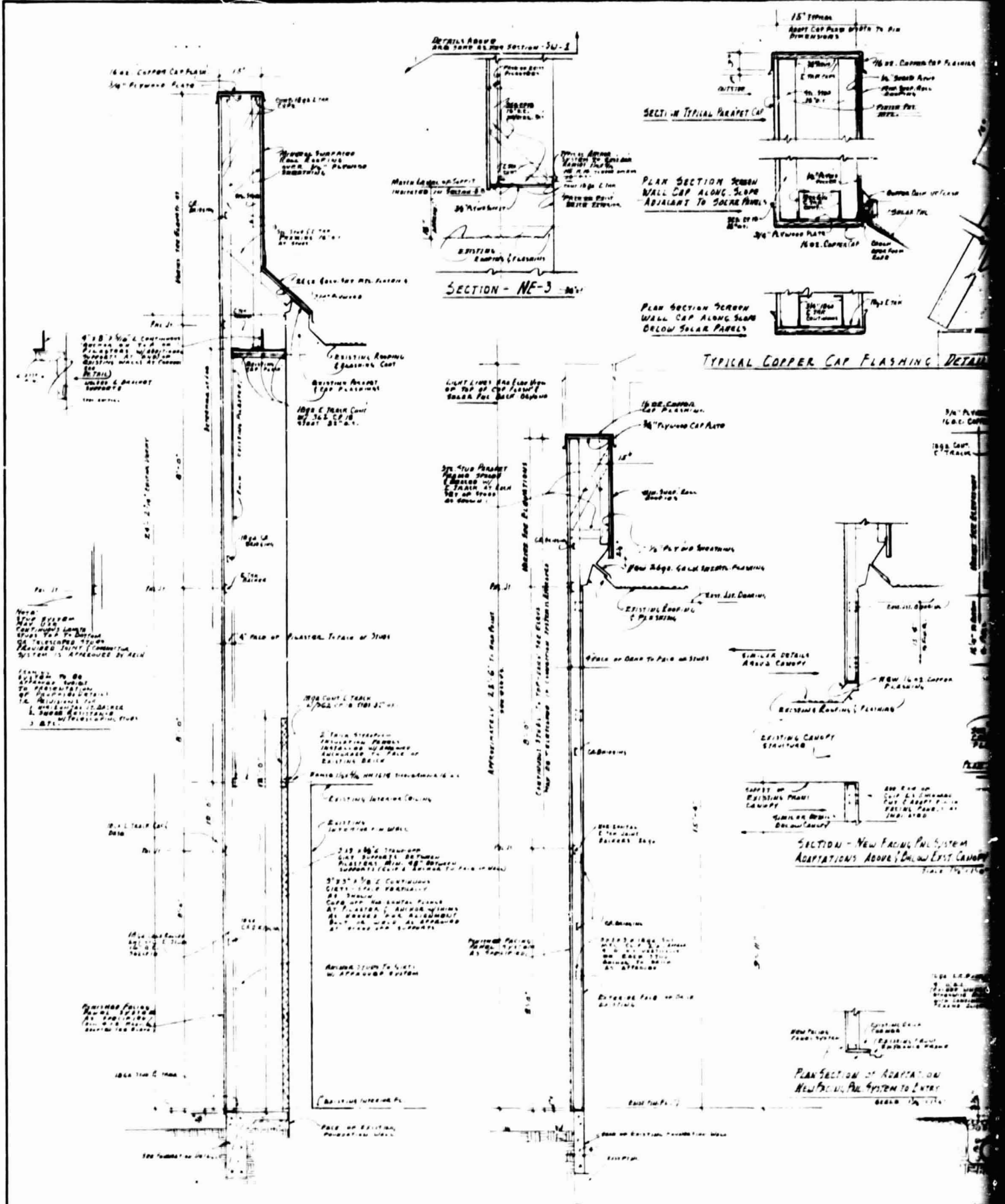
CHECKED

DATE

REVISED

JOB NO

FOLDOUT FRAME 2



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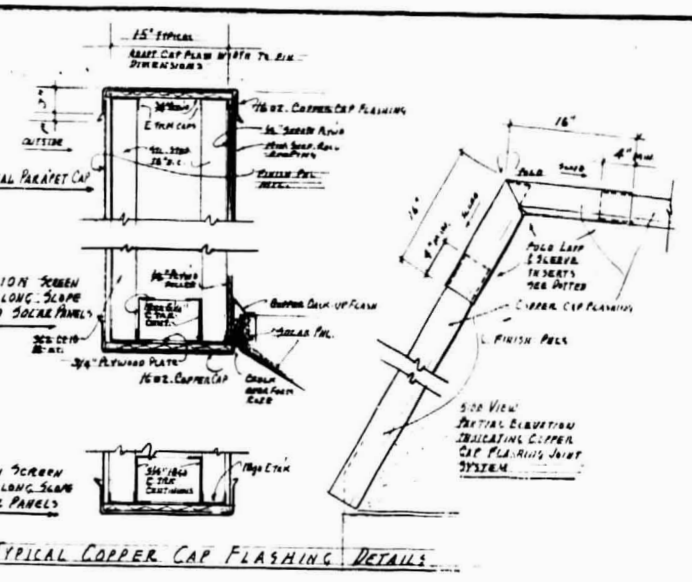
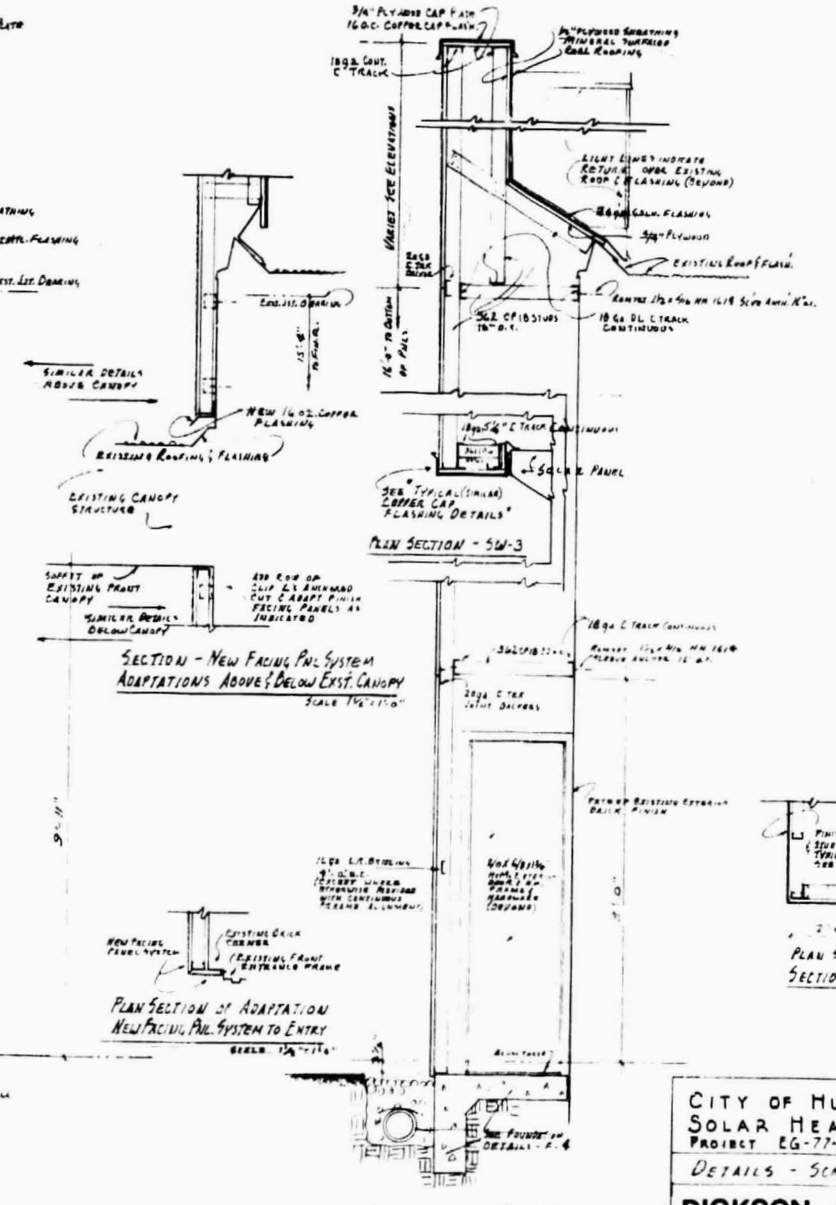


TYPICAL COPPER CAP FLASHING DETAILS



ORIGINAL PAGE IS POOR QUALITY

FOLDOUT FRAME 2

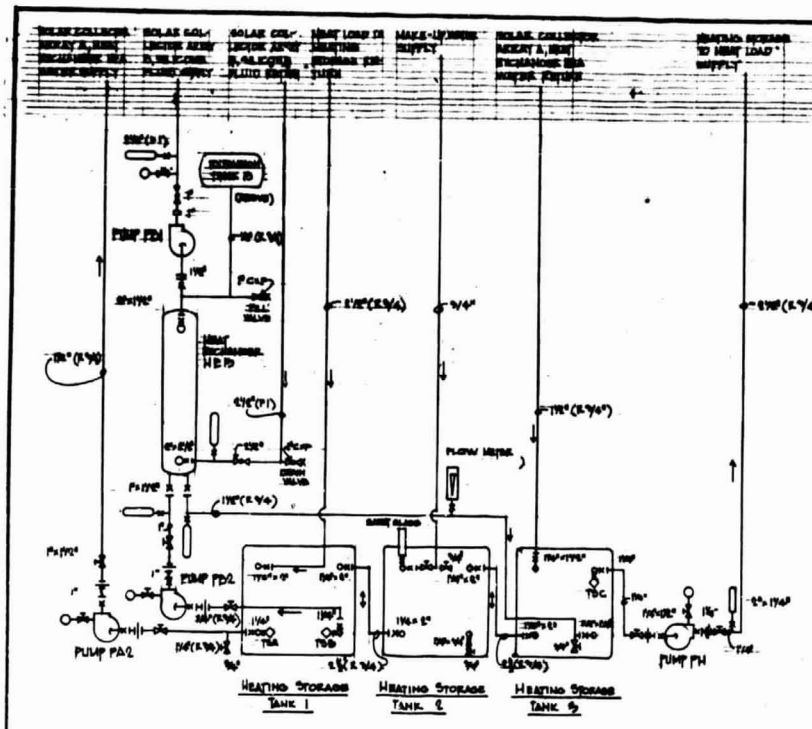
CITY OF HUNTSVILLE SENIOR CITIZEN'S CENTER
SOLAR HEATING AND HOT WATER SYSTEM
PROJECT EG-77-A-01-4071 HUNTSVILLE, ALABAMA

DETAILS - SCREEN WALL FACING, FRAMING, FLASHING, ETC.

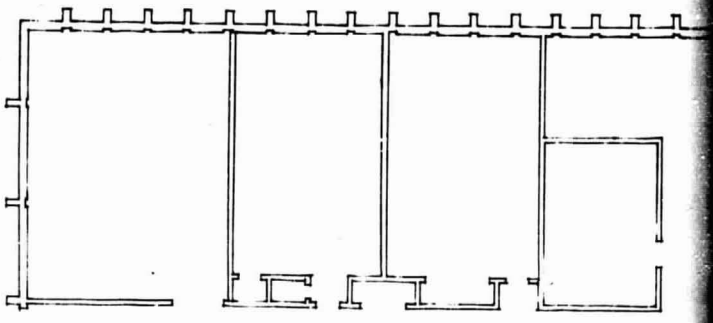
DICKSON AND ASSOCIATES ARCHITECTS
HUNTSVILLE ALABAMA

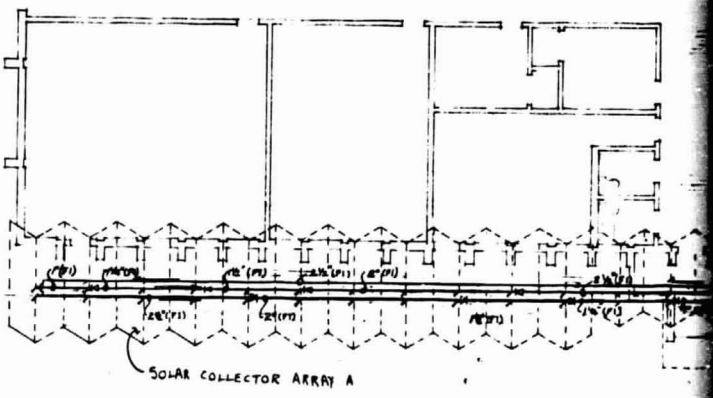
STATE OF ALABAMA REGISTERED ARCHITECTS 3716

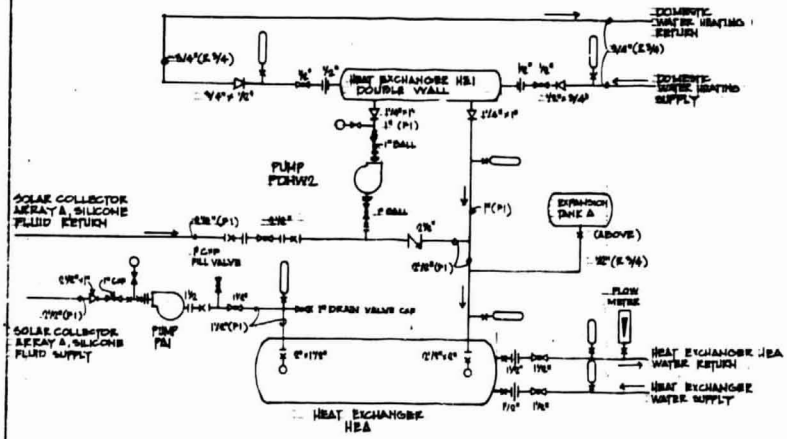
SHEET A-5 OF 8
DRAWN
CHECKED
DATE 1/25/78
REVISED
JOB NO 77-9



SOLAR MECHANICAL SCHEMATIC STORAGE AREA



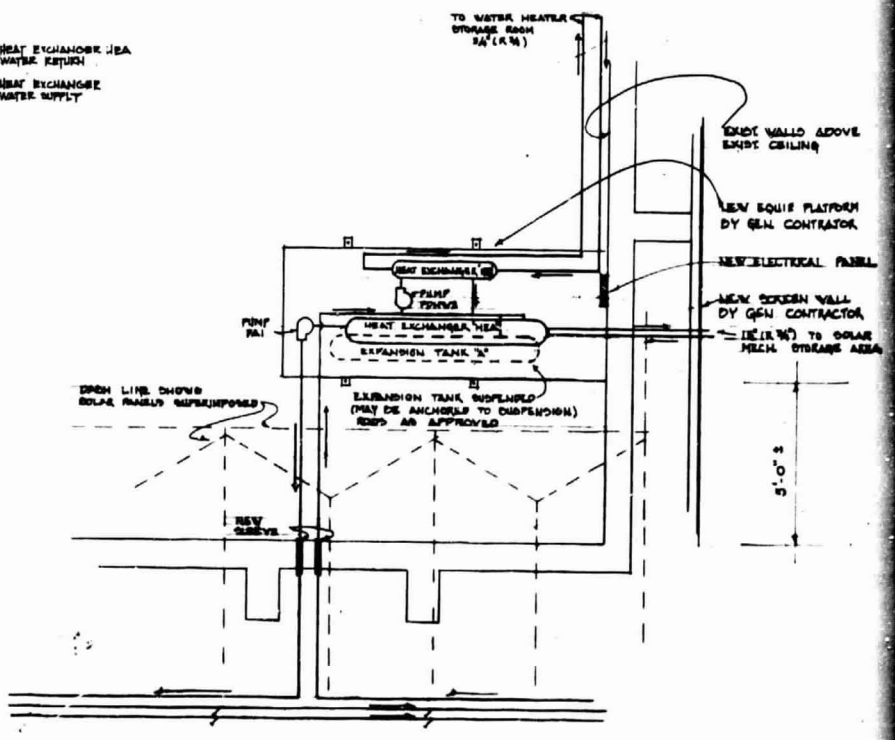




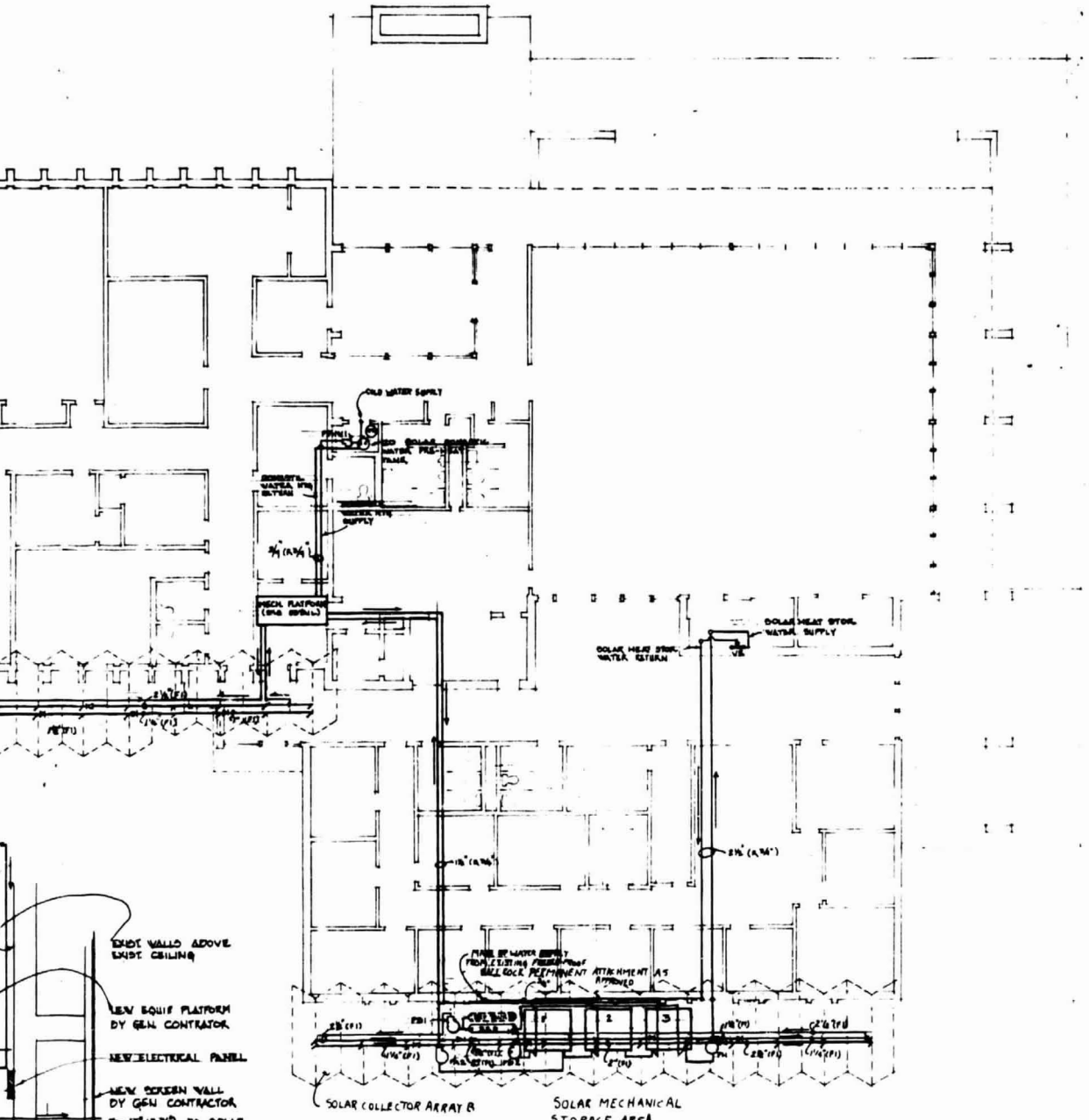
MECHANICAL PLATFORM SCHEMATIC

Note: Scope of Pipe / Mechanical Equipment Insulation Required

1. Collector Fluid Lines - Supply & Return from Collectors to Exchangers from Collectors to Manifolds & all Manifolds
2. Heat Exchangers & Expansion Tanks (as specified)
3. Hot Water Supply & Return Lines from Exchangers to Storage
4. Pumps - No Insulation (Seal Both Sides)
5. Valves - No Insulation (Seal Both Sides)



DETAIL PLAN (SUSPENDED EQUIPMENT PLATFORM)



NOTES:

2½" (F.I.) = 2½" Cu. TYPE M PIPE WITH 1" THICK FIBERGLASS INSULATION
1½" (R-11) = 1½" Cu. TYPE M PIPE WITH ¾" THICK EXPANDED RUBBER INSULATION

FOLDOUT FRAME 2

ROBERT R. WESSELS REGISTERED ENG. SOLAR UTILITIES, INC. HUNTSVILLE, ALA. AUSTIN, TEXAS

CITY OF HUNTSVILLE SENIOR CITIZEN'S CENTER
SOLAR HEATING AND HOT WATER SYSTEM
PROJECT NO. EG-77-A-01-4071 HUNTSVILLE, ALABAMA

SOLAR MECHANICAL PLANS & DETAILS

ALABAMA REGISTERED NO. 11481 PROFESSIONAL ENGINEER ROBERT R. WESSELS

DICKSON AND ASSOCIATES ARCHITECTS

HUNTSVILLE ALABAMA

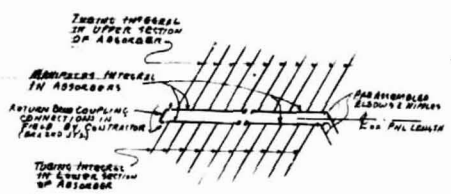
STATE OF ALABAMA REGISTERED ARCHITECTS 824 1716

SHEET	DRAWN	REVISED	JOB NO.
M-1 OF 6	JRB	MAR 14/78	77-9
	CHECKED DN		
	DATE 1/25/78		

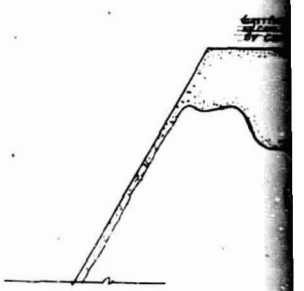
(FORM) SCALE 1/8"=1'-0" 6

EQUIPMENT SCHEDULE

LABEL	ITEM	MANUFACTURER	MODEL	DESCRIPTION	NO. REQ'D	FURN. BY OWNER
PA1	PUMP	GOULD	3196ST-1496-8 AA	CENTRIFUGAL FLEXIBLE COUPLED CIRC. PROCESS PUMP 1 H.P.	1	●
PA2	PUMP	GOULD	3196ST-1496-8 AA	CENTRIFUGAL FLEXIBLE COUPLED CIRC. PROCESS PUMP 1 H.P.	1	●
PB1	PUMP	BELL & GOSSETT	1535-5515	CLOSE COUPLED CENTRIFUGAL, 1½ H.P., 1½"x1" NPT OUTLETS	1	●
PB2	PUMP	BELL & GOSSETT	1532-551 B	CLOSE COUPLED CENTRIFUGAL, 1 H.P., 1½"x1" NPT OUTLETS	1	●
PH	PUMP	BELL & GOSSETT	1512-1½ AAB	CLOSE COUPLED CENTRIFUGAL, ½ H.P. 1½" x 1½" NPT OUTLET 3½" IMP	1	●
PDHW1	PUMP	GRUNDFOS	UP15-GF 99	CANNED IN LINE, ½ H.P., 2"x1" FLANGE, STAINLESS STEEL	1	●
PDHW2	PUMP	GRUNDFOS	UP20-04 F	CANNED INLINE, ½ H.P., 2" FLANGE, CAST IRON HOUSING	1	●
HEA	HEAT EXCHANGER	YOUNG RADIATOR	5006 BY 4P	SHELL TUBE BRASS U TUBE 3/4" DIA. x 61 1/2", 4" x 1 1/4" NPT	1	●
HEB	HEAT EXCHANGER	YOUNG RADIATOR	5006 BY 4P	SHELL TUBE BRASS U TUBE 3/4" DIA. x 61 1/2", 4" x 1 1/4" NPT	1	●
HE1	HEAT EXCHANGER	SOLAR UNLIMITED	HE 232 D	COPPER TUBE IN SHELL, DBL. WALL BATTENALLY VENTED 8" DIA. x 66" LONG	1	●
	EXPANSION TANK A	BELL & GOSS. OR EQUAL	60	60 GALLON ASME STEEL 16" DIA. x 76" LONG, ¾" NPT	1	
	EXPANSION TANK B	BELL & GOSS. OR EQUAL	90	90 GALLON ASME STEEL 16" DIA. x 106" LONG, ¾" NPT	1	
	HOT WATER PREHEAT TANK	A. O. SMITH	STJ 120	120 GALLON GLASS LINED STEEL, HEAVILY INSULATED	1	●
	BULK HEAT STOR. TANK	SOLAR UNLIMITED	18504	1000 GAL. FIBERGLASS FOAM INSUL. 60" x 72" x 204", 2" NPT	9	●
	SOLAR COLLECTOR A	SOLAR UNLIMITED	SCT 41	COROTHERM TU. SECT. SOLAR COLLECTOR, PNLS. 31 5/8" x 78" x 6 3/4"	11	●
	SOLAR COLLECTOR A	SOLAR UNLIMITED	SCT 31	COROTHERM TU. SECT. SOLAR COLLECTOR, PNLS. 23 5/8" x 78" x 6 3/4"	4	●
	SOLAR COLLECTOR B	SOLAR UNLIMITED	SCT 41	COROTHERM TU. SECT. SOLAR COLLECTOR, PNLS. 31 5/8" x 78" x 6 3/4"	15	●
TCA1	TEMP. SENSOR	RHO SIGMA	SA	BRASS CASED ½" DIA. X 1" THERMISTOR	1	●
TCA2	TEMP. SENSOR	RHO SIGMA	SA	BRASS CASED ½" DIA. X 1" THERMISTOR	1	●
TCB	TEMP. SENSOR	RHO SIGMA	SA	BRASS CASED ½" DIA. X 1" THERMISTOR	1	●
TSA	TEMP. SENSOR	RHO SIGMA	SP	BRASS CASED ½" NPT THERMISTOR	1	●
TSB	TEMP. SENSOR	RHO SIGMA	SP	BRASS CASED ½" NPT THERMISTOR	1	●
TSC	TEMP. SENSOR	RHO SIGMA	SP	BRASS CASED ½" NPT THERMISTOR	1	●
TH	TEMP SENSOR	RHO SIGMA	SP	BRASS CASED ½" NPT THERMISTOR	1	●
TR	TEMP SENSOR	RHO SIGMA	SP	BRASS CASED ½" NPT THERMISTOR	1	●
T2	HIGH LIMIT THERMOSTAT	THERMO DISC	SA	PIPE MOUNTED CONTACT THERMOSTAT	1	●
VE	THREE WAY VALVE	FENN DAGO OR EQUAL	M61AEA-2 Y60 ADD-2 V90 CA-7	2½" MOTORIZED MIXING VALVE. MOTOR AND LINKAGE. 2 POSITION SPRING RETURN, STEM UP.	1	
	THERMOMETER	ROCHESTER OR EQUAL	1746	3" DIAL BIMETALLIC 30°-240° F, ½" NPT, 2½" STEM	5	
	THERMOMETER	ROCHESTER OR EQUAL	1706	3" DIAL BIMETALLIC 50°-300° F, ½" NPT, 4" STEM	9	
	PRESSURE GAUGE	MARSH-1 & 2" OR EQUAL	47495	0-60 PSI, 2½" DIAL, ¼" LOWER MOUNT	6	
	PRESSURE SNUBBERS	KAY SNUBBERS OR EQUAL	1	PISTON SHOCK + PULSATION SNUBBER, ½" NPT BRASS	4	
	PRESSURE SNUBBERS	KAY SNUBBERS OR EQUAL	2	PISTON SHOCK + PULSATION SNUBBER, ¼" NPT BRASS	2	
	FLOW METER	METRAFLEX OR EQUAL	13	IMPACT TYPE (1½" PIPE SIZE) 10-80 GPM	2	
	FLEXIBLE CONNECTOR	ANACONDA OR EQUAL	5454F	1¼"-2 1/4" COPPER VIBRATION ELIMINATOR SOLDER CAP	5	
	GATE VALVE					
	BALL VALVE					
	FLANGE					
	UNION					
	MALE ADAPTER					
	REDUCER					
	CHECK VALVE					

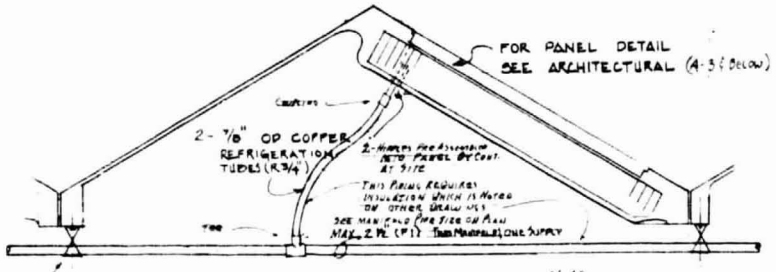


SCHEMATIC-ISOMETRIC (NO SCALE)
ABSORBER MANIFOLD ASSEMBLY
AND FIELD ASSEMBLY CONNECTIONS



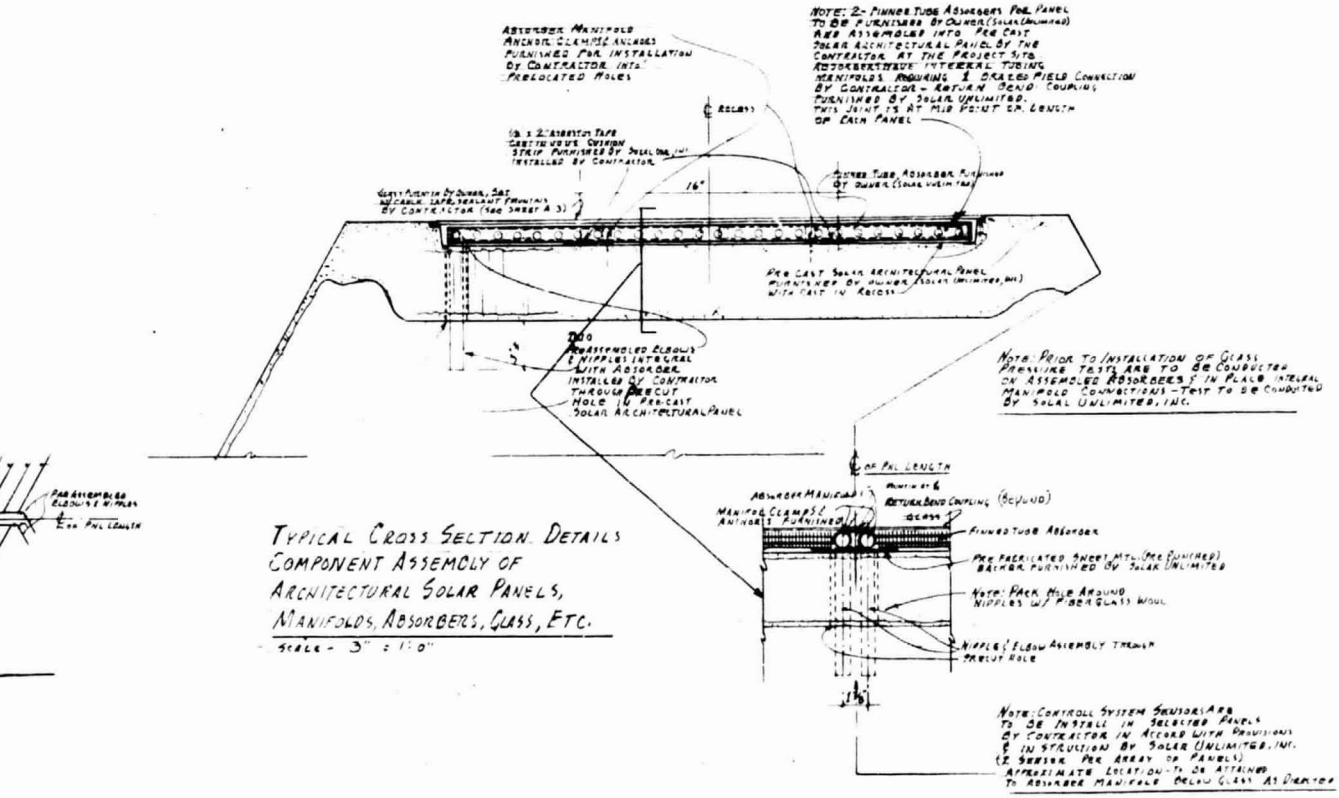
TYPICAL CROSS
COMPONENT ASS
ARCHITECTURAL
MANIFOLDS, ABSOR
SCALE - 3" = 1'-0"

FOLDOUT FRAME



NOTE: MANIFOLD PIPING TO BE SUPPORTED FROM BACK OF SOLAR ARCHITECTURAL PANELS AT THESE TYPICAL LOCATIONS WITH SPECIFIED OR APPROVED PIPE HANGERS, ANCHORED WITH SLOTTED HEX HEAD SHEET METAL SCREWS 1" LONG X #10-24 IN PROPER DRILLED PILOT HOLES

SOLAR COLLECTOR MANIFOLD DETAIL



TYPICAL CROSS SECTION DETAILS COMPONENT ASSEMOLY OF ARCHITECTURAL SOLAR PANELS, MANIFOLDS, ABSORBERS, GLASS, ETC.

SCALE - 3" = 1'-0"

FOLDOUT FRAME 2

ROBERT E. WESLEY PROFESSIONAL ENG. SOLAR UNLIMITED INC. 931 S. CONGRESS PL. W. HUNTSVILLE, ALA.

CITY OF HUNTSVILLE SENIOR CITIZEN'S CENTER
SOLAR HEATING AND HOT WATER SYSTEM
PROJECT NO. EG-77-A-01-4071 HUNTSVILLE, ALABAMA
SOLAR MECHANICAL - DETAILS

ALABAMA REGISTERED NO. 11981 PROFESSIONAL ENGINEER ROBERT R. WESLEY

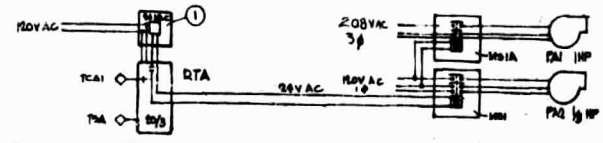
DICKSON AND ASSOCIATES ARCHITECTS
HUNTSVILLE ALABAMA

STATE OF ALABAMA REGISTERED ARCHITECTS 3241 1715

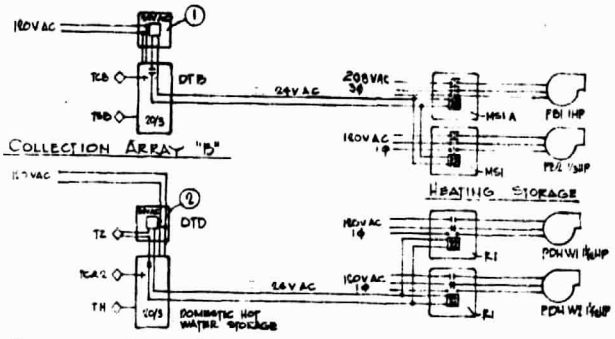
SHEET	DRAWN	REVISED	JOB NO
M-2 OF 8	J.R.D. WD CHECKED DN, J.R.D. DATE 1/25/78	March 28, 1978	77-9

7

SOLAR COLLECTION CONTROL CENTER

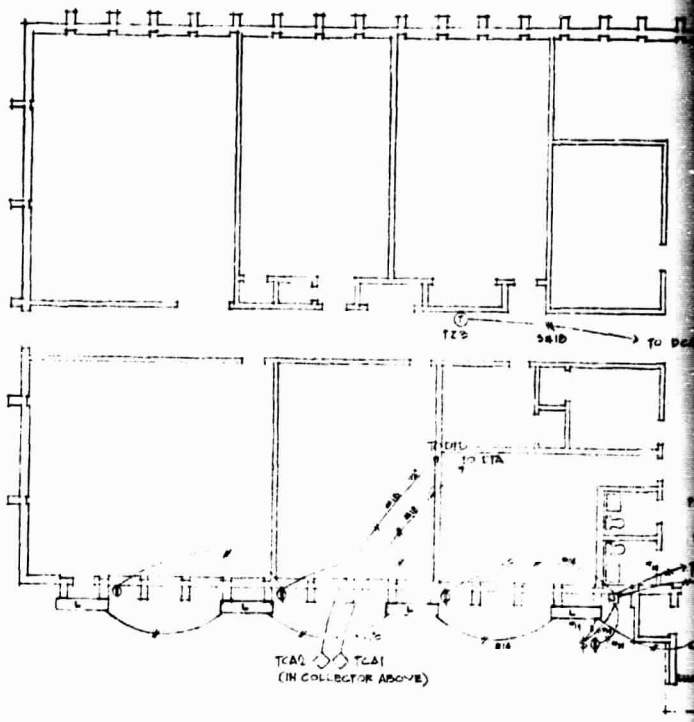


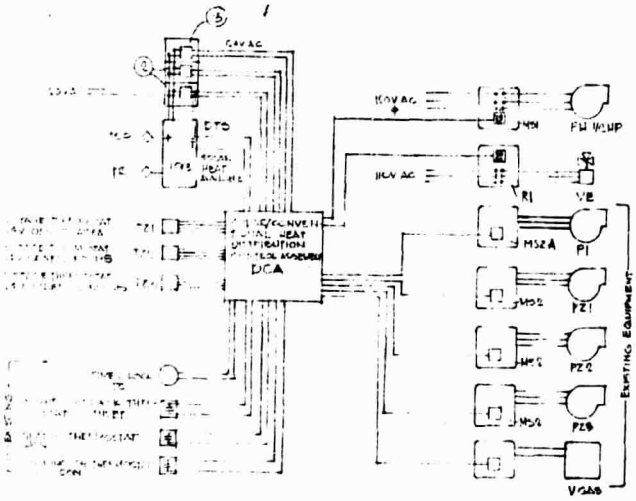
COLLECTION ARRAY "A" — HEATING STORAGE



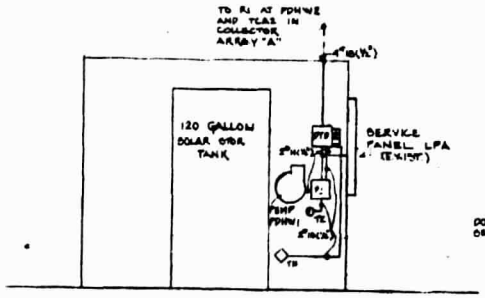
COLLECTION ARRAY "B" — DOMESTIC HOT WATER

COLLECTION ARRAY "A" — DOMESTIC WATER HEATING

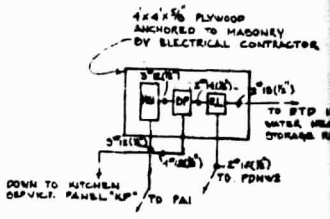




HEAT DISTRIBUTION CONTROL SYSTEM

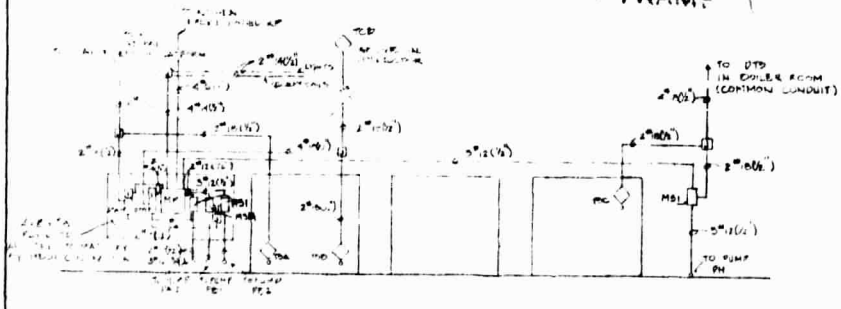


WATER HEATER STORAGE RM. ELECTRICAL DETAIL

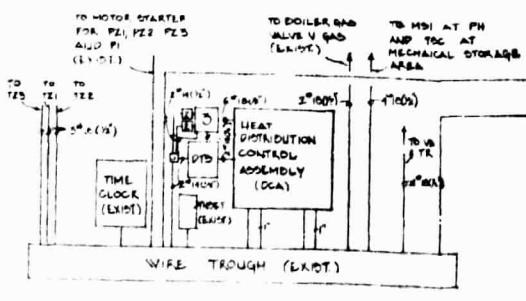


SOLAR MECH. PLATFOR ELECTRICAL DETAIL

FOLDOUT FRAME

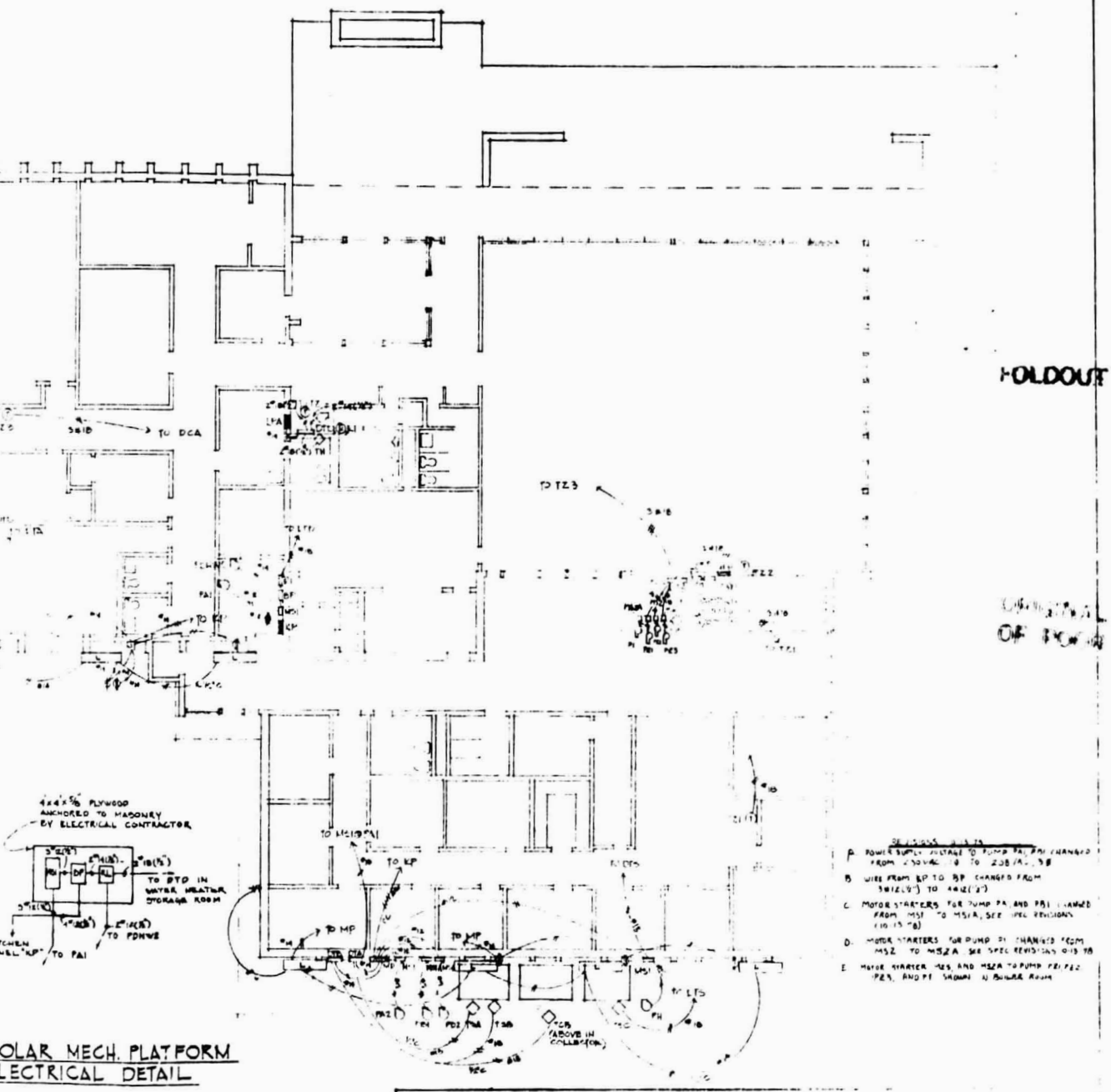


SOLAR STORAGE AREA ELECTRICAL DETAIL

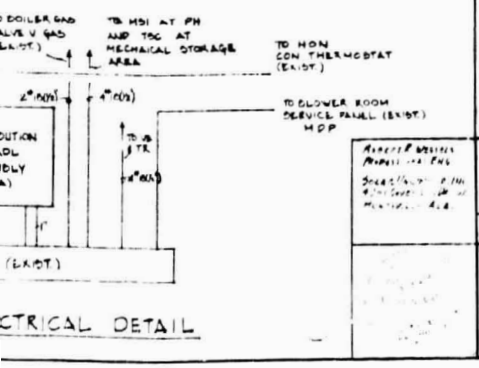


BOILER ROOM ELECTRICAL DETAIL

HOLDOUT FRAME 2



OLAR MECH. PLATFORM
LECTRICAL DETAIL



CTRICAL DETAIL

A. POWER SUPPLY VOLTAGE TO PUMP P2, P21 CHANGED FROM 230 VOLTS TO 208 VOLTS, 3Ø
B. WIRE FROM KP TO BP CHANGED FROM 3#12(½") TO 4#12(¾")
C. MOTOR STARTERS FOR PUMP P2 AND P21 CHANGED FROM MSI TO MSIA, SEE SPEC REVISIONS (10-15-78)
D. MOTOR STARTERS FOR PUMP P1 CHANGED FROM MSZ TO MSZA SEE SPEC REVISIONS 10-15-78
E. MOTOR STARTER MSI AND MSZA TO PUMP P21, P22 (P2), AND P1 SHOWN IN BOILER ROOM

LEGEND

- = SERVICE PANEL BOX EXISTING
- = SERVICE PANEL BOX ADDITION
- #(#) = 3 CONDUCTOR #12 V-90 IN ¾" CONDUIT
- # = 2 CONDUCTOR #12 WIRE IN ½" CONDUIT
- = SERVICE OUTLET
- = SWITCH
- = JUNCTION BOX
- = LIGHTING FIXTURE (FLUORESCENT) EQUAL TO ONE 2'-0" 2 F40 LAMP
- = THERMOSTAT

CITY OF HUNTSVILLE SENIOR CITIZEN'S CENTER
SOLAR HEATING AND HOT WATER SYSTEM
HUNTSVILLE, ALABAMA

SOLAR ELECTRICAL PLANS & DETAILS

DICKSON AND ASSOCIATES ARCHITECTS

HUNTSVILLE ALABAMA

STATE OF ALABAMA REGISTERED ARCHITECT 536 1776

SHEET | DRAWN | REVISED | JOB NO. 8TH
CHECKED | DATE

16.0 INTERIM PERFORMANCE CRITERIA

CERTIFICATION

CONTRACT NO. EG-77-A-01-4071

DEMONSTRATION CONTRACTOR CITY OF HUNTSVILLE

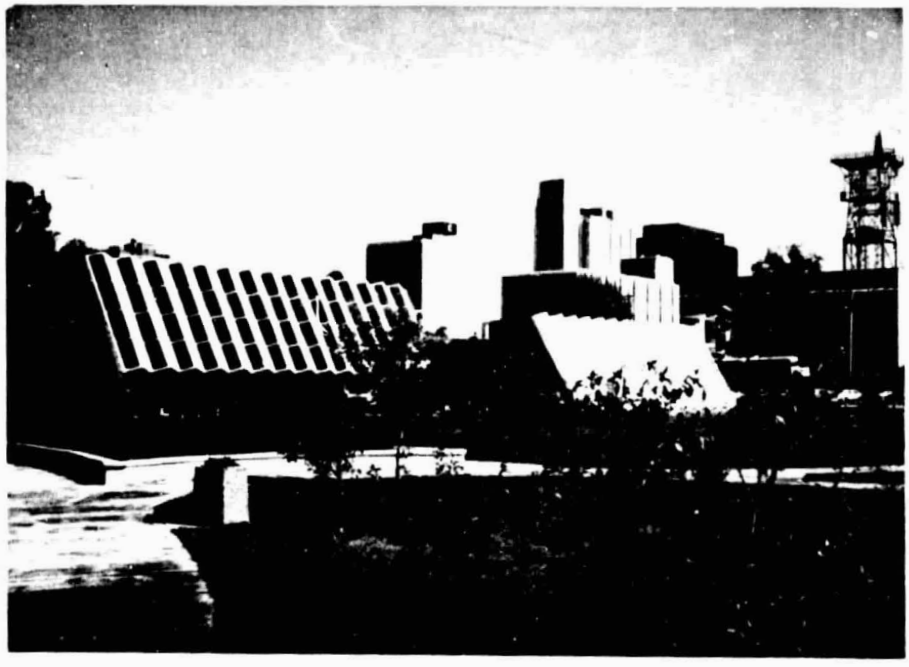
SYSTEM LOCATION HUNTSVILLE, ALABAMA

SYSTEM TYPE SPACE HEATING AND HOT WATER

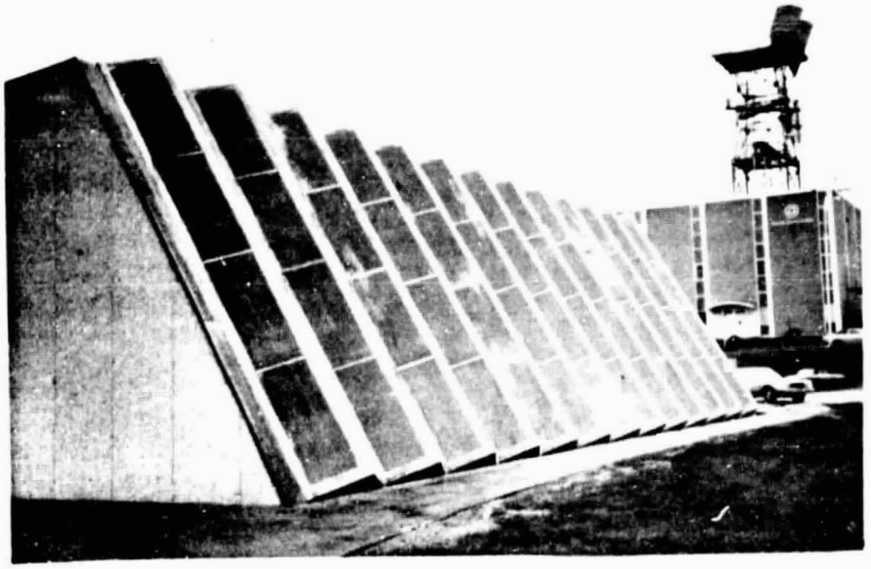
I certify that his solar system comples with the IPC Document No. 98 M10001

CERTIFIED BY [signature]
Authorized Representative

Date 4/27/79

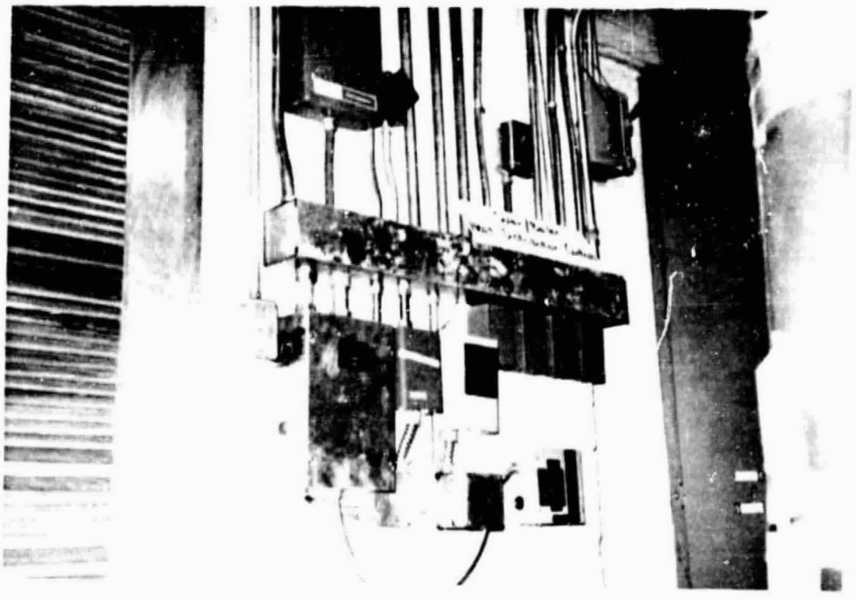


COMPLETED INSTALLATION OF
ARCHITECTURAL SOLAR COLLECTORS

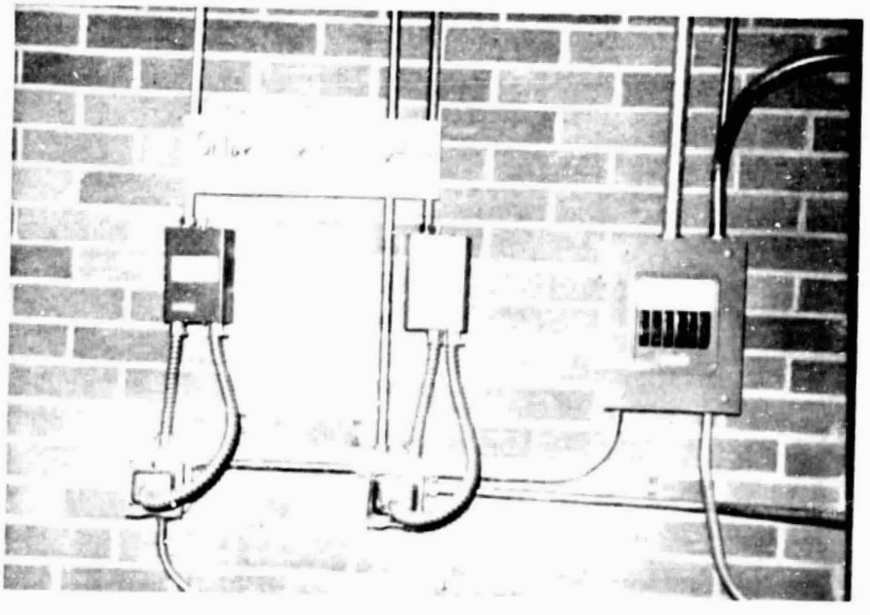


SOLAR COLLECTOR ARRAY B

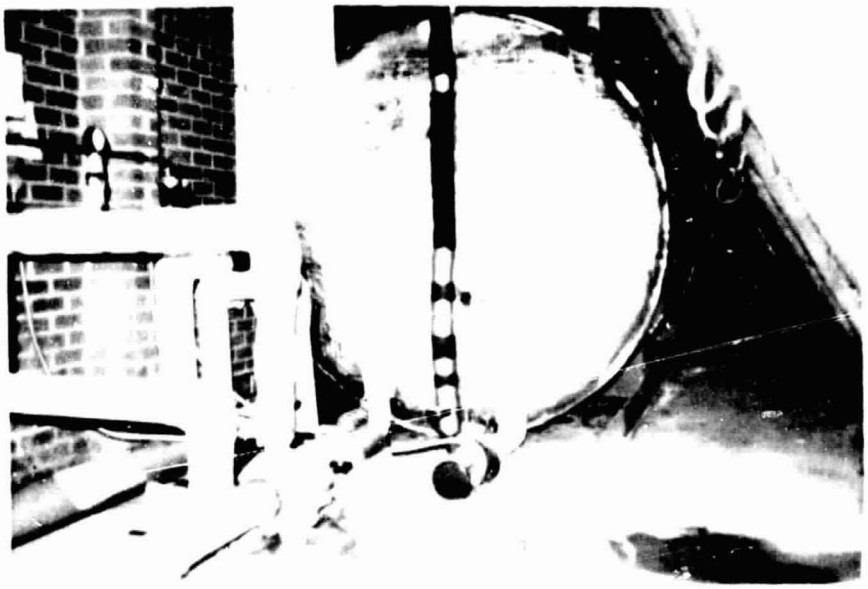
SOLAR COLLECTOR ARRAY A



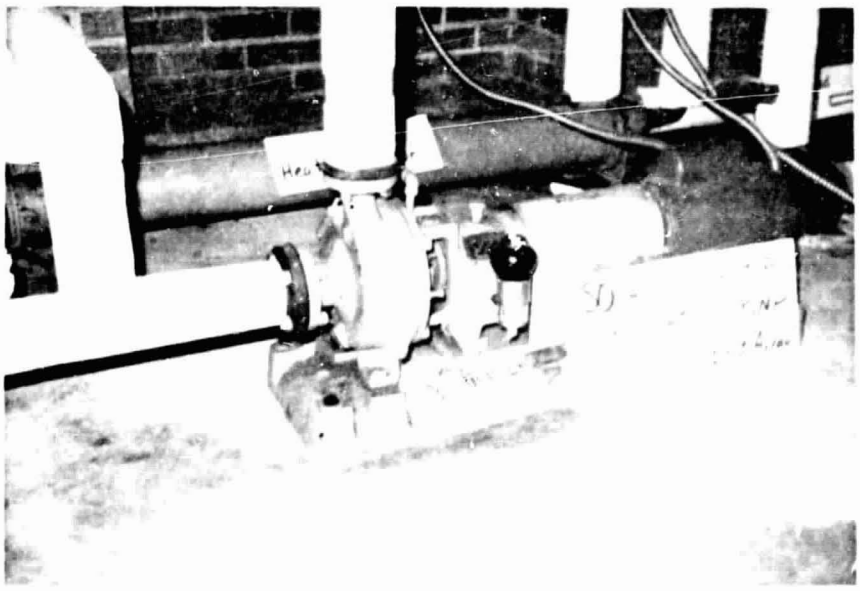
SOLAR SYSTEM DISTRIBUTION
CONTROLS



SOLAR COLLECTION CONTROLS

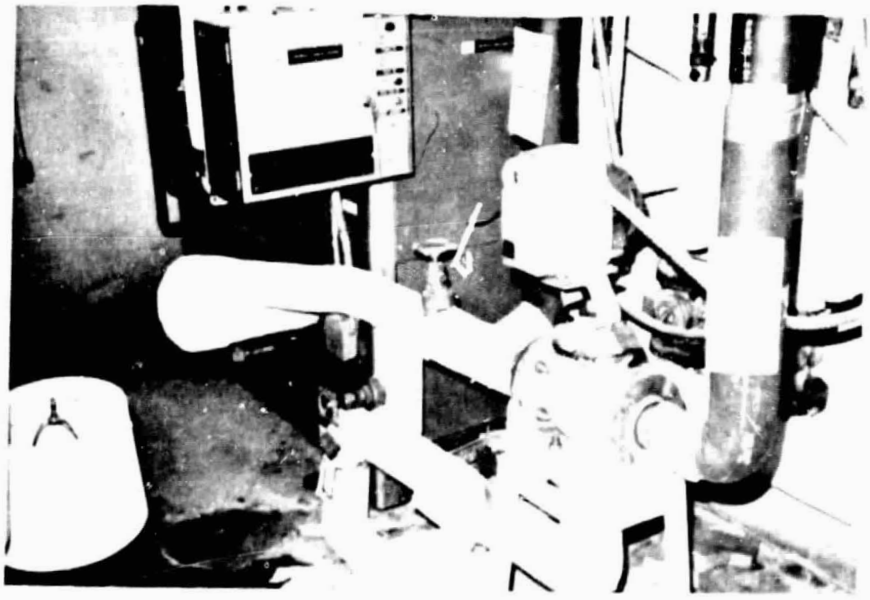


3,000 GALLON POTABLE
WATER STORAGE TANK



SOLAR COLLECTOR CIRCULATION
PUMP AND HEAT EXCHANGER FOR SOLAR ARRAY B

SOLAR HEAT EXCHANGER



AUTOMATIC THREE-WAY VALVE TO
ACTIVATE SOLAR HEATING