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MASTER

SRE STANDARD OPERATING PROCEDURES

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LIST OF PROCEDURES

PART ONE: GENERAL

June 27, 1960

I. GENERAL SRE OPERATING INSTRUCTIONS

A. RESPONSIBILITY

Immediate responsibility for operation of the reactor and its associated systems and for the safety thereof rests with the Shift Supervisor.

In case the Shift Supervisor is absent, the relief Shift Supervisor will be present.

During any period of time when the Shift Supervisor is not on the premises, the reactor Chief Operator assumes responsibility for the plant.

B. AUTHORIZED OPERATORS

Only personnel assigned to the shift operating crews (shown on the attached organization chart) are authorized to operate the controls of the reactor and its associated systems.

C. CONTROL ROOM

1) One operator will be stationed in the control room at all times. When the reactor is running, there will be two operators stationed in the control room.

2) No visitors are allowed in the control room.

3) Entry behind the instrument panels is allowed only with the approval of the Shift Supervisor.

D. REACTOR OPERATION

1) The operating check list will be completed once per shift.

2) The startup check list will be completed prior to any startup except those immediately following a scram. Do not restart the reactor after a scram until cause of the scram is determined.

3) In case of a reactor shutdown caused by:

   a) Reactor period
   b) High neutron flux
   c) High fuel-channel exit temperature,

the following persons will be notified by the Shift Supervisor:

a) R. W. Dickinson (Sodium Reactors Director)

b) L. E. Glasgow (SRE Group Leader)

c) R. E. Durand (SRE Operations Supervisor)

d) J. G. Lundholm (Chairman, SRE Safeguards Review Committee).

Approvals for restarting the reactor following such a scram are delineated in the "SRE Organization Manual," NAA-SR-Memo-5360.

4) When the reactor is critical, one qualified operator will be stationed at the console at all times. An additional qualified operator will be stationed in the control room.

5) Bypass plugs will be used only with the permission of R. E. Durand, (Operations Supervisor) or his alternate as described on the authorization list posted in the control room.

6) The console operator will control access to the area behind the reactor console.

E. OPERATING LIMITS

The following limits shall be adhered to:

1) Maximum allowable rate of temperature change is 60°F in one hour.

2) Maximum allowable fuel channel exit temperature is 750°F.

3) Maximum allowable moderator-can-head delta T is 50°F.

4) Preheating temperature must be within 60°F of the sodium temperature. No lines will be preheated to a temperature above 500°F.

F. FUEL HANDLING PROCEDURES

1) Fuel elements will not be left in the fuel handling machine at shift change.

2) While handling fuel elements with the fuel handling machine, access to the high bay area will be restricted.

3) The element inventory board will be kept current each shift.

4) No elements are to be moved without an authorized ETR form (see Appendix A)

G. CONSOLE

1) The console key will be controlled by the Shift Supervisor.

2) The following materials will be stored in the console drawers:

   a) Console log book

   b) Bypass plugs.

3) The control console will be kept free of books, papers, coffee cups, etc.

H. SCHEDULES

Operating schedules will be posted on the bulletin board in the control room. All schedules will be initialed by the Operations Supervisor.

I. STANDARD OPERATING PROCEDURES

The Standard Operating Procedures Manual will be kept in the bookcase in the control room. Consult this manual frequently.

J. DAILY OPERATING INSTRUCTIONS

Daily operating instructions will be approved by R. E. Durand (Operations Supervisor) and acknowledged by each shift supervisor.

K. OPERATING LOG BOOK

The operating log book will be kept in the bookcase in the control room. This log will be filled out each shift. Log entries shall be made chronologically on the right hand page. The Shift Supervisor will write a summary of the activities and plant conditions for the shift. This summary will be signed by both the Shift Supervisor going off duty and the Shift Supervisor coming on duty.

II. SRE OPERATING LIMITS

The operational limits listed below are to be adhered to with no exceptions by the Shift Supervisor. This section of the manual shall be reviewed and revised whenever experimental fuel elements are installed in the reactor, and when additional technical data become available to raise or lower the limits. In addition, this portion of the manual will be reviewed and revised whenever any change is made in the reactor and its components. The above reviews are in addition to and do not replace the regular six-month review of the procedures.

A. TEMPERATURE

1) The maximum allowable rate of temperature change on all vessels and piping is ± 60°F in one hour. A 60°F step change is allowable provided it is followed by a 1-hour "soaking" period.

2) Maximum preheating temperature, ± 60°F from the temperature of the sodium destined to fill the vessel or piping involved, but no more than 500°F.

3) Maximum allowable mixed mean outlet temperature, 725°F.

4) Maximum allowable difference between corner channel exit temperature and any center-channel exit temperature, ± 50°F.

5) Maximum allowable center channel exit temperature, 750°F.

6) Maximum allowable fuel slug central temperature, 850°F for the Th-U fuel elements (second core loading)

7) Maximum allowable fuel-slug central temperature, 850°F for unalloyed uranium fuel elements (first core loading)

8) Maximum allowable hot trap temperature, 1360°F.

9) Maximum allowable cold-trap inlet temperature, 700°F.

10) Maximum allowable concrete temperature, 150°F.

11) Maximum allowable gallery and vault temperature, 120°F.

12) Maximum allowable cold-leg piping temperature, 750°F.

13) Minimum allowable reactor core temperature, 250°F.

14) For power operation, the plugging temperature will be below 350°F.

B. PRESSURE

1) Maximum allowable gas pressure on reactor, 4.5 psig.

2) Maximum allowable gas pressure on primary fill tank, 15 psig.

3) Maximum allowable gas pressure on secondary fill tank, 25 psig.

4) Maximum allowable gas pressure on main secondary expansion tank, 10 psig.

5) Maximum allowable gas pressure on auxiliary secondary expansion tank 10 psig.

6) Maximum allowable gas pressure on flush and drain tank, 10 psig.

C. POWER

Maximum allowable power, 20 Mwt.

III. PROCEDURE FOR KEEPING MANUAL UP-TO-DATE

a) There will be one authoritative manual. This copy will be marked "Control Room Copy." All other copies will be unmarked.

b) Each page of the manual will bear a date followed by a revision number.

c) New pages will be inserted into the manual and old pages withdrawn by the Operations Supervisor.

d) A bulletin will be issued to all Shift Supervisors calling attention to the new procedure. This bulletin will be acknowledged by each Shift Supervisor by signature and then filed in the operating-procedure-bulletin file.

e) The operating-procedure-bulletin file will be kept in the Operations Supervisor's file cabinet.

f) A schedule of procedure reviews has been established. The schedule will allow for complete procedure review every six months. Procedures will be reviewed by the Shift Supervisors. After a procedure has been reviewed, a new date and revision number will be assigned even if there have been no changes.

g) Procedures affecting reactor safety must be approved by the Sodium Reactors Department Head, the SRE Group Leader, and the SRE Operations Supervisor. Procedures not affecting reactor safety must be approved by the SRE Operations Supervisor.

h) Any procedure with a date older than six months will be removed and replaced in the control room manual on its six-month anniversary. This will be done by the Operations Supervisor.

i) Procedures to be reviewed will be assigned to the Shift Supervisors by the Operations Supervisor.

IV. PROCEDURE REVIEW SCHEDULE

Operating procedures will be revised in accordance with the following schedule. Revisions are to be completed on the date listed.

Procedure	First Revision	Second Revision
General		
I. General SRE Operating Instructions	5/30/60	11/28/60
II. SRE Operating Limits	5/30/60	11/28/60
III. Procedure for Keeping Manual Up to Date	5/30/60	11/28/60
IV. Procedure Review Schedule	5/30/60	11/28/60
V. Procedure for Training Personnel in the Correct Procedures	5/30/60	11/28/60
VI. Proper Use of the Manual	5/30/60	11/28/60
Operating Instructions		
I. Reactor	6/13/60	12/12/60
II. Sodium Heat Transfer Systems	6/27/60	12/26/60
III. Sodium Service Systems	7/11/60	1/9/61
IV. Service Cooling System	7/25/60	1/23/61
V. Helium System	7/25/60	1/23/61
VI. Nitrogen Dehumidification Systems	8/8/60	2/6/61
VII. Vent System	8/8/60	2/6/61
VIII. Liquid Waste System	8/8/60	2/6/61
IX. Fuel Handling Machine	9/5/60	3/6/31
X. Building Ventilation Systems	8/22/60	2/20/61
XI. Wash Cells	9/19/60	3/20/61
XII. Emergency Power System	8/22/60	2/20/61
XIII. Pump Coolant Systems	10/3/60	4/3/61
XIV. 75-Ton-Crane Operation	10/17/60	4/17/61
XV. Off-Normal Conditions	10/30/60	5/1/61
XVI. Special Procedures	11/7/60	5/8/61

V. PROCEDURE FOR TRAINING PERSONNEL IN THE CORRECT PROCEDURES

a) The correct procedures are those in the control-room copy of the manual.

b) The Shift Supervisor is responsible for being sure that his personnel know the procedures.

c) No operator will be permitted to conduct any operation unless he has been "checked out" on the correct procedure.

d) "Checking out" on a procedure will be considered valid only after the Shift Supervisor has signed a form stating that the operator knows the correct procedure for the operation under consideration.

e) No operator, even if he has been checked out on the procedure, will conduct an operation for the first time without guidance and supervision from a qualified operator.

f) The Shift Supervisor must be present when a new operation is being performed for the first time by anyone.

g) Each operator must be checked out on the procedures every six months. The check out will include a verbal examination covering the procedure in question, and in addition the operator will be required to perform the operation outlined by the procedure. If circumstances forbid actual performance of the procedure, a mock operation will be gone through. In this mock operation, the operator will be required to locate all controls, valves, switches, etc., and indicate what manipulations are needed to perform the operation.

h) Each page of the manual will be stamped on the back "Read and understood by me on this date." This stamp will refer to the printed material on the reverse side of the page. Each operator will read, sign, and date each page of the manual to signify that he understands the procedures.

VI. PROPER USE OF THE MANUAL

Procedures in this manual are to be followed exactly and completely, provided that so doing does not create an immediate hazard to personnel or reactor plant. These procedures are the result of many hours of study by members of the SRE Staff and are based on the latest technical information and operating experience available to the Division.

These procedures have been reviewed by the members of the SRE Safeguards Review Committee, SRE supervision, the Director of Sodium Reactors, the Vice-President, Technical, and the AEC. Changes to the procedures, therefore, should be given the same careful consideration that the original procedures received and will be done only as follows:

a) Deviation from the established procedure may be made by the Shift Supervisor in cases where the safety of personnel or the reactor are immediately in jeopardy. If the Shift Supervisor, in reviewing a procedure, finds that the procedure should be changed, he may recommend these changes to R. E. Durand (SRE Operations Supervisor).

b) If the safety of personnel or the reactor is not involved in a procedure change, then the procedure may be revised with the approval of R. E. Durand (SRE Operations Supervisor).

c) If the safety of personnel or the reactor is involved by changing a procedure, then the procedure change must be approved by R. E. Durand (SRE Operations Supervisor), L. E. Glasgow (SRE Group Leader), and R. W. Dickinson (Sodium Reactors Director), and/or higher supervision.

PART TWO: OPERATING INSTRUCTIONS

June 27, 1960

I. REACTOR

June 27, 1960

A. FROM SHUTDOWN CONDITION TO CRITICAL

This procedure is intended to be used to bring the reactor to critical from a completely shutdown condition. Authorization to begin on the preoperation checkout must be by the Shift Supervisor on duty. See General SRE Operating Instructions for additional authority required to start the reactor under various conditions.

Before beginning any of the steps outlined in this procedure, a maintenance checkout of all reactor instrumentation shall be accomplished and recorded on the existing instrument maintenance check sheets. The maintenance foreman will state in writing that all reactor instrumentation has been checked out and is in satisfactory operating condition. This written notice will be forwarded to the Operations Supervisor who will place it in the Daily Operating Instruction file. Unless such a notice is on file, the Shift Supervisor will not start the reactor.

1. Preoperational Check-Out

Prior to reactor startup the following requirements must be satisfied and recorded on the SRE Startup Check List.

The startup check list will be filled in by the Chief Operator, who may, at his discretion, dispatch individual operators to obtain the necessary readings required to fill in the check list. The Shift Supervisor will sign the startup check sheet when it is completed, signifying that in his judgement, plant conditions are appropriate for starting the reactor. The check sheet will then be filed in the binder along with the daily operating data sheets.

1) Check that control power is on. Panel CPP circuits shall be energized as follows:

a) Control power circuit 1	SW 3
b) Control power circuit 2	SW 4
c) Off-normal cabinet and pump control	SW 5
d) Voltage regulator on ac generator	SW 18
e) Nuclear instrumentation ac regulator	SW 20

2) Standardize all instruments and mark the time and date on the instrument charts.

3) Check reactor loading face to ensure that all safety and control rods are bolted in place and that all shield plugs are locked in place with at least one hold down clip.

4) Close high bay doors.

5) Check that all shield blocks are installed in the main and auxiliary galleries.

6) Test the emergency diesel engine. Simulate power failure by following the procedure described in Section VII (Emergency Power System).

7) Check that kerosene is flowing to main and auxiliary galleries. Check that valves V-746, V-749, V-779, and V-782C are open.

8) Put dehumidification system in operation. (Refer to Section VI for operating procedures.)

9) Check that reactor vent line valves V-496 and V-137 are open.

10) Reduce reactor helium pressure to 1 psig as follows:

    a) Open reactor vent valve V-551.

    b) Observe reactor pressure on PI 414. When the pressure reaches 1 psig, close V-551.

11) Check that the primary and secondary bulk sodium temperatures are between 340°F and 350°F.

12) Check reactor sodium level on Panel FF. Level should be 118 in. ± 2 in.

13) Check main secondary expansion tank level on Panel FF. Level should be 45 in. ± 2 in.

14) Check auxiliary secondary expansion tank level on Panel FF. Level should be 9-1/2 in. ± 2 in.

15) Check that the primary eddy-current brake is activitated. Check the following:

a) Selector switch on automatic.

b) "Ready" light on.

If these conditions are satisfied, the brake will come on automatically following a scram.

16) Check that the secondary eddy-current brake is activated. Check the following:

a) Selector switch on automatic

b) "Ready" light on.

If these conditions are satisfied, the brake will come on automatically following a scram.

17) Preset primary and secondary eddy current brakes to come on at 82 gpm. Adjust this using the two dials on the control console.

18) Check that the main primary pump is operating at a speed greater than 100 rpm.

19) Adjust the main secondary flow equal to the main primary flow.

20) Set main pump selector switch on "Both."

21) Set main primary and main secondary pump acceleration rate. On the control console set the main primary pump acceleration and main secondary acceleration adjustment knob to 8% of full flow per minute.

22) Check that the auxiliary primary pump is operating at a speed greater than 450 rpm.

23) Adjust auxiliary secondary flow to match the auxiliary primary flow.

24) Check auxiliary airblast fan for operation as follows: From the control console:

a) Energize fan.

b) Vary fan speed from 150 rpm (minimum) to 500 rpm.

c) De-energize fan.

25) Check louver movement on auxiliary airblast heat exchanger as follows:

a) Actuate the manually operated vertical louvers.

b) Check the horizontal louvers and the shim louver for full travel.

26) Remove all jack plugs from the Scram Bypass Panel.

27) Check reactor drain pump for operation as follows: From Panel NN:

a) Energize pump by pushing the "fill" button.

b) Push "raise" button until volt meter indicates 100 volts.

c) Turn "phase" switch to each of the three phase positions. All three phases should indicate approximately the same voltage, within ± 20%.

d) Push "lower" button until volt meter indicates zero.

e) Push "drain" button and repeat Steps b, c, and d.

This completes the check of the reactor drain pump.

28) Check secondary drain pump for operation as follows: From panel NN:

a) Energize pump by pushing the "fill" button.

b) Push "raise" button until voltmeter indicates 100 volts.

c) Turn "phase" switch to each of the three phase positions. All three phases should indicate approximately the same voltage, within ± 20%.

d) Push "lower" button until voltmeter indicates zero.

e) Push "drain" button and repeat steps b, c, and d.

This completes the check of the secondary drain pump.

29) Test the off-normal circuit for the main primary and main secondary systems. On the "main primary" equipment panel in the equipment room perform the following:

a) Turn the "operate-test" switch clockwise. This switch is spring-loaded and must be held in this position during test.

b) Press right-hand "test" button. The meter relay pointers will move to the right, and the three neon indicator lights will light. This indicates circuits are working properly.

c) Press reset button to clear meter relays and lights.

d) Press the left-hand "test" button. The indicating lights will come on and the meter relay pointers will move to the left.

e) Press reset button.

f) Release "operate-test" switch.

g) Repeat procedure for main secondary system. Switches and buttons for this system are located on the "main secondary" equipment panel in the equipment room.

30) Check vital bus frequency. Adjust frequency to exactly 60 cps.

31) Calibrate both long N amplifiers as follows:

a) Allow amplifier to warm up 30 min before starting calibration procedure.

b) Turn calibrate switch to "ground" position and adjust the "ground" potentiometer to obtain a meter reading at the mechanical zero of the meter.

c) Turn calibrate switch to "low" position and adjust the "CAL" potentiometer to obtain a meter reading at the low red mark.

d) Turn the calibrate switch to "high" position and adjust the "GAIN" potentiometer to obtain a meter reading at the high red mark.

e) Repeat steps b), c), and d) several times, until calibration remains steady.

32) Calibrate both log-count-rate amplifiers as follows:

a) Turn calibrate switch to "CAL" position.

b) Turn adjusting knob to obtain meter reading of 60 counts/sec.

33) Energize safety rod drives. On the emergency power distribution panel, section M, turn safety rod breaker to "on" position.

34) Energize shim rod drives. On the emergency power distribution panel, section L, turn four shim rod breakers to "on" position.

35) Check safety amplifiers (Panel FF) Magnet power and amplifier lights should be on.

36) Check magnet holding current for all four safety rods. On the safety amplifier turn selector knob to each magnet position and check ammeter. The holding current should be approximately 50 ma ± 10 ma.

37) Set the neutron flux level amplifier (Beckman) located on Panel FF on the 10^{-9} scale.

38) Turn console de power on by unlocking the console key switch. Light just above switch will indicate power on.

39) Run fission chambers to lower limit. On control console move 1 and 2 fission chamber control to "in" position. Fission-chamber position indicator will be at zero and lower limit lights will come on when chambers reach lower limit.

40) Move fast drive for control rods 3 and 4 to upper limit in the following manner:

    a) Set control rod indicator range on "Vernier."

    b) Move control rod fast switch to "out" position.

    c) Switch control rod indicator range to "full". Control rod position indicator should read 15 in.

41) Place rod control selector switch on "hand."

42) Install low boiler feedwater pressure scram bypass jack plug. "Interlocks satisfied" light will come on.

43) Check operation of safety rods as follows:

    a) Withdraw safety rods 12 in. by moving safety rod control switch to "out" position. Green bottom-limit light will go off.

b) Check perimeter warning lights when the bottom limit light clears. Lights will be on and flashing.

c) Drop safety rods from 12 in. by pressing scram button. Lower limit lights (green) should come on.

2. Approach to Critical (Combined Procedures for Edison and SRE)

Before proceeding with the following steps, permission must be obtained from the Shift Supervisor to proceed. The startup check list must be signed by the Shift Supervisor and a notation made in the console log that the preoperational check has been satisfactorily completed. The shift supervisor will obtain permission for startup from the Edison Operator before proceeding.

To attain criticality, the safety rods are withdrawn completely. Then three shim rods are withdrawn in increments, one at a time, to their upper limit. The fourth shim rod is withdrawn in 3-in. increments until within 3 in. of predicted criticality and then in 1-in. increments until criticality is achieved.

SRE a) Increase main primary and main secondary flow to 800 gpm.

SRE b) Adjust auxiliary primary system as follows to prevent back-flow during full-power operation:

1) Operate auxiliary primary pump at 450 rpm (minimum speed).

2) Throttle V-177 until flow in auxiliary primary system is 10 gpm.

3) Increase auxiliary primary pump speed until flow is 30 gpm.

4) Adjust auxiliary secondary flow to match auxiliary primary flow.

Under these conditions it is now impossible to operate the main primary pump at a speed high enough to cause reverse flow in the auxiliary primary loop.

Edison c) Place steam generator on water heating system. Operate no. 2 boiler feed pump on minimum slow bypass to deaerator as required to raise temperature in deaerator to 212°F before reactor is operating.

SRE d) Bring reactor to criticality as follows:

1) Switch log-count-rate recorder to channel 1. Observe counting rate while withdrawing fission chamber for channel 1. The counting rate should decrease markedly, indicating that fission chamber is in actuality responding to a neutron flux. Re-insert the fission chamber to the lower limit.

Repeat the above procedure for log-count-rate channel 2. Both chambers should agree to within 20% of the indicated count rate.

Do not proceed any further unless both log-count-rate channels are responding to a neutron flux as indicated by the above tests. Notify the Shift Supervisor if the count-rate channels are not responding.

2) Withdraw safety rod 1 to upper limit (80 in.). As the rod moves out and the bottom limit switch clears, the green bottom-limit light to the left of the safety-rod position indicator will go out and a startup gong will sound for 30 sec. When the rod drive reaches the upper limit, a red light to the right of the position indicator will come on and the rod will stop automatically.

3) Check log-count-rate recorder and period recorder. Stop rod withdrawal if the log-count-rate recorder or the period recorder indicates a sustained period of less than 300 sec.

4) Repeat Steps 2) and 3) for safety rods 2, 3, and 4.

5) Record counter indications of the four shim rods from the counters located on the rod drives. These data are to be recorded in the console log.

6) Withdraw shim rod 1 to 40 in. and wait 5 min.

7) Observe log-count-rate recorder and period recorder continuously as rod is withdrawn and during waiting period. Stop rod withdrawal if the log-count-rate recorder or the period recorder indicates a sustained period of less than 300 sec.

8) A progressive increase in counting rate will be evident as the rods are withdrawn. Switch to alternate log-count-rate channel periodically to confirm the observed level. Both channels should agree to within 20% of the indicated count rate.

9) Withdraw shim rod 1 to upper limit switch. Repeat steps 7) and 8).

10) Repeat steps 6), 7), 8), and 9) for shim rod 2.

11) The reactor will go critical on shim rod 3 (with shim rod 4 fully inserted) in the clean condition. After two to three days of power operation, Xenon buildup will be sufficient to cause criticality to occur on shim rod 4, with the other three shim rods fully withdrawn.

Case 1 - Criticality Predicted on Shim Rod 3

a) Withdraw shim rod 3 three inches at a time with a 5-min wait between pulls. Repeat steps 7) and 8) after each rod withdrawal.

b) When shim rod 3 is within 3 in. of the predicted rod position for criticality, wait 5 min and then pull shim rod 3 one inch at a time with a 5-min wait between each pull until criticality is attained.

Case II - Criticality Predicted on Shim Rod 4

a) Withdraw shim rod 3 three inches at a time with a 5-min wait between pulls. Repeat steps 7) and 8) after each rod withdrawal. Continue withdrawing shim rod 3 until it reaches upper limit.

b) Withdraw shim rod 4 three inches at a time with a 5-min wait between pulls. Repeat steps 7) and 8) after each rod withdrawal.

c) When shim rod 4 position is within 3 in. of the predicted rod position for criticality, wait 5 min and then pull the shim rod 1 in. at a time with a 5-min wait between each pull until criticality is attained.

12) Criticality will be indicated by a steady rise in neutron flux indicated on the log-count-rate recorder with the rods at a fixed position. If the rod positions when the reactor is just critical correspond to a difference of more than $0.14 of reactivity (as indicated by the control-rod calibrations kept in the console drawer) between the actual and the predicted critical position, notify the Shift Supervisor immediately. Then begin orderly shutdown by moving the shim rods in.

    Do not proceed further until the discrepancy between actual critcal position and predicted critical position has been adequately explained.

    Authorization to restart must come from the Operations Supervisor.

13) As the reactor approaches criticality, watch the log count rate recorder. When the instrument reads 10^4 n/cm^2/sec, pull the two fission chambers until the instrument is reading 10^2n/cm^2/sec. Repeat this procedure as necessary until the reactor is at criticality.

14) When the log N recorder begins to indicate, switch the "Period Recorder Input" to the "High Level" position.

B. FROM CRITICALITY TO FULL POWER (Combined procedure for Edison and SRE)

The objective of this procedure is to attain full power after the reactor has achieved criticality. Close coordination between the Edison operator and the SRE operator is required. Authorization to proceed must be obtained from the Shift Supervisor.

To achieve full power, the reactor power is slowly increased from critical to approximately 3 Mwt. During this time, feedwater flow is increased to the steam generator. Superheated steam is produced and the turbine is started. When the turbine is up to speed, the generator is connected to the power line. Reactor power is then increased, while raising sodium flow and increasing sodium temperature.

SRE 1) Adjust reactor power and/or line heaters to maintain the sodium temperatures between 340°F and 350°F. Do not exceed 350°F.

SRE 2) Continue to withdraw control rods until a sustained period is observed. Hold the rising period between 60 sec and 120 sec until a temperature rise is observed on the fuel-channel-exit sodium-temperature recorder.

Edison 3) Switch to normal feedwater system as follows:

a) Set nitrogen pressure on mercury expansion tank at 175 psig. It may be necessary to bleed pressure as sodium temperature increases to keep pressure constant. High and low pressure alarms are set at 195 and 150 psig, respectively.

b) Cut in 165-psig auxiliary nitrogen pressure to main steam line by opening valve 28 on auxiliary nitrogen line preparatory to removing heating system from service.

c) Shut down No. 1 boiler feed pump. Close valves 11 and 15 on both ends of water heater line and nitrogen inlet valve 30 at top of water expansion tank.

d) Set main steam bypass control valve 23 to closed position using remote manual hand control.

e) Place main steam bypass desuperheater in service in accordance with startup procedure for this equipment.

f) Prepare boiler feed and steam systems for normal operation. Close or check closed the following valves:

   1) Feedwater bypass valve 8

   2) Auxiliary steam control valve 24 to closed heater.

   Open or check open the following valves:

   1) No. 2 boiler feed pump discharge valve 20 and suction valves 1 and 2

   2) Blocking valve 27 on auxiliary steam line to closed heater

   3) Main steam bypass blocking valve (MOV3).

   Slowly open bypass valve around main steam stop valve 19 to pressurize main steam line to closed throttle valve. Open valve 19.

g) Place condenser circulating water system and auxiliary vacuum pump in service. Refer to startup procedure for this equipment. (Steam jet air ejector is normally placed in service after unit is on line.)

h) Place test feedwater flowmeter in service, bypassing Bailey flowmeter.

i) Place No. 2 boiler feed pump, condensate pump, and deaerator in service.

j) Raise pressure in steam generator to 600 psig by slowly opening feedwater bypass valve 8 a small amount. To control pressure at 600 psig and to heat feedwater to 200°F or more flash steam to closed heater through auxiliary steam control valve 24. Steam in excess of that required to heat feedwater can be flashed to condenser through main steam bypass valve 23. Feedwater flow should be held to a minimum consistent with stable operation.

Watch thermocouples on water inlet end of steam generator. Rate of temperature change should not exceed 10°F/min.

k) Remove auxiliary nitrogen line from service by closing valve 28 on auxiliary nitrogen line.

l) Notify SRE Shift Supervisor that steam generator is ready to receive higher sodium temperature.

m) When boiler feed pump No. 1 has cooled to 200°F, connect to deaerator by opening isolating valve 4 on suction line and place on automatic service. Open minimum flow bypass valve 6.

SRE 4) Obtain permission from Shift Supervisor to do so and then remove bypass jack plug from scram circuit on boiler feedwater pressure after completion of all portions of step 3.

SRE 5) Increase reactor power to raise sodium temperature at a maximum rate of 60°F/hr, but do not exceed 50°F temperature difference across moderator-can head. Adjust main secondary flow so that secondary delta T equals reactor delta T. Start the auxiliary air-blast fan at minimum speed when necessary to control the auxiliary primary cold-leg temperature to match the main cold-leg temperature. The auxiliary cold-leg temperature must be set to match the main primary cold-leg temperature as closely as possible. Maximum deviation is ±50°F.

Edison 6) When sodium inlet temperature to steam generator reaches 380°F, start establishing a delta T by increasing feedwater flow so that by the time the sodium outlet temperature reaches 440°F, the inlet temperature will be about 465°F and feedwater flow 10, 000 lb/hr (for 800-gpm sodium flow and 200°F feedwater temperature). This feedwater flow is required before starting to generate steam.

Edison 7) Remove test flowmeter from service and place Bailey meter in service.

SRE 8) Continue to increase reactor power to raise reactor outlet temperature at the rate of 60°F/hr.

Edison 9) Reduce setting of main steam bypass control valve 23 to saturation pressure. As sodium inlet temperature to steam generator increases, steam generation will start and progress in quality to saturated and then to superheated steam. Do not allow feedwater flow to drop below 10,000 lb/hr. Maintain steam-generator sodium outlet temperature at 460°F. This temperature may be raised to a maximum of 500°F if required to maintain steam temperature stable.

Edison 10) When steam conditions are satisfactory for turbine startup, notify SRE control room.

SRE 11) Stop increasing reactor power. If necessary, adjust reactor power downward to achieve the following stable conditions in the steam generator:

Main primary sodium flow	800 gpm (max)
Sodium inlet	545°F
Sodium outlet	460°F
Maintain delta T across steam gen. at	85°F
Steam temperature	530°F
Steam pressure	450 psig
Superheat	50°F
Feedwater flow	10,000 lb/hr
Maintain feedwater temp at	220°F

Edison 12) Start turbine. Notify SRE control room when turbine generator is on the line. Open extraction steam line to deaerator prior to rolling turbine. Place steam jet air ejector in service.

SRE 13) Increase reactor power to raise reactor outlet temperature at a maximum rate of 60°F/hr.

Edison 14) Control feedwater flow to maintain steam generator sodium outlet temperature at 460°F.

SRE 15) When reactor delta T is 170°F, slowly increase main primary-sodium flowrate to 1100 gpm, adjusting main secondary flowrate so that secondary delta T equals reactor delta T, and increase reactor power to maintain a constant reactor outlet temperature. Steady the system.

Edison 16) Place closed heater in normal service using extraction steam provided feedwater temperature can be maintained at 200°F or above. (This should be done at about 1-Mw electrical load). If not, continue to operate manually with auxiliary steam through control valve 24. NOTE: Closed heater was designed for a maximum steam temperature of 500°F.

Edison 17) Place Bailey feedwater control valve in operation on manual control. Raise steam pressure to 600 psig. Note that a readjustment of feedwater control will be required. Readjust steam pressure to steam jets. Place initial pressure regulator in service. Set main steam bypass control valve at 610 psig and close blocking valve. (In case of a scram, open blocking valve.)

SRE 18) Check that all plant variables listed in Section XV, Table I are within the specified limits.

SRE 19) Maintain 1100-gpm sodium flow in main primary system. Increase reactor power. Slowly increase main primary-sodium flow to 1200 gpm, adjusting main secondary flowrate so that delta T equals reactor delta T, and increase reactor power to maintain a constant reactor outlet temperature. Steady the system. Repeat step 18.

SRE 20) Increase reactor power to raise reactor outlet temperature at the rate of 60°F/hr. Stop increasing reactor power and steady the system when highest fuel channel outlet temperature reaches 750°F.

Edison 21) Control feedwater flow to maintain steam-generator sodium outlet temperature at 460°f.

SRE 22) Continue running at power. Increase main primary and main secondary pump speeds to maximum (approximately 1300-gpm flow) while watching carefully for overheating of the pump motors and MG sets. Do not exceed 750°F maximum fuel channel outlet temperature.

23) Reactor is now running at full power.

C. NORMAL OPERATION

1. Shim-Rod Positions

After the reactor is operating at a constant power level, shim-rod positions will be adjusted as follows:

a) The selected regulating rod (rod 3 or 4) will be set in the center of its range, between 20 and 50 in.

b) The other three shim rods will be banked at whatever position is required to maintain criticality.

2. Automatic Control

The automatic reactor control system can be utilized during normal operation to maintain a given power level or to control a rate of temperature change. The control system can be set to control by either neutron flux or reactor outlet sodium temperature. The Shift Supervisor will decide whether to operate on automatic or manual control.

a. Neutron Flux-Control

1) Check the two-pen (flux-temperature) recorder mounted in panel EE. It must be on and standardized before proceeding to automatic control.

2) On the Flux-temperature Controller:

   a) Turn synchro selector to "flux".

   b) Turn control selector to "flux".

   c) Place timer switch in "off" position.

   d) Adjust flux "setpoint" dial until the setpoint indicator reads the same as the flux controller indicator.

   e) Push reset button. The indicating light on the programmer will come on. If the light continues to go out after releasing the reset button, recheck Step d). Set point and controller indicators must be within 2% of each other in order to clear the safety circuit for flux control.

3) Turn automatic flux controller manual — auto switch to "Auto".

4) Place reactor on automatic flux control by switching manual-auto switch for either control rod 3 or 4 to "auto". If the flux should deviate more than 2% from the set point, a safety circuit is set to trip. Automatic control will be interrupted and control will revert to manual.

Should the safety circuit trip the following will happen:

a) Light above control switch on programmer will go out.

b) Manual light above "Man-auto" switch on console will come on.

c) Buzzer in programmer will be energized (may be de-energized by throwing "Man-auto" switch on console to manual position).

b. Automatic Temperature Control

To place the automatic temperature control in operation, it is necessary to go from manual to flux control and then switch from flux to temperature control. It is not possible to switch directly from manual to temperature control.

1) Flux to temperature control:

a) Adjust "temperature setpoint" dial until the setpoint indicator reads same as the temperature controller indicator.

b) Push reset button. The temperature setpoint and controller indicators must be within 15°F of each other in order to clear the safety circuit for temperature control. Repeat Step a) if indicating light above the switch does not stay on.

c) Turn the control switch on the programmer from flux to temperature. The safety circuit for temperature control is set to trip if the temperature should deviate more than 15°F from the setpoint.

d) To go from temperature to manual control, turn manual-auto switch on console to "Manual".

2) To control rate of temperature change:

   a) Put reactor on temperature control, as described above.

   b) Set programmer timer to desired rate of change (0-100°F/hr) and turn timer switch to raise or lower position.

   c) The programmer will automatically stop changing temperature setpoint 1 hour after the timer switch is moved to either the raise or lower position. To reset the timer, turn the switch to the "off" position and then return to original position.

D. SCRAM AND SETBACK RECOVERY

The objective of the following procedure is to allow safe and efficient recovery from accidental scrams and setbacks. See "SRE General Operating Instructions" for authorization required for restart after scram.

When a scram occurs, the eddy-current brakes automatically control sodium flow at 82 gpm to maintain sodium temperature rate of change less than 60°F/hr. The shim rods automatically drive to their lower limit. After the cause of the scram is determined and corrected, and authorization is received for restart, shim rods are withdrawn. See "General Operating Instructions" for authorization required. The turbine-generator is restarted when reactor power reaches 3 Mw. After the turbine-generator is on the line, reactor power is increased to normal running power.

1. Scram

   a) The following conditions will initiate a reactor scram:

      1) Manual

      2) Earthquake

      3) Reactor period less than 5 sec for power levels less than 1% of full power

      4) Neutron level greater than 25 Mw

      5) Fuel-channel exit temperature greater than 790°F

      6) Electrical power failure (after 2-sec time delay)

      7) Main primary sodium flow less than 80% of set flow

      8) Main primary pump speed less than 90% of set speed

      9) Main secondary-sodium flow less than 80% of set flow

      10) Main secondary pump speed less than 90% of set speed

      11) Boiler feedwater pressure less than 600 psig (after 8-sec time delay)

      12) Main secondary cold-leg temperature greater than 575°F

13) Loss of auxiliary primary flow

14) Moderator $\Delta T \pm 50°F$.

b) When the reactor scrams, proceed as follows:

1) Main pump speeds will drop to 100 rpm.

SRE 2) Reduce auxiliary primary pump to minimum speed of 450 rpm. Adjust auxiliary secondary pump speed to match auxiliary secondary flow to auxiliary primary flow.

SRE 3) Flow in the main systems will be automatically controlled by the eddy-current brakes. The flow should be controlled between 70 and 120 gpm.

SRE 4) All shim rods will automatically drive to their lower limit.

SRE 5) Notify Shift Supervisor immediately.

Edison 6) Note that the secondary-sodium flow drops to about 100 gpm after the scram. Feedwater flow should follow sodium flow so it will be necessary to reduce feedwater flow as quickly as possible. Close Bailey feedwater valve and close motor-operated blocking valve (MOV-5) ahead of it. (Bailey valve does not shut off tightly.) Check setting of main steam bypass control valve automatic position at 610 psig. Open blocking valve on main steam bypass. When initial pressure regulator reduces load on turbine generator to zero, trip throttle valve. Reduce main steam bypass control valve setting to 600 psig. Use the feedwater bypass valve (8) to control the small feedwater flow required to remove heat from the low sodium flow and to maintain sodium outlet temperature at the value immediately prior to the scram. Heat feedwater by routing steam to closed heater through auxiliary steam line and control valve (24) to closed heater. Feedwater temperature may be allowed to rise above normal. Shut down steam seal regulator on turbine. Shut down steam jet air ejector. Auxiliary vacuum pump should start automatically. Place test flowmeter in service and remove Bailey flowmeter from service.

Check temperatures at thermocouples 11 and 70 on steam generator shell to compare with sodium outlet and inlet temperatures.

SRE 7) Determine cause of scram and take the required corrective action.

SRE 8) Obtain permission from the Shift Supervisor before restarting the reactor. See SRE General Operating Instructions for additional authority required to restart the reactor after a scram.

2. Scram Recovery

If steam-generator sodium inlet temperature and main-intermediate-heat-exchanger secondary outlet temperature are within 250°F of reactor outlet temperature, proceed with Case I and restart the plant as soon as practicable. If the above conditions do not exist, proceed with Case II.

Case 1

SRE a) Bypass main primary-sodium flow and main secondary-sodium flow scram circuits. (This will prevent any off-normal sodium flow conditions from scramming the reactor.)

SRE b) Sodium pump restart permissive light on console will come on when motor-operated rheostats on sodium pump motors reach lower limit.

SRE c) Withdraw safety rods to upper limit.

SRE d) Withdraw shim rods until criticality is achieved. See section A-2 for procedure for approaching criticality.

SRE e) Increase reactor power on a 100-sec period to a log neutron flux level of 0.1%. Increase period to 300 sec so that reactor power is increasing slowly when log neutron flux level is 1%. It is expected that fuel-channel exit temperatures will start to increase when log neutron flux level is 2%.

SRE f) When fuel-channel exit temperature starts to rise, increase reactor power to permit fuel-channel exit temperature to rise at a maximum rate of 60°F/hr.

SRE g) By decreasing brake currents and increasing pump speeds, match sodium flows to reactor power as it rises. After brakes are "Off" reset brake panel.

SRE h) Increase reactor power and main sodium flow rates together until 3-Mw thermal power level is reached. Steady the system.

SRE i) Adjust auxiliary loop flows to achieve same ΔT in the auxiliary loops as in the main loops.

SRE j) Reset the main primary and main secondary off-normal circuits.

SRE k) Remove bypass plugs from "Main primary-sodium flow" and "Main secondary-sodium flow" scram circuits.

Edison l) If steam conditions are unsatisfactory for starting turbine, request power and flow change from SRE. Steady the system.

Edison m) When steam conditions are satisfactory for starting turbine, notify SRE.

Edison n) Start turbine. Notify SRE when turbine is on the line. Open extraction steam line to deaerator prior to rolling turbine.

SRE o) Increase reactor power and sodium flowrates together, maintaining existing reactor ΔT until one of the following conditions has been met.

Reactor ΔT (°F)	Primary-Sodium Flow (gpm)	Startup Procedure, Section II-B Step
0 - 170	800	15
170 - 300	1100	19

While increasing main primary pump speed, adjust main secondary flowrate so that secondary ΔT equals reactor ΔT. When a main primary flowrate appropriate for the existing reactor ΔT (see table above) has been established, enter startup procedure (section I-B) at step indicated above, and proceed.

Case II

SRE a) Allow fuel-channel exit temperature to decrease at 60°F/hr.

Edison b) Adjust feedwater flow to decrease and maintain steam-generator sodium outlet temperature at 440°F.

SRE c) Slowly increase pump speed to 800 gpm, after reactor outlet temperature reaches 465°F.

Edison d) Decrease steam-generator sodium outlet temperature to 380°F by increasing feedwater flow. Rate of temperature change is 60°F/hr maximum.

SRE e) Start reactor as indicated in section I-A-4. Proceed with startup procedure [section II-B at step 6)].

3. Setback

a) The following conditions will initiate a reactor setback.

1) Reactor period less than 10 sec

2) Neutron level greater than 23 Mw

3) Fuel-channel-exit sodium temperature greater than 770°F.

b) If any of the above exceed the limit listed, the reactor will be automatically setback as follows:

1) All four shim rods will be driven in at shim speed.

2) The setback buzzer will be energized and will stay on until reset by a switch on the control console.

3) A light on the control console will indicate cause of the setback. The light can be reset by a switch on the control console only after the condition causing the setback is corrected.

4) The rod insertion will continue only until the condition initiating setback is corrected.

c) When the setback signal is received, proceed as follows:

1) If the control rods are being moved on either slow or fast motion when the setback buzzer sounds, release the rod switch immediately. This returns the switch to the neutral position.

2) If the reactor is on automatic neutron level control, switch to the "hand" position immediately upon receipt of the setback alarm.

3) For a period less than 10 sec

(a) The corrective action is automatic for this situation. The four shim rods will be driven in until the indicated period is greater than 10 sec.

(b) Increase the period to the desired value by inserting one shim rod the required amount.

(c) Notify the Shift Supervisor immediately. If the cause of the short period cannot be determined, the reactor will be shut down using "normal shutdown" procedure.

4) For neutron level greater than 23 Mw

(a) The setback will drive the rods in until the power falls below 23 Mw.

(b) When the power falls below 23 Mw, the rod drive will stop. The reactor will be on a negative period. The magnitude of this negative period will depend upon the amount of positive reactivity present when the power was at 23 Mw.

(c) Withdraw one control rod to increase the period to ∞.

(d) Decrease flow in the main primary- and secondary-sodium loops as required to hold the fuel channel outlet temperature constant.

(e) Readjust power and flow to obtain the desired power level and core outlet temperature.

5) For fuel-channel exit sodium temperature greater than 770°F

(a) If this setback signal is a result of high reactor power, the corrective action will correct for both conditions.

(b) If reactor power is normal, this setback alarm will indicate that sodium flow is low.

The setback will cause reactor power to decrease on a negative period.

(c) Manually control primary and secondary flow to hold the rate of change of temperature to 60°F/hr.

(d) As the desired power level is approached, withdraw one control rod to increase the period to ∞.

(e) Readjust power and flow to achieve the desired fuel-channel outlet temperature.

E. NORMAL SHUTDOWN

The objective of this procedure is to shut the reactor down in a manner which avoids thermal and mechanical stresses on the reactor components. Authorization to proceed with this procedure must come from the Shift Supervisor.

Normal shutdown involves reducing the reactor power at a controlled rate by reducing neutron flux, sodium flow, and sodium temperature. When the power reaches 3 Mw, the turbine-generator is taken out of service. Power reduction is continued until the reactor is subcritical, at which point the safety rods are dropped. Sodium temperature is maintained at 340 to 350°F, and the water is allowed to evaporate from the steam generator. The auxiliary sodium system is used to dissipate afterglow heat.

SRE 1) Notify the Edison operator of shutdown.

SRE 2) Remove the reactor from automatic control by the following action:

a) Switch "Rod Control Selector" to the "Hand" position.

b) Switch "Indicator Range" for the selected regulating rod to the "Full" position.

SRE 3) Check that the ramp rates for the main primary and main secondary pump are set at 8% of full flow per minute.

SRE 4) Insert shim rods to reduce reactor power and decrease main primary and main secondary flow while maintaining a constant delta T across the reactor. Stop reducing flow when both main loops reach 800 gpm.

SRE 5) Level off when the following conditions have been reached:

a) Main primary-sodium flow, 800 gpm.

b) Steam-generator sodium outlet temperature, 460°F.

c) Steam generator sodium inlet temperature, 545°F.

Edison 6) Place test flowmeter in service and check that flow is within the capacity of the main steam bypass.

Edison 7) Place main steam bypass in service and reduce turbine-generator load to zero. Trip unit off line.

SRE	8)	Reduce the reactor power until the delta T across the core is 50°F.
SRE	9)	Continue to reduce power and to reduce flow so as to hold the temperature rise across the core constant at 50°F until reactor is subcritical.
SRE	10)	Press the "Scram" button. This will cause the following:
		a) The four safety rods will drop into the core.
		b) The four shim rods will be driven to the lower limit.
		c) The main primary and main secondary pump speed will be lowered to 100 rpm.
SRE	11)	Reset the scram horn.
SRE	12)	Check the lower limit light for each safety rod to determine that each rod has dropped on the scram signal.
Edison SRE	13)	Continue to remove heat to bring reactor temperatures down at the rate of 60°F/hr.
Edison	14)	When sodium loop temperatures reach 350°F, shut down steam generator on steam-water side.
SRE	15)	Adjust auxiliary-sodium-system heat removal rate to maintain reactor inlet temperature at 350°F.
Edison SRE	16)	Energize the line heaters if necessary to maintain isothermal conditions at 350°F. The reactor is now shut down.

F. EMERGENCY SHUTDOWN

The objective of this procedure is to shut the reactor down as rapidly as possible consistent with engineering limitations on the reactor and its components.

The reactor is scrammed manually and sodium flow is controlled by the eddy-current brakes to maintain the rate of decrease of reactor outlet temperature at 60°F/hr maximum. Heat is removed by the steam generator until sodium temperature reaches 340 to 350°F, at which point the water is allowed to evaporate from the steam generator. The auxiliary sodium system is used to dissipate afterglow heat.

No authorization is required to initiate the first step in this procedure. Any qualified operator may scram the reactor if an emergency condition exists.

SRE 1) Scram the reactor by pressing the manual scram button on the console.

SRE 2) Notify Shift Supervisor of scram.

SRE 3) Notify Edison Operator of scram.

SRE 4) Main pump speeds will drop to 100 rpm.

SRE 5) Reduce auxiliary primary pump to minimum speed of 450 rpm. Adjust auxiliary secondary pump speed to match auxiliary secondary flow to auxiliary primary flow.

SRE 6) Flow in the main systems will be automatically controlled by the eddy-current brakes. The flow shall be controlled between 70 and 120 gpm.

SRE 7) All shim rods will automatically drive to their lower limit.

SRE 8) Note that the secondary-sodium flow drops to about 100 gpm after the scram. Feedwater flow should follow sodium flow so it will be necessary to reduce feedwater flow as quickly as possible. Close Bailey feedwater valve and close motor-operated blocking valve (MOV-5) ahead of it. (Bailey valve does not shut off tightly). Check setting of main steam bypass-control-valve automatic position at 610 psig. Open blocking valve on main steam bypass-control-valve automatic position at 610 psig. Open blocking valve on main steam bypass. When initial pressure regulator reduces load on turbine-generator to zero, trip throttle valve. Reduce main steam bypass control valve setting to 600 psig. Use the feedwater bypass valve 8 to control the small feedwater flow required to remove heat from the low sodium flow and to maintain sodium outlet temperature at the value immediately prior to the scram. Heat feedwater by routing steam to closed heater through auxiliary steam lines and control valve 24 to closed heater. Feedwater temperature may be allowed to rise above normal. Shut down steam seal regulator on turbine. Shut down steam jet air ejector. Auxiliary vacuum pump should start automatically. Place test flowmeter in service and remove Bailey flowmeter from service.

Check temperature at thermocouples 11 and 70 on steam generator shell to compare with sodium outlet and inlet temperatures.

SRE 9) Notify Edison operator that reactor is to be shut down completely in accordance with Emergency Shutdown Procedure.

Edison 10) Continue removing heat by adjusting feedwater flow to reduce steam-generator sodium outlet temperature at the rate of 60°F/hr.

SRE 11) Control primary- and secondary-sodium flow by means of the eddy-current brakes to permit reactor temperature to decrease at a maximum rate of 60°F/hr.

Edison 12) When sodium loop temperatures reach 350°F, shut down steam generator on steam-water side.

SRE 13) Adjust auxiliary-sodium-system heat-removal rate to maintain reactor inlet temperature at 350°F.

SRE 14) Energize line heaters, if necessary, to maintain isothermal conditions at 350°F.

The reactor is now shutdown.

II. SODIUM HEAT TRANSFER SYSTEMS

June 27, 1960

A. PURGING

The objective of this procedure is to guarantee that the primary-sodium system is free of oxygen and filled with inert gas prior to admitting sodium to the system. Failure to do this can result in oxide plugging of small lines in the system, and can decrease cold-trap life. Authorization to proceed with the steps in this procedure must come from the Shift Supervisor.

In general, the sodium systems are purged by admitting helium at high points in the system and venting it from low points. Oxygen concentration of the vented gas is measured with a Beckman oxygen analyzer. The system is considered purged when the oxygen concentration of the vented gas reaches 0.25%.

1. <u>To Purge the Primary-Sodium Systems</u>

   a) Open the following sodium valves: V101, V103, V112, V157, V175, V177.

   b) Close the following sodium valves: V113, V616, V617.

   c) Close vent valves V137 and V496.

   d) Open vent valve V528, from line 113 freeze trap.

   e) Admit helium to the system by opening the following helium pressure control stations and valves:

      PC 436-V312A & B; line 103 freeze trap

      PC 442-V318A & B; main primary pump case

      PC 446-V305A & B; line 176 freeze trap

      PC 445-V326A & B; auxiliary primary pump case.

   f) Take periodic samples of the system gas by connecting the Beckman portable O_2 analyzer to the line 113 freeze-trap helium supply line. Continue to purge until oxygen content is less than 0.25% or until Shift Supervisor gives instructions to discontinue purge.

   g) Purge the system to one vent decay tank. Have the shift Health Physicist continuously sample the gas through line 526 sample connection. If at any time prior to the complete filling of the decay tank the gas activity is 5.0×10^{-5} $\mu c/cm^3$ after the vent decay tank is filled, two courses of action are available for selection:

1) The purging rate must be set equal to the venting rate specified by Health Physics. Have Health Physics periodically sample the gas to see if the venting and purging rate can be increased.

2) Set the purging rate greater than the specified venting rate and fill the four vent decay tanks. The system O_2 concentration should be down to 0.25% at or before this time.

The choice of these two courses of action will be determined by the plant conditions. The decision will be made by the Shift Supervisor.

h) To be assured that line 103 is thoroughly purged, close V101 and continue to purge for an additional 15 min or until the oxygen content is 0.25% or less, as measured in Step c.

i) To be assured that lines 104 and 177 are thoroughly purged, close V103 and V175 and continue to purge for an additional 10 min or until the oxygen content is 0.25% or less, as measured in Step f)

j) Close vent valves V521C and V528.

k) Pressurize the system to 2.0 psig with helium and then close the following helium valves: V312A, V312B, V318A, V318B, V305A, V305B, V326A, and V326B.

l) The system is now purged.

2. To Purge the Main and Auxiliary Secondary-Sodium Systems

CONDITIONS: Establish that the main secondary piping, the B & W steam generator, the auxiliary secondary piping, and the auxiliary airblast heat exchanger are drained.

3. To Purge the Main Secondary System

a) Close sodium valve V-131 (fill valve).

b) Open main secondary-pump-case-seal vent valve.

c) Admit helium to the system by opening the following PC stations and valves:

1) PC 457 - V307A Main secondary expansion tank helium supply. (Melt freeze trap R.)

2) PC 490 - Edison steam generator. Freeze trap V must be melted to complete this operation (10 psig)

d) Use the Beckman O_2 analyzer to take periodic samples of the atmosphere from the main secondary pump case seal. Purge until desired (0.25% or less) O_2 concentration is attained.

4. <u>To Purge Auxiliary Secondary System</u>

a) Close sodium valve V-198 (fill valve).

b) Open auxiliary secondary pump-case-seal vent to atmosphere.

c) Simultaneously admit helium to the system by opening the following PC stations and valves:

1) PC 462, valve 325C. (auxiliary secondary expansion tank helium supply)

2) Auxiliary secondary freeze trap line.

d) Proceed as in Step d) of main secondary purge, taking samples at auxiliary secondary pump case.

B. SODIUM SYSTEM PREHEATING

The following general instructions apply to preheating all sodium piping and vessels.

1) Although sodium melts at a temperature of 208°F, experience has shown that a minimum of difficulty is experienced when all piping to be filled with sodium is heated to a temperature between 300 and 400°F.

2) To preheat any piping system,

a) Obtain isometric heater and thermocouple drawing for the system to be preheated.

b) The isometric drawing shows in abbreviated notation the location of the breaker for a given heater and the readout point for a given thermocouple.

Abbreviation	Meaning
ER	Equipment Room
NaS	Sodium Service Building
PP	Panel PP in Main Secondary Area
TT	Panel TT in Auxiliary Secondary Area
DH	Dehumidification System Panel on North Wall of High Bay
NN	Panel NN in Sodium Service Building
LL	Panel LL in Control Room
KK	Panel KK in Control Room
Sp	"Special" Panel (120 volts)
HB	High Bay Panel on South Wall of High Bay
V+P	Valve and Pump Heater Panel on East Wall of High Bay
VH	Valve Heater Panel in Sodium Service Building.

c) Start heating all lines from a free sodium surface. Turn on heaters progressively. Do not turn on the next heater in the series until the previous line section has reached an indicated temperature of 200°F.

d) Piping heaters are circuited in such a way as to allow the equilibrium temperature of the pipe being heated to level out between 300 and 500°F. Thus the rate of heating may vary for different thicknesses of piping, for pipe full of sodium versus empty pipe, etc.

e) When preheating valves, particularly bellows-sealed valves, it is important that the sodium in the valve be completely fluid before the valve is operated. To insure that this is the case, allow the indicated temperature of the valve to reach 350°F. Turn off the valve heater and wait fifteen minutes. Read the temperature at the end of this time. If the temperature is still above 300°F, it is safe to operate the valve.

f) When all temperatures on the piping and vessels to be filled with sodium indicate between 300 and 500°F, the system is preheated and is ready to be filled.

C. FILLING

The objective of this procedure is to enable the primary- and secondary-sodium systems to be filled with sodium. The steps in the procedure are designed to avoid difficulties such as trapping gas in the system and freezing sodium in small lines.

Filling the systems is accomplished by energizing an EM pump in the drain-and-fill tank. Inert gas is vented, as the system fills, from the reactor in the case of the primary system, and from the expansion tanks in the case of the secondary systems.

Authorization to proceed with the steps in this procedure must come from the Shift Supervisor.

1. Primary Sodium System

The following steps are to be followed in filling the primary-sodium systems:

a) Check to see that all temperatures in main primary and auxiliary primary systems and lines 112 and 113 are between 300 and 500°F and within 60°F of the temperature of the sodium in the primary fill tank.

b) Check to see that there is coolant flow on the main and auxiliary primary pump case and shaft freeze seals, and bearing housing.

c) Check to see that the freeze trap on the auxiliary primary pump discharge line 176 is open for gas removal and that the freeze trap temperature is less than 150°F.

d) Check to see that the freeze trap on main reactor inlet line 103 is open for gas removal and that the freeze trap temperature is below 150°F.

e) Check to see that vent valves 137 and 496 are open so that a common atmosphere exists between the reactor and the primary fill tank.

f) Start the main primary pump and run at minimum speed (100 rpm).

g) Close the following sodium valves: V-113, V-112, V-112S, V-101, and V-616.

h) Open fill valves V-156 and reactor sodium inlet valve V-103.

i) Watch the line temperature readouts on LL4, LL5, and LL7 for indications that sodium has passed into the suction side of the main primary pump. When these temperatures level out at sodium temperatures, sodium has passed into the line. Establish pump case freeze seal by opening the vent pressure control bypass valve (V-521C) and increase the pump speed to 500 rpm. After 5 min, close this valve and pressurize the pump case to 0.5 psig.

j) Start auxiliary primary pump and run at minimum speed (450 rpm).

k) When reactor sodium level reaches 130 in. from the loading face as indicated by the level coil, open the following sodium valves: V-101, V-175, and V-177.

l) Monitor auxiliary primary piping temperatures read out on LL114, LL115, LL116, LL117, and LL119. When these temperatures level out at sodium temperatures, the auxiliary primary pump is primed. Vent pump case to establish freeze seal by opening the vent pressure control bypass valve (V-521-C). Then increase the auxiliary primary pump speed to 500 rpm. After 5 min, close this valve and pressurize the pump case to 0.5 psig.

m) When reactor sodium level reaches 120 in. from the loading face as indicated by the level coil, close sodium fill valve V-156. The main and auxiliary primary systems are now filled.

n) If gas voids or other causes prevent establishing flow in fill line 156, a delta P can be established between the primary fill tank and the reactor to provide an initial driving force to get flow started. Maximum allowable pressure on primary fill tank is 15 psig. This can be accomplished by doing the following prior to step g).

   1) Open vent valve (V-497) and vent reactor and primary fill tank to 0.5 psig.

   2) Close vent valves 137 and 496 to isolate primary fill tank from reactor.

3) Pressurize primary fill tank to 4.0 psig by opening pressure control valve V-401. This valve is controlled from panel in the control room.

4) Continue with steps g), h), and i). NOTE: The primary fill tank pressure will drop due to sodium being displaced from the primary fill tank into the primary lines. This pressure should be monitored closely and maintained at 3.5 ±0.5 psig.

5) When step 9 is completed, open vent valves 137 and 496 to establish a common atmosphere between the primary fill tank and the reactor.

If for any reason, line 156 cannot be used for filling the primary systems, the following alternate procedure may be followed:

a) Check to see that all preheat thermocouples on main primary and auxiliary primary systems and lines 112 and 113 are indicating between 300 and 500°F and that the reactor temperature is at 300°F.

b) Check to see that the freeze trap on line 176 is open for gas removal and that the freeze trap temperature is less than 150°F. This is accomplished by opening helium PC station 446-V305A & B. If helium flow is established, the trap is open. If flow cannot be established, energize heater switch SS-1 and melt the sodium seal. Trap temperature is read out on SS-5.

c) Check to see that the freeze trap on line 103 is open for gas removal and that the freeze trap temperature is less than 150°F. This is accomplished by opening helium PC station 436-V312 A & B. If helium flow is established, the trap is open. If flow cannot be established, energize heater switch SS-12 and melt the sodium seal. This temperature is read out on DH-2

d) Check that there is coolant flow on the main and auxiliary primary pump case and shaft freeze seals.

e) Open the following sodium valves: V-101, V-103, V-113, V-175, V-177.

f) Close reactor drain and fill valve V-112.

g) Check to see that there is coolant flow on the following valve freeze seals: V-101, V-103, V-175, and V-177.

h) Open vent valves V-137 and V-496.

i) Place the panel NN flowmeter switch in the "reactor fill" position and the control room flowmeter in the "fill" position.

j) Start the main and auxiliary primary pumps at minimum speed. (100 and 450 rpm respectively).

k) Start the reactor fill-and-drain pump in the fill direction and set the voltage at 50.

l) Open V-112 and increase fill-pump voltage to 150. Observe flowmeter to see that sodium is flowing. If sodium flow is not established, stop the fill pump and close V-112. Then close V-137 and V-496. Establish a delta P between the reactor and the primary fill tank by pressurizing the fill tank to 4.0 psig and venting the reactor to 0.5 psig. Start the drain pump and open V-112, V-137, and V-496.

m) When the level coil indicates the reactor level is 160 in., open the main and auxiliary primary-pump-case vent valves and allow sodium to enter the pumps. Then open vent valve V-199 for line 176 freeze trap. Continue to vent from line 176 freeze trap until flow is established in both main and auxiliary primary loops.

n) Continue to fill reactor until the level coil indicates reactor level is 126 in. Stop the drain-and-fill pump and close V-112.

o) Observe all freeze-seal temperatures and adjust coolant flows to maintain temperatures below 150°F. Establish helium backup pressure on both the pumps and valves. Pressure is to be maintained at 0.5 psig.

2. <u>Main Secondary-Sodium System</u>

The following procedure is to be used in filling the main secondary system:

Condition 1: Sodium is to be circulated through the Edison Babcock & Wilcox steam generator only.

a) Close the following sodium drain and fill valves: V-166, V-167, V-168, and V-198.

NOTE: Edison personnel must remove clearance tags from V-164, V-165, V-166, and V-168 before these valves are operated.

b) Open the following sodium valves: V-164, V-165, and V-132.

c) Check to see that the Babcock & Wilcox freeze trap is open and that temperature is below 150°F.

d) Check to see that all preheat thermocouples on the B & W boiler and associated piping, plus fill-and-drain lines, are reading greater than 300°F and less than 500°F. The secondary-fill-tank sodium temperature should be 350 ±20°F.

e) Start the main secondary pump at minimum speed (approximately 100 rpm).

f) Establish coolant flow in the main secondary pump case and shaft freeze seals.

g) Place the panel NN flowmeter selector switch in the main secondary fill position.

h) Pressurize the secondary fill tank to 20 psig with helium. It will be necessary to use helium bypass valve V-298C to accomplish this.

i) Open V-131 and start the secondary EM pump in the fill direction. Do not exceed 150 volts on any phase of the pump. Check the panel NN flowmeter to see that sodium is flowing into the system.

j) Open the B & W freeze-trap valve.

k) Closely observe the main secondary-expansion-tank level gauge. When the expansion tank is filled to 50 in. of sodium, close V-131 and stop the EM pump. Vent tank to 3 psig. Close the expansion-tank vent valve.

NOTE: The expansion-tank thimble top is 98 in. above the tank bottom, and the baffle is 33 in. above the tank bottom.

l) Increase the main-secondary-pump speed to 400 rpm. When sodium flow is established, the expansion-tank level will drop due to the filling of voids in the system and the flowrate will show a decrease. Reduce the main-secondary-pump speed to minimum (100 rpm).

m) Repeat steps h), i), and j).

n) Increase main-secondary-pump speed to 400 rpm. If the expansion tank level remains greater than 40 in. and less than 50 in., the system is filled. If the level is less than 40 in., additional sodium must be added to the system to raise the level to at least 40 in. by opening V-131 and energizing the EM pump.

o) Reduce the secondary fill tank pressure to 2 psig.

p) Observe the main-secondary-pump-case and shaft-freeze-seal temperatures and adjust the coolant flows to maintain the temperatures and adjust the coolant flows to maintain the temperatures greater than 80°F and less than 150°F.

q) Close the B & W freeze-trap-vent valve.

Condition 2: Sodium is to be circulated through the steam-generator bypass line (215) only.

To fill the system with sodium:

a) Close the following sodium valves: V-164, V-165, V-166, V-167, V-168, and V-198.

   NOTE: Edison Personnel must place a clearance tag on V-164, V-165, V-166, and V-168.

b) Open the following sodium valves: V-132 and V-215.

c) Check to see that all preheat thermocouples on the main intermediate heat exchanger, the fill-and-drain lines, line and valve 215, and all other lines concerned with the sodium flow path are reading greater than 300°F and less than 500°F. The secondary-fill-tank sodium temperature should be 350 ±20°F.

d) Start and run the main secondary pump at minimum speed (approximately 100 rpm).

e) Establish coolant flow in the main secondary pump case and shaft freeze seals.

f) Place the panel NN flowmeter selector switch in the main secondary fill position.

g) Pressurize the secondary fill tank to approximately 15 ± 5 psig with helium.

h) Open V-131 and start the EM secondary fill-and-drain pump in the fill direction. Do not exceed 150 volts on any phase of the pump. View the panel NN flowmeter to see that sodium is flowing into the system.

i) Open the main-secondary-expansion-tank vent valve sufficiently to maintain approximately 2-psig helium pressure on the system.

j) Open the "Y" freeze trap vent valve on bypass line 215.

k) Closely observe the main-secondary-expansion-tank level gage and the exhaust of gas from the freeze trap on line 215.

l) When line 215 freeze trap no longer passes vent gas, signifying sodium has filled the trap and frozen off, close the trap vent valve.

m) When the expansion tank is filled to 50 in. of sodium, quickly close V-131 and stop the EM fill-and-drain pump. Close the expansion-tank vent valve.

NOTE: The expansion tank thimble top is 98 in. above the tank bottom, and the baffle is 33 in. above the tank bottom.

n) Increase the main-secondary-pump speed to 400 rpm. When sodium flow is established, the expansion tank level will drop due to the filling of voids in the system, and the flowrate will decrease.

o) Repeat steps h), i), k), and m) if necessary.

p) Increase main-secondary-pump speed to 400 rpm. If the expansion tank level remains between 40 and 50 in., the systemis filled. If the level is less than 40 in., additional sodium must be added.

q) Bleed the secondary-fill-tank pressure down to 2 psig. Maintain expansion tank pressure at approximately 3 psig.

r) Observe the main-secondary-pump case and shaft-freeze-seal temperatures, and adjust the NaK cooling flowrate so as to maintain these temperatures greater than 80°F and less than 140°F.

3. Auxiliary Secondary-Sodium System

a) Turn NaK coolant on to auxiliary secondary pump case and pump shaft freeze seals according to section IV.

b) Open helium valve (V-339) and establish helium flow through the plugging-meter freeze trap.

c) Close the following sodium drain and fill valves V-166, V-167, V-168, and V-131.

d) Check to see that all preheat thermocouples on the auxiliary air-blast heat-exchanger loop and the fill-and-drain lines are reading greater than 300°F and less than 500°F and that secondary-fill-tank sodium temperature is approximately 350°F.

e) Start the auxiliary secondary pump and run at minimum speed.

f) Pressurize the secondary fill tank to 20 psig with helium.

g) Open the following sodium valves, V-132 and V-186.

h) Place Panel NN flowmeter selector switch to the "Main Secondary Fill" position.

i) Open V-198 and start the secondary EM pump in the fill direction. Do not exceed 150 volts on any phase of the pump. Check panel NN flowmeter for indications of flow.

j) Open the auxiliary-secondary-expansion-tank vent valve sufficiently to maintain approximately 2-psig helium pressure on the system.

k) Closely observe the auxiliary-secondary-expansion-tank level gage. When the auxiliary secondary expansion tank is filled to 8.7 in. of sodium, quickly close valve 198 and stop the EM pump. Close the auxiliary-secondary-expansion-tank vent valve (V-325C).

l) Increase the auxiliary-secondary-pump speed to 400 rpm. When sodium flow is established, the expansion-tank level will drop due to the filling of voids in the system and the flowrate will show a decrease. Reduce the auxiliary-secondary-pump speed to minimum and repeat steps i), j), and k) if necessary.

D. NORMAL OPERATION

The objective of this procedure is to outline the steps necessary to start up and maintain the sodium-heat transfer systems in normal operating condition. It is assumed, for the purpose of this procedure, that all equipment is functioning properly.

1. Main Primary-Sodium System

To operate main primary pump,

a) Close M-G set breaker 4 on panel E in equipment room.

b) In main-primary-pump control cabinet, turn manual rheostat to lower limit.

c) Turn control selector switch in cabinet to "manual."

d) At console, press main primary M-G set start button. Light just above button will come on, indicating that M-G set is running.

e) At console, press main-primary-pump start button. Light just above button will come on, indicating that pump is running.

f) Observe tachometer mounted on console. Pump speed will come up to about 80 rpm.

g) From main-primary-pump control cabinet, increase main-primary-pump speed to 100 rpm, using manual rheostat.

h) From main-primary-pump control cabinet, turn control selector switch to "automatic."

i) Pump is now on automatic control. Speed may be adjusted between 100 rpm and maximum (1350 rpm) by turning pump-speed control switch on console clockwise to increase pump speed and counter-clockwise to decrease pump speed.

To operate moderator coolant eductor,

a) The pumping ability of the eductor depends on the main primary-sodium flowrate.

b) Observe temperature of moderator as recorded on moderator differential temperature recorder in control room.

c) With both V-104 and V-104A wide open, note whether moderator temperature is higher or lower than fuel-channel exit temperature.

d) If moderator temperature is higher than fuel-channel exit temperature, more coolant flow is required. Throttle V-104A (thus increasing flow in line 104), until moderator temperature is equal to fuel-channel exit temperature.

e) If moderator temperature is lower than fuel-channel exit temperature, less coolant flow is required. Throttle V-104 (thus decreasing flow in line 104) until moderator temperature is equal to fuel-channel exit temperature.

f) Further adjustments are to be made by opening V-104 (to reduce moderator temperature) and throttling V-104 (to increase moderator temperature). Opening V-104A with V-104 throttled can result in undesirable reverse flow through the moderator. If necessary, V-104 shall be throttled slightly to allow a range of adjustment in flow.

2. Main Secondary-Sodium System

To operate main secondary pump,

a) Close M-G set breaker 1 on panel D in equipment room.

b) In main-secondary-pump control cabinet, turn manual rheostat to lower limit.

c) Turn control selector switch in cabinet to "manual."

d) At console, press main secondary M-G set start button. Light just above button will come on, indicating that M-G set is running.

e) At console, press main-secondary-pump start button. Light just above button will come on, indicating that pump is running.

f) Observe tachometer mounted on console. Pump speed will come up to about 80 rpm.

g) From main-secondary-pump control cabinet, increase main-secondary-pump speed to 100 rpm, using manual rheostat.

h) From main-secondary-pump control cabinet, turn control selector switch to "automatic."

i) Pump is now on automatic control. Speed may be adjusted between 100 rpm and maximum (1350 rpm) by turning pump-speed control switch on console clockwise to increase pump speed and counterclockwise to decrease pump speed.

To adjust flow in line 427,

a) Observe flow indicator on panel PP. Turn selector switch beneath flow indicator to position 3 (line 427 flow)

b) With main secondary-sodium flow between 900 and 1100 gpm, adjust throttle valve V-427 until flow indicator reads between 1 and 3 mv

c) Flow in line 427 is now adjusted to prevent gas trapping in the main-secondary-pump discharge line.

3. Auxiliary Primary System

To operate auxiliary primary pump,

a) Turn auxiliary-primary-pump rheostat on console to its lower limit (counterclockwise).

b) Press start button for auxiliary primary pump. Light above button will come on, indicating that pump is running.

c) Console rheostat may now be used to adjust auxiliary-primary-pump speed; clockwise to increase speed, counterclockwise to decrease speed.

d) To throttle flow in auxiliary primary loop, use V-177.

4. Auxiliary Secondary System

To operate auxiliary secondary pump,

a) Turn auxiliary-secondary-pump rheostat on console to its lower limit (counterclockwise).

b) Press start button for auxiliary secondary pump. Light above button will come on, indicating that pump is running.

c) Console rheostat may now be used to adjust auxiliary secondary pump speed; clockwise to increase speed, counterclockwise to decrease speed.

d) To throttle flow in auxiliary secondary loop, use V-186.

To operate auxiliary airblast heat exchanger,

a) Place "auto-manual" switch for auxiliary airblast fan on console in "manual" position.

b) Press start button for auxiliary airblast fan. Light will come on, indicating that fan is running.

c) Adjust fan speed by turning "raise-lower" switch on console. Turn switch clockwise to raise fan speed; counterclockwise to lower fan speed.

d) Open lower louvers on auxiliary airblast heat exchanger.

e) Adjust heat removal rate by opening upper main and vernier louvers to maintain auxiliary secondary cold-leg temperature between 400 and 500°F.

f) If desired, fan speed may be controlled automatically as follows:

1) Adjust set point on Wheelco controller (panel DD) to be at desired temperature between 400 and 500°F.

2) Using "raise-lower" switch, set fan speed at the middle of its range (500 rpm).

3) Manually adjust louvers on auxiliary airblast heat exchanger until cold-leg temperature matches (± 10°F) set point on Wheelco controller.

4) Turn manual-automatic switch for auxiliary airblast fan to "automatic" position.

5) Fan is now on automatic control and will increase and decrease in speed to maintain cold-leg temperature at the desired value.

E. DRAINING

Draining of the sodium systems is accomplished by energizing an EM pump and pressurizing the system to be drained. Sodium flows through a drain line to one of two sodium drain-and-fill tanks. As sodium fills the tank, inert gas is vented to the radioactive vent system or to atmosphere depending on whether the sodium is primary or secondary sodium.

The objective of this procedure is to permit the sodium systems to be drained to the fill tanks in a manner which permits easy maintenance on the systems by preventing holdup of sodium. The Shift Supervisor must authorize proceeding with the following steps:

1. Primary-Sodium Systems

Condition No. 1 - The reactor sodium level is to be reduced to the top of the moderator cans.

To drain:

a) The core loading must be reduced to dry critical (15 elements). NOTE: A thimble must be provided for the portable level probe. This will be inserted in the reactor when fuel is being removed.

b) Observe the preheat thermocouples on the drain-and-fill lines 112 and 113 and the drain line strainer lines to see that the temperatures are all above 300°F.

c) Check that primary fill-tank temperature is being 350 and 400°F.

d) Place panel NN flowmeter selector switch in the reactor drain position. Place the control-room flowmeter selector switch in the drain position.

e) Check open-vent-valves V-137 and V-496.

f) Connect the portable level probe to the amplifier and energize the amplifier.

NOTE: The probe is sensitive to long time at temperature and must not remain in the thimble when not in use.

g) Reduce main primary and auxiliary primary pumps to minimum speed (100 and 450 rpm respectively).

h) Check that reactor temperature is within 60°F of the primary fill-tank temperature.

i) Start the reactor fill-and-drain pump in the drain direction. Set the voltage to 50.

j) Open V-112 and increase the drain-pump voltage to 150. Observe the flowmeter to see that sodium is flowing. Continue to drain sodium until the reactor level is 178 in. as indicated on the portable level probe.

1) When the main and auxiliary primary pumps lose suction, stop the pumps.

2) If sodium flow cannot be established in the drain line, stop the drain pump and close V-112. Then close V-137 and V-496. Establish a delta P between the reactor and primary fill tank by pressurizing the reactor to 4 psig and venting the fill tank to 0.5 psig. Start the drain pump at 140 volts, and open V-112, V-137, and V-496. Maximum allowable pump voltage is 150.

k) Close V-112, reduce the pump voltage to zero, and stop the pump.

Condition No. 2 - The main primary and auxiliary primary systems and the reactor are to be drained completely.

To drain:

a) The core loading must be reduced to less than a dry critical load (15 elements). The SRE Group Leader must approve the loading.

b) Observe the preheat thermocouples on fill-and-drain lines 112 and 113 and the reactor strainer lines to see that the temperatures are all above 300°F.

c) Check that the primary fill-tank temperature is between 350 and 400°F.

d) Check open vent valves V-137 and V-496.

e) Open the following sodium valves: V-101, V-103, V-113, V-157, V-175, and V-177.

f) Place the panel NN flowmeter selector switch in the "reactor drain" position. Place the control room flowmeter switch in the drain position.

g) Check that the reactor temperature is within 60°F of the primary fill-tank temperature.

h) Start the reactor fill-and-drain pump in the drain direction and set the voltage at 50.

i) Open sodium drain-and-fill valve V-112 and increase the drain pump voltage to 150. Check the sodium flowmeter on panel NN to see that flow is established. Continue to drain sodium from the reactor until the drain pump loses suction; then reduce the pump voltage to zero and stop the pump. Close V-112.

   1) When the main primary and the auxiliary primary pumps lose suction, stop the pumps.

   2) If sodium flow in the drain line is not established, stop the drain pump and close valve 112. Vent primary fill-tank pressure to 0.5 psig by cracking open V-497. (Close 497 completely when 0.5 psig is attained.) Close valves 496 and 137 and pressurize the reactor to 4.0 psig with helium solenoid valve SV-400. This should provide enough moving force to start drain-line sodium flow. This step of the procedure should also be followed when the reactor is to be completely drained.

j) To completely drain all auxiliary primary piping,

   1) Close V-177.

   2) Admit helium to the system through auxiliary-pump discharge-sodium-line-176 freeze trap by opening helium PC-446, V-305A and B. Energize heater switch SS-1 to melt the sodium in the freeze trap. Purge until the helium pressure will immediately fall off when V-305A is closed.

3) Close auxiliary reactor outlet valve V-175 and open auxiliary reactor inlet valve V-177. Purge until the helium pressure will immediately fall off when V-305A is closed.

4) Close V-177, V-305A, and V-305B.

k) When the reactor and primary-sodium systems have been drained to the desired level, stop the drain pump and close valve 112. When it is desired to drain the reactor completely, the flowmeter at the control board in the sodium service building should be monitored closely during the final stages of draining. A sudden increase in the indicated flow means that the reactor drain line is drawing helium from the lower core-tank plenum. If this indication is not received, the loss of flow can be attributed to reasons other than complete drainage.

2. Main Secondary-Sodium System

The B & W steam generator is to be drained to the secondary fill tank.

a) Energize heaters on the fill-and-drain line. Check that the secondary fill-tank temperature is between 350 and 400°F.

b) Shut off the helium supply to the secondary fill tank (V-298B).

c) Vent secondary fill tank to atmosphere by opening vent valve (V-299F).

d) Open the following valves:

1) Main secondary drain valve (V-131)

2) Secondary fill tank inlet (V-132)

3) Steam-generator drain lines (V-168, V-166, and V-170)

4) Vent valve (V-169).

e) Melt sodium in freeze traps V and S and supply helium through the traps at 5 psig through helium valves V-403B and V-428B.

f) Pressurize main secondary expansion tank to 5 psig through helium valve V-311.

g) Start secondary fill and drain EM pump in drain direction with panel NN flowmeter switch in "secondary drain" position. Do not exceed 150 volts on any phase.

h) Monitor flow on panel NN flowmeter and stop EM pump immediately when an increase in flow followed by zero flow is noted. This indicates that drainage is complete.

i) Close drain valve (V-131).

j) Close vent valve (V-299F).

3. <u>Auxiliary Secondary System</u>

a) Energize heaters secondary fill-and-drain lines. Check that secondary fill-tank temperature is between 350 and 400°F.

b) Shut off the helium supply to the secondary fill tank (V-298B).

c) Vent the secondary fill tank to atmosphere by opening valve (V-299F).

d) When the tank and lines are up to 350°F, open the following valves:

1) Auxiliary secondary drain valve (V-198)

2) Secondary fill-tank inlet (V-132).

e) Melt sodium in freeze trap K and supply helium to the trap at 5 psig through helium valve V-339. Pressurize auxiliary expansion tank to 5 psig through helium valve V-322.

f) Start secondary fill-and-drain EM pump in drain direction with Panel NN sodium flowmeter in drain position. NOTE: Do not exceed 150 volts <u>on any phase</u> of the EM pump.

g) Monitor flow on panel NN flowmeter and stop EM pump immediately when zero flow indication is noted on the Panel NN flowmeter.

h) Close drain valve (V-198).

i) Close vent valve (V-299F).

III. SODIUM SERVICE SYSTEMS

June 27, 1960

A. PURGING

Purging of the sodium service system consists of displacing the atmosphere in the lines and vessels to the vent system with helium. The following procedure will be initiated upon approval of the Shift Supervisor.

1. Cold Traps

In order effectively to purge the cold trap and its inlet-outlet lines, gas is admitted at the cold-trap freeze trap and the main primary system at the reactor. This gas is vented through the flush and drain tanks to the primary fill tank and from there to the vent system. This involves isolating the cover gas atmosphere of the primary fill tank and reactor.

To purge the cold trap:

a) Isolate the primary fill tank and reactor by closing V-496 and V-137.

b) Check that the following sodium valves are open: V-101, V-103, V-616, V-609, V-610, V-618, and V-619.

c) Check that the following sodium valves are closed: V-634, V-635, V-617, and V-620.

d) Open bypass valve V-295C, valve V-295D, and valve V-296. Check that valve V-561 to the vent system is closed. This introduces helium to the cold trap.

e) Introduce helium to the primary system by energizing SV-400.

f) Vent system to decay tanks by opening V-497C.

g) Check oxygen content with Beckman Oxygen Analyzer at V-554B to verify that O_2 content is below 0.25%.

2. Hot Trap

In purging the hot traps it is possible to admit helium through the freeze trap on hot trap A and vent through the freeze trap on hot trap B, or vice versa.

a) Check that the following sodium valves are closed, V-636, V-637, V-616, and V-609.

b) Check that the following sodium valves are open: V-634, V-635.

c) Close helium valve V-425 and vent valve V-562.

d) Open helium valves V-295C, V-295D, and V-424. Open vent valve V-563. Observe flowmeter in line 424.

e) Check oxygen content at the "t" connection provided at the pressure gauge. The Beckman Oxygen Analyzer should be used and the O_2 content should be below 0.25%.

B. COLD TRAPS

The objective of this procedure is to allow the system cold traps to be operated in a manner which will rapidly reduce the oxygen content of the sodium to below 10 ppm. The Shift Supervisor must authorize proceeding with the steps in this procedure.

Operation of the cold traps is accomplished by circulating sodium through the trap while cooling the cold trap jacket. As the sodium is cooled below the plugging temperature in the trap, sodium oxide particles are deposited in the steel mesh in the trap. Sodium flow and cooling rate are adjusted to maintain the internal temperature of the trap between 250°F and the plugging temperature of the sodium.

The temperature limitation on the cold traps is 700°F maximum. The primary cold trap is on the hot leg of the primary circuit, and, therefore, the use of the cold trap is restricted to reactor outlet temperature below 700°F. The oxide concentration of the primary system must be less than 20 ppm as measured with a plugging meter (see section III-D) before increasing the reactor temperature above 700°F. If additional cold trapping is required, it will be performed during periods with the reactor outlet temperature below 700°F.

The secondary cold trap is on the cold leg of the secondary system, and, therefore, the cold trap may be operated at any time without exceeding the 700°F temperature limitation, if the oxide concentration requires it.

1. Cold Trap Start-Up

The cold trap operational procedure will be described for the primary cold trap first and the secondary cold trap second.

a. Primary Cold Trap

1) Energize, from panels in the sodium-service building, all required heaters on the cold trap, associated piping, and valves. Close damper valve on cold-trap gas cooler. Limit rate of temperature rise to 60°F/hr.

2) Energize the cold-trap freeze trap heater. When the freeze trap temperature reaches 200°F (NN38, 39, and 40), crack the helium

inlet valve (V-296) and observe the helium flowmeter on line 296 for flow. When flow starts, the freeze trap is open and the supply valve should be closed. Shut off the freeze trap heaters.

3) Check the following sodium valves to see that they are closed:

   a) V-620, to primary fill tank.

   b) V-619, inlet to flush and drain tank.

   c) V-608, outlet from flush and drain tank.

   d) V-609A, drain.

   e) V-610, inlet to cold trap.

   Check to see that V-618, the outlet from the cold trap, is open.

4) With valves V-616 and V-617 open and V-610 cracked open, it should be possible to obtain circulation in the cold trap. The freeze trap vent (V-142) should be opened. Check the freeze trap temperature to see that it is 200°F or less before filling.

5) As evidence of sodium flow in cold trap is indicated by uniform pipe temperatures and indication on panel NN sodium flowmeter, the freeze trap vent should be closed.

6) Slowly open the cold-trap inlet valve (V-610) until a flow of approximately 10 gpm is achieved.

7) Shut off all equipment and piping heaters except for heaters on the trap inlet and outlet lines. The reason for this is to avoid oxide plugging in the cold-trap lines.

8) Check that the kerosene inlet valve (V-663) to the atmosphere cooler is opened and the kerosene outlet valve (V-664) is closed.

9) Energize the 10-hp blower. Slowly open the damper valve while monitoring the trap internal temperature, NN149. Do not let this temperature fall below 250°F. Also, watch the gallery atmosphere temperature WW121. As WW121 reaches 140°F, open the kerosene cooler valve (V-663) slightly and observe the rate of temperature change. The vault atmosphere temperature WW121 shall not be allowed to exceed 150°F.

10) The flowrate of sodium to the cold trap shall be watched carefully for a decrease in flow, indicating possible oxide plugging. Should a plug start to form, the sodium flowrate should be increased by opening the inlet valve (V-610).

11) Continue cold trap operation until the sodium internal temperature has been at 250°F for five hours, or until the results of the plugging run indicate 10 ppm oxygen (see section III-D).

b. Secondary Cold Trap

1) Energize all required heaters on the cold trap, associated piping, and valves. Switches for these heaters are located on panel PP in the secondary area. Close the damper valve controlling gas cooling of the cold trap. Limit rate of temperature rise to 60°F/hr.

2) Energize the cold trap freeze trap heater. When the freeze trap temperature reaches 200°F (10, 11, and 32), open helium inlet valves V-307C and V-310 (close V-311) and observe the helium flowmeter on line 310 for flow. When flow starts, the freeze trap is open and the supply valve shall be closed. Shut off the freeze trap heaters.

3) Check the following valves to see that they are closed:

a) V-127, inlet valve to plugging meter economizer.

b) V-126.

c) V-130, outlet from plugging meter economizer.

d) V-124, inlet to cold trap.

4) Check that outlet from cold trap V-125 is open.

5) Crack open V-124, inlet to cold trap. Also open the freeze trap vent (V-309C). Check the freeze trap temperature to see that it is 150°F or less before filling.

6) As evidence of sodium flow in cold trap loop is indicated by pipe temperatures evening out to sodium temperature and indication on sodium flowmeter in line 124 (Panel PP), the freeze trap vent valve shall be closed.

7) Slowly open the cold-trap inlet valve (V-124) until a flow of approximately 10 gpm is achieved.

8) Shut off all equipment and piping heaters except for the heaters on the trap inlet and outlet lines. The reason for this is to avoid oxide plugging in the cold-trap lines.

9) Close the damper valve downstream of the 7-1/2-hp blower and then energize the blower. Slowly open the damper valve while monitoring the sodium internal temperature PP86. Do not let this temperature fall below 250°F.

10) The flowrate of sodium to the cold trap should be watched carefully for a decrease in flow indicating possible oxide plugging. Should a plug start to form, the sodium flow shall be increased by opening the inlet valve (V-124).

11) Continue cold-trap operation until the sodium internal temperature has been at 250°F for five hours, or until the results of the plugging run indicate 10 ppm oxygen (see section III-D).

c. Cold-Trap Shutdown

Both the primary and secondary cold traps may be shut down in two different ways, depending on whether the system is to be drained or not.

d. Primary Cold Trap - System Not to be Drained

1) Close cold-trap sodium inlet valve (V-610).

2) Continue running blower until cold trap internal temperature is less than 200°F (readout NN149). Then shut down blower.

3) Leave the cold-trap sodium outlet valve (V-618) open.

4) Close kerosene-cooler inlet valve (V-663).

The primary cold trap is now shut down.

e. Primary Cold Trap - System to be Drained

1) Close cold-trap sodium inlet valve (V-610).

2) From heater panel in sodium-service building, energize cold-trap heaters and line heaters. Maintain cold-trap temperature between 350 and 400°F.

3) After piping system has been drained, energize cold-trap freeze trap heater from freeze-trap push button station on north wall of high bay.

4) Supply 5 psig helium pressure to freeze trap by opening helium supply valve V-296. Read pressure on pressure gauge PI435.

5) Open cold-trap sodium inlet valve (V-610).

6) Sodium will now drain from the trap. When it no longer becomes possible to maintain a 5 psig pressure on the trap, the trap has been completely drained.

7) De-energize heaters on the cold trap.

8) Close kerosene cooler inlet valve (V-663).

The primary cold trap is now shut down.

f. <u>Secondary Cold Trap - System Not to be Drained</u>

1) Close cold-trap sodium inlet valve (V-124).

2) Continue running blower until cold-trap internal temperature is less than 200°F (readout PP86). Then shut down blower.

3) Leave the cold-trap sodium outlet valve (V-125) open.

The secondary cold trap is now shut down.

g. <u>Secondary Cold Trap - System to be Drained</u>

1) Close cold-trap sodium inlet valve (V-124).

2) From Panel PP, energize cold-trap heaters and associated line heaters. Maintain cold-trap temperature between 350 and 400°F.

3) After piping system has been drained, energize cold-trap freeze-trap heater from freeze-trap push-button station near northeast corner of reactor building.

4) Supply 5 psig helium pressure to freeze trap by opening helium supply valve V-310. Read pressure on pressure gauge PI453.

5) Open cold-trap sodium inlet valve (V-124).

6) Sodium will now drain from the trap. When it no longer becomes possible to maintain a 5 psig pressure on the trap, the trap has been completely drained.

7) De-energize (from Panel PP) heaters on the cold trap.

The secondary cold trap is now shut down.

C. HOT TRAPS

The purpose of the hot traps is to remove carbon from the primary-sodium coolant. This removal is due to the "gettering" action of the stainless steel formed into coils of alternate flat and corrugated strip in the hot trap. In normal operations, the hot trap will be valved into the main primary coolant loop across the main primary pump, and approximately 10,000 lb/hr of sodium will flow through the hot trap at a sodium outlet temperature of 1300°F.

The hot traps will be operated one at a time only. During normal operation, the hot trap will be used only when necessary. If necessary, one hot trap can be operated continuously. The traps will be operated for a specified period of time and then shut down for inspection of samples in the dome of the vessel. If the specimens are 90% saturated with carbon, the trap will be replaced. This inspection is to be made only when authorized by the SRE Group Leader.

The objective of this procedure is to outline the steps required to purge, fill, and operate the SRE hot traps. Operation of the traps will maintain the carbon content of the system low enough to prevent carburization of reactor components.

The Shift Supervisor must authorize performance of the following procedure:

1. Filling the Hot Traps

From Panel in Sodium Service Building

a) Energize heaters on all affected vessels, valves, and lines. Control to maintain loop within 60°F of reactor outlet temperature. This is to reduce the effects of thermal transients on the system.

b) The following sodium lines are to be heated: 632, 616, 633, 634, 635, 636, 637, 638, 617; the following valves: V616, V609A, V608A, V634, V635, V636, V637, V610, V617, V644, V630; V618, V619, and the following vessels: hot trap economizer and trap "A" or trap "B", depending on which trap is to be used.

c) Also, the hot-trap freeze trap heaters must be energized to determine whether the freeze trap is free of obstructions. This is to be done by introducing helium and noting the rate of pressure decrease in the freeze-trap vent lines. If the pressure drops from 10 psig to 1 psig in less than 10 seconds, the trap is free.

d) Energize the heaters on vent line 639 and the freeze trap, if trap "A" is to be used, and on line 640 and the freeze trap, if trap "B" is to be used. Close the following valves:

1) V621, vent from primary fill tank and flush-and-drain tank,

2) V623, from primary cold-trap freeze trap,

3) V529, line to vent system,

and open the helium valve to the hot trap that is to be used — V543 for trap "A" and V542 for trap "B".

e) Open helium inlet valve V295A and, at the pressure control station, observe the change in pressure on the gauge PI435. It may be necessary to block off momentarily the pressure regulator, PC434, by closing V295B and cracking open V295C to maintain a reasonably high pressure (5 to 10 psi) on the freeze trap.

f) When the freeze trap is free of any obstruction, close the helium inlet valve (V295A) and shut off the freeze trap heaters (also the lines leading to the freeze traps, line 639 and line 640).

When their temperatures have reached 350°F, the following valves shall be closed:

1) Inlet valve on hot trap not to be used; trap "A" (V634), trap "B" (V635).

2) Sodium valves V609 and V609A.

3) Cold-trap sodium inlet valve (V610).

4) Flush-and-drain tank inlet and outlet (V619 and V608).

5) Primary fill-tank inlet (V620).

6) Plugging-meter economizer outlet (V644).

g) Open the following valves in the order listed:

1) Main primary loop hot-trap inlet and outlet valves (V616 and V617).

2) Selected hot-trap inlet and outlet valves cracked open.

h) Vent selected trap by opening vent valve (V542 or V543). When the freeze-trap inlet temperature increases, indicating that sodium is in the trap, close the vent valve.

i) Operate the main primary pump at low speed to remove any trapped gas from the hot-trap loop. Check for sodium flow in line 617 indicated on panel NN in sodium-service building.

j) Set hot-trap temperature controller (Wheelco) at 1300°C.

k) The hot trap is now in operation.

2. Hot-Trap Shutdown

a. Piping Not to be Drained of Sodium

1) Set hot-trap temperature controller at 350°F.

2) Close hot-trap sodium inlet valve (V634 for hot trap "A" and V635 for hot trap "B").

Hot trap is now on standby.

3) Turn off hot-trap furnace. Breakers are in sodium service building, panel F.

Hot trap is now shut down.

b. Piping to be Drained of Sodium

1) Set hot-trap temperature controller at 350°F.

2) When piping system has been drained, apply 5 psig helium to hot-trap freeze trap (V424 for hot trap "A" and V425 for hot trap "B").

3) Energize freeze trap heater (switch Nas-79; push button "W" for hot trap "A" and switch Nas-79; push button "X" for hot trap "B".

4) Sodium will now drain from hot trap. Complete drainage will be evident when it is no longer possible to maintain 5 psig on the trap.

5) Shut off helium valves designated in Step 2.

6) De-energize freeze trap heaters designated in Step 3.

Hot trap is now shut down and drained.

D. PLUGGING METERS

Purpose of the plugging meters is to determine the oxide content in the sodium systems. The meters function on the principle of the reduction of the solubility of sodium oxide in sodium as the temperature is reduced. Sodium leaves the main system, flows through the economizer, the gas cooler, the plugging meter valve, back through the economizer, and out into the system. By controlling the cooling rate of the sodium, a temperature is reached at which the sodium oxide begins to precipitate on the surface of the slots cut into the periphery of the plugging meter valve disc, causing a reduction of flow. By observing flow and plugging meter temperature the temperature at which flow drops off can be determined. This is called the plugging temperature. By reference to a solubility curve for sodium oxide in sodium as a function of temperature, the oxide content of the sodium can be approximated.

There are three plugging meter systems installed in the SRE sodium systems; they are located in the primary, main secondary, and auxiliary secondary systems, respectively.

1. Normal Operation, Primary System

The operational sequence will be described for the primary system. Three possible plugging meter operational situations exist:

(a) A plugging run with both cold-trap and hot-trap shutdown.

(b) A plugging run during operation of the cold trap to determine oxide content of the main sodium system.

(c) A plugging run during operation of the hot trap to determine oxide content of the main sodium system.

2. Operation with Both Cold Trap and Hot Trap Shutdown

The plugging meter loop will be maintained with 9.5-gpm flow at all times, when the loop is not being used for a plugging determination.

Prior to making a plugging run, the following conditions must exist.

a) Inlet valve V-616 from main-primary system, open.

b) Inlet valves to hot traps closed: V-634, hot trap A: V-635, hot trap B.

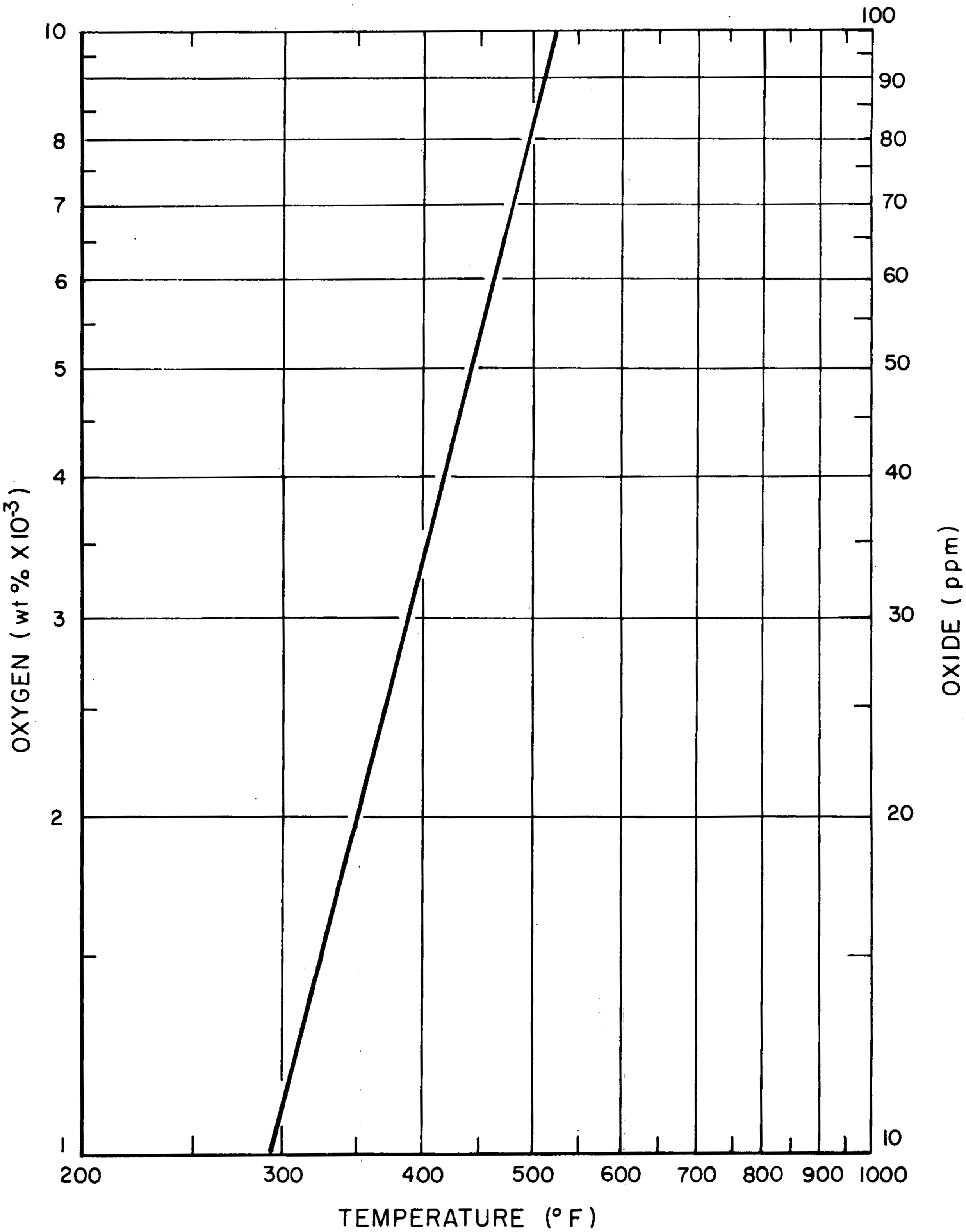


Figure III-D-1. Solubility of Oxygen

c) Inlet valve to cold trap (V-610) closed.

d) V-609 and V-617 closed.

e) Drain valve V-608 from flush-and-drain tank closed.

f) Inlet valve V-619 to flush-and-drain tank closed.

g) Fill line V-620 to primary fill tank closed.

h) Throttle valve V-644 downstream of plugging-meter assembly throttled to give 9.5-gpm through the loop.

i) Plugging-meter valve (V- 643) open (three quarters turn only) to minimize wear on the valve bellows.

j) Plugging-meter blower off and damper valve closed.

k) All plugging-meter-loop electrical heaters off.

To prepare for plugging run, proceed as follows:

a) Plug the portable plugging-meter instrument panel into Panel NN. The portable panel contains a two-pen recorder for flow and temperature indication.

b) Energize the plugging-meter heaters controlled from Panel NN, until plugging-meter-loop temperature is above bulk temperature.

c) Close the plugging meter valve V-643.

d) Regulate downstream throttle valve V-644 to obtain 1-gpm (75° on recorder scale) flow through the plugging meter. Allow to flow for at least 5 min to assure steady flow.

e) De-energize plugging-meter heaters.

The plugging meter loop is now ready for a plugging run. Proceed as follows:

a) Start plugging-meter-cooler blower.

b) Adjust damper valve so that the temperature rate of change is 5°F/min.

c) At the plugging temperature the flow will begin to drop off. Continue the plugging run until the flow has decreased to one-half of its initial value. The temperature at which the flow initially decreases will correspond to the plugging temperature, which can be read from the temperature trace on the recording. Reference to the sodium-oxide-solubility curve will give an indication of the oxide concentration.

In order to prevent further plugging:

a) Open throttle valve V-644 to increase flow.

b) Increase electrical heat input.

c) After plugging meter valve reaches 300°F, open plugging valve V-642 until flow reaches 9.5 gpm (less than one turn).

d) This completes the plugging measurement sequence.

Operation for oxide determination of main primary-sodium system may be performed with the cold trap in operation and V-610 and V-609 open. The plugging run is to be performed as outlined above.

Operation for oxide determination of main primary-sodium system may be performed with the hot trap in operation.

Under these conditions, the inlet valve to the hot trap (V-634 -Trap A or V-635 - Trap B) and valve 617 are open. The plugging run is to be performed as outlined above.

3. Normal Operation - Main Secondary System

The operational sequence will be described for the main secondary system.

a. Plugging Meter Operations

Three possible plugging meter operational situations exist:

1) A plugging run with the cold trap shutdown.

2) A plugging run during operation of the cold trap to determine the oxide content of the main secondary-sodium system.

b. Operation with Cold Trap Shutdown

1) The plugging-meter loop will be maintained with a 2-gpm flow at all times, when the loop is not being used for plugging determination (valves V-127 inlet and V-130 outlet open). Prior to making a plugging run, the following conditions must exist.

   a) Bypass valve (V-163) open.

   b) Inlet throttle valve (V-127) regulated to achieve a 2-gpm flow through the plugging meter loop.

   c) Cold trap inlet (V-124) valve closed.

   d) Blower motor off and damper valve closed.

   e) Electrical heaters off.

   f) Plugging valve open one full turn.

c. To Start a Plugging Run

1) Plug the portable meter instrument panel into Panel PP. The portable panel contains a two-pen recorder for flow and temperature indication.

2) Energize the heaters from the PP heater panel.

3) With the bypass valve (V-163) wide open, close the plugging meter valve (V-128).

4) Regulate the inlet throttle valve (V-127) to obtain a 1-gpm flow (200°F an recorder scale) through the plugging meter. It is usually necessary to close the bypass valve (V-163) somewhat to achieve this flow. Allow to flow for at least 5 min to assure steady flow.

5) De-energize heaters on line 128 and 129.

The plugging-meter loop is now ready for a plugging run. Proceed as follows:

1) Energize blower with damper closed.

2) Turn off all plugging-meter-loop heaters

3) Adjust damper so that the temperature rate of change is minus 5°F/min.

4) At the plugging temperature, the flow will begin to drop off. Continue to decrease the temperature until the flow has decreased by 50%.

d. Plugging Prevention

1) Open inlet throttle valve (V-127) to increase flow.

2) Energize electrical heaters on plugging-meter loop.

3) When plugging-meter valve (V-128) temperature reaches 300°F, open valve to obtain a 3-1/2-gpm flow.

Operation for oxide determination of the main secondary-sodium system may be performed with the cold trap in operation; under these conditions, the cold trap inlet and outlet valves V-124 and V-125 are open. The plugging run is to be performed as outlined above.

3. Normal Operation - Auxiliary Secondary System

The operational sequence for the auxiliary secondary system is similar to that for the main secondary system. Since the cold trap for the auxiliary system is of the diffusion type (air cooled), the cold trap is always in operation.

The plugging meter loop will be maintained with a 2-gpm flow at all times, when the loop is not being used for a plugging determination (valves V-190 inlet and V-197 outlet open).

The following conditions must be obtained before beginning a plugging run.

a) Bypass valve V-214 open.

b) Inlet throttle valve V-190 regulated to achieve a 2-gpm flow through the plugging-meter loop.

c) Blower motor off and damper valve closed.

d) Electrical heaters off.

e) Plugging valve open one full turn.

To start a plugging run proceed as follows:

a) Plug the portable plugging-meter instrument panel into panel TT. The portable panel contains a two-pen recorder for flow and temperature indication.

b) Energize the plugging-meter loop heaters from panel TT.

c) With bypass valve V-214 wide open, close plugging-meter valve V-196.

d) Regulate inlet throttle valve V-190 to obtain a 1-gpm flow through the plugging meter. It may be necessary to close bypass valve V-214 somewhat to achieve this flow. Allow to flow for 5 min to assure steady flow.

e) De-energize the plugging-meter-loop heaters.

The plugging meter loop is now ready for a plugging run. Proceed as follows:

a) Energize blower with damper closed.

b) Adjust damper so that temperature rate of change is minus 5°F/min.

c) At the plugging temperature the flow will begin to drop off. Continue to decrease the temperature until the flow has decreased by 50%.

In order to prevent further plugging:

a) Open inlet throttle valve V-190 to increase flow.

b) Energize electrical heaters on plugging-meter loop.

c) When plugging-meter valve temperature reaches 300°F, open valve to obtain a 3.5-gpm flow.

E. DRUM UNLOADING

The objective of this procedure is to outline the steps required to transfer sodium from the drums in which it is received to the two sodium fill tanks.

The drums are transferred, by means of an overhead hoist, to a mounting cradle at each of the two melt stations where the sodium is melted by electric wrap-around heaters. The sodium then flows by gravity through preheated pipes to the 80-gal capacity transfer tank and then to the primary or secondary fill tank. The detailed unloading procedure follows:

1) Normal procedure shall be to empty only one drum at a time. The piping is arranged to allow the replacement of an empty drum with a full one, while the drum at the other melt station is being emptied.

2) Energize the trace heaters from heater panel in sodium service building, on the line from the melt stations to the transfer tank, and either the primary or secondary fill tank, as required. Actual emptying of the sodium will not commence until the thermocouples on the dump line indicate all points have reached a temperature of at least 350°F.

3) Place drum in unloading rack and proceed with purging. Drums will be purged as follows:

   a) Open valve in vent line at upper drum connection to the atmosphere (V-304-1F) or (V-304-2F).

   b) Immediately open helium supply line just downstream from union and purge for one minute (V-302) or (V-303).

   c) Close vent-line atmosphere valve and the helium-purge-line valve.

4) Install drum wrap-around heaters and wrap drum with asbestos blanket provided.

5) With valves V-601 and V-602 closed, open helium supply valve (V-304-1 or V-304-2) at upper drum vent connection and energize drum heaters.

6) During drum heating and dumping operations, constant personnel attendance in the area is required.

7) Close helium supply to transfer tank (V-345B) and open tank vent line (V-347). The check valve in the vent line will maintain 0.5 psig pressure in the tank.

8) To drain drum.

   a) When drum, transfer tank, and line temperature indicators have reached 350°F, open valve V-601 or V-602 and drain the drum to the transfer tank.

   b) Energize the liquid-level alarm circuit on the drain line, and transfer tank after starting sodium flow to the transfer tank. This is done by turning on "on-off" switch on panel NN. A green light will come on, indicating power on.

   The alarm will sound and an amber light will come on when the sodium level in the line falls, indicating that the drum is empty. The low-level alarm and an amber light on panel NN will indicate when the transfer tank is empty. Reset the alarms by turning the "reset" knob on panel NN.

9) To dump to primary fill tank

   a) Close melt-station drain valve (V-601 or V-602).

   b) Check that the following valves are closed:

      1) Line to secondary fill tank (V-605).

      2) Inlet and outlet of inactive sodium filter (V-629 or V-628, V-603 or V-603-A).

      3) Primary fill tank to flush and drain tank (V-624).

      4) Primary fill tank inlet to flush and drain tank (V-606).

   c) Check pressure indications on helium-supply line to fill tank. This should be 3 psig. If above 3 psig, open bypass valve (V-497C) in primary fill tank vent line and adjust to 3 psig.

d) Open the following valves in order listed:

1) Inlet to primary fill tank (V-607).

2) Valve in header to primary fill tank (V-604).

3) Valve downstream of filter station (V-603 or V-603A).

e) Close transfer tank vent (V-347).

f) Admit helium to transfer tank by opening helium inlet valve (V-345B). See that helium pressure remains constant at 20 psig. If not, reset pressure controller in inlet helium line.

g) Slowly open inlet line to filter station (V-628 or V-629).

h) Sodium flow shall be checked by the flow indicator downstream of filter. Readout for this flowmeter is on panel NN.

i) Completion of transfer will be indicated by low-level alarm on the transfer tank. Amber light and buzzer on panel NN will come on.

10) Restore transfer tank to condition to receive the next drum of sodium as follows.

a) Close inlet to filter station valve (V-628 or V-629).

b) Close helium supply to transfer tank (V-345B).

c) Open transfer-tank vent valve (V-347). When tank pressure has dropped to 0.5 psig, tank is ready to receive the contents of the next sodium drum. Repeat steps 3 to 8.

11) If it is desired to continue filling the primary fill tank, repeat steps 9 and 10.

12) To fill secondary fill tank:

a) Proceed with steps 3 to 8.

b) When contents of drum are in the transfer tank, proceed as follows:

1) Check that the following valves are closed:

a) Inlet to primary fill tank (V-607).

b) Inlet header to primary fill tank (V-607).

c) Inlet and outlet valves of inactive filter station (V-628 or V-629), (V-603 or V-603A).

d) Close the valves in the helium supply line to the secondary fill tank (V-2981B).

e) Open the secondary fill tank vent valve (V-605).

f) Open the secondary fill tank inlet valve (V-605).

g) Proceed with steps 9 to 10c.

13) If it is desired to continue filling the secondary fill tank, repeat step 8 followed by step 12. Restore secondary fill-tank helium supply to normal operation by closing tank vent-valve (V-299F) and opening helium inlet valve (V-298B) upon completion of sodium dumping.

14) To remove sodium drum:

a) De-energize and remove strip heaters.

b) Close the drum-helium-pressure-supply valve (V-304-1 or V-304-2) and open the vent valve to atmosphere (V-304-1F or V-403-2F). Close when pressure reaches atmospheric.

c) Close drum-outlet valve in special drum fitting.

d) Remove insulation blanket from union in drum-outlet line. Permit this line and union to cool to below 150°F before breaking the union.

e) Remove drum flexible helium connection and install special helium-hose connection.

This hose is to be connected to a helium bottle through a pressure-reducing valve set at 0.5 psig and a relief valve set at 1 psig. This connection will be maintained until the drum reaches room temperature at which the connection will be removed and the drum capped off with standard plug.

15) The sodium drums will be weighed as received and again after the transfer to the fill tanks, and this information will be recorded in the operations log.

IV. SERVICE COOLING SYSTEM

June 27, 1960

A. FILLING

The service cooling system has a liquid capacity of approximately 1100 gal. The flowing medium is kerosene which will be supplied in 55-gal drums. The system will fill by gravity with the exception of the two evaporative coolers and a few high points in the system.

Filling is accomplished by pumping kerosene directly from the drums in which it is shipped to the supply tank. By running the kerosene pumps, gas is swept from the system into the supply tank. Additional kerosene is added until the level has stabilized with the pumps running.

To fill the system, proceed as follows:

1) Connect the two flexible lines between the top-shield cooling circuit and lines 717 and 719.

2) Check all header and tank drain valves closed.

3) Open all header valves and inlet and outlet valves for cooling circuits including the top-shield cooling circuits.

4) Check the vent valve on the top-shield cooling circuit expansion tank closed.

5) Ground the supply drum to the 500-gal supply tank.

6) Pump kerosene from the supply drums to the supply tank using a hand-operated drum pump.

7) Continue filling until gravity flow stops and supply tank is approximately half full.

8) Close the throttle valves V-703 and V-704 on the discharge of both pumps.

9) Start one pump and crack the discharge throttle valve while observing the level in the 500-gal supply tank. If the level drops to bottom of the gauge glass, stop the pump and refill the supply tank to the original level.

10) Continue operation of one pump until level in the supply tank stabilizes with the discharge valve full open.

11) Start the second pump and fully open its discharge throttle valve.

12) With both pumps running, bleed trapped gas from the top shield circuit expansion tank by cracking open the vent valve slowly. When the tank is approximately half full, close the vent valve.

13) Close valves V-761A, V-761B, V-762A, and V-762B in the top-shield circuit jumper lines.

14) Start the top-shield-cooling-circuit pump. If the level in the expansion tank drops to the bottom of the gauge glass, stop the pump and open the valves V-761A and V-761B in the discharge jumper connection and repeat step 12. Close the valves in the jumper line.

15) Repeat step 14, as required, until the level in the expansion tank stabilizes.

16) Operate the two circulating pumps and the top-shield-cooling-circuit pump for approximately 30 min. Then de-energize the pumps.

17) Fill the 500-gal supply tank to 57 in.

18) Fill top-shield-cooling-circuit expansion tank to the fill level (designated on gauge glass).

19) Disconnect jumper lines to top shield cooling circuit. Drain kerosene holdup from the jumper into a can. Plug open ends of jumper lines with quick disconnect plugs.

B. NORMAL OPERATION

1. Balancing

As the various components cooled by the service cooling system are placed in operation, it will be necessary to adjust the flows in the individual circuits in order to obtain the desired heat removal and flow conditions. In most cases the temperature of the serviced component will be used to control the flow. However, in some cases the outlet coolant temperature will be used. The following is a list of the cooling circuits, instrument readouts and control limits.

TABLE IV-B-1

COOLING CIRCUITS, INSTRUMENT READOUTS, AND CONTROL LIMITS

Cooling Circuit	Instrument Read-Out	Control Limits
Nuclear instrument thimbles (north)	Panel K-K Reactor low temp. indicator Pt. 1	Less than 150°F
Nuclear instrument thimbles (south)	Panel K-K reactor low temp. indicator Pt. 3	Less than 150°F
V-101 freeze seal	Panel K-K Pt. 6	Less than 150°F
V-103 freeze seal	Panel K-K Pt. 7	Less than 150°F
V-104freeze seal	Panel K-K Pt. 8	Less than 150°F
V-104A freeze seal	Panel K-K Pt. 16	Less than 150°F
V-175 freeze seal	Panel K-K Pt. 26	Less than 150°F
V-177 freeze seal	Panel K-K Pt. 27	Less than 150°F
Main gallery cooling coils	Panel J-J Pts. 5 & 6	Less than 150°F
Sodium service vault cooling coils	Panel J-J Pt. 8	Less than 150°F
Auxiliary gallery cooling coils	Panel J-J Pt. 7	Less than 150°F

Cooling Circuit	Instrument Read-Out	Control Limits
Primary fill-tank cooling coils	Panel J-J Pt. 9	Less than 150°F
Secondary fill-tank diffusion cold trap	Panel N-N Pt. 56	More than 225°F
Primary cold trap cooler		Control as required
Fuel storage cells		
Row 9-99	Local TI-370	Less than 120°F
Row 8-98	Local TI-369	Less than 120°F
Row 7-97	Local TI-368	Less than 120°F
Row 6-96	Local TI-367	Less than 120°F
Row 5-95	Local TI-366	Less than 120°F
Main core liner ear	Panel E-E Points	Less than 150°F
Auxiliary core liner ear	Panel E-E Points	Less than 150°F
Top-shield cooling system		
20-in. plug	Panel E-E Pts. 48-45, 48-46	Less than 150°F
40-in. plug	Panel E-E Pts. 48-47, 48-48	Less than 150°F
40-in. center plug (2 circuits)	Panel E-E Pts. 48-49, 48-50	Less than 150°F
Ring shield	Panel E-E Pts. 48-51, 48-52	Less than 150°F
140-in. shield (4 circuits)	Panel E-E Pts. 48-41, 48-42, 48-43, 48-44	Less than 150°F
Core cavity liner	Panel E-E Pts. 28, 35, 30, 39, 26	Less than 150°F

2. Kerosene Pumps

a. General

1) Each kerosene pump has sufficient capacity to supply the full flow requirements.

2) The east pump is the main pump and is to be used during normal operation. The west pump is coupled to the emergency gasoline engine and will serve as a standby when the east pump is down for repairs.

3) During normal operation the auto-manual switch (located inside the locally mounted panel for the emergency gasoline engine) for emergency gasoline engine shall be in the auto position.

4) The block valves on each side of the standby pump shall be kept in the open position.

b. Operation of Kerosene Pumps

To place the kerosene pumps in operation perform the following:

1) Check that the blocking valves on each side of both pumps are open (V-701A, V-704A, V-702A, V-703A).

2) On the 480V distribution panel in the equipment room, turn the following breakers to the "on" position.

Kerosene system motors	Panel section C	Breaker 18
East kerosene pump	Panel section H	Breaker 23
West kerosene pump	Panel section	Breaker 22

3) Place the auto-manual switch for the emergency engine in the "auto" position. The gasoline engine will start.

4) On panel J-J in the control room turn the pump selector switch to the east pump "manual" position. The east pump will start, and the green indicating light above and to the left of the selector switch will come on.

5) Push the gasoline engine stop and reset button on panel J-J. The engine will drop to an idle for approximately 1 min and then stop.

6) Check flowmeter BFI-301 on panel J-J to determine that kerosene flow is established.

3. Evaporative Coolers

a. General

1) Both coolers are to be operated in parallel. However, if one cooler fails, the remaining cooler will carry the load.

2) If a water circulating pump fails, an emergency supply of water to the spray nozzles is established automatically through a differential pressure control valve in the main water supply line. A pressure actuated alarm will sound in the control room if one of the pumps fails.

b. Operation of Evaporative Coolers

To place the evaporative coolers in operation, perform the following:

1) Check to see if the valves in the make-up water lines to the cooler reservoir are open.

2) Check water level in both cooler reservoirs. Level should be approximately 1/2 in. below the overflow nozzle.

3) Check that valves V-869, V-870, V-871, V-872 in the cooler inlet and outlet lines are full open.

4) Energize the cooler pumps and fans.

a) On the 480V distribution panel in the equipment room turn the following breakers to the "on" position.

Kerosene system motors (supplies power to individual breakers)	Panel Sec. C	Breaker 18
North cooler pump	Panel Sec. G	Breaker 18
South cooler pump	Panel Sec. G	Breaker 19

North cooler fan	Panel Sec. G	Breaker 21
South cooler fan	Panel Sec. H	Breaker 24

b) On panel J-J in the control room turn the switches for the cooler pumps to the "on" position and the switches for the fans to the "fast" position. The green light above each switch should come on indicating that the fans and pumps are operating.

5) Open the valves on each side of the two differential pressure control valves in the water supply lines to the coolers.

4. Top-Shield Cooling Circuit

a. General

1) The top-shield cooling circuit is to be operated normally as a closed circuit. The flexible jumper lines to the main system shall not be connected during normal operation. The jumper lines may be connected only with the approval of the Operations Supervisor.

2) The level in the expansion tank is to be checked and recorded on the operating data sheet every 2 hours. A change in level of greater than 1/4 in. shall be reported to the Shift Supervisor immediately.

b. Operation of Top-Shield Cooling Circuit

To place the top-shield cooling circuit pump in operation perform the following:

1) On the 480V distribution panel, section F in the control room, turn breaker 9 to the "on" position.

2) Turn the locally mounted disconnect switch to the "on" position.

3) Check the locally mounted flowmeter to determine that flow is established.

C. EMERGENCY OPERATION

1. Power Failure

In the event of a power failure the following will occur:

a) Power will be interrupted to the evaporative cooler fans and pump.

b) Power to the east pump will be interrupted, and the emergency gasoline engine will start. The west pump will pick up the load and continue to circulate kerosene at normal flow.

c) The top-shield-cooling-circuit pump will continue to circulate kerosene.

When a power failure occurs the following corrective action shall be taken:

a) Stop coolant flow to the following components:

1) Primary cold-trap cooler

2) Primary fill-tank cooling coils

3) Secondary diffusion cold trap.

b) Throttle the flow in the remaining circuits and allow the temperature of the components to approach the limits specified in Table IV-B-1.

2. Low Kerosene Flow

a) If the kerosene system flow drops below 300 gpm, an alarm will sound in the control room.

b) The following corrective action shall be initiated upon receipt of a low flow alarm:

1) Check the pump discharge pressure on panel JJ.

a) If the pressure is above 40 psig, the condition should be corrected by switching to the alternate basket on the duplex strainer downstream of the pumps.

b) If the pressure is below 40 psig, start the standby pump. If this does not correct the condition, check for low supply-tank level.

2) If the flow continues to drop, shut down the reactor.

3. Low Kerosene Supply-Tank Level

a) When the supply tank level drops below 36 in. an alarm will sound in the control room.

b) Low kerosene-supply-tank level indicates that there is a leak in the system.

c) The following corrective action will be taken:

1) If the rate of decrease of supply-tank level is large (greater than 1 in./hr), the reactor shall be shut down immediately and every effort made to isolate the leaking section.

2) If the rate of decrease is small (less than 1 in./hr), the leaking section will be determined and isolated.

3) Supply make-up kerosene to the supply tank when level falls below 58 in.

4) If the leaking section is supplying a vital reactor function, the reactor will be shut down and repairs made, if possible, without interruption of the required coolant flow.

4. Top-Shield Cooling Circuit

Low kerosene flow is treated as follows:

a) If the flow in the top-shield cooling-circuit drops below 10 gpm, an alarm in the control room will sound.

b) The following corrective action will be taken:

1) Close valve V-753B.

2) Connect jumper lines 761 and 762.

3) Open valves V-862A, V-862B, V-761A, V-761B.

4) Check the strainer basket on the suction side of the pump for plugging. If the basket is plugged, clean, replace, and return the pump to normal operation.

5. <u>Low Expansion-Tank Level</u>

a) This condition will be indicated by an alarm in the control room.

b) Low expansion-tank level is the result of a leak in the circuit or losses.

c) The following corrective action shall be initiated when the low-level alarm sounds:

1) Visually inspect the piping and equipment for leaks.

2) If no leaks are visible, the leak may be within the top shield. In this case it will be necessary to shut down the reactor and drain the kerosene from the circuit per the draining procedure in section V-D.

3) If the leak is external to the top shield, make the required repair. Supply make-up kerosene as required.

4) If the leak is large and an immediate repair cannot be made, de-energize the top-shield-cooling-circuit pump and shut down the reactor.

D. DRAINING

With the exception of a few isolated portions of the system, draining must be accomplished by purging the kerosene from the piping with compressed air. Purge gas pressure shall not be in excess of 100 psig (system design pressure).

To drain the system proceed as follows:

1) Connect a flexible hose to the supply tank drain connection and drain the tank into portable containers. Introduce nitrogen to the tank through line 352 to displace the kerosene as it drains from the tank.

2) Drain the inlet headers as follows:

   a) Connect purge lines to following locations:

      1) Strainers on the suction side of the two kerosene pumps

      2) End of line 732

      3) End of line 765

      4) End of line 720.

   b) Connect a drain line from flexible jumper line 761 to a portable container.

   c) Close inlet valves to all cooling circuits.

   d) Close V-701A and V-702A in the kerosene pump suction lines.

   e) Introduce compressed air at the connections specified in step a) and purge the kerosene from the inlet headers to the disposable containers.

3) Drain outlet headers as follows:

   a) Connect compressed air lines to the following locations:

      1) V-717

      2) V-733

      3) End of line 716

      4) End of line 721.

b) Close the valves in all of the cooling-circuit outlet lines.

c) Open valves V-869 and V-871 in the inlet and outlet lines to the north evaporative cooler and close V-870 and V-872.

d) Introduce compressed air at the connections specified in step a), with the exception of V-717, and purge the kerosene from the return headers to the kerosene supply tank.

e) Close V-869 and V-871, open V-870 and V-872, and repeat step d).

f) Connect a drain line from the flexible jumper line 762 to a portable container.

g) Introduce compressed air at all the connections specified in step a) and purge remaining kerosene from the headers to portable containers.

4) Drain each cooling circuit individually as follows:

a) Close inlet and outlet valves for the circuit to be drained.

b) Remove plugs from the circuit drain connections, or in the case of the circuits not provided with drain connections, disconnect the inlet and outlet lines as close as possible to the circuit blocking valves. Connect one side of the circuit to a portable container and the other side to a compressed air supply.

c) Purge the kerosene from the circuit.

d) Replace drain plugs or reconnect piping as required.

5) Drain the top-shield cooling system.

a) Connect temporary lines from the drain connections on headers 752 and 753 to portable containers.

b) Connect a compressed-air line to the vent connection on the surge tank.

c) Close V-753B in the inlet line to surge tank and open V-754 in outlet line.

d) Close the inlet valves to the individual cooling circuits.

e) Open drain valve V-752.

f) Introduce compressed air at the surge tank vent connection and purge kerosene from the surge tank and inlet header to the portable container.

g) Close V-752 and open V-753A.

h) Pressurize the surge tank and inlet header with compressed air.

i) Crack open the inlet valve in one of the cooling circuits and purge the kerosene from the circuit through the drain connection in line 753 to the portable container.

j) Repeat step i) for each cooling circuit.

k) Remove the temporary compressed-air lines and drain lines and cap the connections.

6) Drain the kerosene, which accumulated during header draining operations, from the supply tank.

V. HELIUM SYSTEM

Purpose of the helium system is to establish and maintain an inert gas atmosphere for all piping, vessels, and equipment containing sodium. Table V-I is a list of pressure control stations and the components they serve.

TABLE V-I

Station	Pressure Indicator	Normal Pressure (psig)	Service
PC-400	PI-401	3	Fuel-element-cask service, at cask service area; moderator-cask service.
PC-402	PI-403	3	Cleaning cells; new fuel storage cells; service connection in fuel-storage-cell area
PC-410	PI-410	0-1	Main primary block valves
PC-413	PI-413	5-15	Main primary double-wall pipes
PC-417	PI-414 BPIM 465	3	Reactor atmosphere
PC-418	BPIM 465	0.5	Reactor atmosphere
PC-419	PI-420	8-12	Reactor shim rods
PC-421	PI-422	8-12	Reactor safety rods
PC-423	PI-424	3	Service Connection at reactor
PC-425	PI-426	0-1	Auxiliary primary block valves
PC-427	PI-428	5-15	Auxiliary primary double-wall pipe
PC-432	PI-429 BPIM 468	3	Primary fill-tank atmosphere
PC-433	BPIM 468	0.15	Primary fill-tank atmosphere
PC-434	PI-435	10	Primary cold trap; flush-and-drain-tank drain line; sodium line from primary cold trap; sodium flush line to primary cold trap
PC-436	PI-437	10	Main primary line at main intermediate heat exchanger
PC-442	PI-441	0-1	Main primary-sodium pump casing
PC-445	PI-444	0-1	Auxiliary primary-sodium pump casing
PC-446	PI-447	10	Auxiliary primary line at auxiliary intermediate heat exchanger

TABLE V-I (Continued)

Station	Pressure Indicator	Normal Pressure (psig)	Service
PC-448	PI-449	3	Sodium drums; sodium transfer line at melt station
PC-452	PI-453	3	Secondary-sodium fill-tank atmosphere
PC-454	PI-455	0-1	Main secondary-sodium pump casing
PC-457	PI-458	3	Main secondary expansion-tank atmosphere; main secondary cold trap
PC-459	PI-460	0-1	Auxiliary secondary-sodium pump casing
PC-462	PI-463	3	Auxiliary secondary expansion-tank atmosphere; auxiliary secondary plugging-meter piping
PC-469	PI-470	10	Reactor drain line
PC-473	PI-474	0-1	Core-tank cavity atmosphere
PC-475	PI-488	30	Sodium-service transfer tank
PC-489	PI-495		Secondary block valves (at Edison plant)
PC-490	PI-496	10	Steam generator

A. PURGING

Purging of the helium system may be accomplished at the same time the heat-transfer circuits and the sodium-service system are being purged. If purging of the sodium systems is accomplished in more than one step, the helium headers should be purged separately. Purging is accomplished in general by admitting helium at high points in the system and venting from the low points.

To purge entire helium system,

1) Open all stations in one of the two main branch headers consecutively from the start of the header.

2) Open the last station in the header not being purged.

3) Adjust flow to approximately 1.5 scfm using the PC upstream block valve.

4) If the individual station has more than one service line downstream of the PC, opening of the various spurs should be alternated.

5) Crack open the PC bypass valves to purge momentarily this line at each station of the header being purged.

6) After approximately 20 min of purging, close all stations with the exception of the last in the header being purged and proceed with steps 1, 2, 3, 4, and 5 above on the header.

7) After 20 min close all station block valves.

Completeness of a purge may be determined by sampling of the gas at a given service's exhaust sampler. Purge is considered complete when exhaust gas tests less than 0.25% oxygen.

B. NaK BUBBLER

The inlet and outlet valves (V-336A) (V-336B) shall normally be open. The bypass valve (V-336C) shall be kept closed at all times except during initial purge of the helium and heat transfer systems or during maintenance. A check valve is included in the outlet line to prevent reverse gas flow in the event of pressure loss on the helium manifold. To prevent reverse flow in the event of failure of the check valve, the outlet (V-336B) and inlet valve (V-336A) must be closed, in that order, during any service operation upstream of the bubbler unit.

Gloves, flameproof clothing, and a face shield with safety goggles are required during filling, draining, or any maintenance operation on the bubbler units.

C. NORMAL OPERATION OF THE HELIUM SYSTEM

After the helium pressure controllers have been set for the correct pressure (Table V-I), operation of the system is largely automatic.

1) The helium high-pressure manifold system alarm shall be set to trip at 125 psig. Upon receipt of this alarm in the control room, the system shall be manually valved to the standby manifold. The exhausted bottles shall be replaced as soon as possible and this manifold purged and placed in standby service.

2) Normal operating pressure adjustment for the various stations shall be as shown in Table V-I.

3) PC station bypass valves are to be maintained closed at all times. Exceptions are during the purging operation, a period of maintenance on the PC valve or assembly, or when checking relief valve operability.

4) Changes in the following stations are required under the following operating conditions:

   a) PC-417 and PC-418. (Reactor Atmosphere) PC-418 is set for 1/2 psig, and is to be used normally. PC-417 is set for 3 psig and is to be used only when the reactor atmosphere pressure is to be increased above 0.5 psig.

   Should the pressure alarm sound (5 psig), an immediate investigation shall be initiated to ascertain the trouble. Check the helium-supply system for operability and the vent relief system. Close the helium-supply blocking valves (V-292A) (V-292AI) (V-268A) (V-268AI).

   PC-418 should be always kept in service to guard against a negative pressure being established in the reactor.

   b) PC-432 and PC-433. (Primary Fill Tank Atmosphere) PC-433 is set for 1/2 psig and is to be used normally. PC-432 is set for 3 psig and is to be used only when the primary fill-tank atmosphere is to be increased above 0.5 psig.

   Should the pressure alarm sound (5 psig), an immediate investigation shall be initiated to determine the trouble. Check the helium supply system and the vent relief system for operability. Close the helium supply blocking valves V-268A, V-268AI, V-292A, V-292AI.

   PC-433 shall always be kept in service to guard against a negative pressure being established in the primary fill tank.

   c) PC-452. (Secondary Fill Tank) When filling the secondary fill tank with sodium the helium supply shall be cut off by closing the block valve downstream from PC-452 (V-298B) and the normally closed block valve in the vent line (V-299) is manually controlled to maintain a slight positive pressure (2 psig) in the tank as the level rises. Upon initiating heating, the vent block valve shall be closed.

d) PC-457. (Main Secondary Expansion Tank and Cold Trap) During normal operation the supply is set for 3 psig, the relief valve bypass (V-309C) is closed, the block valve ahead of the relief valve (V-309F) is open, and the gas supply to the freeze trap (V-310) is colsed.

   1) During main secondary system filling, close the helium supply valve (V-307A), slightly crack open the PC bypass valve (V-307C), and open relief valve bypass (V-309C).

   2) During secondary system draining, the block valve to the relief valve (V-309F) is closed and the gas pressure raised to force the sodium into the fill tank.

e) PC-462. (Auxiliary Secondary Expansion Tank) During normal operation the supply is set for 3 psig, the relief valve bypass (V-325C) is closed, the block valve ahead of the relief valve (V-325F) is open, and the gas supply to the freeze trap (V-339) is closed.

   1) Upon auxiliary secondary system filling, close the helium supply valve (V-321A), crack open the pressure control bypass valve (V-321C), and open relief valve bypass (V-325C).

   2) During auxiliary secondary system draining the block valve to the relief valve (V-325F) is closed and the gas pressure raised to force the sodium into the fill tank.

f) PC-475. (Sodium Service Transfer Tank) This tank is used only during the transfer of sodium from the 55-gal drums to the primary or secondary fill tanks.

g) PC-489 and PC-490. (Steam Generator and Secondary Block Valves) During normal operation these pressure control stations are supplying backup helium pressure for the freeze traps on the main secondary system and the steam generator and the secondary block valves. Helium is supplied through station PC-490 for purging the steam generator and associated piping prior to filling with sodium.

During normal reactor operation each high-pressure manifold shall be checked once each shift and the pressure recorded on the operations log sheet.

D. SAMPLING

Gas samples from the helium system will be obtained by Health Physics.

Frequency of sampling will depend upon operational conditions. A request for gas samples will be initiated by Operations and be available to the Health Physics representative in sufficient time to allow for the preparation of the necessary apparatus.

The Health Physics group will maintain the necessary apparatus to take gas samples on an emergency basis when so requested.

Samples may be requested from any service connection in the low-pressure system.

Samples will be taken as follows:

1) Connect sample tank to special evacuation apparatus.
2) Evacuate tank to -20 in. of Hg as indicated on sample tank gauge. Repeat twice.
3) Disconnect sample tank from evacuation apparatus after closing sample tank valve.
4) Place sample tank in shielded counter. Take one 3-min count. Record this count (background) in Health Physics log.
5) Connect sample tank to selected sample connection. Wear rubber gloves and full face mask. Make loose connection.
6) Open selected sample valve. Purge helium gas through loose connection for 15 sec. Tighten connection.
7) Open sample tank valve. Pressure will rise.

8) Close valve when pressure reaches 0 psig

9) Close selected sample valve.

10) Remove sample tank.

11) Repeat step 4).

VI. NITROGEN AND DEHUMIDIFICATION SYSTEM

Objective of this procedure is to describe the steps required to maintain a nitrogen atmosphere in the vaults and galleries, to fill the liquid-nitrogen supply tank, and to start up, operate, and shut down the dehumidification system.

Purpose of the nitrogen system is to establish and maintain an atmosphere of nitrogen gas in the following areas:

Main Primary System Gallery
Auxiliary Primary System Gallery
Primary Fill-Tank Vault
Sodium-Service Vault
Insulation Cavity
Kerosene Supply Tank

The gallery dehumidification system circulates the atmosphere of the main and auxiliary galleries and sodium-service vault through separate ducting to common supply and return headers which pass through a cooling unit. The temperature of the atmosphere is lowered approximately 50°F and thus moisture condensation takes place.

Radiation monitors mounted in the return ducts automatically close the keystone valves when the radiation level exceeds 1950 cpm.

A. VAULT AND GALLERY ATMOSPHERE

During periods of reactor operation and when sodium is flowing, a continuous nitrogen purge of the galleries and vaults will be maintained. A sufficient flow of nitrogen will be maintained to hold the oxygen content below 1%.

When the oxygen content in a particular gallery or vault is above 1%, the pressure regulator bypass valve will be opened. This valve will be kept open until the oxygen content is reduced to a value below 1%. The valve can then be closed, and the inlet pressure controller will maintain this level.

Measuring the gallery oxygen content is to be done by using the Beckman oxygen analyzer mounted on the DH panel in the high bay or using the portable

Beckman analyzer. This latter unit utilizes the sample connections that are in the return ducts from the galleries and vault.

B. NORMAL OPERATION OF NITROGEN AND DEHUMIDIFICATION SYSTEM

The nitrogen system has two alarms in the control room. The one (N_2 storage tank, abnormal pressure) given an alarm when the storage tank pressure is below 9 psig and also when the pressure is greater than 26 psig. When it is ascertained that the abnormal pressure alarm is due to low liquid-nitrogen level, then a new supply of LN_2 is required.

1. Filling the Liquid-Nitrogen Tank

With the arrival of a shipment of liquid nitrogen and while the vendor is connecting his supply hose to the liquid-nitrogen storage tank, take the following steps.

a) Close the pressure buildup supply valve (white).

b) Close the outlet valve (V-351) to the low pressure storage tank.

c) Crack open the vent valve (red) and manually check the two relief valves for operation.

d) Open the fill valve (blue) when the vendor is ready to fill the tank.

When the tank is full (capacity 1000 gal) as evidenced by the level indicator and the chart on the tank door, take the following steps:

a) Close fill valve (blue) and bleed the fill line to atmosphere using the manually operated relief valve. Vendor will then disconnect his line and cap the fill line.

b) Close vent valve (red).

c) Open outlet valve (V-351) to the low-pressure storage tank.

d) Crack open the pressure buildup supply valve (white).

After step d) check the air-operated supply valve as it goes through three open-close cycles to check operation of the indicator and controller. The dead band on this valve should not exceed 5 psig. The system is now in operation.

2. Operating Pressure

Normal operating pressure adjustment for the space pressure control stations is 0.25 psig with the exception of the insulation cavity station, which shall be adjusted for 3 psig.

Pressure control station bypass valves are to be maintained closed at all times except during purging operations (section VI-A) and for maintenance on the PC station.

3. To Operate the DH System

a) Open the keystone valves to the main and auxiliary gallery and to the sodium-service vault by turning the rotary switches on the DH panel in the high bay.

b) The "auto-off-manual" switch at the compressor should be on "auto." This switch, if turned to manual, will bypass all the oil safety and pressure control switches built into the compressor. It will be used for major maintenance purposes and should be operated on "manual" only by refrigeration service personnel.

c) Turn on all breakers in the DH system control cabinet at the north-east corner of the SRE.

d) Condensate trap will discharge into collecting drums underneath the dehumidification tank.

4. Oxygen Content

The oxygen content of the vaults and galleries will be measured using the Beckman oxygen analyzer located on panel QQ in the high bay, and will be recorded on the log sheet once each shift. It is also possible to utilize the Beckman portable oxygen analyzer and the sample connections provided in the return ducts from each gallery and vault.

C. NITROGEN AND DEHUMIDIFICATION SYSTEM SHUTDOWN

During periods when the nitrogen system is to be shut down (for maintenance, equipment removal, etc.), take the following steps to put liquid nitrogen supply on standby:

1) Close the pressure buildup supply valve (white).

2) Close the outlet valve (V-351) to the low-pressure storage tank.

3) Crack open the vent valve (red).

4) Close the fill valve (blue).

Liquid-nitrogen supply is now on standby.

To shut down the DH system two possibilities exist:

1) To shut down the system for periods less than a week, stop the supply fan by pushing the stop button under breaker 1 in the DH control cabinet. If there is a high activity in the galleries, all keystone valves should be turned off at DH panel. These are the only switches that should be actuated. During such a shutdown the compressor will cycle intermittently to prevent liquid from collecting in the system.

2) To shut down the system for an indefinite period:

   a) Close the liquid-freon valve on freon receiver tank outlet. The tank is located at the south of the freon condenser and the valve is at the northeast end of the tank.

   b) After the compressor shuts off, turn off supply fan.

   c) Turn off the main transformer switch, breaker 8.

3) To start up the system:

   a) Turn on the main transformer switch, breaker 8.

   b) Turn on supply fan, breaker 1.

   c) Open the liquid-freon valve on freon receiver tank outlet.

   d) System should start. If any components are not operating, check that all breakers in the DH control cabinet are closed.

To enter the Galleries and Vaults

When the shield blocks are removed for access to the galleries, the atmosphere will be exchanged for air using a portable blower. Before entry into the galleries, the oxygen content will be checked using an MSA portable oxygen analyzer.

VII. VENT SYSTEM

Operation of the vent system consists of routing all radioactive gases to the decay tanks by means of compressors. When sampling indicates that the activity of specific vent gases is sufficiently low, the gases may be routed directly to the stack by actuating solenoid valves in the several vent-system headers.

Gas samples taken from the decay tanks determine whether the gas can be vented to the stack and at what flowrate. Upon authorization of the Shift Supervisor, radioactive gases are then vented to the stack at the rate specified by Health Physics. The objective of the following procedures is to specify vent-system valve positions and to designate steps required to sample and dispose of radioactive gases.

A. NORMAL OPERATION

1. Radioactive Services

a. Reactor and Primary Fill-Tank Atmospheres

1) Bypass valves V-497 and V-551 shall be closed normally except during purging of the reactor and fill tank atmospheres. These valves may be opened to relieve excessive reactor and primary fill-tank pressures only with permission of the Shift Supervisor.

2) Freeze-trap vent valve V-523 will remain closed except during primary cold trap venting operation.

3) The sample valve V-497-B immediately upstream of the relief valve assembly is normally closed. Samples can be taken here to determine completeness of helium purges on the core and primary fill tank.

b. Helium Vent from Freeze Traps for Piping Adjacent to the Intermediate Heat Exchanger

1) These valves (V-140 and V-200) are normally closed.

2) They are only to be opened when lines are being filled with sodium, in accordance with Section II-B.

c. Cleaning Cells

The three fuel cleaning cell block valves (V-676-1, V-678-2, and V-676-3) shall be closed unless fuel washing operations are in progress.

d. Fuel-Handling-Machine Service Connections

1) Vent system block valves (V-504-G1 and V-504-G2) are to remain closed unless these service connections are in use.

2) Valve-to-atmosphere (V-518) from the coffin-service area shall be closed normally. Use of this valve requires approval of the Shift Supervisor.

e. Hot-Cell-Vent Service Connections

Vent-service header-block valve V-520 shall be closed unless header is in use. Use of this header requires prior approval of the Shift Supervisor.

2. Normally Nonradioactive Services

Gases from these services will be routed to the suction tank except under special conditions where a gas sample indicates levels low enough to be vented directly to the stack.

a. Operation of Diversion Station

1) Filter station bypass valve V-507B is normally closed. This valve may be opened in conjunction with valve V-507A for specific purging operations or during filter maintenance, with the approval of the Shift Supervisor.

2) Proper operation of radiation indicators will be checked monthly by Health Physics. Results of this check will be forwarded to the SRE Group Leader.

b. Main and Auxiliary Primary Pump Vents

1) The pressure controller bypass valves (V-521C-Main and V-522C-Auxiliary) shall be normally closed except during purging.

2) The pressure controllers shall be set to vent the pump casings at 15 psig.

3) Manual venting is accomplished after closing the helium inlet valve (V-319 main or V-327 auxiliary) by opening the pressure controller bypass valves (V-521-C and V-522-C) and observing the indicated pressure on the pump being vented.

c. Insulation Cavity Vent

1) Blocking valve (V-491A) shall be normally closed.

2) Sampling valve immediately upstream of blocking valve shall be normally closed.

d. Core Tank Cavity Vent

Blocking valve (V-459A) shall be normally closed.

e. Main and Auxiliary Primary Blocking Valves

1) Vent-system blocking valves (V-471A, V-473A, V-453A, V-559A, V-462A, and V-456) are normally closed. Always be sure that these valves are closed after they have been opened for a purging operation, to keep sodium out of the vent system.

2) Sample valves immediately upstream of the blocking valves shall be normally closed.

f. Main and Auxiliary Double-Wall Pipes Vent

1) Blocking valve (V-452A, V-469A, and V-467A) shall be closed normally.

2) Sample valves immediately upstream of blocking valves shall be closed normally.

B. SAMPLING AND DISPOSAL OF GAS

1. Sampling

Vent system gas samples are to be taken, using an evacuated sample chamber with adapter to connect to the various sample connections. Samples will be taken, once a week, from the following locations:

a) Core tank cavity (V-459D)

b) Insulation cavity (V-491D)

c) Auxiliary double-wall pipes (V-452D)

d) Main double-wall pipes (V-467 and V-469D)

e) Decay tanks

1) Decay tank samples will be taken as required to determine the gas decay rates. This information will be used to give a projected activity level and a date and rate for release.

2) A second sample will be taken just prior to release to obtain the exact release rate and activity level.

All gas samples will be taken by the Health Physics Unit, on request of the Reactor Operations Unit. See Section V-D for sampling procedure.

2. Disposal

As each decay tank is filled to 90 psig, an alarm will be sounded in the control room. The inlet valve to an alternate decay tank will then be opened, and the inlet to the decay tank with the high pressure will be closed.

Health Physics will then take a gas sample from the tank with the high pressure and will notify the Shift Supervisor of the recommended rate and date of release. The rate of release is controlled by V-537B, the decay-tank outlet valve. Gas flow is measured on a flowmeter located on the decay tank vault.

A solenoid valve (SV-604) is set to trip and stop the venting, if the stack monitor indicates a level higher than 5×10^{-7} $\mu c/cc$.

The display panel in the control room, showing which tank is being filled and which is being vented, shall always be kept up-to-date.

VIII. LIQUID WASTE SYSTEM

Operation of the lqiuid waste system consists of pumping liquid waste from the sump tank to the radioactive holdup tanks or the 5000-gal waste tanks, trasnferring liquid from one holdup tank to another, and draining liquid from the holdup tanks to the 5000-gal waste tanks.

The objective of this procedure is to outline the steps necessary to perform the above operations.

A. FILLING SUMP TANK

1) Check sump tank level on liquid-level gauge located on wash-cell control board.

2) Drain sump tank (if necessary) by following procedure outlined in section VIII-B.

3) To fill sump tank,

   a) If wash cells are to be drained, open
      V-901 for wash cell "C"
      V-902 for wash cell "B"
      V-903 for wash cell "A".

   b) To drain compression water reservoir, open V989.

   c) Hot-cell floor drains and metallurgical cell floor drains through V-904 into sump tank.

B. DRAINING SUMP TANK

The sump tank is drained by energizing the sump tank pump from the wash-cell control panel. The pump may be stopped manually, or a "low level" float will shut off the pump automatically. Capacity of the sump tank is 150 gal, while the working level is approximately 120 gal.

Discharge from the sump tank is pumped to one of the two liquid-waste storage tanks. Each tank has a capacity of 5000 gal.

To route liquid waste to the waste storage tanks:

1) Check the level in the liquid-waste storage tank selected to determine whether the tank has sufficient capacity to handle the waste.

2) Close the holdup tank vault header drain line valve V-909. Also close the valves leading to the holdup tanks, V-907, V-949, and V-911.

3) Open the liquid-waste storage line valve V-947.

4) Open the valve to the respective waste storage tank, V-910 for tank "B" or V-909B for tank "A," and close the other valve.

5) Energize the sump pump.

If sample analysis indicates long-lived fission products with an activity level of 10^{-2} $\mu c/cm^3$ or greater, prohibiting disposal to the liquid-waste storage tanks, the waste can be routed to the holdup tanks. There are 10 holdup tanks, 80-gal capacity each, divided into two groups, A and B.

To route liquid waste to the holdup tanks,

1) Open the main header valve from the sump tank pump to the respective group of holdup tanks: V-949 for group B or V-907 for group A. Check V-908 and V-908A closed.

2) Check drain valves V-911 and V-947 closed.

3) Check that the vent header pressure-relief bypass valve is open for the portion of the vault containing the receiving vessels: V-538 for group A; V-539 for group B.

4) Check the drain line and sample line valves of the particular holdup tank(s) closed.

5) Open the inlet valve to the first tank making sure the inlet valves to the other tanks are closed.

6) Start and control sump tank pump from the holdup tank station control board.

7) When the holdup tank contains approximately 60 gal, a reading of 3 ft 6 in. on level gauge, stop the pump, close the inlet valve to the tank, and open the inlet valve to the next tank.

8) After the second tank is filled to approximately 60 gal, sump tank will be empty.

After activity in the holdup tanks has decayed to less than 10^{-2} $\mu c/cm^3$, the liquid waste can be drained to the storage tanks by opening the drain valve from the individual tank and V-909A leading to the storage tanks.

C. HOLDUP TANK TRANSFER

The 10 holdup tanks are divided into groups A and B separated by a center shielding wall. Should a line, valve, or vessel require servicing, the waste in the section in question may be transferred to the other, thus allowing better accessibility. Transfer is accomplished by pressurizing the vessel to be emptied, and provisions are installed for flushing the vessel and lines. The Shift Supervisor must authorize proceeding with holdup tank transfer.

D. INTERVAULT TRANSFER

1) Attach the nitrogen supply cylinder to the vent manifold serving the holdup tank to be transferred.

2) Open the three-way valve in the vent manifold to position number two, which opens the manifold to the nitrogen bottle (V-961K or V-962K).

3) Close the vent manifold pressure-relief bypass valve (V-961C or V-962C).

4) Open the following valves:

   a) Drain valve of tank to be emptied.
   b) Fill valve of receiving tank.
   c) Valve connecting the drain line to the fill-line manifold to be used.

5) Check that the following valves are closed:

   a) All holdup tank sample valves.

   b) All drain valves except 4)-a) above.

   c) Vault sump drain valves.

   d) All fill valves except 4)-b) above.

6) Slowly open the nitrogen supply valve at the cylinder and pressurize the manifold. Do not exceed 25 psig. Completion of transfer will be shown by a sudden decrease in vent manifold pressure.

7) Close the nitrogen supply valve.

8) Close the drain valve on the tank emptied, the valve connecting fill-and-drain headers, and the fill valve to the receiving vessel.

9) Open the three-way valve on the pressurized manifold to the normal position (one), thus connecting the vent manifold to the sump tank.

10) Open the vent manifold pressure-relief bypass valve.

11) If a flush of the emptied vessel is required, water may be added from the water-fill connection on the fill manifold and either drained directly to the storage tanks or transferred to the other section as above.

IX. FUEL HANDLING MACHINE

A. PREPARATION

The objective of the following procedure is to ensure that the fuel handling machine is in proper operating condition prior to initiating a fuel transfer, and that other necessary steps have been taken to enable fuel to be transferred in a safe, efficient manner.

1) Calibrate the Baldwin-Lima-Hamilton load cells for both grapples. This need not be done for each transfer, but should be done before every reactor shutdown which involves unloading fuel from the reactor. The procedure follows:

   a) Attach lift ring in the special load testing weight located in a storage cell. This test weight weighs 1095 lb.

   b) Install index ring. Index fuel handling machine by moving machine over index ring and registering by eye to within 1/4 in. Use special mirror to accomplish this.

   c) Turn off crane power.

   d) Lower bellows by activating valve on console. Fuel handling handling machine, if properly indexed, will not shift. Lower the outer shield.

   e) Lower grapple 1 to within 12 in. of full down position as indicated on Veeder counter located on console. (Full down position is indicated when Veeder counter reads zero.)

   f) Adjust zero set on PTL (Pressure-Torque-Load) amplifier as follows: Amplifiers are located on front of console.

      1) Turn on the power switch located in the front of the PTL amplifier. Allow 2 min for warm up.

      2) Set the amplifier selector switch at "operate." With no live load or pressure on either the load cell or the pressure cell, adjust alternately the "zero" and "Phase"

controls on the amplifier front panel until the minimum possible reading is obtained on the meter.

3) If the meter reading now differs significantly from zero, adjust the set-screw on the face of the meter until its pointer is exactly at zero.

g) Lower grapple 1 into position to pick up test weight. Negative load light will come on when grapple rests against lift ring.

h) Actuate grapple fingers by pressing "grapple release" on console. Negative load light should go out.

i) Actuate "grapple down" switch for grapple 1 while simultaneously performing step h). When negative load light comes on, release "grapple release" actuating button. Grapple is now attached to test weight.

j) Raise grapple 1 12 in.

k) Adjust the PTL front panel calibration control until the load cell meter reading is 1095 (equal to the test weight).

l) Turn the amplifier selector switch to the "check" position. Adjust the screwdriver control on the amplifier chassis (next to the vacuum tube) until the meter reading is at the long red line.

m) Return the selector switch to "operate." The system has now been calibrated.

n) Before each fuel transfer, check the system as follows:

   1) Turn the selector switch to "calibrate."

   2) If the meter pointer does not come to the long red line, adjust the calibration control on the front of the amplifier until it does.

   3) Return the selector switch to "operate."

o) Lower grapple 1 until negative load light comes on.

p) Press "grapple release" button.

q) Raise grapple 1 to upper limit.

r) Rotate fuel handling machine inner mechanism to place grapple 2 in lifting position.

s) Repeat steps e) through g) for grapple 2. Both grapple load cells are now calibrated.

2) Check the vent system for proper operation, on panel GG.

a) Check vent system pressure on gauge. Pressure should be between -3 and -5 in. of mercury as read on the gauge.

b) Check that pressure in decay tank in use is less than 70 psig by reading decay tank pressure gauge on panel HH.

3) From panel GG open SV-607 to "tank" position. This will permit the fuel handling machine to be evacuated and purged.

4) Check that high bay exhaust and supply fans are on.

5) Check that high bay doors are closed.

6) Check that two MSA air breathing units are in operating condition and available on the fuel handling machine console.

7) Lay a path of plastic sheeting for the fuel handling machine to follow.

8) Lower sodium flow through reactor to 200 gpm.

9) Check that reactor pressure is 3 psig.

The fuel handling machine is now ready for operation.

B. OPERATION

The object of this procedure is to outline the steps necessary to utilize the fuel handling machine to remove a fuel element from the reactor and replace it with a shield plug. Operation of the fuel handling machine to perform other transfers, such as exchanging fuel elements, exchanging shield plugs, etc., is similar.

Authorization to perform any element transfer is by means of an ETR (Element Transfer Request) form. In order to be valid, the form must be signed by the Operations Supervisor in the space marked "approved by."

As each element is moved with the fuel handling machine, the spaces on the ETR form (see Appendix I) will be filled out by the Shift Supervisor. At the same time, each element transfer is to be accompanied by movement of the tag corresponding to the element on the "Element Inventory Board."

The Shift Supervisor is to check each element transfer against the ETR form. In case of any question regarding the correctness or appropriateness of the element transfer, the Shift Supervisor has the authority to stop such transfer immediately, pending review by the Operations Supervisor and/or higher authority.

To remove a fuel element from the reactor and replace it with a plug:

1) By sighting through periscope window, check that both grapples are empty. Raise both grapples to upper limit. Both upper limit lights will come on.

2) Using "Auxiliary Chamber Hoist," pump down storage cell containing shield plug to 27 in. vacuum. Refill the storage cell with helium to a pressure of 3 psig.

3) Close vacuum valve on fuel handling machine. <u>Note:</u> To close this valve, turn handle <u>counterclockwise</u>. There are <u>no</u> interlocks connected to the vacuum valve. Hence, extreme caution should be exercised when manipulating the valve.

4) Using special hose, connect discharge of fuel handling machine vacuum pump to vent valve located adjacent to fuel storage cells. Valve has a blue handle. Open vent valve.

5) Open valve on suction side of vacuum pump and pump entire interior of fuel handling machine down to 27 in. Hg vacuum.

6) Close vacuum pump valve and open helium valve. Pressurize fuel handling machine to 3 psig helium.

7) Install index ring in storage cell containing shield plug.

<u>Check element number and storage cell number against ETR form.</u>

8) Index fuel handling machine over storage cell as follows:

   a) Using mirrors, sight under fuel handling machine.

   b) Move machine north-south and east-west until bellows is centered over index ring within 1/4 in. in any direction.

   c) Lower bellows by moving pneumatic valve on console to the left. "Gas seal down" light will come on.

   d) If fuel handling machine does not shift when bellows is lowered, indexing is proper.

9) Turn off crane power main breaker. Breaker is located on high bay support beam on south side of high bay. This will prevent fuel handling machine from moving inadvertently while it is indexed.

10) Push index ring plunger in to lock plug into place.

11) By opening valve on suction side of vacuum pump, pump down gas seal to 25 in Hg vacuum. Fill with helium to 3 psig. Repeat.

   Note: Gas seal should pump down in about 30 sec. If it does not, leakage is indicated. To locate source of leakage:

   a) Check fuel handling machine body pressure while pumping on gas seal. If it drops, the vacuum valve is leaking.

   b) Check height of fuel handling machine above floor. It should be 3-1/2 in. If machine is too high, bellows will not contact index ring with sufficient pressure to make a good seal. Reposition fuel handling machine to correct height.

12) Open vacuum valve.

13) Pull index ring plunger out to release plug hold-down device.

14) Lower the outer shield.

15) Lower grapple and pick up the shield plug. Follow sequence described in section IX-A-1, steps g), h), and i).

16) Raise grapple to upper limit. Verify that plug is actually attached to the grapple by noting the load cell weight indication (100 to 400 lb depending on the type of element).

17) Observe ascent of plug in guide tube by sighting through periscope window.

18) When grapple reaches upper limit, guide tube will raise up about 1/2 in. above the drip pan inside the fuel handling machine. Load cell indication will rise to about 500 to 800 lb. Grapple will stop automatically and "grapple up" light will come on.

19) Verify that both guide tubes are in fact 1/2 in. above drip pan by sighting through periscope window.

20) Close vacuum valve.

21) Rotate fuel handling machine inner mechanism 90° until empty grapple is in lifting position. Lights on the console indicate that rotation is complete.

22) Raise outer shield. Monitor with gamma survey meter.

23) Vent lower cavity (through vacuum pump) to atmospheric pressure.

24) Raise bellows. Monitor gas with AM-3 air monitor.

25) Sight under fuel handling machine to make sure that bellows is up and that there are no obstructions to fuel handling machine movement.

26) Close main crane breaker.

27) Install lifting ring in fuel element to be replaced. Remove holddown clips from shield plug.

28) Install index ring in core channel from which the fuel element is to be removed. Check element number and core channel number against ETR form.

29) Index fuel handling machine over core channel as outlined in step 8).

30) Turn off crane power main breaker.

31) Push index ring plunger in to lock fuel element shield plug in place.

32) Pump down gas seal (lower cavity) to 25 in. Hg vacuum and fill with helium to a pressure of 3 psig. Repeat. See step 11) for items to check in case of seal leakage.

33) Open vacuum valve.

34) Pull index ring plunger out to release plug holddown device.

35) Lower empty grapple. Attach grapple to fuel element shield plug as outlined in IX-A-1 steps g), h), and i).

36) Raise grapple (and fuel element) to upper limit. Check that load cell reading is about 350 lb. Do not exceed a pull of 600 lb. It may be necessary to exceed 350 lb, however, in order to overcome the friction of the quad-rings on the shield plug.

Observe ascent of fuel element through periscope window. Note any unusual conditions in the Operations Log and on the ETR form in the "remarks" column.

While the fuel element is being raised, monitor exterior of fuel handling machine thoroughly for gamma radiation.

37) Verify that both guide tubes are in fact 1/2 in. above drip fan by sighting through periscope window.

38) Rotate fuel handling machine inner mechanism 90° until grapple with shield plug on it is in position to be lowered.

39) Lower shield plug. Observe descent through periscope. Note in particular that quad-rings are installed on plug.

40) When plug has been fully lowered (as indicated by a counter reading of zero and appearance of a negative load light) release grapple by pressing "grapple release" button.

41) Raise grapple to upper limit. Check load indication when raising the grapple to insure that the plug has been released.

42) Verify that both guide tubes are in fact 1/2 in. above drip pan by sighting through periscope window.

43) Close vacuum valve.

44) Raise outer shield. Monitor radiation level with gamma survey meter.

45) Push index ring plunger in to lock shield in place.

46) Pump down gas seal (lower cavity) to 25 in. Hg vacuum and fill with helium to a pressure of 3 psig. Repeat, but adjust final pressure to atmospheric. See step 11) for items to check in case of seal leakage.

47) Raise bellows. Monitor gas with AM-3 air monitor.

48) Sight under fuel handling machine to be sure that there is vertical and lateral clearance for movement.

49) Close crane power main breaker.

50) Move fuel handling machine away from loading face.

51) Monitor shield plug which has just been installed for beta and gamma radiation.

52) Remove index ring.

53) Install holddown clips on plug.

The operation of replacing a fuel element with a shield plug is now complete.

C. ELEMENT HANDLING

The purpose of the following is to give general and specific instructions to permit the above procedure to be applied to the various types of elements in use at the SRE.

1) When installing or removing an element of any type which extends below 180 in., the main primary-sodium flow shall be decreased to 200 gpm. This will prevent possible deflection of the element as it enters the coolant channel.

2) When installing or removing any element which extends below 180 in., the reactor will be filled with sodium to at least the 130 in. level.

3) When installing corner-channel dummy elements, allow the element to "soak" in the upper sodium pool for 15 min before lowering the tip of the dummy into the coolant channel.

4) When installing fuel elements, center channel dummies, heaters, and thimbles, allow the element to soak in the upper sodium pool for 5 min before lowering the tip of the element into the coolant channel.

5) The following table lists the overall lengths of SRE core elements:

Element Type	Length (in.)
a) Fuel	285-1/2
b) Center-channel dummy	301-1/4
c) Corner-channel dummy	297-11/16
d) Control-rod thimble	279-25/32
e) Core heater (long)	283
f) Pool heater (short)	175
g) Level coil	175-1/2
h) Source assembly	281
i) Sodium Temperature Measuring Element	281

6) Electrical interlocks protect the fuel handling machine. The following chart shows what interlocks must be satisfied to perform a given operation.

TABLE IX- 1

Operation	Interlocks to Satisfy										
	Bellows Up	Shield Up	Shield Down	Valve Closed	Grapple 1 Up	Grapple 2 Up	Grapple Position 1	Grapple Position 2	Negative Load	Overload	Cable Slack
Bridge Crane Travel	x	x		[x]							
Bellows Operation											
Shield Up					x	x					
Shield Down											
Valve Operation											
Grapple 1 Up			[x]				x			[x]	
Grapple 1 Down			[x]				x		[x]		x
Grapple 2 Up			[x]					x		x	
Grapple 2 Down.			[x]					x	[x]		x
Rotation					x	x					

[x] Indicates interlock bypass; operation requires Shift Supervisor approval

X. BUILDING VENTILATION SYSTEMS

A. GENERAL

The ventilation systems for the SRE building fundamentally may be considered as three different functional zones. These zones are (a) contaminated, (b) potentially contaminated, and (c) noncontaminated. Static pressure is maintained lower in the contaminated than in the noncontaminated zones to assure air flow into zones where particulate or gaseous activity may exist, thus deterring the spread of contamination. Also, all intrazone openings such as ductwork or louvers, are provided with means of positive isolation, in the event of emergency conditions requiring zonal isolation. Venting of process vessels or enclosures is not discussed herein; see Section VII, Vent System.

Table I shows the static pressure maintained in the three zones.

TABLE I

Zone	Area	Static Pressure Inches of Water
Contaminated	Metallurgical hot cell	-0.5
	Primary hot cell	-0.5
Potentially contaminated	Reactor Bay	-0.12
	Hot-cell service area	+0.25
	Hot-cell work area	+0.25
Noncontaminated	Administration area	+0.25
	Control and instrument room	+0.25
	Electrical equipment rooms	+0.25
	Rest rooms	+0.25
	Storage battery room	-0.12

B. NORMAL AND EMERGENCY OPERATION

Normal and emergency operating practices and procedures concerning building ventilation are as follows:

1. General

   a) All supply and exhaust fans should be operating at all times. Failure of any unit shall be reported to the Shift Supervisor immediately.

   b) Should unit failure change the fundamental air-flow pattern of non-contaminated-zone air flowing into a contaminated or potentially contaminated zone, the areas in question shall be isolated by the closing and tagging of appropriate dampers and/or doorways.

   c) Operability of all ventilating equipment shall be checked once each week, and the required information recorded in the Weekly Operations Check-Off Sheet.

   d) Once each month pressure-drop data shall be taken across all supply and exhaust filters. When the pressure drop approaches the below-listed values, filter replacement is required.

      Bay Area Supply No. 1 ------------- 2 in. water
      Bay Area Supply No. 2 ------------- 2 in. water
      Multizone Supply ----------------- 3 in. water.

   e) Locked dampers controlling overall building ventilation balancing shall not be reset without permission of the Shift Supervisor.

   f) Permission shall first be obtained from the Shift Supervisor before any operational changes are made in any ventilation system component.

2. Hot-Cell Areas

   a) The air-lock doors between the hot-cell-work and-service areas shall not be opened simultaneously.

   b) Should the hot-cell service area become contaminated, close the supply air damper in the duct located in the air-lock area and de-energize the exhaust blower. Tag damper and blower as to reason of outage.

c) The door leading to the hot-cell work area from the bay area shall be maintained closed at all times.

d) Should the hot-cell work area become contaminated, close the supply air damper in the duct located in the bay area and de-energize the service-area exhaust blower.

3. Reactor Bay Areas

a) All doorways entering into the bay area from outside or from equipment or personnel areas shall be kept closed except momentarily when being used for access.

b) Shift Supervisor shall be notified prior to the opening of the vehicle access doorway if:

1) Airborne contamination is present in the bay area.

2) Bay-area supply and exhaust systems are not 100% operative.

c) Bay-area supply fans 1 and 2 are electrically interlocked with exhaust fans 1 and 2, respectively. Each supply fan will not operate until and unless its associated exhaust fan is operating. These fans normally shall be kept in operation; any operational changes in this regard shall be approved by the Operations Supervisor.

d) Should the bay area ventilation equipment not be 100% operative, all work producing airborne contamination shall proceed or be initiated only by approval of Shift Supervisor.

4. Personnel Areas

a) If airborne contamination is present in the bay area, exhaust louvers leading to the bay area shall be closed.

b) All supply and exhaust fans serving the rest rooms and the electrical equipment rooms shall be kept in operation at all times. Any deviation from this must be authorized by the Shift Supervisor.

5. Storage Battery House

a) Circulation is provided by an exhaust fan mounted on the roof and outside air being drawn in through a screened, louvered, opening in the south wall. This exhaust fan shall be kept in operation at all times in order to assure a constant purge of the hydrogen envolved from the batteries.

C. PROCEDURE DURING POWER OUTAGE

1. Normal power source failure to the building will shut down all ventilation equipment. Upon power failure:

   a) Close the damper in the supply air duct to the hot-cell work area,

   b) Close all building entrance doorways,

   c) Close all louvers between the bay and personnel areas,

   d) All work of such a nature that airborne contamination could result shall be curtailed until ventilation equipment is again operative.

2. When power is restored:

   a) Restart all ventilation equipment,

   b) Check that hot cell exhaust fans are operating,

   c) Open the damper in the supply air duct to the hot-cell work area, and

   d) Open all louvers between the bay and personnel areas.

XI. WASH CELLS

The objective of the following procedure is to outline the steps required to wash fuel and other SRE core elements in a manner which effectively prevents any possibility of pressure surges which might damage the core element.

This procedure covers the complete washing cycle beginning with system preparations followed by positioning of the core component in the cell, cleansing with steam, rinsing with water, and the eventual vacuum drying of the component and its removal. Operation of the wash cells will be described for Cell A and Oxidizer Unit 1. The Shift Supervisor must approve initiation of the following procedure.

A. PREPARATION

Check to see that the valves under 1), 2), and 3) below are closed.

1) Wash Cells

a) Wash Cell A

Vent	V-676
Steam	V-979A
H_2O	V-945
Drain	V-903
Helium return	V-981

b) Wash Cell B

Vent	V-679
Steam	V-979B
H_2O	V-965
Drain	V-902
Helium return	V-980

c) Wash Cell C

Vent	V-680A
Steam	V-979C
H_2O	V-946
Drain	V-901
Helium return	V-690B

2) Steam Generator

Make-up water inlet	V-977A
Blow down	V-978
Steam outlet	V-979
Helium inlets	V-416, V-417, and V-418
Make-up H_2O	V-977B

3) Baffle Box

Water flush	V-984
Water drain	V-985
Baffle box and oxidizer bypass	V-986.

4) Turn off all switches on wash-cell panel. Turn on switches ER-B-17, ER-B-19, and ER-NCP-19. Turn on upper and lower zone wash-cell heaters. Set the wash-cell temperature controllers (TC-3 and TC-4) to maintain an average cell temperature of 275°F.

Turn on oxidizer 1 switch and set TC-1 for 600°F. Oxidizer temperatures will overshoot and may reach 750°F. Points 1 through 4 will show a spread of approximately 100°F.

Turn on the radiation detector switch.

Turn on the hydrogen analyzer switch.

Turn on the interlock and level-alarm switch.

5) Purge steam generator by opening V-978 (steam generator drain) and V-416 (helium inlet). Close V-978 and V-416 after 1-min purge.

6) Observe the steam-generator-current indicator while turning on the steam-generator heater switches. One switch is located at the wash-cell panel, and one is located at the steam generator. There should be no water in the steam generator. Therefore, there should be no current indication because the steam generator low-level switch is not satisfied. If a current is indicated, turn off the heater and investigate the cause. If no current is indicated, open valves V-976 and V-977A and pump water into the steam generator with the hand pump. Observe

the increasing water level in the sight glass and note the level at which the low switch is actuated (heater current). Turn off the heater switches. Continue to fill the steam generator while opening the small vent valve at the top of the generator to prevent pressure buildup. Fill to 7-lb mark and close V-977A and V-976 and generator vent.

7) All of the valves which directly serve the steam generator are to be closed. Turn on the steam-generator switches. Observe the pressure gauge at the top of the generator and observe the heater current indicator on the wash-cell panel.

   About 20-min is required to bring the steam pressure to the cut-off point (40 to 41 psig) at which time the high pressure switch will open the heater circuit. The pressure switch will maintain adequate steam pressure by cycling the power to the immersion heater in the steam generator.

8) Bring water level in tank T3 to marked operating level by observing LG-1 on wash-cell panel and operating valve V-976 and V-977B (compressor-water-tank water supply valves) and make-up water hand pump. Close V-976 and V-977B.

B. PURGING

The vent system and wash cell will be purged to receive the core component to be cleaned in the following manner:

1) A dummy plug (no component attached) shall be inserted in the opening in the top of the wash cell.

2) Open V-417 (helium inlet) and V-979A (steam and helium inlet Cell A), to admit purge gas to bottom of the wash cell.

3) Open V-903 (Cell A drain valve) to drain any water that may be in the cell. Alarm light LA on panel MM will indicate when the cell is empty. Close V-903 and V-979A.

4) Open V-676 (Cell A vent), V-680B (baffle box inlet), V-682 (oxidizer No. 1 inlet), V-685 (oxidizer No. 1 outlet), and V-989 (Vent system inlet).

5) Open V-730 and V-729, and establish a kerosene coolant flow between 6 and 8 gpm. (See FI-3, south wash-cell trench).

6) Operate switches on wash-cell panel to turn on Pl (Vacuum pump) and P2 (vent system water pump). (FI-1 and FI-2, wash-cell panel, indicates proper water flow to Pl and T2). These flow indicators are lights and indicate only flow or no flow. The flowrates have been set and need no adjustment.

7) With V-993B (vacuum control valve) and V-690A (helium return) closed, pump will evacuate cell to about 24-in. Hg vacuum (PI-1 wash-cell panel or PI-A Cell A).

8) Close V-680B (baffle-box inlet) and open V-979A allowing cell to fill with helium to between 1 and 3 psig. Close V-979A (helium and steam supply valve).

9) Open V-680B and evacuate the cell again. Repeat steps 8 and 9 until a total of three purges has been accomplished.

10) Open V-993B (vacuum control) and V-690A (helium return). PI-1 on wash-cell panel will read 10-in. Hg vacuum.

11) Close V-989 (vent system inlet). Note pressure on T-3 (PI-3); it may begin to rise. If so, crack V-989 occasionally to relieve this pressure.

12) Close V-689B (baffle box inlet), V-682 (oxidizer No. 1 inlet), and V-676 (cell A vent). Open V-979A (Cell A helium and steam), and raise cell pressure to match cask pressure. Close V-979A. With all interlocks satisfied, the locking device can be removed to permit the fuel cask to move over the cell.

13) The fuel-handling machine is now to be used to replace the shield plug with an element to be washed (per ETR) and moved away from the cell.

14) Place the locking device on the cell (note that both solenoid-operated retainer bolts have snapped into place).

C. CLEANING

The component can now be cleaned by the following sequence of operations:

1) The wash cell and oxidizer in use must be up to operating temperature.

   a) Wash-cell temperature, between 275 and 325°F

   b) Oxidizer temperature, between 580 and 750°F.

   The steam generator pressure must be between 40 and 42 psig.

2) With 1) above satisfied open the following valves:

V-676	(cell "A" vent)
V-680B	(baffle box inlet)
V-682	(oxidizer No. 1 inlet)
V-685	(oxidizer No. 1 outlet)
V-690A	(recirculation gas return)
V-981	(recirculation gas return to cell A).

   The vacuum pump and compressor are still energized. Therefore, an internal helium flow is established.

3) Close V-417 (helium inlet) if open.

4) Admit steam to the cell by opening V-979A (Cell A helium and steam inlet), and V-979 (steam-generator outlet). The cell pressure before steam admission is about 8 to 10 in. Hg vacuum. This pressure will change when steam is admitted and may go slightly positive.

5) Continue admitting steam to the cell until the water level as indicated by the steam-generator sightglass has dropped an equivalent height of 4 lb. (sight glass is calibrated in lb.) Then open switch SG-1 and close V-979 (steam generator outlet) and V-979A (cell A steam and helium inlet). Oxidizer lower temperatures (1 and 2 on TR) will drop considerably due to being cooled by steam and recirculating gas. The upper two points (3 and 4) should stay up in temperature.

6) If no further components are planned for washing turn the power off the oxidizer in use.

D. RINSING

The component will be water-rinsed as follows:

1) Fill the 50-gal water tank (located in the North-East corner of the cask storage area) with the required amount of water as determined by the type of component being washed. A list of these quantities is attached to the metering tank. V-974 is the valve directly above the tank and is used when filling.

2) Close V-981 (cell A helium return)
Close V-680B (Baffle-box inlet)
Close V-682 (Oxidizer-1 inlet)
Close V-685 (Oxidizer-1 outlet)

3) Open V-986 (baffle-box and oxidizer by-pass)
Open V-989 (vent-system inlet from T-3)
Open V-945 (cell A H_2O inlet)
Open V-964 (H_2O pump suction valve)

4) Start water pump by pressing start button on panel MM West wall of SRE high bay. Pump will run until float switch on metering tank cuts pump off. Close V-945 and V-964. Note temperature drop on wash cell due to flooding with cold water.

5) Check sump-tank level. Drain if required.

6) Drain cell A by closing V-986 (baffle-box and oxidizer-1 bypass); opening V-418 (helium inlet) and V-903 (cell A drain). Light on panel MM will go out when cell is empty. Close V-418 and open V-417, and V-979A to purge steam line. Close V-417, V-979A, and V-903.

7) Close V-989 (vent system inlet).

E. DRYING

The components shall be dried as follows:

1) Open V-986 (oxidizer and baffle-box bypass) and V-981 (cell A helium return)

2) Wash-cell temperatures will begin to rise after being cooled by the water rinse. Drying can be assumed complete when cell returns to normal operating temperature. (275 to 325°F)

3) Close V-676 (cell A vent) V-981 (helium return) and V-986.

4) Open V-417 (helium inlet) and V-979A (Cell a helium and steam inlet). Cell pressure will begin to rise. (PI-A). Close V-417 and V-979A when cell pressure reaches 0 psig.

5) With all interlocks satisfied, the locking device can be removed from the cell and the fuel handling machine can remove the component.

6) Replace with plug or another component to hold atmosphere.

7) If another component is to be washed, repeat process starting with Step b (13). Fill steam generator with H_2O as per XI-A-6.

8) The following sequence applies if the wash system is to be shut down:

   a) Turn off the wash-cell upper and lower zone heaters.

   b) Turn off the vacuum pump and vent-system water pump.

   c) Turn off the radiation detector.

   d) Turn off the hydrogen analyzer.

   e) Turn off the safety interlock and level-alarm power.

   f) Turn off wash-cell panel control power.

   g) Turn off switches ER-B-17, ER-B-19, and ER-NCP-19.

9) Close V-729 and V-730, kerosene inlet and outlet valves.

XII. EMERGENCY POWER SYSTEM

For safe operation of the SRE, certain equipment must be supplied with an uninterrupted source of power. This uninterrupted source is referred to as the Emergency Power System. Table XII-1 lists the loads supplied from this system.

TABLE XII-1

EQUIPMENT SUPPLIED FROM EMERGENCY POWER SYSTEM

1) Safety-Rod Drive Motors
2) Skim-Rod Drive Motors
3) NaK Cooling Systems for the Main and Auxiliary Primary and Secondary Sodium Pumps
4) Reactor Control System
5) Instrument Panels
6) Annunciator Alarm System
7) Hot-Cell Exhaust Fans
8) Emergency Lights
9) Fission-Chamber Drive Motors
10) Control Power Panels
11) Diverter-Pole M-G Sets
13) Auxiliary Secondary Pump
14) Auxiliary Airblast Heat-Exchanger Fan
15) Main and Auxiliary Primary Eddy-Current Brakes
16) Diesel Governor Motor.

The 100-kw diesel-driven 480 volts, three-phase, 60-cycle generator furnishes power to the emergency system when power is not available from the Edison Company.

A. EMERGENCY OPERATION

The emergency condition is considered to exist when voltage is lost on the bus of the 480-volt emergency control center. This is primarily thought of as a failure of power from the Edison System; however, protective opening or inadvertent opening of breaker B-7 would also establish this condition.

Should this emergency situation arise, the following sequence automatically takes place.

1) Breaker B-7 opens.

2) No. 2 diverter-pole M-G set (or No. 1 set if for any reason No. 2 is not operating) changes over to a battery-driven motor-alternator and supplies 480-volt, three-phase power to the emergency system.

3) The diesel-engine alternator automatically starts, and when the alternator is producing the proper voltage and frequency, it automatically synchronizes with the voltage being delivered by the battery supplied M-G set in 2) above.

4) Breaker 52-G, which is normally open, closes, and the diesel generator takes over the emergency system load. This change-over occurs within a few seconds.

5) The diverter-pole M-G set in 2) above reverts back to a dc generating unit operating now on power supplied by the diesel generator, and again supplies the dc load and recharges the batteries.

NOTE: Should difficulties arise in the automatic synchronizing of the diesel generator, it may be necessary manually to adjust the diesel engine speed using the control mounted on the dc switchboard.

When normal power is restored, the diesel generator automatically synchronizes with the Edison system frequency. Breaker B-7 closes and picks up the load; breaker 52-G opens, and the diesel engine shuts down. An adjustable time delay is provided in the closing sequence of B-7. This delay is to ensure the permanent return of normal power and prevent B-7 from closing prematurely.

Also, upon return of normal power, the following equipment must be manually restarted:

a) Main primary pump M-G set

b) Main secondary pump M-G set

c) Stack dilution fan

d) High-bay supply fans

e) High-bay exhaust fans

f) Hot-cell service-area exhaust fan

g) Main Building ventilation supply fan

h) Mezzanine supply fan

i) Equipment-room exhaust fans

j) Equipment-room supply fan

k) Kerosene-system pumps and fans

l) All tank and piping heaters that are supplied through magnetic contactors.

B. DIVERTER-POLE M-G SETS

The diverter-pole M-G sets shall be started only from the ac machine end by closing breaker 52-1 or 52-2, with the dc breakers 72-1 or 72-2 in the open position.

No changes shall be made in the mode of operation of the diverter-pole M-G sets without prior approval of the Operations Supervisor.

Should M-G set 1 fail, or develop mechanical or electrical difficulties which require that the set be taken out of service, open breaker 72-1 and operate switch MS-1 to the alternate source position for supplying the instrument vital bus panel. The reactor will "scram."

Should M-G set 2 fail, or have to be taken out of service, M-G set 1 shall be immediately changed over to battery changing duty by first opening breaker 52-2 and then closing breaker 52-1. The reactor may "scram" under this operating condition.

C. EMERGENCY DIESEL-GENERATOR SET

The emergency diesel-generator set shall be manually started once each week and operated for a period of 30 min. At the conclusion of this test run, the fuel tank shall be checked for adequacy of diesel fuel. This procedure shall be noted on the operations weekly checkoff sheet.

The engine-starting batteries shall be checked once each shift for adequate water and state of charge, and the inspection shall then be noted on the operations daily log sheet.

D. BATTERIES

The 125-volt, dc battery bank is composed of 60 lead-acid cells and connects to the bus of the dc control center switchboard through manually operated disconnect switches. The batteries are normally maintained by the maintenance electricians.

Operations is responsible for keeping the battery room neat and clean. The batteries shall be inspected once a week by Operations and the state of charge as indicated by the pilot cells shall be noted on the weekly checkoff sheet.

E. SPECIFIC OPERATING INSTRUCTIONS

1. To Test Emergency Power System

a) Check that "auto-manual" switch on diesel alternator is set on "auto."

b) Check that battery voltage is 133.5 volts. Adjust voltage by operating rheostat marked "No.2 Generator Voltage Adjustment" mounted on the EP (Emergency Power) panel in the electrical equipment room.

c) Open switch 1 on the 120-volt switch panel on panel F-17. This switch supplies a signal to the emergency power system which tells it whether the normal power has been interrupted or not. When the switch is opened, the emergency power system will respond as though normal power has in actuality been lost.

d) Motor operated breaker B-7 should open immediately. Within a few seconds, the diesel alternator should begin to crank and then start.

e) Observe diesel alternator frequency on the frequency meter located to the left of the EP panel. This frequency should settle out between 59 and 61 cycles as the diesel governor warms up and stabilizes.

f) Simultaneously, observe battery charging rate. This will show a large negative value depending on the load on M-G set 2.

g) Within less than 1 min, the diesel alternator should synchronize with M-G set 2. When this happens, breaker 52-G will close, and the diesel alternator will take the load on the emergency bus.

h) After the diesel alternator has taken the load on the emergency bus, the charging rate on the batteries will increase to plus 20 to 30 amperes or more, depending on how long they have been discharging and what the load was before the diesel alternator picked up the load.

i) Allow the diesel alternator to run until the battery voltage is back up to 133.5 volts, and the charging rate is essentially zero as read on the meter on the EP panel. This will take about 10 min.

j) Close switch 1 on the 120-volt switch panel on panel F-17. Breaker B-7 should close. The diesel alternator should synchronize with the incoming line voltage and then drop the load as breaker 52-G opens.

k) If necessary, readjust battery voltage to 133.5 volts. The emergency power system has now been tested.

2. <u>To Adjust Vital Bus Frequency</u>

a) <u>Slowly</u> turn "No. 1 Generator Voltage Adjustment" clockwise to increase vital bus frequency. Turn counterclockwise to reduce frequency.

b) Read vital bus frequency on frequency meter located on south wall of electrical equipment room. This frequency can also be read on recorder in control room.

3. <u>To Start No. 2 M-G Set</u>

a) Open breaker 72-2 on EP panel.

b) Close breaker 52-2 on EP panel.

c) M-G set 2 will pick up speed rapidly. Watch voltage output of generator on gauge located on EP panel. When voltage reaches 133.5 volts, close breaker 72-2.

d) M-G set 2 is now charging the batteries. Readjust battery voltage if necessary by turning "No. 2 Generator Voltage Adjustment" knob on the EP panel.

4. To Start No. 1 M-G Set

a) Open breaker 72-1 on EP panel.

b) Open breaker titled "Normal Supply to Vital Bus." This breaker is located on the south wall of the electrical equipment room.

c) Place vital bus switch in the "alternate" position.

d) Close breaker 52-1 on EP panel.

e) M-G set 1 will rapidly pick up speed. Watch voltage output of generator on gauge located on EP panel.

f) When output of generator reaches battery voltage (133.5 volts), open breaker 52-1 and quickly close breaker 72-1.

g) If necessary, adjust vital bus frequency to 60 cps by turning "No. 1 Generator Voltage Adjustment" clockwise to increase frequency and counterclockwise to decrease frequency.

5. To Recover From Oscillations of the No. 2 M-G Set

If the battery terminal voltage drops because of prolonged discharge, M-G set 2 will be overloaded as it attempts to charge the batteries and bring the terminal voltage up.

The overloaded condition will cause the drive motor for the M-G set to drop out of synchronization with the incoming line voltage. When this occurs, the M-G set will slow down and tend to drop the load.

As the load falls off, the M-G set will speed up, and the entire sequence will be repeated. The resultant oscillations will severely upset the emergency bus voltage.

To stop the oscillations once they have started:

a) Lower output voltage of generator 2 by turning field rheostat clockwise.

b) Oscillations will cease as load on generator 2 decreases.

c) Slowly increase battery terminal voltage by turning field rheostat counterclockwise.

d) When battery terminal voltage reaches 133.5, system has been restored to its normal condition.

XIII. PUMP COOLANT SYSTEMS

June 27, 1960

A. FILLING

The objective of this procedure is to outline the steps necessary to fill the pump coolant systems with sodium-potassium alloy (NaK). Approval of the Shift Supervisor must be obtained prior to initiating the steps in this procedure.

To fill the NaK systems, the system is first evacuated and purged with inert gas. NaK is then admitted to the system by pressurizing a NaK barrel to 3 psig, and allowing the NaK to fill the system until the level in the expansion tank is correct, as indicated by the level probe.

In the handling of systems containing NaK, it is necessary to wear full protective clothing. This includes flame-proof coveralls, face shield, and polyethylene gloves. NaK is liquid at room temperature and could get into any open line. Therefore, during venting, wear the protective clothing, and consider the lines to contain NaK.

1) Weigh NaK supply barrel and record. The barrel contains 200 lb of NaK. The main-primary NaK system will contain approximately 145 lb of NaK.
2) Have a fireman stand by with a barrel of calcium carbonate.
3) Have level probe set with 5 in. protruding above top of flange.
4) Attach Tygon tubing connection from NaK barrel to fill-and-drain line, valve 45.
5) Attach a helium bottle to NaK barrel vent valve.
6) Open the drain valve on the NaK system, V-22.
7) Open all the valves within the NaK panel (not on the supply barrel).
8) Attach a tee at the helium supply fitting at the back of the panel. Attach a helium valve supply and a vacuum pump to the tee.
9) With the helium valve closed, evacuate the system. DO NOT attempt to run NaK pump while there is a vacuum on the system.

10) Close the vacuum valve.

11) Open the helium valve and purge the entire system. Pressurize to 5 psi.

12) Close the helium valve.

13) Repeat steps 7, 8, and 9 two more times.

14) Repeat step 7 once more.

15) From helium bottle put 3 psi on the NaK barrel.

16) With the system completely evacuated, slowly open the fill valve on the NaK barrel.

17) Allow the NaK to flow into the system until it gets to the level probe. Watch annunciator low-NaK-level lights. This will reset itself when level gets to probe. Immediately shut off NaK system fill-and-drain valve, V-22.

18) Clamp off the Tygon tubing as close to the drain valve, V-22, as possible.

19) Place a small pan of calcium carbonate under the end of the drain line.

20) Remove Tygon tubing from NaK system drain line (V-22).

21) Reduce pressure on NaK barrel to zero psig.

22) Lift free end of tube and let the NaK in the tube run back into the barrel. Do not open wide - let flow back in slowly.

23) As soon as the tube is empty close vent valve tightly.

24) Close fill valve and remove tubing.

B. OPERATION

The following procedure describes the steps required to put a NaK cooling loop into service. It is assumed that the loop has been filled with NaK and that it is leak tight. The Shift Supervisor must approve initiation of the steps in this procedure.

1) Close 480-V supply breaker on panel D, on the north wall of the equipment room, for the NaK system being operated, in accordance with Table XIII-1.

2) Close 120-V control-power breaker on panel H in the northwest corner of the equipment room, in accordance with Table XIII-1.

TABLE XIII-1

System	480-Volt Breaker	120-Volt Breaker
Main Primary	7	12
Main Secondary	5	10
Aux. Primary	8	8
Aux. Secondary	6	6

3) The "440-V power" and "control power" lights should be on.

4) Check to see that valves going to and from the sodium pump are open (V-5, V-16, V-17, V-18, V-1, V-2).

5) Check V-21 to be sure it is closed.

6) Press annunciator-light test button and observe annunciator.

7) Check level probe by loosening compression nut and slowly pulling probe out.

   CAUTION: Use gloves for this step. While probe is immersed in NaK, the circuit is grounded. When it is out of the NaK, there are 110 V on the probe. Alarm should sound and annunciator light should come on. Then press annunciator reset button. Then push probe back to its original position.

8) Select a pump to be lead running pump. Then, with the pressure-switch reset button pushed in, turn on the pump. Hold reset button in a few seconds until pump discharge pressure builds up to normal. If this is not done, an automatic switchover will take place and the standby pump will run. Observe the three flowmeters. All three should indicate a flow. The meters read out in millivolts, and no direct conversion to gpm can be made.

If one pump is selected as a lead pump and a switchover takes place, the standby pump will run. To make the original lead pump run again, it is necessary to shut down manually the standby pump and manually start the original lead pump again.

9) Check for corresponding pump running light.

10) Close the discharge valve on the pump that is running.

11) After the discharge pressure drops to 5 to 6 psi, the pump switchover should take place. When alarm sounds, press annunciator reset button.

12) Open discharge valve (V-1 or V-2, whichever pump is selected).

13) Repeat steps 8, 9, 10, 11, and 12 for the other pump.

14) Start one fan motor and check fan running light.

15) Close louvers by pulling handle to forward position.

16) When low-air-flow alarm sounds, press reset button. There is no automatic switchover on the blower motors. This is manual. The centrifugal clutch coupling will not disengage until the motor speed drops below 900 rpm.

17) Open louvers again. Alarm should reset.

18) Loop is now in service.

19) When sodium system has been filled, adjust exit throttle valves for the cooling to the shaft freeze seal, the case freeze seal, and the bearing housing to maintain these temperatures below 150°F. Normal running temperature will be about 100 to 120°F.

NOTE: The case freeze-seal cooling circuit has a much lower hydraulic resistance than the shaft freeze-seal. The case circuit should, therefore, be throttled to give a 5°F temperature rise.

C. DRAINING

The following procedure will refer to equipment numbers and part numbers associated with the main primary pump NaK system. The procedure will be the same for other sodium pumps, except that the valves, breakers, etc., to be operated, will be those of the system being drained.

Before doing any work on the NaK system, the power supply must be shut off.

1) Open all four (4) breakers located in the electrical box on the NaK panel.

2) Open 480-V supply breaker on panel "D" on north wall of equipment room. (See Table XIII-1, section B).

3) Open 120-V control power breaker in the northwest corner of the equipment room. (See Table XIII-1, section B).

4) Connect fittings and Tygon tubing to the main secondary pump NaK drain valve V-22 and a NaK tank.

5) Evacuate and purge the tubing just installed three times, before attempting to drain the NaK system.

6) Open wide V-16, V-17, and V-18 on NaK return lines.

7) Open V-21 on NaK-drain connecting line.

8) Open valve on NaK barrel slowly.

9) Open fill and drain valve V-22 slowly. The pressure on the NaK system should force the NaK into the barrel.

10) When the NaK system drains and no more flow is observed, close V-21 on the drain connecting line tightly.

11) Pressurize the NaK expansion tanks to approximately 4.5 psi. This will force the NaK up from the seals in the sodium pump.

12) When gas bubbles appear in the tubing, close drain valve V-22. It may be necessary to vent the barrel while putting NaK back into it. This should be done slowly and carefully so as not to allow air to get into the barrel.

13) Pinch the tubing tight on the end near drain valve V-22. Place pan of calcium carbonate under end of tubing connection.

14) Lower pressure on expansion tank to 0 psig.

15) Remove the tubing from the drain valve and raise the end of the tube to drain what NaK may be in the tube into NaK barrel. It may be necessary to vent slowly to do this.

16) When draining stops, close the NaK barrel valve tightly and pinch tube tightly at that end. Be sure to have a pan of calcium carbonate under the tube opening. There will be a little NaK drain from the ends of the tubes.

17) Close valve V-55, V-16, V-17, and V-18 tightly.

18) Close helium valve V-419 and vent valve V-564 tightly.

XIV. 75-TON CRANE OPERATION

The following rules apply to operation of the 75-ton crane at the SRE site:

1) Do not use the cranes without a license.
2) Shift Supervisor must be notified prior to closing the main breaker.
3) Check to see that the cask storage rails are in the "up" position prior to moving the bridge.
4) Do not depend on limit switches. Stop the drive before the limit is reached.
5) Do not attempt to use two controls at the same time when approaching a limit.
6) Understand all signals. Do not move the controls until a given signal is completely understood.
7) Do not move a load over any personnel. Request that they move from the expected path of the lift.
8) Test all controls before each job.
9) Test the brakes by a short lift before handling unusually heavy loads.
10) Lift the load only as high as required to permit movement.
11) If the load, when raised, does not ride properly, lower it and readjust slings.
12) Personnel must not ride on the load or hook at any time.
13) A load will be stopped by releasing the raise or lower button and allowing the brakes to operate. Never reverse direction rapidly.
14) The crane bridge and trolley will be positioned over the load in a manner that the lift is always vertical.
15) Loads must be grounded when the crane is unattended.
16) One man will be stationed at the main switch at all times while heavy (greater than 5-ton) loads are being lifted.

17) The block of the 75-ton crane must not be lowered below floor level. Suitable cables, chains, or slings will be used when lifting an object located below the reactor room floor.

18) Take up the strain in the slings slowly to prevent snapping.

19) When not in use, the bridge will be left at the west end of the building with the trolley on the south end and the hook in the "up" position.

20) The main switch must be turned off when the crane is not in use.

XV. OFF NORMAL CONDITIONS

Any parameter outside set points which gives an alarm is "off normal". In addition, unusual dynamic variations or other changes in usually steady parameter shall be considered off normal. In the case of the latter condition, the reactor will be shut down using normal shutdown procedure.

Any condition which arises because of malfunction of any of the important reactor or service components will cause an alarm to be set off. These can be divided into three categories.

a) Alarms which result from reactor scram; the scram drops all four safety rods and drives the four shim rods in.

b) Alarms which result from automatic setback: the automatic setback drives all four shim rods in until the cause is eliminated.

c) Alarms which require manual corrective action: the corrective action to be taken in each case is outlined below. The first two categories which cause 1) reactor scram, and 2) automatic setback will be listed only, as the corrective action is automatic.

The annunciator system will sound the following audible signals:

1) Scram horn

2) Setback buzzer

3) Alarm bell.

A light on panel CC will come on indicating the cause for the alarm. The alarm may be turned off at the operator's console. However, the light will stay on until the cause is corrected.

a) Alarms which result from reactor scram

1) Earthquake

2) Reactor Period: less than 5 sec (from 10^{-4}% to 1% of full power).

3) Neutron Level: greater than 25 Mw.

4) Fuel-Channel Exit Temperature: greater than 790°F.

5) Electrical Power Failure (after 2-sec time delay)

6) Main Primary-Sodium Flow: less than 80% set flow

7) Main Secondary-Sodium Flow: less than 80% set flow

8) Main Primary Pump Speed: less than 90% set speed

9) Main Secondary Pump Speed: less than 90% set speed

10) Loss of Boiler Feedwater: less than 600 psig (8-sec time delay)

11) Main Secondary Cold-Leg Temperature: greater than 575°F

12) Loss of Auxiliary Primary Flow

13) Moderator Delta T: ± 50°F.

b) Alarms which result from automatic setback are

1) Reactor Period: less than 10 sec

2) Neutron Level: greater than 23 Mw

3) Fuel-Channel Exit Temperature: greater than 770°F.

c) Alarms which require immediate corrective action are shown in Table XV-I.

TABLE XV-I

SRE ANNUNCIATOR ALARMS

Alarm Condition	Alarm Setting
1) Reactor period	20 sec
2) Neutron level	21 Mw
3) Neutron flux - deviation circuit (to be installed)	15% deviation from set power
4) Main primary-sodium flow	90% set flowrate
5) Main secondary-sodium flow	90% set flowrate
6) Primary - secondary deviation (to be installed)	10% deviation
7) Auxiliary primary flow	17 gpm
8) Auxiliary secondary flow	14 gpm
9) Loss of feedwater	600 psig

TABLE XV-I (Continued)

Alarm Condition	Alarm Setting
10) Fuel-channel exit temperature	750°F
11) In-Fuel temperature	850°F
12) Reactor outlet temperature	725°F
13) Reactor inlet temperature	>550°F <450°F
14) Steam-generator sodium outlet temperature	>500°F <400°F
15) Auxiliary primary hot-leg temperature	725°F
16) Auxiliary primary cold-leg temperature	>550°F <450°F
17) Auxiliary secondary cold-leg temperature	>500°F <400°F
18) Dummy fuel-channel exit temperature	750°F
19) Freeze seal temperature	150°F
20) Kerosene flow	300 gpm
21) Reactor sodium level	<128 in. >108 in.
22) Main secondary expansion-tank sodium level	>65 in. <40 in.
23) Auxiliary secondary expansion-tank sodium level	>12.5 in. <7.5 in.
24) Stack radiation level	$>5 \times 10^{-7} \mu c/cm^3$
25) Steam-generator mercury pressure	>210 psig <165 psig
26) Turbine throttle valve	tripped closed
27) Sodium leak	x
28) Helium gas supply	125 psig
29) Decay tank pressure	125 psig
30) Failure of B^+ power for neutron detector	x
31) Core cavity helium pressure	5 psig
32) Primary fill-tank helium pressure	>4 psig <0.5 psig
33) Reactor helium pressure	>4 psig <0.5 psig
34) Nitrogen gas supply	>25 psig <9 psig
35) Insulation cavity nitrogen pressure	>5 psig <0.5 psig
36) Compressor suction tank pressure	14 psig
37) Pump casing helium pressure	0.5 psig
38) Pump coolant systems	
a) Low NaK flow	x
b) Low NaK level	x
c) Loss of air flow	x

TABLE XV-I (Continued)

Alarm Condition	Alarm Setting
d) Abnormal pump control circuit	x
e) Loss of control power	x
39) Brake Panel	
a) MP brake temperature	300°F
b) MS brake temperature	300°F
c) Abnormal brake circuit	x
d) Abnormal brake current	20 amp
40) Loading-face cooling flow	10 gpm
41) Loading-face cooling expansion tank level	2 in.
42) Moderator-can differential temperature	±10°F
43) Kerosene-supply-tank level	36 in.
44) Evaporative-cooler water flow	5 gpm

When an alarm is received, the console operator will take corrective action or will notify the other control room operator that an off-normal condition exists. If corrective action must be taken at locations other than at the console, the alternate control-room operator will take action.

In the following procedures, the conditions which cause an alarm are numbered in Table XV-I. The objective of each procedure is to return the "off-normal" parameter to its normal operating range, in a safe and efficient manner.

1) Reactor Period: less than 20 sec

Corrective Action

a) Insert one or more shim rods to increase period.

b) Notify Shift Supervisor.

2) Neutron Level: greater than 21 Mw

Corrective Action

a) If on automatic control, switch to manual.

b) Insert one or more shim rods to decrease power.

c) If the sodium fuel-channel outlet temperature is also high, the power correction will lower this temperature. If this temperature is normal, a reduction in sodium flow will be necessary while reducing power.

d) Check that the setpoint on the automatic controller is set at the desired power level (less than or equal to 20 Mw)

e) Notify Shift Supervisor.

3) Neutron Flux-Deviation Circuit: 15% deviation from set power:
This indicates that the reactor neutron flux level is higher or lower than the thermal power

Corrective Action if Flux is higher than Thermal Power

a) Insert shim rods to reduce reactor neutron flux.

b) Notify Shift Supervisor.

c) By inspection of log N recorder and sodium flow charts, determine whether the flux deviation was caused by low sodium flow or by high flux level.

d) Restore flux and sodium flow to desired values.

Corrective Action if Flux is Lower than Thermal Power

a) Reduce main primary-sodium flow to reduce thermal power.

b) Notify Shift Supervisor.

c) By inspection of log N recorder and sodium flow charts, determine whether the flux deviation was caused by high sodium flow or by low flux level.

d) Restore flux and sodium flow to desired values.

4) Main Primary-Sodium Flow: less than 600 gpm

Corrective Action

a) Increase main primary pump speed.

b) Notify Shift Supervisor.

c) Determine the reason for flow decrease.

5) Main Secondary-Sodium Flow: less than 600 gpm

Corrective Action

a) Increase main secondary pump speed.

b) Notify Shift Supervisor.

c) Determine reason for flow decrease.

6) Primary-Secondary Deviation: greater than 10%

This alarm indicates that main secondary-sodium flow differs by more than 10% of full flow from the main primary-sodium flow.

Corrective Action

a) Determine by inspection of the main primary- and main secondary-sodium flow charts which flow is the highest.

b) Depending upon results of step a), raise or lower the main secondary flow to match the main primary flow.

c) Notify Shift Supervisor.

7) Auxiliary Primary-Sodium Flow: Less than 20 gpm

Corrective Action

a) Observe auxiliary primary pump tachometer to determine if pump speed is decreasing. If so, increase pump speed by turning rheostat on console clockwise.

b) If pump speed will not increase and/or flow continues to drop decrease auxiliary secondary-sodium flow and control air-blast fan speed to hold the reactor auxiliary inlet temperature constant. Shut the reactor down using normal shutdown procedure. (Section I-E).

8) Auxiliary Secondary-Sodium Flow: less than 14 gpm

Corrective Action

a) Observe auxiliary secondary pump tachometer to determine if pump speed is decreasing. If so, increase pump speed by turning rheostat on console clockwise.

b) If pump speed will not increase or flow continues to drop, decrease auxiliary primary-sodium flow and control airblast fan so as to hold the reactor auxiliary inlet temperature constant. Shut the reactor down using normal shutdown procedure (section II-A-5).

9) Loss of Feedwater: less than 600 psig

Corrective Action

a) If alternate feedwater pump does not come on the line in 8 sec, the reactor will scram.

b) Upon receipt of this alarm, the Edison operator will proceed immediately to the main secondary throttle valve (V-165). An SRE operator will proceed to the main primary block valve (V-103).

c) Upon receipt of the scram signal, the console operator will notify the personnel at the valves, by means of the intercommunication system. They will close the main secondary cold-leg and main primary cold-leg valves (V-165) and (V-103).

d) Notify Shift Supervisor.

e) The auxiliary system is to be adjusted to remove afterglow heat to keep the reactor inlet temperature constant.

10) Fuel Channel Exit Temperature: greater than 750°F

Corrective Action

a) Increase main primary- and main secondary-sodium flow to reduce the fuel-channel exit temperature to less than 750°F.

b) Notify Shift Supervisor.

c) If step a) does not correct the condition, reduce reactor power until fuel-channel exit temperature is below 750°F.

11) In-Fuel Temperature: greater than 850°F

Corrective Action

a) Increase main primary- and main secondary-sodium flow to reduce the fuel temperature to less than 850°F.

b) Notify Shift Supervisor.

c) If step a) does not correct the condition, reduce reactor power until fuel temperature is below 850°F.

12) Reactor Outlet Temperature: greater than 725°F

Corrective Action

a) Increase main primary-sodium flow until reactor outlet temperature is below 725°F.

b) Notify Shift Supervisor.

c) If step a) does not correct the condition, reduce reactor power until reactor outlet temperature is below 725°F.

13) Reactor Inlet Temperature: greater than 550°F or less than 450°F

Corrective Action to Reduce the High Temperature

a) Check that secondary cold-leg temperature is between 400 and 500°F.

b) Increase the main secondary flow if necessary.

c) Notify Shift Supervisor.

d) Reduce reactor power if fuel-channel exit temperature is also excessive.

Corrective Action to Increase the Low Temperature

a) Check that secondary cold-leg temperature is between 400 and 500°F.

b) Decrease the main secondary flow if necessary.

c) Notify Shift Supervisor.

14) Steam Generator Sodium Outlet Temperature: greater than 500°F or less than 400°F

Corrective Action to Reduce the High Temperature

a) Notify Edison operator that cold-leg temperature is above 500°F.

b) Edison operator will increase feedwater flow to reduce cold-leg temperature.

c) Notify Shift Supervisor.

Corrective Action to Increase the Low Temperature

a) Notify Edison operator that cold-leg temperature is below 400°F.

b) Edison operator will decrease feedwater flow to increase cold-leg temperature.

c) Notify Shift Supervisor.

15) Auxiliary Primary Hot-Leg Temperature: greater than 725°F

Corrective Action

a) Increase main primary-sodium flow until auxiliary primary hot-leg temperature is below 725°F.

b) Notify Shift Supervisor.

c) If step a) does not correct the condition, reduce reactor power until auxiliary primary hot-leg temperature is below 725°F.

16) Auxiliary Primary Cold-Leg Temperature: greater than 550°F or less than 450°F

Corrective Action to Reduce the High Temperature

a) Check auxiliary secondary-system temperatures; if normal, increase flow in the auxiliary primary system.

b) Notify Shift Supervisor.

Corrective Action to Increase the Low Temperature

a) Check auxiliary secondary-system temperatures; if normal, decrease sodium flow in the auxiliary primary system.

b) Notify Shift Supervisor.

17) Auxiliary Secondary Cold-Leg Temperature: greater than 500°F or less than 400°F

Corrective Action to Reduce the High Temperature

a) Check auxiliary primary hot-leg temperature; if normal, increase auxiliary airblast fan speed.

b) Notify Shift Supervisor.

Corrective Action to Increase the Low Temperature

a) Check auxiliary primary hot-leg temperature; if normal, decrease the auxiliary airblast fan speed.

b) Notify Shift Supervisor.

18) Dummy Fuel Channel Exit Temperature: greater than 750°F

Corrective Action

a) Increase main primary- and main secondary-sodium flow to reduce the dummy fuel-channel exit temperatures to less than 750°F.

b) Notify Shift Supervisor.

c) If step a) does not correct the condition, reduce reactor power until dummy fuel-channel exit temperature is below 750°F.

19) Freeze Seal Temperature: greater than 150°F

Corrective Action to Reduce the Temperature

a) Check freeze seal NaK flow. Increase flow by operation of the exit globe valve to decrease the freeze-seal temperature.

b) Check pump casing helium pressure. Set pressure at 10 to 15 psig on the pump involved.

c) If the freeze-seal temperature continues to increase, reduce reactor power and coolant temperature (60°F/hr maximum), as outlined in normal shutdown procedure (section I-E).

d) If the freeze seal temperature reaches 200°F, shut the reactor down using emergency shutdown procedure (section I-E).

1) If the freeze seal involved is in either the main primary or main secondary pump, allow the auxiliary system to take over the load as soon as possible (power less than 1 Mw).

2) As soon as the auxiliary system takes over the load, stop the main system pumps.

e) If the high freeze-seal temperatures are on one of the auxiliary pumps, allow the main system to take the load and shut down the auxiliary pumps.

f) If the seal fails in spite of the above measures, the Shift Supervisor will request that Health Physics make a radiation survey of the pump area.

g) If design NaK flow cannot be established, conduct complete checkout of NaK cooling system in accordance with section XIII.

h) The reactor will not be restarted until the seal is operating satisfactorily.

20) Kerosene Flow: less than 300 gpm

Corrective Action

a) Start the standby kerosene pump.

b) Notify Shift Supervisor.

c) Check the level in the kerosene supply tank.

d) If the flow is still low, switch to alternate basket on the duplex filter downstream of the pumps.

e) If flow continues to drop, shut down the reactor.

21) Reactor Sodium Level: less than 128 in. below floor level or higher than 108 in. below floor level

Corrective Action to Increase the Level

a) Notify Shift Supervisor.

b) This alarm may indicate a leak in the primary-sodium system. If a leak alarm exists, shut the reactor down.

c) Proceed to isolate the leak as directed under section 27, Sodium Leak.

d) If no leak is indicated, sodium level may be dropping because there is flow in the reactor drain line. Check drain valve V-112 to be sure that it is closed. Check temperatures on the reactor drain line. If the temperatures indicate sodium flow, it will be necessary to freeze the sodium in this line. Turn off the heaters to accomplish this.

e) To fill the reactor to the correct level, reduce reactor temperature until the upper pool temperature is within 60°F of the lower plenum temperature. Drain as soon as lower plenum temperature is within 60°F of the primary-fill-tank temperature.

22) Main Secondary Expansion Tank Sodium Level: greater than 65 in. or less than 40 in.

Corrective Action to Reduce the Level to 65 in.

a) This alarm indicates that the initial filling has been too large.

b) It will be necessary to remove enough sodium so that the level is correct at the maximum operating temperature.

c) Notify Shift Supervisor.

d) Removal of sodium from the loop shall be accomplished in the following manner:

1) Energize heaters on the secondary fill tank and secondary drain lines (131-2-A) and (132-2-A).

2) Close helium supply line to secondary fill tank (V-298A).

3) Open tank vent valve (V-299F).

4) Open main secondary drain valves (V-131) and (V-132).

5) Operate secondary drain EM pump until proper level is attained in secondary expansion tank.

6) Return valving to normal.

Corrective Action to Increase the Level to 40 in.

This alarm indicates a loss of sodium from the main secondary system. If level is decreasing rapidly, proceed as follows:

a) Notify Shift Supervisor.

b) Decrease reactor power as rapidly as possible. At approximately 1 Mw allow the auxiliary system to take over the load.

c) Determine by visual inspection if there is a sodium leak in the main secondary system. If a leak is detected, take steps to isolate the leaking section or reduce the sodium level below the leak by draining to the secondary fill tank as outlined in 20)-d) above.

d) If visual inspection does not indicate a leak, check the sodium level in the reactor core tank. An increase of the core-tank sodium level will indicate a failure in the main intermediate heat exchanger. Since the secondary system is at a higher pressure, sodium may leak into the primary system. If this condition exists,

1) Transfer afterglow heat load to the auxiliary system.

2) Close block valves to reactor on main primary loop (V-101, V-103, V-104, and V-104A).

3) When afterglow heat has decreased, the primary loop will be drained back to the reactor and the secondary sodium pumped to the secondary fill tank.

23) Auxiliary Secondary Expansion-Tank Sodium Level: greater than 12.5 in. or less than 7.5 in.

Corrective Action to Reduce the Level to 12.5 in.

The high level alarm indicates overfilling. The action required is as follows:

a) Notify Shift Supervisor.

b) Drain enough sodium from the loop to reduce the level to normal as in 22) c), except use the auxiliary secondary drain valve V-198.

Corrective Action to Increase the Level to 7.5 in.

a) This alarm indicates a leak in the auxiliary secondary system.

b) Notify Shift Supervisor.

c) Shut down the reactor as rapidly as possible.

d) Use the main sodium system for the afterglow heat removal.

e) Conduct a visual inspection of the auxiliary secondary area. If a leak is detected, take steps to isolate the leaking section or lower the sodium below the leak by draining the system to the secondary fill tank.

f) If visual inspection and examination of the leak detector panel does not indicate a leak, proceed to fill the system to the correct level.

24) Stack Radiation Level: greater than $5 \times 10^{-7} \mu c/cm^3$

Corrective Action to Reduce Radiation Level

a) Notify Shift Supervisor.

b) The corrective action for this alarm will depend upon the conditions existing at the time of the alarm. A stack high-level alarm could be caused from any or all of the following:

1) Excessive gas release rates from the gas decay tanks.

2) Failure of one or more of the solenoid valves in the vent system.

3) High-level gas release from the hot cells.

4) Excessive gas release from nitrogen constant pressure gallery atmosphere controller. The above could result from failure of the solenoid valve downstream of the constant pressure gallery atmosphere controller.

c) Each of the above possible sources must be investigated and steps taken to valve off all stack discharge lines until the malfunctioning unit is determined and the trouble corrected.

25) Steam Generator Mercury Pressure: greater than 210 psig or less than 165 psig

Corrective Action for High Pressure

a) A high-pressure alarm will indicate a leak from the steam side of the boiler into the mercury.

b) Notify Shift Supervisor.

c) The reactor shall be shut down using standard shutdown procedure.

d) The afterglow heat load shall be transferred to the auxiliary system.

e) Close the main primary block valves (V-101, V-103, V-104, and V-104A).

f) Drain the sodium from the steam generator by performing the following operations:

1) Energize heaters on drain lines (166-2-A), and (168-2-A).

2) Apply helium pressure to the steam-generator freeze trap by opening valve (V-353).

3) Energize freeze-trap heaters. A helium flow will indicate that the trap is free of sodium.

4) Open the steam-generator drain and vent valves (V-169 and V-170).

5) When the lines and tanks are at a minimum temperature of 350°F, open the steam-generator drain valves (V-168 and V-166).

6) Close the helium inlet to the secondary fill tank (V-298B).

7) Vent the secondary fill tank to 3 psig by opening valve (V-299F).

8) Start the secondary drain EM pump to remove sodium from the steam generator. A loss of indicated flow on panel NN will indicate completion of draining operation. Stop EM pump immediately.

<u>Corrective Action for Low Pressure</u>

a) A low-pressure alarm will indicate a leak from the mercury into the sodium side of the steam generator or a leak to atmosphere from the mercury system.

b) The action to be taken is dependent upon the leak rate.

   1) If the leak rate is high, the Edison operator may request a scram.

   2) If the leak is very small, proceed as though a high-pressure alarm had occurred.

   3) If the leak rate is such as to require immediate shutdown, proceed as follows:

      a) Shut down the reactor using emergency shutdown procedure.

      b) Transfer the afterglow heat load to the auxiliary system by closing the main primary block valves after the core temperature gradient is below 120°F.

c) The Edison operator will cool the steam generator at a rate not to exceed 100°F/hr by manual control of the feedwater flow.

d) Drain the sodium in the steam generator to the secondary fill tank when the temperature has been reduced to 450°F.

e) Test the sodium in the secondary fill tank and main secondary system for mercury.

f) If the secondary sodium contains mercury, it will also be drained to the secondary fill tank.

c) If a double leak is involved (water-mercury-sodium), the following may result:

1) Explosive reaction between sodium and water.

2) High steam pressure may rupture the secondary-sodium system.

3) If no violent reaction results, this failure will be indicated by the following alarms:

a) High mercury pressure.

b) High secondary-sodium pressure.

c) Possible high temperature in the steam generator and secondary-sodium loop.

d) Possible high level in the main secondary expansion tank.

4) If the above events are indicated, proceed as follows:

a) Press reactor scram button.

b) The Edison operator will shut off the boiler feedwater pumps.

c) Close the steam-generator outlet and inlet blocking valves V-164 and V-165.

e) Adjust the auxiliary system to handle the afterglow heat load.

26) Turbine Throttle Valve: tripped closed

This alarm may be caused in the following ways:

a) Nonsynchronization between the turbine-generator output and the line voltage.

b) Reverse current in the generator, causing the generator to act as a motor.

c) Inadvertent closing of the generator field breaker.

d) Generator overspeed (>3960 rpm).

e) Loss of auxiliary power.

f) Generator phase unbalance.

g) 480-V bus overload.

h) Opening of 4160-V air circuit breaker.

When the throttle valve trips, the heat removal capability of the Edison Plant is reduced to 4 Mw.

<u>Corrective Action</u>

a) If reactor power is over 4 Mw, safety valves on the steam generator will open.

b) Reduce reactor power and sodium flow as rapidly as possible until the reactor power is below 4 Mw. It will not be necessary to scram the reactor.

c) Maintain reactor power below 4 Mw until Edison personnel have determined cause of the turbine throttle trip and corrected the difficulty.

d) Notify Shift Supervisor

27) Sodium Leak

A sodium leak alarm will indicate the location, or in case of line leakage, the line number in which the leak occurs. The action to be taken will depend upon the location. The Shift Supervisor is to be notified immediately upon receipt of a leak alarm.

a) A leak in the main or auxiliary process piping will, in general, require the reactor to be shut down immediately.

b) A leak in any of the branch loops can be isolated by valving off the loop. These are listed below:

1) Cold traps

a) Primary

b) Main Secondary.

2) Plugging-meter loops

a) Primary and main secondary

b) Auxiliary secondary.

c) An isolated loop can be allowed to cool so that further leakage is reduced.

d) If a leak alarm is received for the main primary system, the reactor will be shut down using emergency shutdown procedure and the load transferred to the auxiliary system.

1) Reduce the core-tank helium pressure to 0.5 psig.

2) The main primary and secondary pumps will be stopped as soon as possible.

3) If the indicated leak is high in the system, it may be possible to reduce the sodium level in the main system by lowering the core-tank level and thus lower the sodium below the leak.

This is to be done only after unloading the reactor to 15 elements as indicated in section II-E (Heat Transfer System Draining).

4) If the indicated leak is near the sodium exit level of the core tank, the main loop will be valved off by closing the main block valves (V-101), (V-104), (V-103),

and (V-104A). No attempt to lower the sodium level will be made until the afterglow heat has decreased to a level where it is considered safe to remove the auxiliary heat transfer system from service. Sodium level shall be lowered only according to procedure II-E.

e) A leak in the auxiliary primary system will be treated as outlined above for the main primary.

   1) Afterglow heat load will be transferred to the main system.

   2) Auxiliary pumps will be shut down.

   3) Valve off either the auxiliary primary loop or drain the loop to a level below the leak.

f) An indicated leak in the sodium-service piping in the main gallery, auxiliary gallery, primary fill tank, or sodium service vault will be handled as outlined for the separate loops. The leaking section will be isolated from the remainder of the system.

g) Indicated leak in the core tank.

   1) The reactor will be shut down immediately.

   2) When safe to do so and when ordered by the SRE Group Leader, fuel will be removed and the core tank drained to the primary fill tank.

h) Indicated leak on the secondary-system piping between the intermediate heat exchangers and the secondary area.

   1) Shut down the reactor using emergency shutdown procedure.

   2) Transfer the afterglow heat load to the system not affected.

   3) Isolate the leaking section if possible.

4) Drain the secondary system involved to the secondary fill tank.

28) Helium Gas Supply: less than 125 psig

Corrective Action

a) This alarm indicates either a leak in the high-pressure manifold or depletion of the bottle bank in use.

b) Proceed immediately to the helium-bottle manifold located outside the northwest corner of the building and valve off the bottle bank in use and cut in the standby bank.

c) A check of the helium-bottle log should be made to determine if the rate of helium depletion is excessive. If so, a check should be made for abnormal downstream flow.

29) Decay Tank Pressure: greater than 125 psig

Corrective Action

a) Valve off the inlet line to the tank with excessive pressure.

b) Valve the compressor discharge into an empty tank.

30) Failure of B+ power for Neutron Detector

Corrective Action

a) If only one chamber is involved, the power level will be maintained constant and necessary repairs effected.

b) If two or more of the chambers are inoperative, the reactor will be shut down in accordance with normal shutdown procedure.

31) Helium Pressure in Core Tank Cavity: greater than 5 psig

Corrective Action

a) This alarm indicates failure of the helium-pressure relief valve (RV-402) (relieves at 4.5 psig).

b) Vent the core tank cavity to the vent system by opening vent valve (V-459) and reduce the pressure to 0.2 psig. Close vent valve (V-459).

c) At 0.2 psig there should be no helium flow indicated at PC-473. If flow exists reset PC-473 for no flow at 0.2 psig.

d) By opening PC-473 bypass valve (V-270C) increase pressure to 4.5 psig. RV-402 should be set so that flow is just starting at 4.5 psig.

32) Primary-Fill-Tank Helium Pressure: >4 psig <0. 5 psig

Corrective Action to Reduce the High Pressure

a) Notify Shift Supervisor.

b) Close the solenoid control valves for pressure control stations PC-432 and PC-417 by pressing the buttons on panel HH.

c) If the primary-fill-tank-pressure continues to rise, the primary fill tank relief valve will open at 5 psig. At 5.25 psig, the primary-fill-tank rupture disc will allow the pressure to be relieved to the vent system. As the pressure drops below 5 psig, the reactor relief valve will close to permit the rupture disc to be replaced.

d) Open the solenoid valve for helium-pressure control station PC-432 and vent the primary fill tank to 3 psig by opening the relief-valve bypass valve (V-497C).

e) With the primary fill tank pressure at 3 psig, observe the flow indicator on PC-432. If flow is indicated, the set point is above 3 psig and requires resetting.

f) If no flow is indicated, repeat steps c), and d) for PC-417.

g) If both pressure control stations and pressure gages are operating properly and the primary fill tank pressure again rises to 4 psig, a survey of the entire helium supply for the main-heat-transfer system is required. Check all branch lines for abnormal flow. Correct, if necessary.

Corrective Action to Increase the Low Pressure

a) Notify Shift Supervisor.

b) Check PC-417 and PC-432. Flow should be indicated for primary fill tank pressure lower than 0.5 psig. Check to be sure that the pressure gage is operating properly.

c) If pressure continues to drop, bring the pressure back up to 0.5 psig by opening PC-432 bypass valve V-292C.

d) If no flow is indicated at PC-417 and PC-432 for a pressure less than .05 psig, the controllers must be reset.

e) If PC-432 and PC-417 are operating properly, a leak is indicated. A survey of vent and helium corrections must be made to determine leakage point.

33) Reactor Helium Pressure: >4 psig <0.5 psig

Corrective Action to Reduce the High Pressure

a) Notify Shift Supervisor.

b) Close the solenoid control valves for pressure control stations PC-432 and PC-417 by pressing the buttons on panel HH.

c) If the reactor pressure continues to rise, the reactor relief valve will open at 5 psig, and the reactor rupture disc will allow the pressure to be relieved to the vent system. As the pressure drops below 5 psig, the reactor relief valve will close to permit the rupture disc to be replaced.

d) Open the solenoid valve for helium pressure control station PC-432 and vent the reactor core tank to 3 psig by opening the relief valve bypass valve V-551.

e) If no flow is indicated, repeat steps c) and d) for PC-432.

f) If both pressure control stations and gages are operating properly and the reactor pressure again rises to 4 psig, a survey of the entire helium supply for the main heat-transfer system is required. Check all branch lines for abnormal flow. Correct, if necessary.

Corrective Action to Increase the Low Pressure

a) Notify Shift Supervisor.

b) Check PC-417 and PC-432. Flow should be indicated for reactor pressure lower than 3 psig. Check the operation of the pressure gage.

c) If pressure continues to drop, bring the pressure back up to 3 psig by opening PC-417 bypass valve (V-268C).

d) If no flow is indicated at PC-417 and PC-432 for a pressure less than 3 psig, the controllers must be reset.

e) If PC-432 and PC-417 are operating properly, a leak is indicated. A survey of vent and helium connections must be made to determine leakage point.

34) Nitrogen Gas Supply: less than 9 psig and greater than 25 psig

Corrective Action to Increase the Pressure

a) This alarm indicates failure of the automatic pressure controller or depletion of the supply of liquid nitrogen.

b) Check instrument air pressure.

c) Notify Shift Supervisor.

d) Check pressure controller and gages for proper operation. If operation is normal, check level in tank. Refill tank if necessary.

Corrective Action to Reduce the Pressure

a) This alarm indicates failure of the automatic pressure controller.

b) Notify Shift Supervisor.

c) Check instrument air pressure. It should be about 50 psig.

d) Check pressure controller for proper operation and repair if necessary. Manually open vent valve on tank and lower pressure to 20 psig. Check pressure gages to be sure they are operative.

35) Insulation Cavity Nitrogen Pressure: greater than 5 psig or less than 0.5 psig

Corrective Action to Reduce the High Pressure

a) This alarm indicates failure of the nitrogen pressure relief valve RV-501 (relieves at 4.5 psig). If the pressure continues to rise, it will relieve at 6 psig by the vent system relief RV-601.

b) Notify Shift Supervisor.

c) Vent the insulation cavity to the vent system by opening valve (V-491), and reduce the pressure to 3 psig. Close valve (V-491).

d) At 3 psig there should be no nitrogen flow indicated at PC-505. If flow exists, reset PC-505 for no flow at 3 psig.

e) By opening PC-505 bypass valve (V-358C) increase pressure to 4.5 psig. RV-501 should be set so that flow is just starting at 4.5 psig.

f) Check pressure gages to be sure they are operative.

Corrective Action to Increase the Pressure

a) This alarm will indicate either a leak in the insulation cavity or a malfunction of the pressure control station and/or vent system relief valve.

b) Notify Shift Supervisor.

c) If pressure is decreasing, check the flow and pressure gages at PC-505. If flow is indicated, the nitrogen-system relief valve RV-501 or vent-system relief valve RV-601 may be sticking in the open position. These valves must be checked and reset if necessary. If no flow is indicated at PC-505, this will indicate malfunction of PC-505 and will necessitate repair or resetting.

d) Nitrogen pressure can be controlled manually during this period by operation of PC-503 bypass valve (V-358C).

36) Compressor Suction Tank Pressure: greater than 14 psia (0.3 psig)

Corrective Action

a) Notify Shift Supervisor.

b) Check to see that both compressors are operating.

c) See that suction tank valve (V-519A) is closed.

d) Check the operation of the high pressure switches (HPS-612) (HPS-614).

e) Operate one compressor at a time to isolate the defective unit.

f) Check pressure gages to be sure they are operative.

37) Pump Casing Helium Pressure: less than 0.5 psig

Corrective Action

a) Notify Shift Supervisor upon receipt of alarm.

b) Inspect the area and determine which of the four pump casings has the low pressure. Check pressure gages.

c) Increase the pressure by adjusting one of the following pressure control valves:

Main Primary	PC 442	Auxiliary Primary	PC 445
Main Secondary	PC 454	Auxiliary Secondary	PC 459

d) If the low pressure still exists, check the pump casing for leaks.

38) Pump Coolant Systems

a) Low NaK Flow

This alarm may be caused by a loss of NaK level, stoppage of the pump, or plugging of the coolant line.

Corrective Action

1) Notify Shift Supervisor.

2) Proceed immediately to the NaK system which has originated the alarm.

3) Check for NaK flow in all circuits. If only one circuit has low flow, NaK level is adequate and pumps are operating.

4) Check valves in the circuit which originated the alarm. They should be open.

5) Check temperature of freeze seal being cooled by the NaK circuit under consideration. If temperature is normal, NaK flow exists and the alarm has been caused by an instrument failure.

6) If the above steps indicate loss of NaK flow, shut the reactor down using emergency shutdown procedure.

7) Pressurize the pump case to 15 psig and stop the pump. Allow the other loop (main or auxiliary) to take over the cooling load.

b) Low NaK Level

Corrective Action

1) Notify Shift Supervisor.

2) Shut the reactor down using emergency shutdown procedure.

3) Pressurize the pump case to 15 psig and stop the pump. Allow the other loop (main or auxiliary) to take over the cooling load.

4) Refill NaK loop to the proper level after leak checking the system.

c) Loss of Air Flow

Corrective Action

1) Notify Shift Supervisor.

2) Proceed to the NaK system which has originated the alarm.

3) Switch to alternate blower motor.

4) If neither blower motor will run, check that breakers 5, 6, 7, and 8 on panel D in equipment room are closed. Check that breakers 6, 8, 10, and 12 on panel H in the equipment room are closed.

5) If steps 1) through 4) do not correct the situation, shut the reactor down in accordance with emergency shutdown procedure.

6) Check pressure gage and then pressurize the pump case to 15 psig and stop the pump. Allow the other loop (main or auxiliary) to take over the cooling load.

d) Abnormal Pump Control Circuit

Corrective Action

1) Notify Shift Supervisor.

2) This alarm indicates that the pump other than the selected lead pump is running.

3) Turn pump selector switch to the pump which is running. This will clear the alarm.

4) Notify maintenance unit that NaK pump requires a mechanical and electrical checkout. This checkout should be performed immediately.

e) Loss of Control Power

Corrective Action

1) Notify Shift Supervisor.

2) Check that breakers 6, 8, 10, and 12 on panel H in the equipment room are closed.

3) If the above breakers are closed, and control power is still lost, proceed to shut the reactor down in accordance with emergency shutdown procedure.

4) Pressurize the pump case to 15 psig and stop the pump. Allow the other loop (main or auxiliary) to take over the cooling load.

39) Brake Panel

a) Main primary brake temperature: greater than 300°F

b) Main secondary brake temperature: greater than 300°F

Corrective Action

1) Notify Shift Supervisor.

2) Reduce current to the brake which shows the high temperature.

c) Abnormal brake circuit

This alarm indicates an open brake coil circuit. In case of a scram, the brake will not come on.

Corrective Action

1) Notify Shift Supervisor.

2) Immediately begin to reduce reactor temperature at the rate of 60°F/hr. Follow "Normal Shutdown Procedure." This will minimize convection flow after scram and hence minimize the need for the brake.

3) In case of a scram, adjust convection flow by throttling V-103 in the main primary loop or V-165 in the main secondary loop, depending on which brake is out of service.

4) Repair brake circuit at earliest possible time.

d) Abnormal Brake Current: >20 amperes

Corrective Action

1) Notify Shift Supervisor.

2) Immediately reduce brake current from console rheostat.

3) If step 2) fails, turn off brake supply breaker on brake panel.

40) Loading Face Cooling Flow: less than 10 gpm

Corrective Action

1) Notify Shift Supervisor.

2) Close kerosene valve V-735B.

3) Connect kerosene jumper lines 761 and 762.

4) Open valves V-862A, V-862B, V-761A, and V-761B.

5) Check the strainer basket on the suction side of the pump for plugging; if the basket is plugged, clean, replace, and return pump to normal operation.

6) If these steps do not correct the flow, cool the reactor to 350°F.

41) Loading Face Cooling Expansion Tank Level: less than 2 in.

Corrective Action

1) Notify Shift Supervisor.

2) Low expansion-tank level will be the result of a leak in the circuit.

3) Visually inspect the piping and equipment for leaks.

4) If no leaks are visible, the leak may be within the top shield. In this case it will be necessary to shut down the reactor and drain the kerosene from the circuit per section V-D.

5) If the leak is external to the top shield, make the required repair. Supply make-up kerosene as required.

6) If the leak is large and an immediate repair cannot be made, de-energize the top-shield cooling circuit pump and shut down the reactor. Cool the reactor down to 350°F.

42) Moderator-Can Differential Temperature: greater than ±10°F

This alarm indicates that the fuel-channel exit temperature is either greater than or less than the moderator-can wall temperatures.

Corrective Action

1) Observe the moderator differential recorder. If the pen has moved to the right, tripping the upscale alarm, the fuel-channel exit temperature is higher than the moderator-can wall temperature. To correct this condition, decrease the moderator-reflector coolant flow (line 104).

2) If the pen has moved to the left, indicating that the fuel-channel exit temperature is lower than the moderator-can wall temperature, increase the moderator-reflector coolant flow (line 104).

3) When increasing and decreasing reactor power (neutron level), maintain the rate of power change low enough to prevent the moderator differential temperature alarm from occurring.

43) Kerosene Supply Level: less than 36 in.

Corrective Action

a) Notify Shift Supervisor.

b) This alarm indicates a leak in the kerosene system.

c) If the rate of decrease of supply tank level is large, the reactor should be shut down immediately and every effort made to isolate the leaking section.

d) If the rate of decrease is small, the leaking section will be determined and isolated.

e) Supply make-up kerosene to the supply tank if required.

f) If the leaking section is supplying a vital reactor function, the reactor will be shut down using normal shutdown procedure and repairs made if possible without interruption of the required coolant flows.

44) Evaporative Cooler Water Flow: less than 5 gpm

This alarm indicates a low water level in the evaporative cooler reservoir or failure of the cooling-tower water pump.

Corrective Action

1) Check water level in reservoir. Adjust float level if necessary.

2) Check water makeup valve. Open if necessary.

3) If water pump has stopped, emergency water flow should be established automatically. Check emergency water valves to be sure that they are open.

4) Repair pump if necessary.

5) Cooling load on this system is such that either evaporative cooler can carry the load by itself. Make sure that alternate cooler is operating normally.

6) If none of the above steps removes the condition, the reactor shall be shut down according to normal shutdown procedure.

XVI. SPECIAL PROCEDURES

June 27, 1960

A. OPERATING PROCEDURE FOR 25-FT GAS LOCK

The 25-ft gas lock is to be used only to insert and withdraw nonradioactive (300 mr/hr max.) elements from the SRE core. Operation consists of bolting the gas lock to the reactor loading face, purging the gas lock with inert gas, and raising (or lowering) the element by means of a hand-operated switch.

The objective of the following procedure is to outline the steps necessary to replace a shield plug with another type of element.

1. Removal of Shield Plug

   a) Install lifting adapter to selected shield plug.

   b) Install 6-in. vacuum valve.

   c) Locate gas lock over selected hole on loading face and lower pickup device with winch.

   d) Attach pickup device to lifting adapter.

   e) Bolt gas lock down to 6-in. gas lock valve.

   f) Vent core to 0.5 psig.

   g) Run Tygon tubing from valve to vent system. Open valve.

   h) Connect argon supply to the two quick-disconnects and purge for 5 min.

   i) Select "up" position on winch and remove element from hole.

   j) Close gas-lock valve.

   k) Purge 5 min to vent system.

   l) Unbolt and remove gas lock from vacuum valve.

   m) Move gas lock to selected storage cell. Lower element in hole.

2. Installation of Element in Core

   a) Assuming element is in gas lock, follow steps A2, 5, 7, and 8.

   b) Open vacuum valve and lower element in core.

   c) Purge for 5 min, unbolt from vacuum valve, and remove gas lock.

B. PROCEDURE FOR INSTALLING NEUTRON SOURCE IN REACTOR

The objective of the following procedure is to outline the steps necessary to transfer the source capsule from the shipping cask in which it is received, to the reactor. To do this, the Component Development Hot Cell (CDHC) is used to remove the source capsule from its aluminum irradiation capsule, and the source capsule is shipped from CDHC to the SRE hot cell where it is attached to the inner source assembly. The fuel handling machine is then used to transfer the inner source assembly to the reactor.

The SRE Neutron source is irradiated in the ETR, Arco, Idaho. Upon discharge from the reactor, activity of the SB^{124} is normally 30 to 40 curies. Thus, the radiation level at one foot from the source capsule in about 400 r/hr (2 Mev gamma).

TO INSERT NEW SOURCE IN REACTOR

In High Bay Area

1) Transfer entire source assembly from storage cell to R39 with fuel cask.

At CDHC

2) Source capsule (9693-72127) will be delivered to CDHC in a lead-shielded cask.
3) Place cask in cell.
4) Remove cask lid.
5) Withdraw new source capsule. Capsule is contained in an aluminum enclosure. Remove cotter pin from cap on aluminum enclosure. Remove cap.
6) Place new source capsule in cask. Replace lid. Ship cask to SRE hot cell.

At SRE Hot Cell

7) Withdraw new source capsule from cask. Place in special capsule holder. (Two such holders are required)

In High Bay Area

8) Remove outer snap ring from source assembly upper plug.

9) Install snap ring and lifting ring in inner plug assembly.

10) Using fuel handling machine, transfer inner assembly from R39 to hot cell. Lower assembly into hot cell. Stop lowering when hot cell personnel indicate that source capsule is in proper position for detachment from inner hanger. NOTE: An inert atmosphere will not be required for this operation.

In SRE Hot Cell

11) Clamp inner hanger at a position about 3 in. above source capsule.

12) Place capsule holder in position just under source capsule.

13) Grip flats on capsule with a 7/16-in. open-end wrench. (Distance across flats is 0.406 in. Use of a 7/16-in. wrench will allow clearance between wrench and flats of about 0.031 in. This is sufficient to allow for easy manipulation.)

14) Unscrew source capsule from inner hanger. This is a right-hand 1/4-20 thread. It requires approximately 5 1/2 turns to unscrew the capsule.

15) Place old source capsule in cask and attach new capsule to hanger. Screw capsule up tight against the shoulder on the inner hanger cap.

16) Place lid on cask.

In SRE High Bay Area

17) Transfer inner assembly, complete with new source capsule, from hot cell to R39. Use fuel handling machine.

18) Lower inner assembly carefully into outer assembly. At a grapple veeder reading of 175 in. above floor level, the tip of the capsule will reach the step in the outer assembly. At this point, there is a 1-3/4-in. "funnel" to guide the tip of the capsule into place. However, around the perimeter of the funnel is a 3/4 in. ledge, which may cause the assembly to "hang up."

19) If load falls off at this point, attempt to free the "hang up" by raising and lowering the assembly several times. If the capsule goes in freely, continue lowering all the way.

20) If hang up cannot be freed, raise the fuel handling machine shield and bellows. Have H.P. monitor. (Radiation level should be low.)

21) Using special hook, guide assembly while lowering the fuel handling machine grapple. After several trials, inner assembly should slide in freely.

22) Replace outer snap ring. Remove inner lift ring. Source is now installed in reactor.

C. SRE EMERGENCY EVACUATION PLAN

1. Objective

To remove personnel from dangerous areas to safe locations and minimize extent of a hazard at the source.

2. Purpose

To minimize hazards to personnel and to contain the extent of an incident as much as reasonably possible.

3. Method

a) Establish that an emergency or potential emergency condition exists and determine extent of this situation.

b) Alter or secure operation of facilities to minimize severity of emergency.

c) Notify all concerned personnel and order evacuation when required.

d) Evacuate designated areas.

e) Establish which areas are safe to re-enter and issue such orders.

f) Re-enter "cleared" areas.

4. Procedure

a. Definitions

1) Nonradioactive incidents are caused by fires, explosions, collapse of structures and facilities, etc., in which radioactivity has not been released.

2) Radioactive incidents are characterized by a release of radiation or radioactive materials and are classified into three categories:

Class I - Any small-scale radiological situation which may be controlled by concerned personnel who are immediately available.

Class II- Any radiological situation involving personnel or areas outside the immediate locale of the incident but within the confines of AI or AEC property.

Class III- Any radiological situation involving personnel and areas outside AI or AEC property.

b. Initial Notification and Determination

It is the duty and responsibility of any person at the SRE site immediately to notify the Shift Supervisor of SRE Operations of any situation which presents a danger to personnel who are either on or off the site.

The Shift Supervisor of SRE Operations with the cooperation of Health Physics and Industrial Security Fire Groups shall immediately determine the extent of the hazard.

The Industrial Security Fire Group will monitor and evaluate all situations concerning radiation levels and radioactive contamination relative to an incident and promptly advise the Shift Supervisor of SRE Operations and other concerned personnel involved, such as Industrial Security employees. Atmospheric conditions shall be considered as a factor in such cases.

In case of a Class III radioactive incident, Health Physics Group will immediately notify the proper personnel concerning the protection and/or evacuation of people outside AI or AEC property.

The supervisor, Hot Cell, or delegated representative will advise concerning incidents involving the Hot Cell. In absence of Hot Cell personnel, this activity will be performed by Health Physics Group.

c. SRE Operation Changes

As required, the Shift Supervisor of SRE Operations shall direct the operation or shutdown of reactor components in such a manner as to minimize severity of a hazardous situation. When possible, equipment shutdown shall be effected in accordance with SRE Standard Operating Procedures.

d. Evacuation Instructions and Notifications

The Shift Supervisor of SRE Operations shall have the responsibility and authority to order a partial or complete evacuation of SRE areas when a situation merits such action. Except for Industrial Security personnel, evacuation orders will be considered mandatory.

Health Physics may appeal any decision regarding evacuation, entry, of re-entry by contacting proper company personnel.

The Shift Supervisor of SRE Operations has the responsibility to advise all persons affected by evacuation decision of emergency situations and action to be taken. People to be notified include Operations, Maintenance, Hot Cell, Medical, Industrial Security, ETB, Experimental, Southern California Edison, and outside contractor employees plus visitors. PA system, telephone, and personal contact messages may be used for notification.

If possible, evacuation route and temporary assembly area will be announced which will depend upon weather conditions, contamination, and other dangerous situations, etc., as recommended by Industrial Security and Health Physics.

The Shift Supervisor of SRE Operations will notify Industrial Security Post I (Ext. 444 or DIamond 0-0300) of evacuation plans and policing required. Post I will then contact Industrial Security Control Center at DeSoto facility. DeSoto control center maintains lists of personnel to be called under various emergency conditions and will accordingly take such action depending, on degree and type of incident or emergency.

e. Evacuation

All persons at SRE site subject to evacuation orders shall immediately cooperate and vacate designated premises per instructions issued by the Shift Supervisor of SRE Operations. Trapped or incapacitated personnel will be rescued and evacuated by Industrial Security Fire Group.

Transportation of persons in company vehicles for purposes of evacuation will be under the direction of Industrial Security. Operation of vehicles may be performed by support and auxiliary personnel as directed by Industrial Security supervision at site.

f. Determining Safe Areas and Re-entry Orders

Industrial Security Fire Group will advise the Shift Supervisor of SRE Operations when an area which was evacuated for non-radioactive reasons may be re-entered.

Health Physics will advise the Shift Supervisor of SRE Operations when an area which was evacuated for radioactive reasons may be re-entered.

The Shift Supervisor of SRE Operations shall issue instructions and orders relative to re-entry of areas judged to be safe. Industrial Security Guard Group, including Post I, shall be notified immediately of such decision, and policing required.

g. Re-Entry

Persons re-entering a previously evacuated area at the SRE site shall do so in accordance with instructions issued by the Shift Supervisor of SRE Operations and in cooperation with Industrial Security and Health Physics Personnel. Areas which have not been cleared or which are posted as being unsafe will not be re-entered.

D. RESCUE, FIRST AID, AND CONTROL OF DESTRUCTIVE EVENTS AT THE SRE

1. Objective

To aid personnel in physical distress and minimize damage caused by destructive conditions.

2. Purpose

To provide the best possible conditions from which to recover from an incident.

3. Method

a) Notify concerned personnel regarding emergency condition.

b) Establish that personnel require aid or that an emergency or destructive condition exists, and determine extent of this situation.

c) Alter or secure operation of facilities to minimize severity of emergency.

d) Rescue personnel and render first aid; transport incapacitated personnel to hospital.

e) Perform action to control or contain destructive conditions.

4. Procedure

a. Definition

An emergency represents a condition where special equipment or skills are immediately necessary to prevent or contain a development which threatens personnel or property.

b. Notification

It is the duty and responsibility of any person at the SRE site or adjoining location to notify immediately Industrial Security Post I (Ext. 444 or DIamond 0-0300) and the shift supervisor of SRE Operations when a person is in physical distress or when a condition exists which represents or may develop into an emergency situation. This also applies to hazardous experiments which might create a destructive event.

If immediate action appears to be required, Post I will promptly notify all available personnel necessary to cope with the emergency. Post I will also notify Vanowen Control Center when required.

Vanowen Control Center will maintain notification lists and action plans for various emergencies.

c. Evaluation

Industrial Security Group and the Shift Supervisor of SRE Operations, with the cooperation of any other group concerned, shall immediately determine the extent of the emergency.

The Health Physics Group will monitor and evaluate all situations concerning radiation levels and radioactive contamination and consistently advise the shift supervisor of SRE Operations and other concerned personnel, such as Industrial Security and Medical employees. In absence of Hot Cell personnel, Health Physics will advise concerning matters involving the Hot Cell facility.

d. Operation Changes and Traffic Control

The Shift Supervisor of SRE Operations shall direct the operation or shutdown of reactor components and other site facilities in such a manner as to minimize severity of a hazardous situation. When possible, equipment shutdown shall be effected in accordance with Standard Operating Procedures.

Industrial Security Guards will control movement of all traffic relative to emergency situations.

e. Rescue and First Aid

Industrial Security Fireman will respond to all calls pertaining to personnel in physical distress and will perform rescue and resuscitation operations, working in conjunction with other personnel, as required.

Use of resuscitation on ill persons will be made with great care, and directions from Medical Department personnel will be followed when possible.

Medical Department personnel will perform required first aid operations, advise regarding resuscitation requirements, advise regarding additional medical attention. Normally, AI employees requiring hospital treatment will be directed to Northridge Hospital, 18300 Roscoe Boulevard (immediately east of Reseda Boulevard, Northridge, California.)

AI Medical Director will supply Industrial Security Post I, Vanowen Control Center, and the SRE First Aid Station with a list of doctors and hospitals to be called under various conditions.

Purchasing Department will supply AI Medical Director with a list of doctors and hospitals to be contacted when contractor personnel require medical attention.

In case of contaminated wounds, Health Physics personnel will advise Medical personnel on decontamination operations.

f) Transporting Incapacitated Personnel

Medical Department will determine when transportation to a hospital is advisable and if ambulance is required.

Industrial Security Fireman or authorized representative will drive vehicle when requested by Medical Department personnel and/or as instructed by Industrial Security supervision present. Excessive speed and use of siren will be avoided whenever possible.

The ambulance may travel without Medical Department personnel aboard and before a doctor or hospital has been contacted. Medical Department personnel (nurse) will normally call a doctor and hospital before ambulance leaves SRE site. In all cases, Industrial Security Post I will make sure such contact has been made; and if not, Post I will place such calls.

Except for the ambulance which normally will be parked near the SRE First Aid Station, all company-owned vehicles assigned to AI at Santa Susana Field Laboratory that are not in use on swing and graveyard shifts will be left at Post I parking lot for emergency use.

g) Emergency Control Action

Industrial Security Fireman will respond to all calls concerning fire, explosions, and other destructive situations such as uncontrolled release of dangerous or undesired chemical substances, flood or storm conditions, etc., and will utilize necessary equipment and personnel for control or containment purposes.

Health Physics personnel will monitor radiological situations and advise Industrial Security Firemen regarding such matters.

SRE Operations Shift Supervisor and delegated personnel shall assist Industrial Security Firemen as much as reasonably possible when such help is requested.

APPENDICES

June 27, 1960

APPENDIX I: SRE FORMS

June 27, 1960

WASH-CELL CHECK OFF SHEET (Sheet 1 of 4)

Procedure XI Step	Open Valve (s)	✓	Close Valve (s)	✓	Open then Close Valve (s)	✓	Point (s) to Check	✓	Turn Power On	✓	Turn Power Off	✓	Adjust Instru.	✓
A-1)-a.			676											
			979A											
			945											
			903											
			981											
A-1)-b.			679											
			979B											
			965											
			902											
			980											
A-1)-c.			680A											
			979C											
			946											
			901											
			690B											
A-2)			977A											
			978											
			979											
			416											
			417											
			418											
			977B											
A-3)			984											
			985											
			986											
A-4)											All WC Panel Sw.			
									ER-B-17					
									ER-B-19					
									ER-NCP-19					
									Wash Cell Upper Zone					
									Wash Cell Lower Zone					
													T-3 & T-4 to 275 F	
									Oxidizer No. 1 or 2				T-1 or T-2 to 600 F	
A-5)					416									
					978									
					976		Low Level & High Press. c/o							
					977A									

WASH-CELL CHECK OFF SHEET (Sheet 2 of 4)

Procedure XI Step	Open Valve (s)	√	Close Valve (s)	√	Open then Close Valve (s)	√	Point (s) to Check	√	Turn Power On	√	Turn Power Off	√	Adjust Instru.	√
A-7)							Steam Generator Current		Steam Generator (2) Sw's.					
A-8)					976 977B		Water Level in T-3							
B-1)							Plug Placed in Cell							
B-2)	417 979A													
B-3)			979A		903		Empty Cell							
B-4)	676 680B 682 685 989													
B-5)	729 730						6-8 GPM							
B-6)							PI-4 20-30 Psig		Water Pump & Vacuum Pump					
B-7)					993B 690A		PI-Cell 22-24 in. Hg. Vac.							
B-8)	979A		680B				PI-Cell 1-3 psig							
B-9	680B		979A				Repeat Purge							
B-10)	993B 690A						PI-2 10" Hg. Vac.							
B-11)			989											
B-12)			680B 682 676											
					979A		Match Cask Press. & Remove Locking Device							
B-13)							Element in Cell							
B-14)							Cell Lock in Place							

WASH-CELL CHECK OFF SHEET (Sheet 3 of 4)

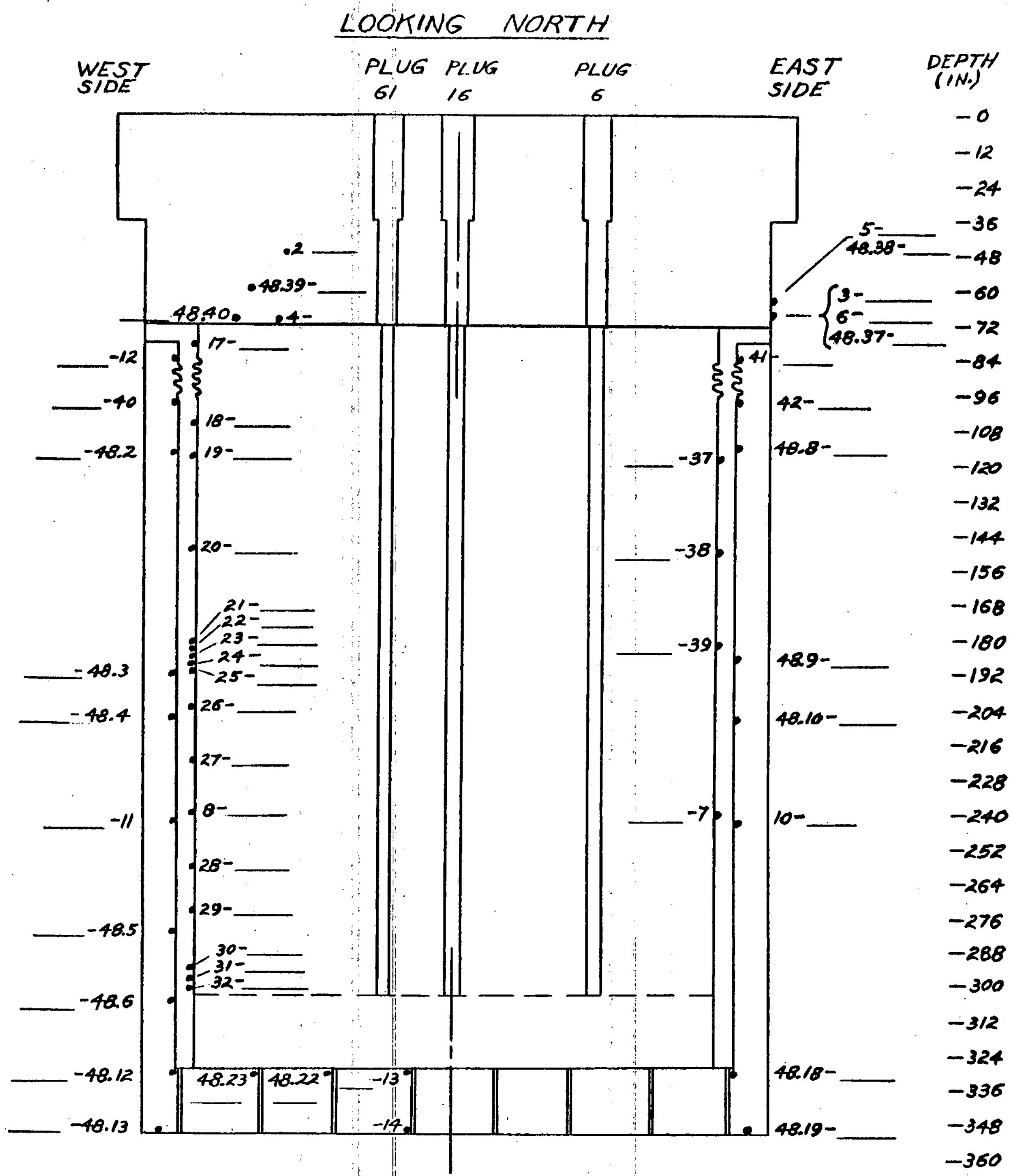
Procedure XI Step	Open Valve (s)	√	Close Valve (s)	√	Open then Close Valve (s)	√	Point (s) to Check	√	Turn Power On	√	Turn Power Off	√	Adjust Instru.	√
C-1)-a.							Wash Cell 275-325 F							
C-1)-b.							Oxidizer 580-750 F							
							Steam Press. 40-42 psig							
C-2)	676 680B 682 685 690A 681													
C-3)			417											
C-4)	979A 979													
C-5)							LC-2 shows a H_2O loss of 4 lb							
			979 979A								Steam Generator			
C-6)											Oxidizer if no more washing			
D-1)					974		H20 Level in tank							
D-2)			981 680B 682 685											
D-3)	986 989 945 964													
D-4)									H20 Pump MM Panel					
			945 964											
D-5)							Drain Sump Tank							
D-6)	418 903		986				MM Panel Light Out							
	417 979A		418											
			417 979A 903											

WASH-CELL CHECK OFF SHEET (Sheet 4 of 4)

Procedure XI Step	Open Valve (s)	√	Close Valve (s)	√	Open then Close Valve (s)	√	Point (s) to Check	√	Turn Power On	√	Turn Power Off	√	Adjust Instru.	√
D-7)			989											
E-1)	986 981													
E-2)							Cell Temp. will rise to 275-325 F							
E-3)			676 986 981											
E-4)					417 979A		Bring Cell Press. to 0 psig PI-A							
E-5)							Remove Element from Cell							
E-6)							Cell is sealed							
E-7)							Start with B-13) Fill S.G. with H_2O							
E-8)							Washing is to be secured							
E-8)-a.											Cell Heaters			
E-8)-b.											Vac. Pump System			
E-8)-c.											H_2O Pump Radiation Det.			
E-8)-d.											Hydrogen Analyzer			
E-8)-e.											Interlock & Level Alarm			
E-8)-f.											WC Panel Control			
E-8)-g.											ER-B-17 ER-B-19 ER-NCP-19			
E-9)			729 730											

WASH CELL VALVE DESIGNATION

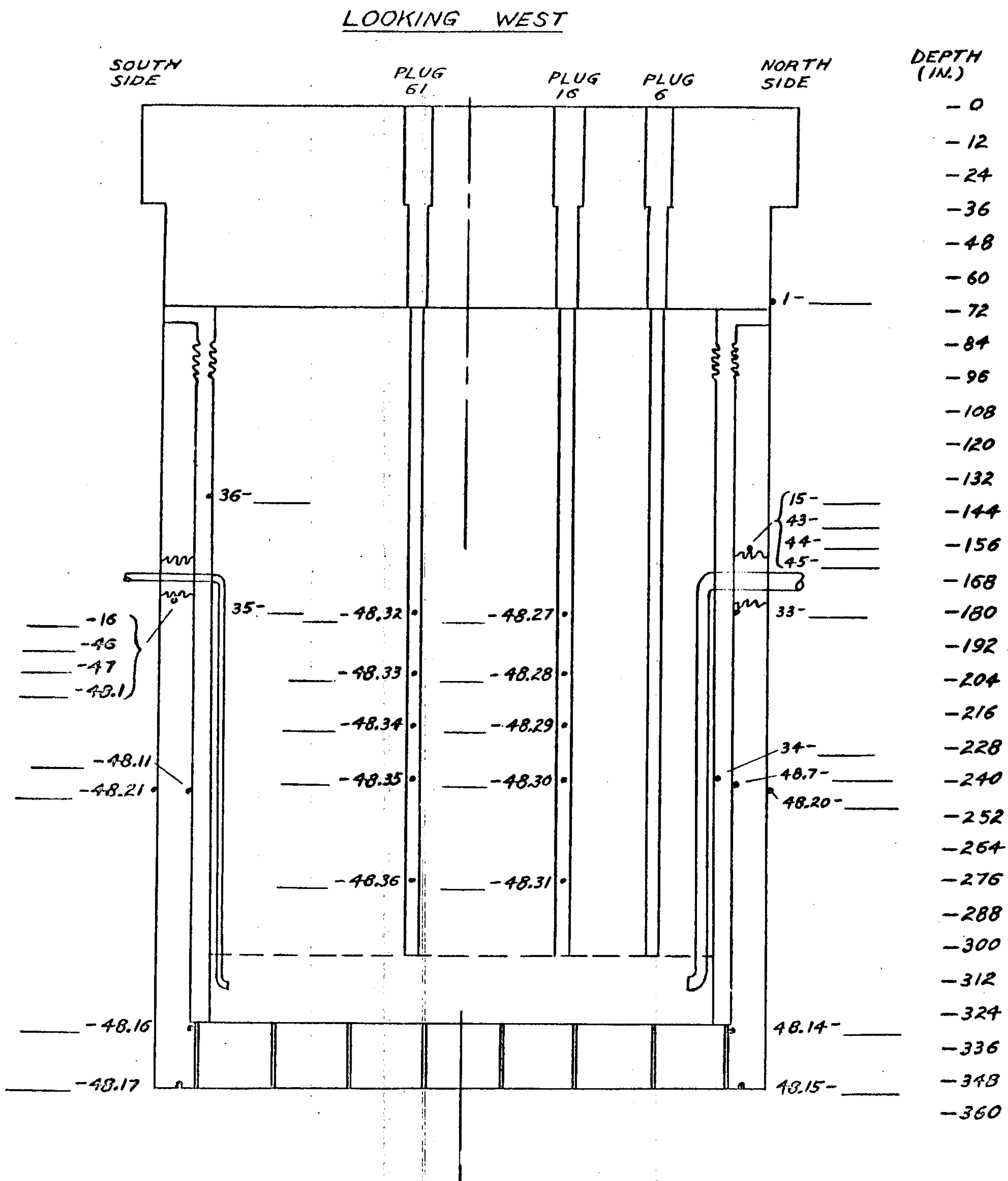
Valve	Description
416	Helium Supply to Steam Generator
417	Helium Supply to Bottom of Cells
418	Helium Supply to Vent Piping
676	Wash Cell A Vent
679	Wash Cell B Vent
680A	Wash Cell C Vent
682	Oxidizer No. 1 Inlet
683	Oxidizer No. 2 Inlet
685	Oxidizer No. 1 Outlet
686	Oxidizer No. 2 Outlet
690A	Recirculation Valve
690B	Wash Cell C He Recirculation Valve
729	Kerosene Coolant Inlet
730	Kerosene Coolant Outlet
901	Wash Cell C Drain
902	Wash Cell B Drain
903	Wash Cell A Drain
945	Wash Cell A Water Inlet
946	Wash Cell C Water Inlet
964	Rinse Water Pump Suction
965	Wash Cell B Water Inlet
977A	Steam Generator Water Inlet
977B	Compression Water Tank (T-3) Water Inlet
978	Steam Generator Drain (Blow Down)
979	Steam Generator Steam Outlet
979A	Wash Cell A Steam Inlet
979B	Wash Cell B Steam Inlet
979C	Wash Cell C Steam Inlet
980	Wash Cell B He Recirculation Valve
981	Wash Cell A He Recirculation Valve
984	Baffle Box Water Flush Inlet
985	Baffle Box Water Flush Outlet
986	Baffle Box and Oxidizer Bypass
989	Vent System Inlet
993B	Vacuum Control Valve



SRE REACTOR TEMPERATURES

HIGH TEMP. SWITCH I-6

OBSERVED BY:
TIME:
DATE:

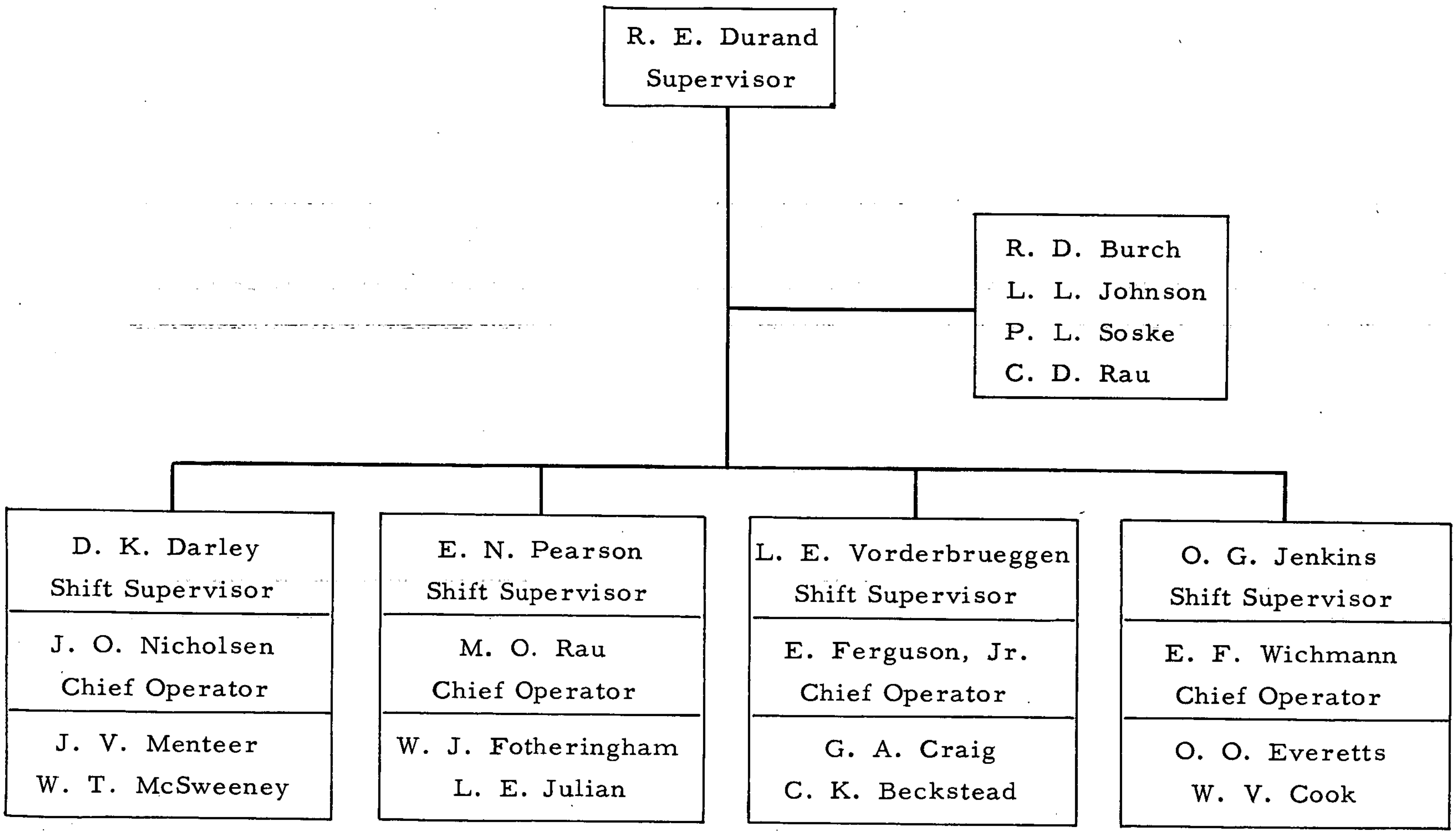


SRE REACTOR TEMPERATURES

HIGH TEMP. SWITCH I-6

OBSERVED BY:
TIME:
DATE:

SRE OPERATIONS UNIT



SRE OPERATING CHECK LIST

Time____________________

Date____________________

Operator____________________

Shift Supervisor____________________

Item	Reading
1. Set helium pressure on control and safety rods at 8-12 psig.	
2. Auxiliary Primary Pump	
a. Casing pressure 0-1 psig	
b. Check for abnormal vibration and noise, overheating of motor, sparking armature brushes	
c. Thrust bearing temperature <150°F	
d. Radial bearing temperature <150°F	
e. NaK level normal	
f. NaK flow normal	
3. Auxiliary primary block valve helium pressure 0-1 psig	
4. Auxiliary primary double wall pipes helium pressure 5-15 psig	
5. Main Primary Pump	
a. Casing pressure 0-1 psig	
b. Check for abnormal vibration and noise, overheating of motor, sparking armature brushes	
c. Thrust bearing temperature <150°F	
d. Radial bearing temperature <150°F	
e. NaK level normal	
f. NaK flow normal	

SRE OPERATING CHECK LIST

Item	Reading
6. Brake Panel	
a. Primary brake "ready"	
b. Secondary brake "ready"	
c. Primary brake preset to come on at 82 gpm	
d. Secondary brake preset to come on at 82 gpm	
7. Radioactive Sump Panel	
a. Alarm lights out	
b. Sump tank drained	
8. Close high bay doors	
9. Gallery O_2 concentration (increase N_2 flow if above 1%)	
a. Main gallery	
b. Auxiliary gallery	
c. Sodium service vault	
10. Primary Fill Tank Vault	
a. Kerosene cooling 4-6 gpm	
b. Nitrogen flow 2 cfm	
c. Replace loose valve operator covers	
11. Main primary double wall pipes helium pressure 5-15 psig	
12. Main primary block valves helium pressure 0-1 psig	
13. Kerosene Pad	
a. Surge tank level 58 inches. If level is below 58 inches, add one barrel of kerosene	
b. Check kerosene pumps for noise, vibration, overheating, oil reservoir	

SRE OPERATING CHECK LIST

Item	Reading
c. Check emergency engine for gasoline, oil, water	
d. Check evaporative cooler pumps and fans for noise and vibration	
e. Check evaporative cooler reservoirs for proper water level and presence of algae	
f. Nitrogen pressure on surge tank 3 psig	
14. Check reactor drain line for proper temperature (300-500°F)	
15. Check secondary drain line for proper temperature (300-500°F)	
16. Sodium service vault	
a. Kerosene flow 4-6 gpm	
b. Replace loose valve operator covers	
17. Main gallery kerosene flow 10-15 gpm	
18. Main secondary pump	
a. Casing pressure 0-1 psig	
b. Check for abnormal vibration and noise, overheating of motor, sparking armature brushes	
c. Thrust bearing temperature <150°F	
d. Radial bearing temperature <150°F	
e. NaK level normal	
f. NaK flow normal	
19. Dehumidification pad	
a. Check water level in collection drum	
b. Check trap for operability (control water level at 1/2 sight glass by operating lower valve)	
c. Check pump and evaporators for overheating	

SRE OPERATING CHECK LIST

Item	Reading
20. Flow in main secondary plugging meter 1-3 mv	
21. Flow in line 427, 1-3 mv	
22. Main secondary expansion tank helium pressure 2-3 psig	
23. Main secondary block valve helium pressure 0-1 psig	
24. Auxiliary gallery kerosene cooling 4-6 gpm	
25. Auxiliary secondary expansion tank helium pressure 2-3 psig	
26. Auxiliary secondary pump	
a. Casing pressure 0-1 psig	
b. Check for abnormal vibration and noise, overheating of motor, sparking armature brushes	
c. Thrust bearing temperature <150°F	
d. Radial bearing temperature <150°F	
e. NaK level normal	
f. NaK flow normal	
27. Blow-down instrument air driers	
28. Check battery room	
29. Diesel control switch on "auto"	
30. Check all M-G sets for overheating	
31. Check lighting timers	
32. Vital bus frequency 60 cps	
33. Vital bus voltage 116-120 volts	
34. M-G set load 20-50 amperes	
35. Battery charging voltage 134 volts	
36. Test off-normal circuits	
37. Mark time on all instrument charts	

SRE OPERATING CHECK LIST

Item	Reading
38. Standardize instruments	
39. Building ventilation system	
a. One high bay exhaust fan on	
b. One high bay supply fan on	
c. Equipment room supply fan on	
d. Four equipment room exhaust fans on	
e. Stack dilution fan on	
40. Drain water from interstages of vent compressors	
41. Drain water from instrument air compressor	
42. Discuss operating plans with Edison personnel	

W = Weekly (30 min.)
M = 1st Sunday of Month
* = Replace filter bag

SRE OPERATIONAL CHECK-OFF

	W		W		M		M							M				M		
Date	Diesel Gen.		Tetralin Gas Engine		Switching of Vent Compressors		Switch & Clean Tet. Strainers							Switch & Dry Inst. Air Driers				Switch Exh. Fans-Inspect Filters		Inspect Outside Pipe Vaults
Sunday 0800-1600	Start	Stop	Start	Stop	Lead	Back-up	1	2	3	4	5	6	7*	One line		Drying		In service		
														East	West	On	Off	East	West	

ELEMENT TRANSFER REQUEST

No.

Requested by________________ Coordinated by________________ Approved by________________

Date________________ Date________________ Date________________

Element	Number	From	To	Purpose	Completion		Remarks
					Date	Initial	

SRE START-UP CHECK LIST

Time____________________

Date____________________

Operator____________________

Shift Supervisor____________________

Item	Check
1. Check control power on.	
2. Standardize all instruments and mark the time on the instrument chart.	
3. Check reactor loading face to insure that all safety and control rods are bolted in place and that all elements are secured in place with at least one washer.	
4. Close high bay doors.	
5. All blocks in main and auxiliary gallery.	
6. Test emergency diesel engine.	
7. Kerosene flowing to main and auxiliary galleries.	
8. Dehumidification system in operation.	
9. Check reactor vent line valves V496 and V137 open.	
10. Reduce reactor helium pressure to 1 psig.	
11. Primary and secondary bulk sodium temperatures between 340°F and 350°F.	
12. Reactor sodium level 118 inches ± 2 inches.	
13. Main secondary expansion tank level 45 inches ± 2 inches.	
14. Auxiliary secondary expansion tank level 9-1/2 inches ± 2 inches	
15. Primary eddy current brake on ready.	
16. Secondary eddy current brake on ready.	
17. Preset primary and secondary eddy current brakes to come on at 82 gpm.	

SRE START-UP CHECK LIST

Item	Check
18. Main primary pump operating at a speed greater than 100 rpm.	
19. Adjust main secondary flow equal to the main primary flow.	
20. Set main pump selector switch on "both."	
21. Set main primary and main secondary acceleration rates at 8%.	
22. Auxiliary primary pump operating at a speed greater than 450 rpm.	
23. Adjust auxiliary secondary flow to match the auxiliary primary flow.	
24. Check auxiliary airblast fan for operation.	
25. Check louver movement on auxiliary airblast heat exchanger.	
26. Remove <u>all</u> jack plugs from scram bypass panel.	
27. Check reactor drain pump for operation.	
28. Check secondary drain pump for operation.	
29. Test off-normal circuit for main primary and main secondary systems.	
30. Vital bus frequency at 60 cps.	
31. Calibrate both Log N amplifiers.	
32. Calibrate both log count rate amplifiers.	
33. Energize safety rod drives.	
34. Energize control rod drives.	
35. Check safety amplifiers.	
36. Check magnet holding current for all four safety rods. The holding current should be approximately 50 ma.	
37. Set the neutron flux level amplifier (Beckman) on the 10^{-9} scale.	
38. Console dc power on.	
39. Fission chambers full in.	
40. Move fast drive for control rods 3 and 4 to upper limit.	

SRE START-UP CHECK LIST

Item	Check
41. Rod control selector switch on "hand."	
42. "Interlocks satisfied" light on.	
43. Check operation of safety rods.	
44. Check perimeter warning lights.	

DECAY TANK SAMPLING AND DISPOSAL

Date	Time	Sampling			Opr.	Release			Operator
		Tank	Activity d/sec	Decay t 1/2		Rate cu. ft/min	Completion Date	Completion Time	

Atomics International — Sodium Graphite Reactors

	REACTOR								FLOW RATES - GPM			
	CR #1	CR #2	CR #3	CR #4	ELECTRO METER	THR. PWR. IND.	THR. PWR. CALC.	Δt	MN. PRI.	MN. SEC.	AUX. PRI.	AUX. SEC.
INSTR.												
0900												
1100												
1300												
1500												
1700												
1900												
2100												
2300												
0100												
0300												
0500												
0700												
AVER.												

	TEMPERATURES								
	REACTOR				REACTOR				
	INLET °F	OUTLET °F	MIHE INLET °F	MIHE OUTLET °F	AUX. INLET °F	AUX. OUTLET °F	AIHE INLET °F	AIHE OUTLET °F	
INSTR.									
0900									
1100									
1300									
1500									
1700									
1900									
2100									
2300									
0100									
0300									
0500									
0700									
AVER.									

	FREEZE SEAL TEMPS.							
	MN. PRI. CASE	MN. PRI. SHAFT	MN. SEC. CASE	MN. SEC. SHAFT	AUX. PRI. CASE	AUX. PRI. SHAFT	AUX. SEC. CASE	AUX. SEC. SHAFT
INSTR.								
0900								
1100								
1300								
1500								
1700								
1900								
2100								
2300								
0100								
0300								
0500								
0700								
AVER.								

	PRESSURES PSI			NA LEVELS			EDISON				
	CORE TK. CAV.	PRI. FILL TK. HE	REACTOR	REACTOR INCHES	MN. SEC. EXP. TK. IN.	AUX. SEC. EXP. TK. IN.	STEAM TEMP °F	STEAM PR. PSIG	FEED-WATER °F	FEED-WATER #/HR.	ELECT. MW IND.
INSTR.											
0900											
1100											
1300											
1500											
1700											
1900											
2100											
2300											
0100											
0300											
0500											
0700											
AVER.											

	SHIFT READINGS																			
	COLD TRAPS				HOT TRAPS†				TETRALIN			SEC. FILL TK.			PRI. FILL		MISCELLANEOUS			
	*TYPE: PRI. SEC.				*TYPE: "A" "B"				LEVEL	FLOW		LEVEL	PR.	TEMP.	LEVEL	TEMP.	"DH"	HE CRADLES		LN_2
									TANK IN.	FUEL STOR. CELL GPM	CORE CAV. LINER GPM	NA IN.	HE PSI	NA °F	NA IN.	NA °F	O_2 CONCENTRATION	PR. PSI	BANK IN SERV.	GALS. ON HAND
INSTR.																				
0900																				
1700																				
0100																				
AVER.																				

DAILY READINGS (TAKEN AT 1700)												
TEMPERATURES												
TETRALIN COOLER				VALVE FREEZE SEALS								
#1 INLET °F	#1 OUTLET °F	#2 INLET °F	#2 OUTLET °F	V101 °F	V103 °F	V104 °F	V114 °F	V160 °F	V164 °F	V165 °F	V175 °F	V177 °F

______ TOTAL HOURS CRITICAL

______ RUN NUMBER

______ MEGAWATT DAYS

DAILY READING AT 1200		
WATT HOUR METERS	240V	480V

NOTES:

DATE: ______

	8-4	4-12	12-8
ENGINEER IN CHARGE:			
CHIEF OPERATOR:			

* CIRCLE ONE

† COLD TRAP LOG ON START UP

730-1-7

APPENDIX II: SRE ELECTRICAL POWER DISTRIBUTION

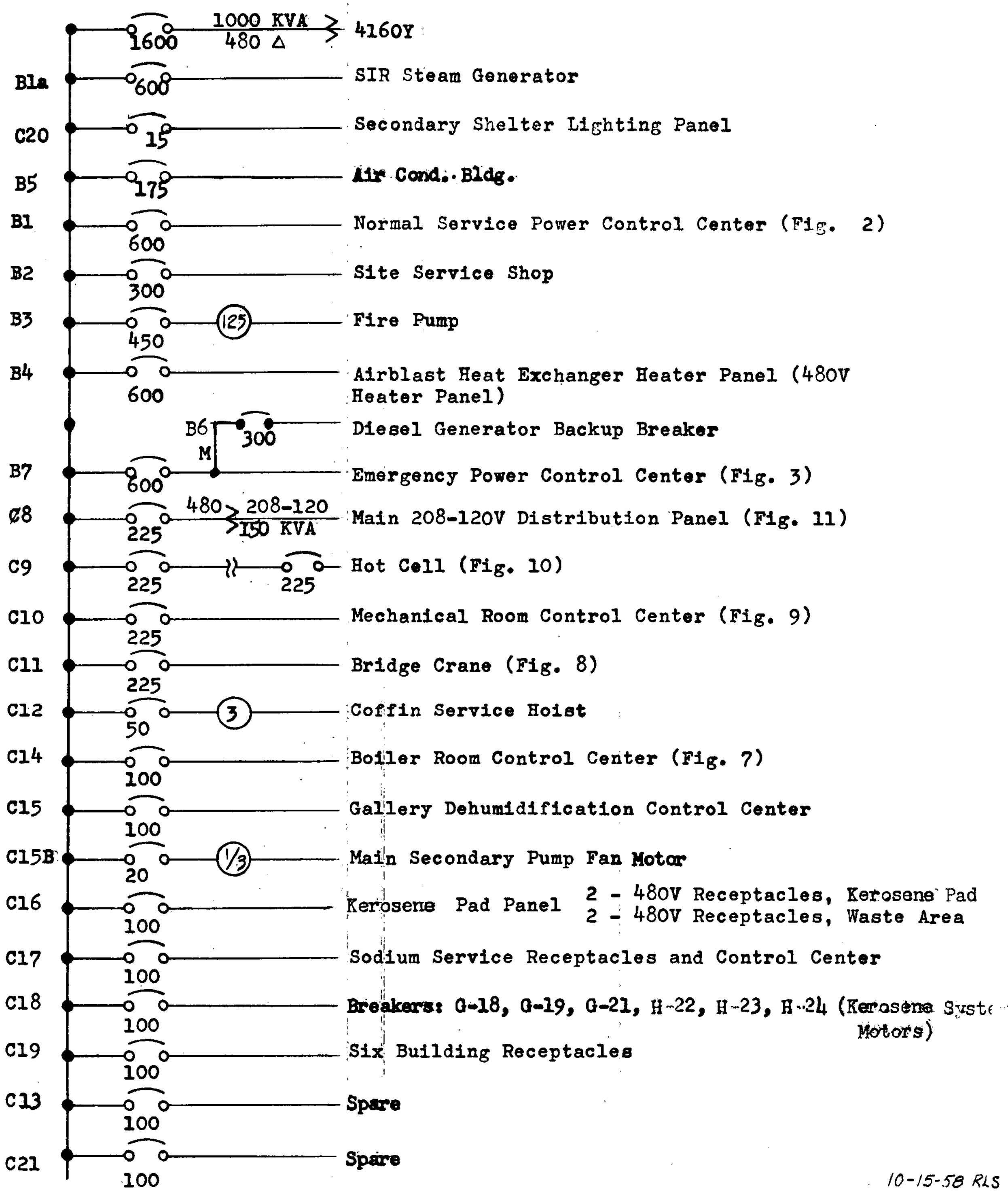
June 27, 1960

Figure No. 1

480V Power Distribution

Location: Electrical Distribution Room **Power:** 480V, 3ph., delta

Ref.: 9693-77218, 77219, 77208, 77209, 77223, 77224, SRE-72204



10-15-58 RLS

Figure No. 2

Normal Service Power Distribution

Location: Electrical Equipment Room **Power:** 480V, 3 ph.

Ref.: 9693-77218, 77219

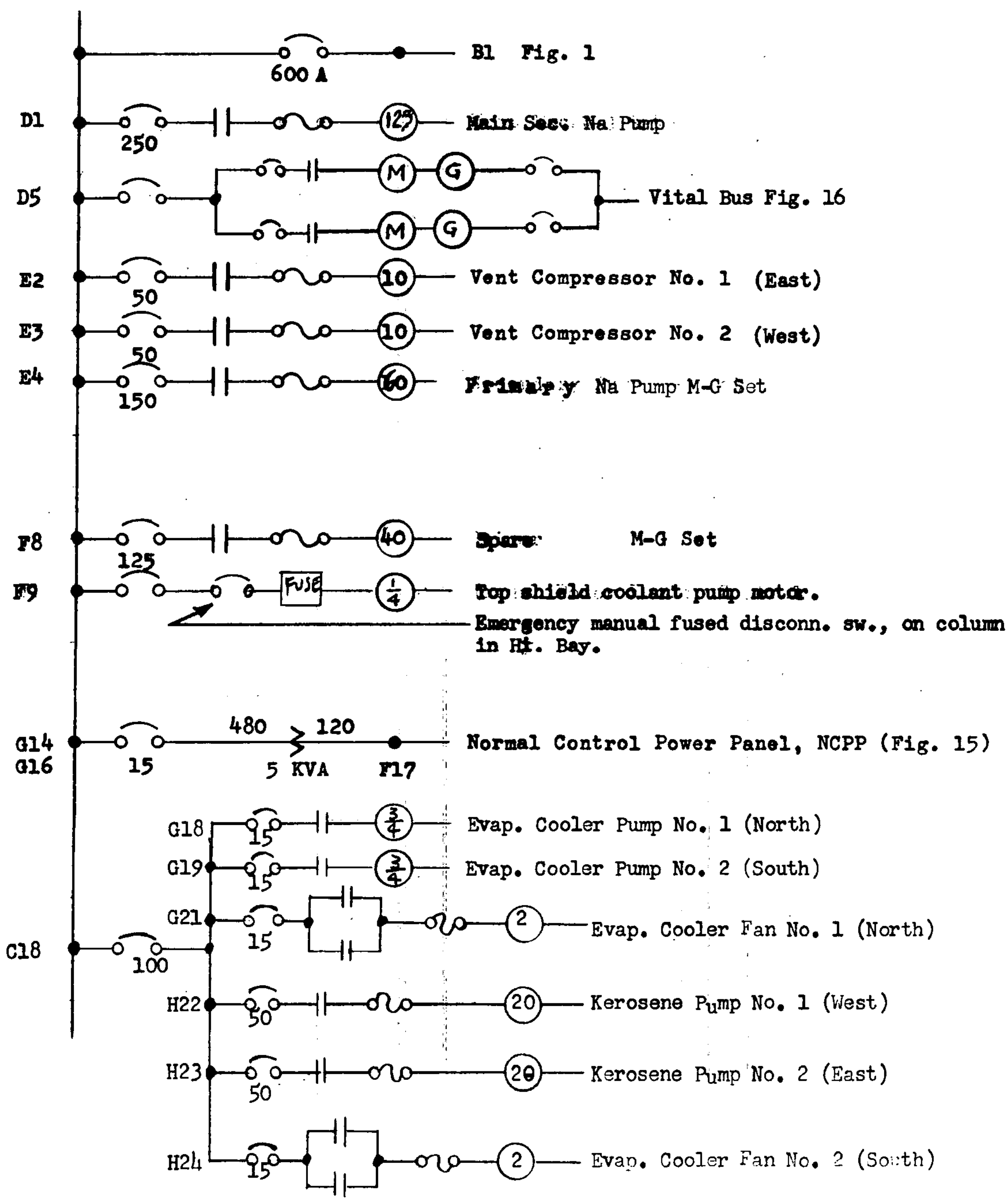


Figure No. 3

Emergency Power Distribution

Location: Electrical Distribution Room **Power:** 480V, 3 ph.
Reference: 9693-77218, 77219, 77220, 72503

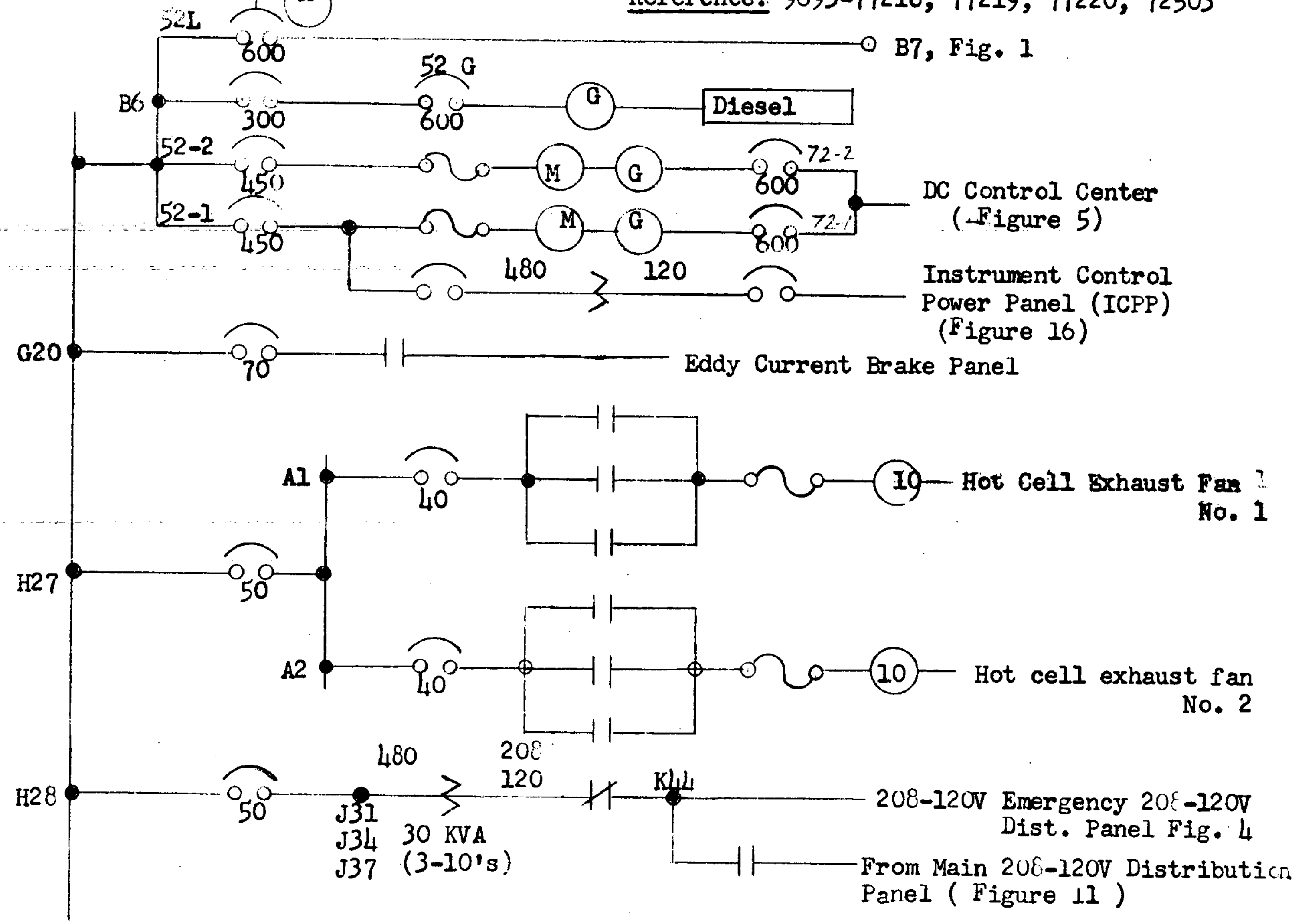
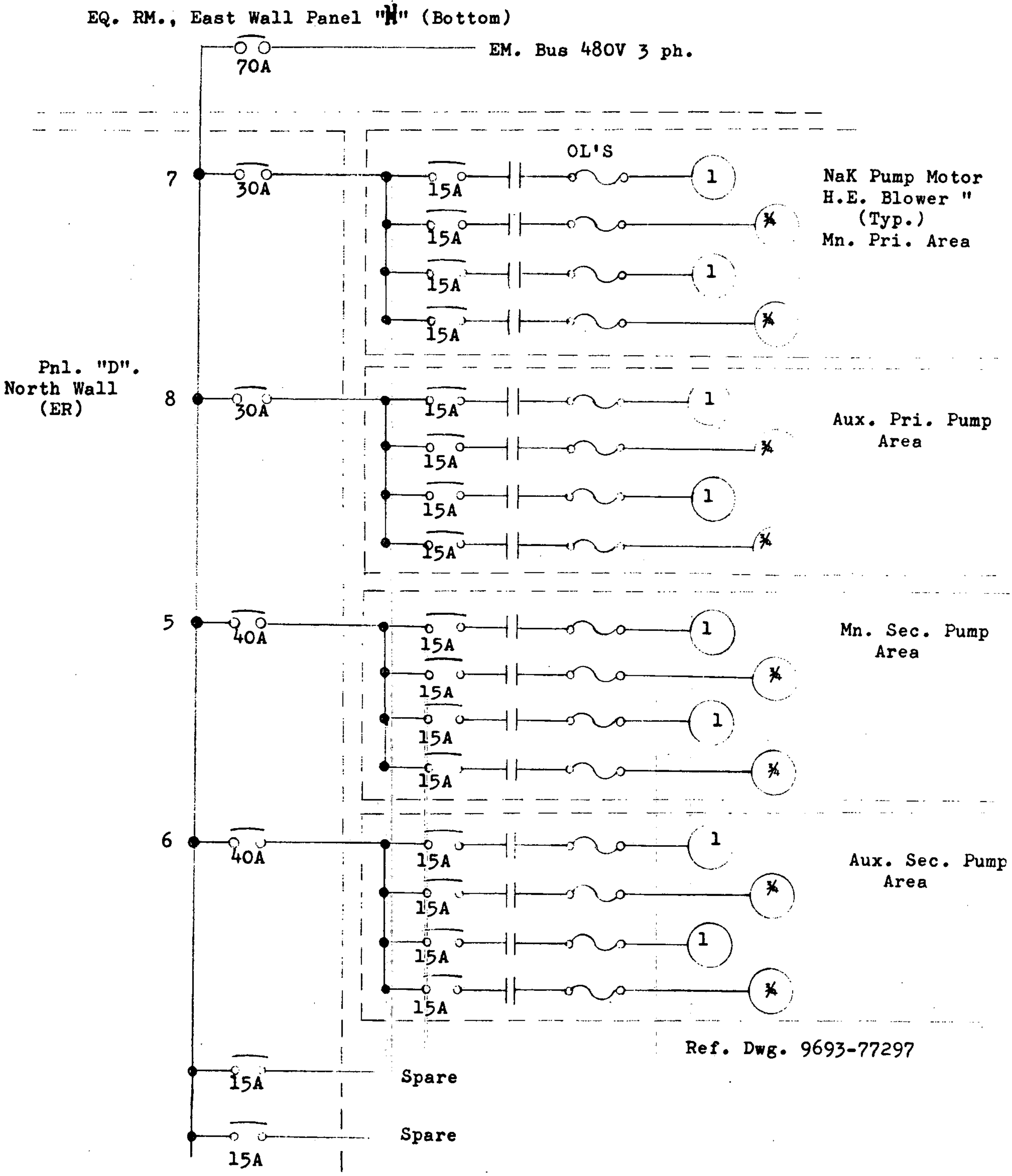


Figure No. 3A

Emergency Power Distribution

NaK Coolant Systems for the SRE Na Pumps



Ref. Dwg. 9693-77297

Figure No. 4

Emergency 208-120V Distribution

Location: Electrical Distribution Room **Power:** 208V, 3 ph.
120V, 1 ph.

Ref.: 9693-77218

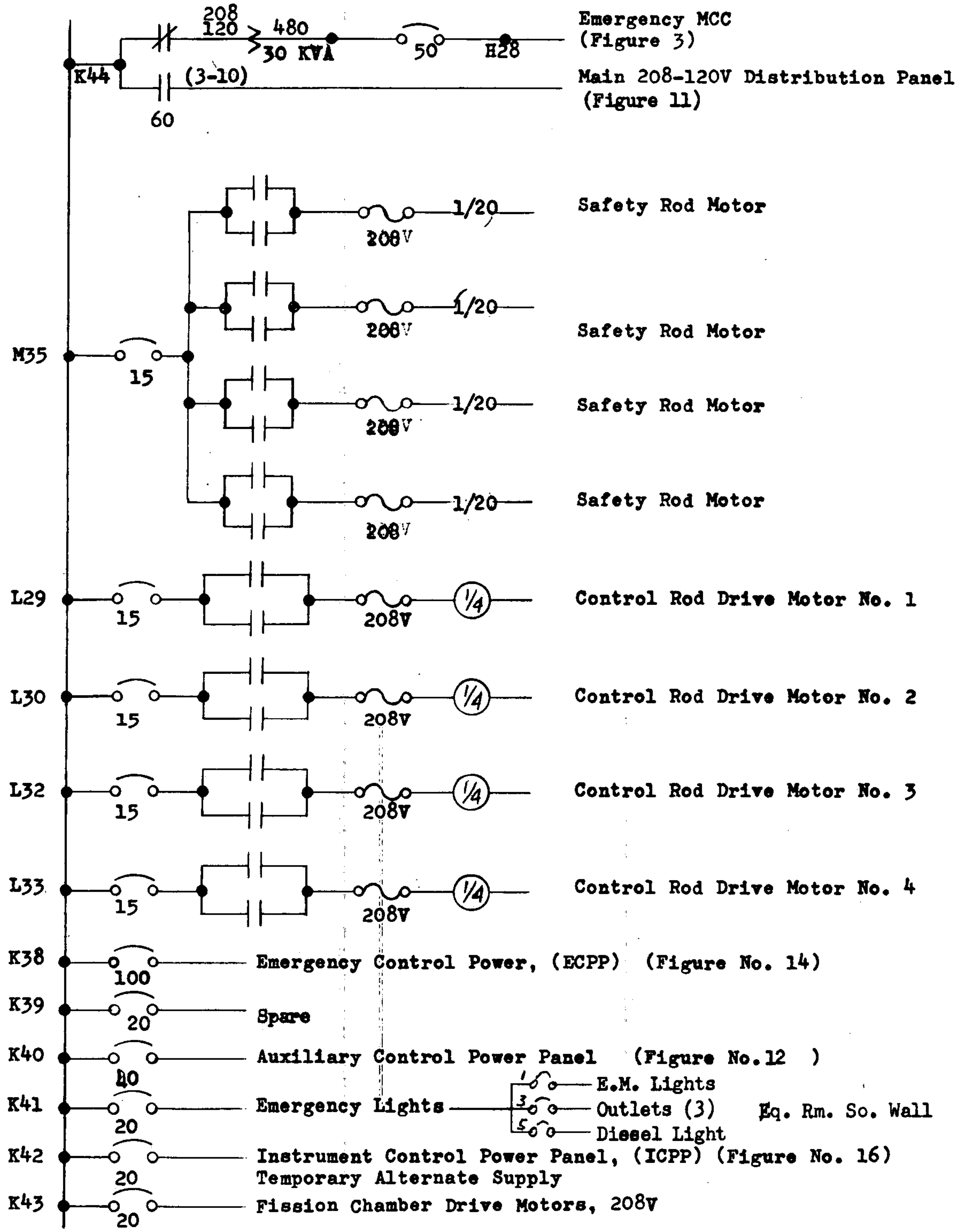


Figure No. 5

DC Power Distribution

Location: Electrical Distribution Room **Power:** 120V DC

Ref.: 9693-77218

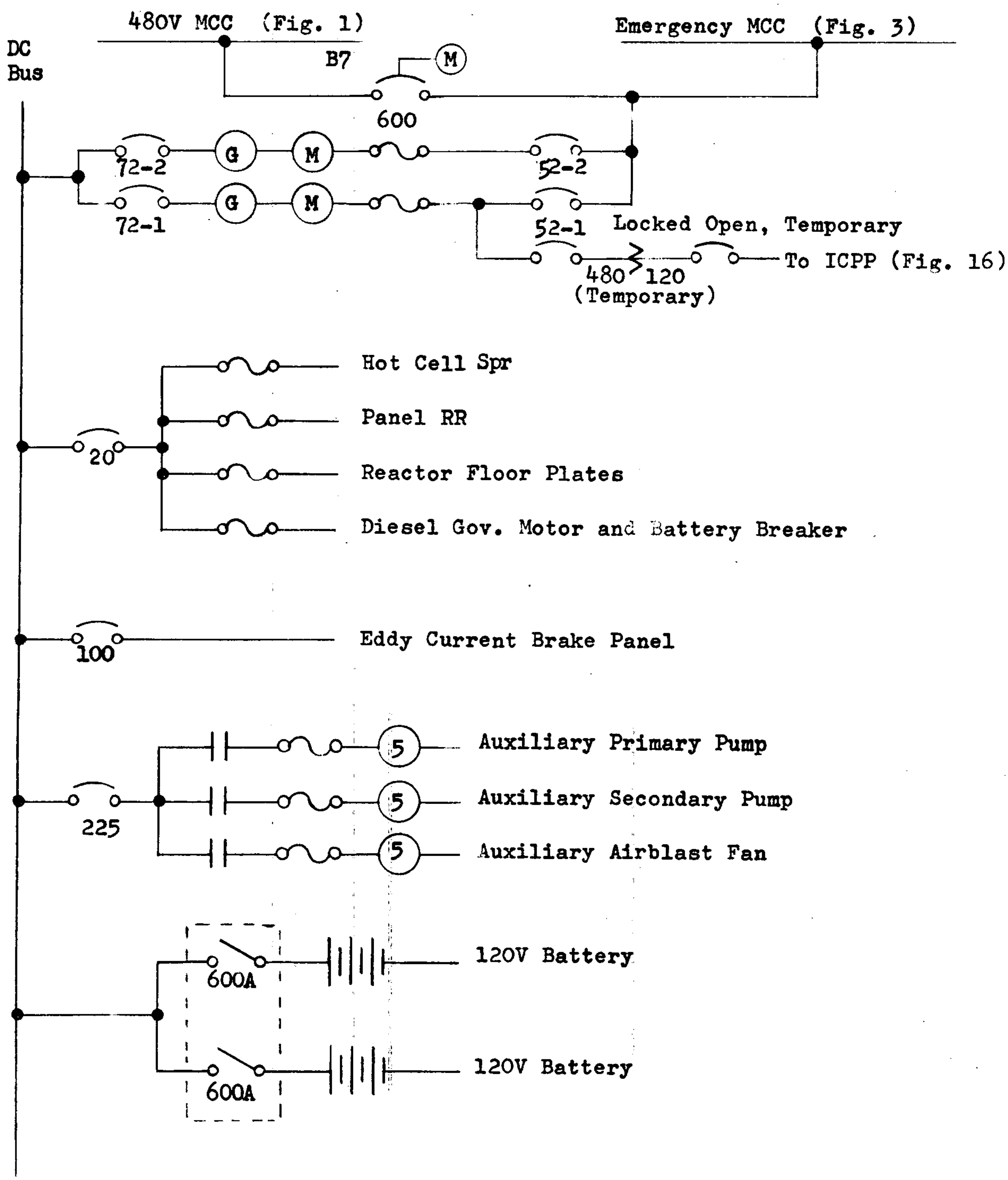


Figure No. 6

Mechanical Room Lighting Panel

Location: Mechanical Room **Power:** 120V, 1 ph.

Ref.: 9693-77208, 97221

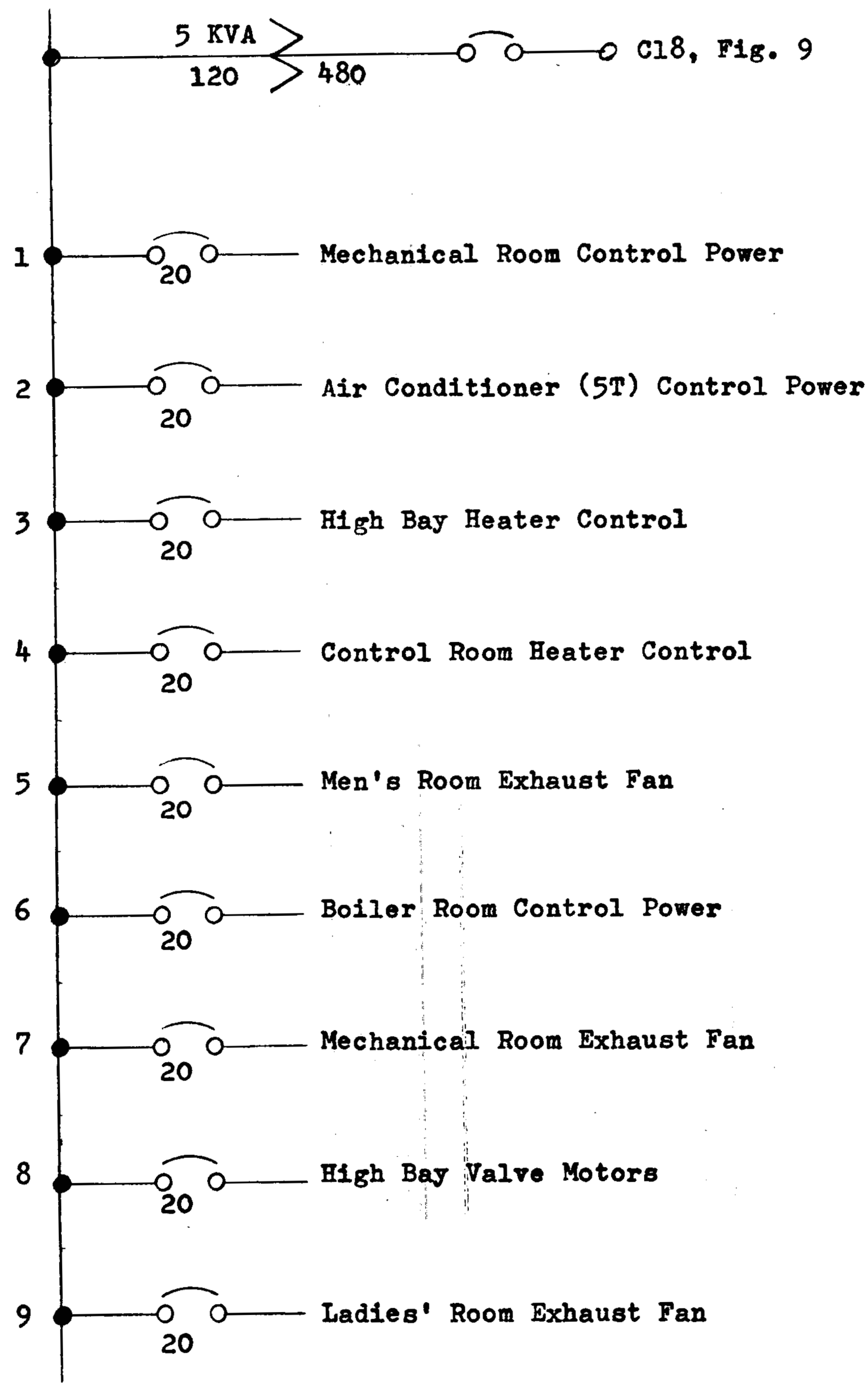


Figure No. 8

75-Ton Bridge Crane Power

Location: Crane Bridge **Power:** 480V. 3 ph. **Ref.:** 9693-77218

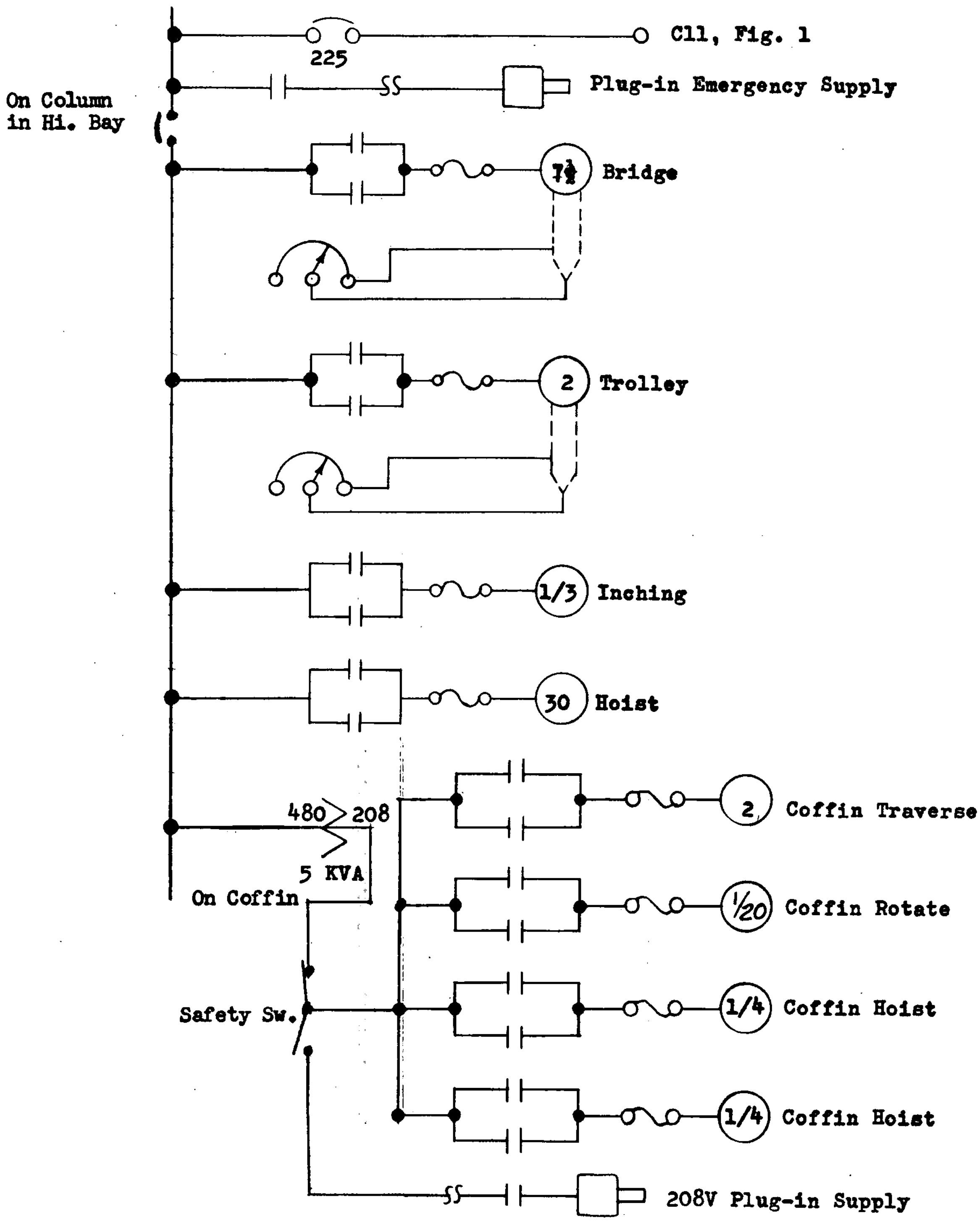


Figure No. 9

Mechanical Room Motor Control Center

Location: Mechanical Room **Power:** 480V, 3 ph.

Ref.: 9693-77208, 97221

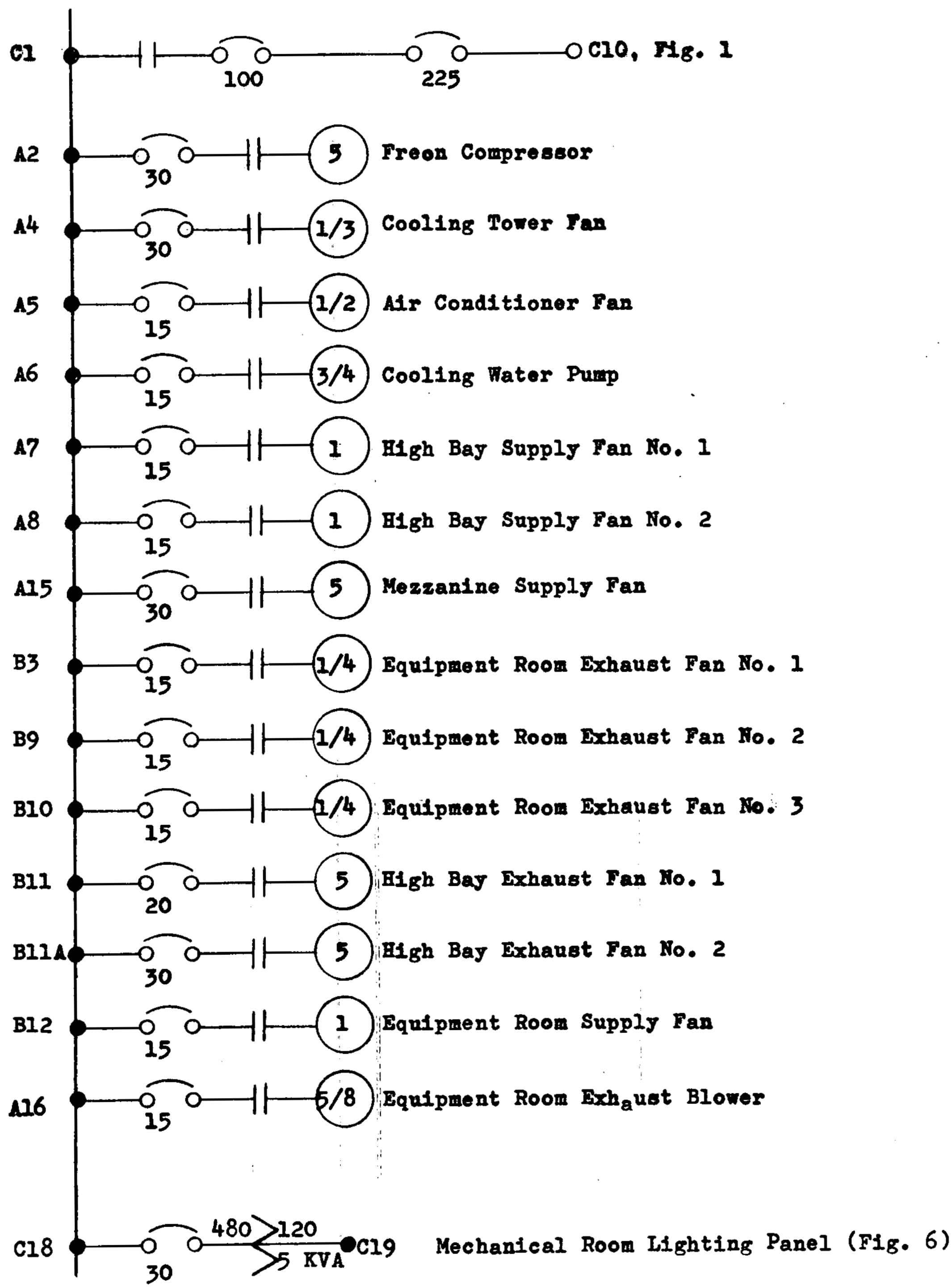


Figure No. 10

Hot Cell Power Distribution

Location: Hot Cell West Wall **Power:** 480V, 3 ph.

Ref.: 9693-77208, 77221

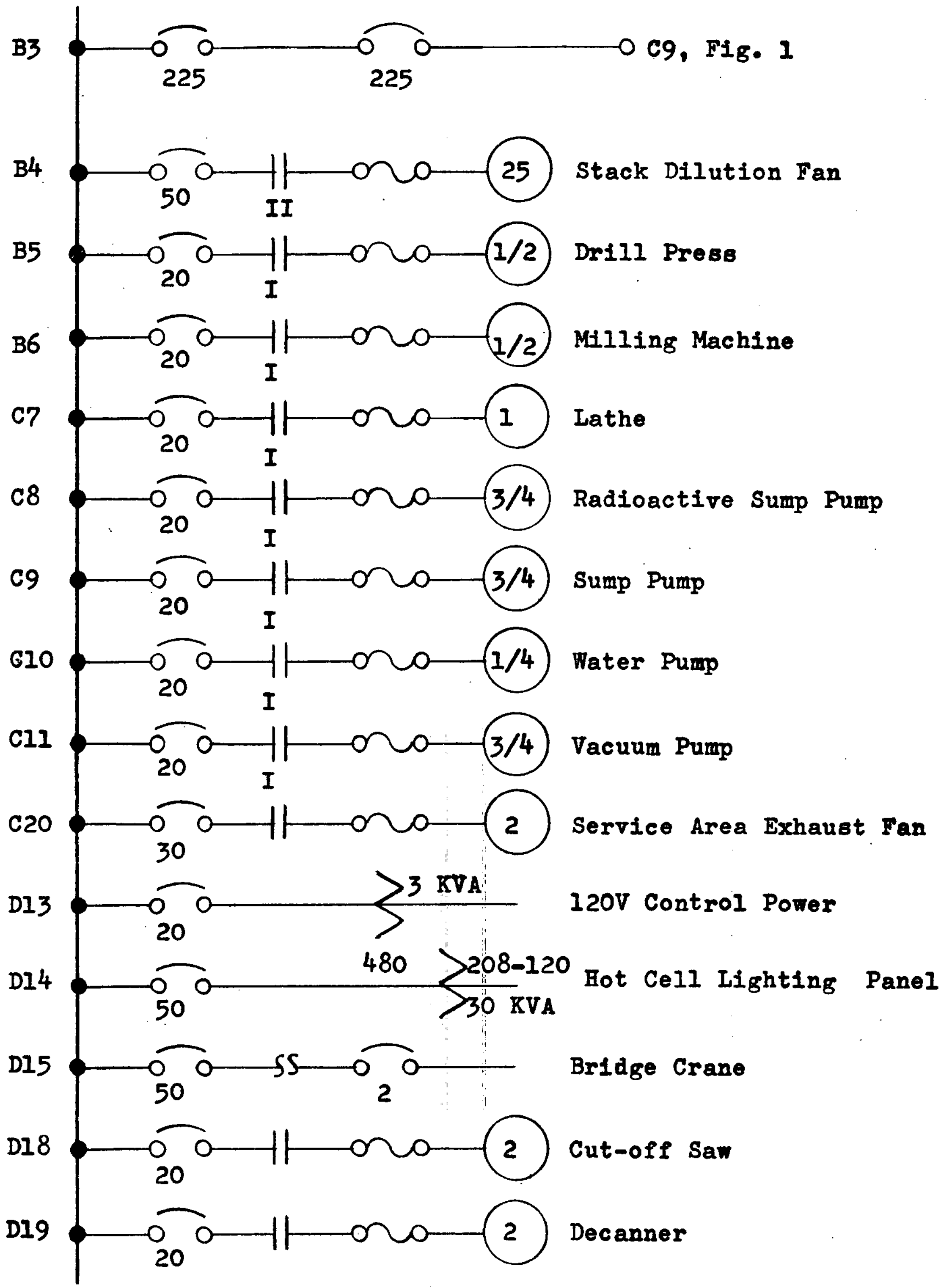


Figure No. 11

Main 208-120V Distribution

Location: Electrical Distribution Room Addition **Power:** 120V, 1 ph., 208V, 3 ph.

Ref.: 9693-77213, 77204, 77205

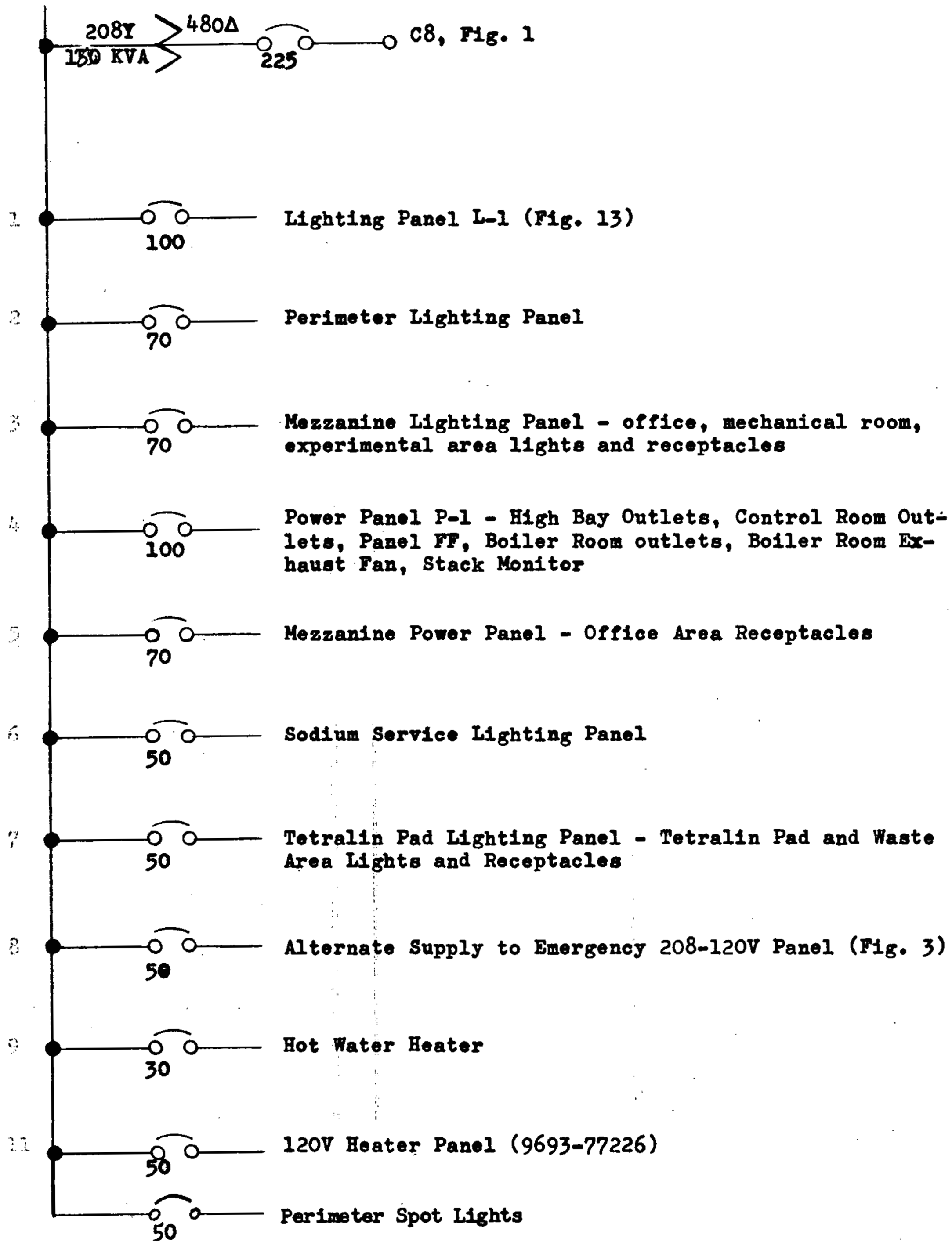


Figure No. 12

Aux. Emergency 208 - 120V Dist.

Location: Electrical Distribution Room (West Wall) Power: 208V, 3 ph.
Ref: 9693-77218 120V, 1 ph.

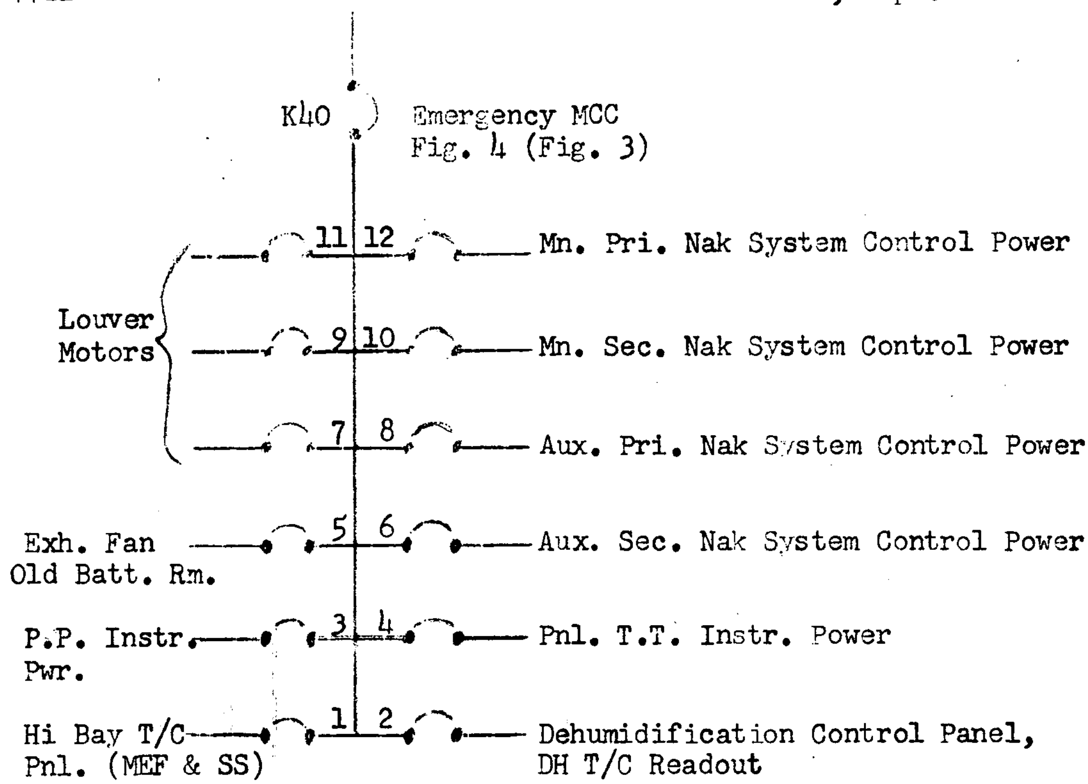


Figure No. 13

Lighting Panel L-1

Location: Electrical Distribution Room **Power:** 120V, 1 ph.

Ref.: 9693-77213

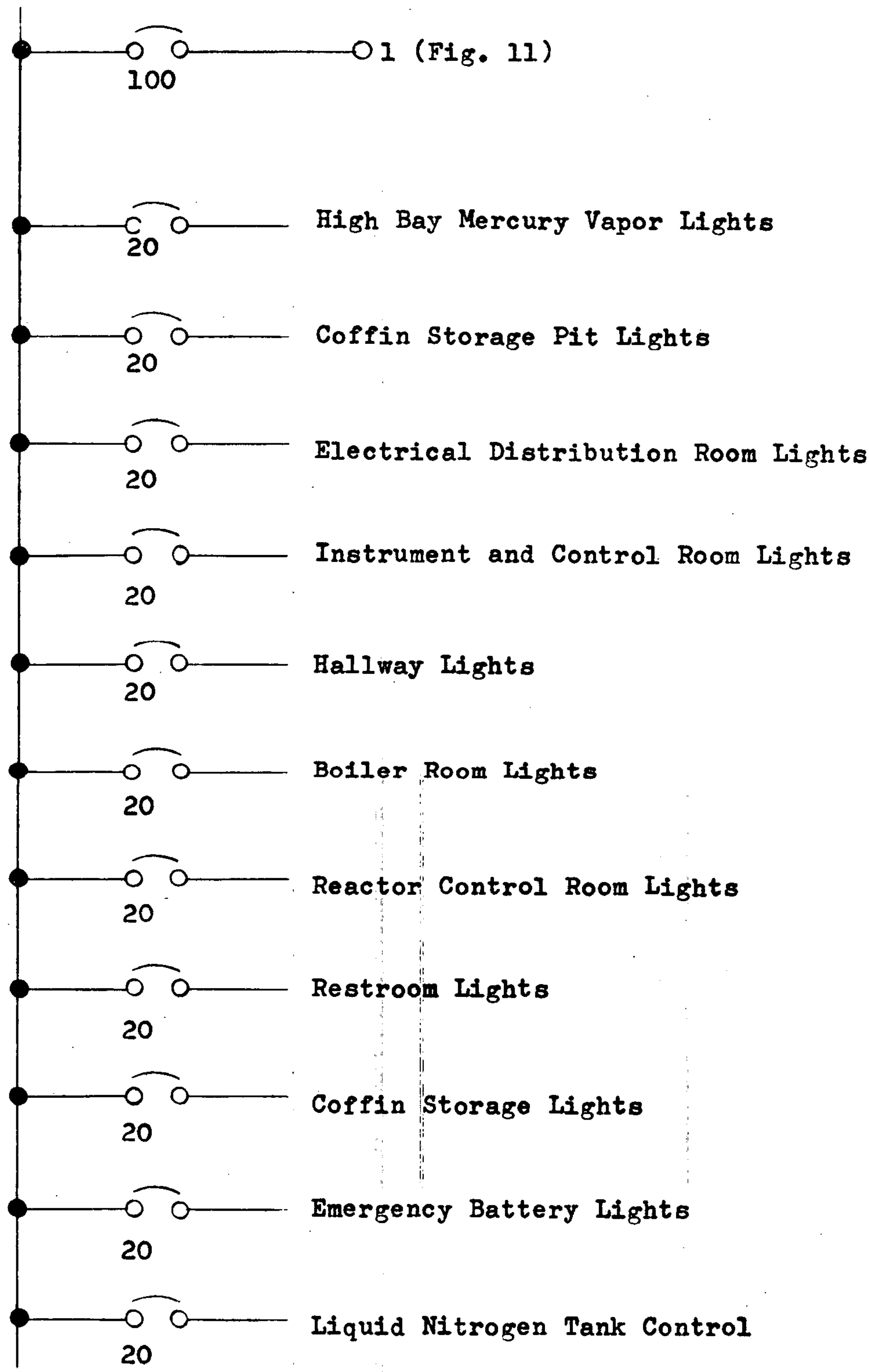


Figure No. 14

Emergency Control Power Distribution (ECP Panel)

Location: Electrical Distribution Room (So. Wall) **Power:** 120/208V

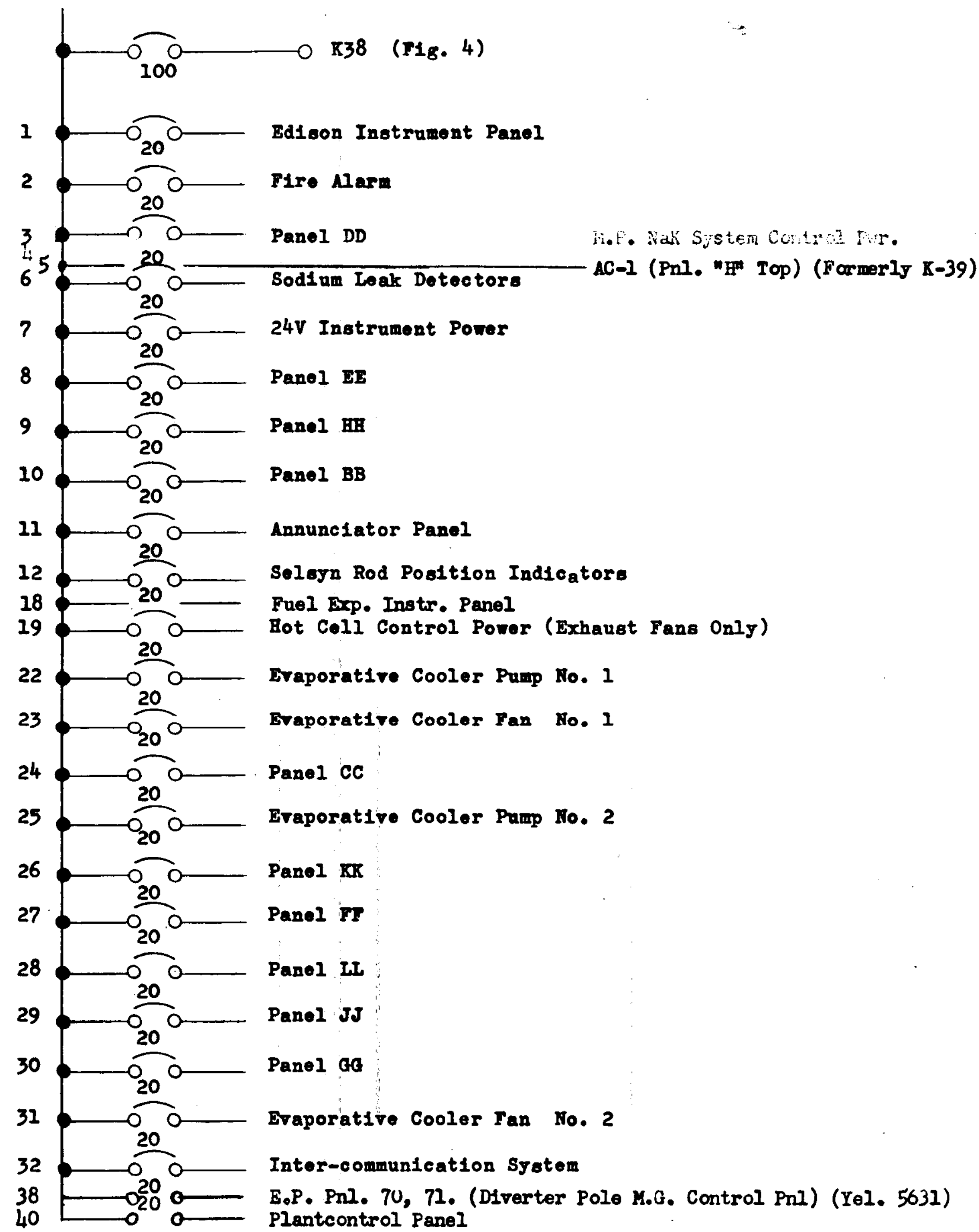


Figure No. 15

Normal Service Control Power (NCPP)

Location: Electrical Distribution Room **Power:** 120V

Ref.: 9693-77218

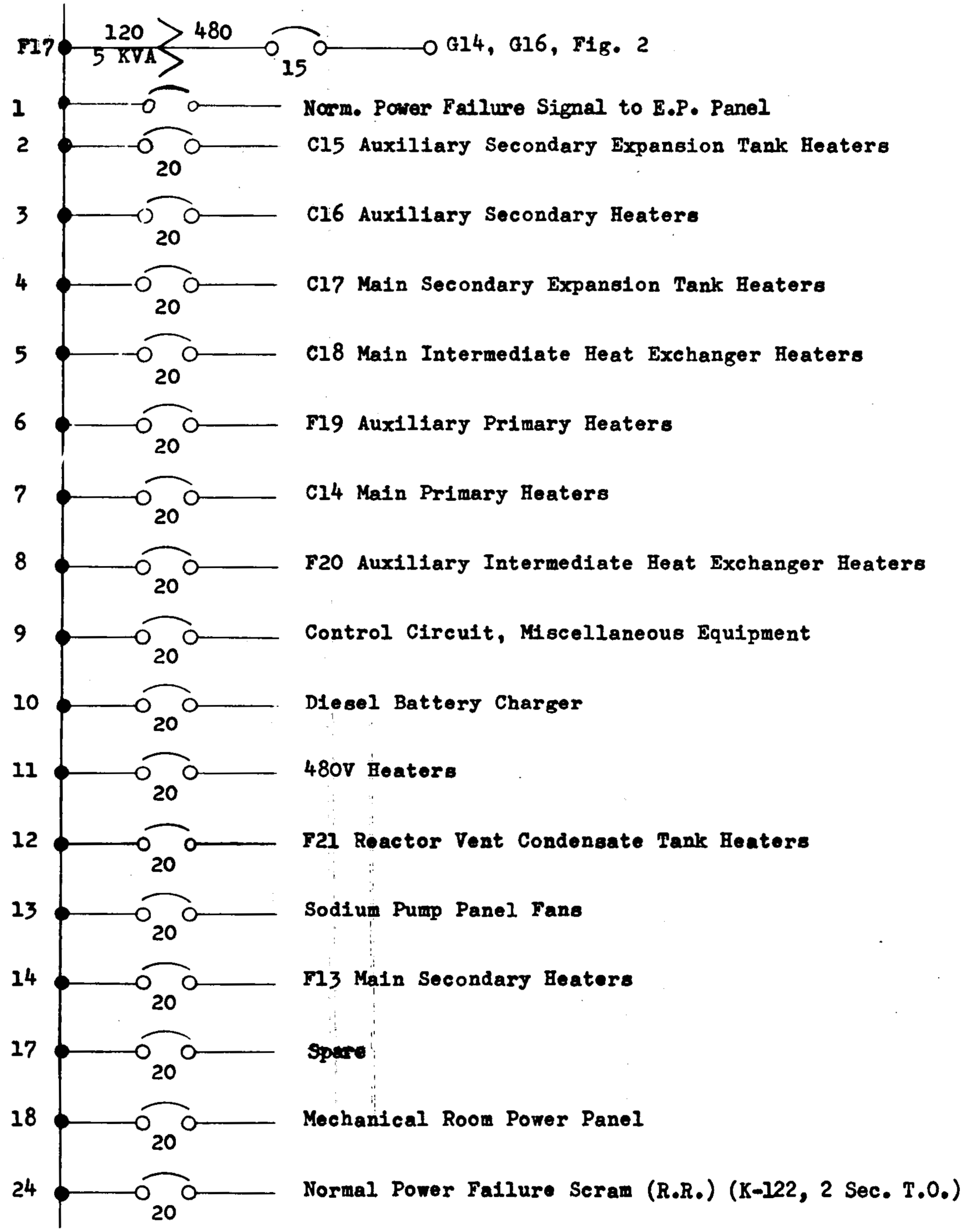


Figure No. 16

Instrument Control Power (ICPP)

Location: Electrical Distribution Room **Power:** 120V, 1 ph.

Ref.:

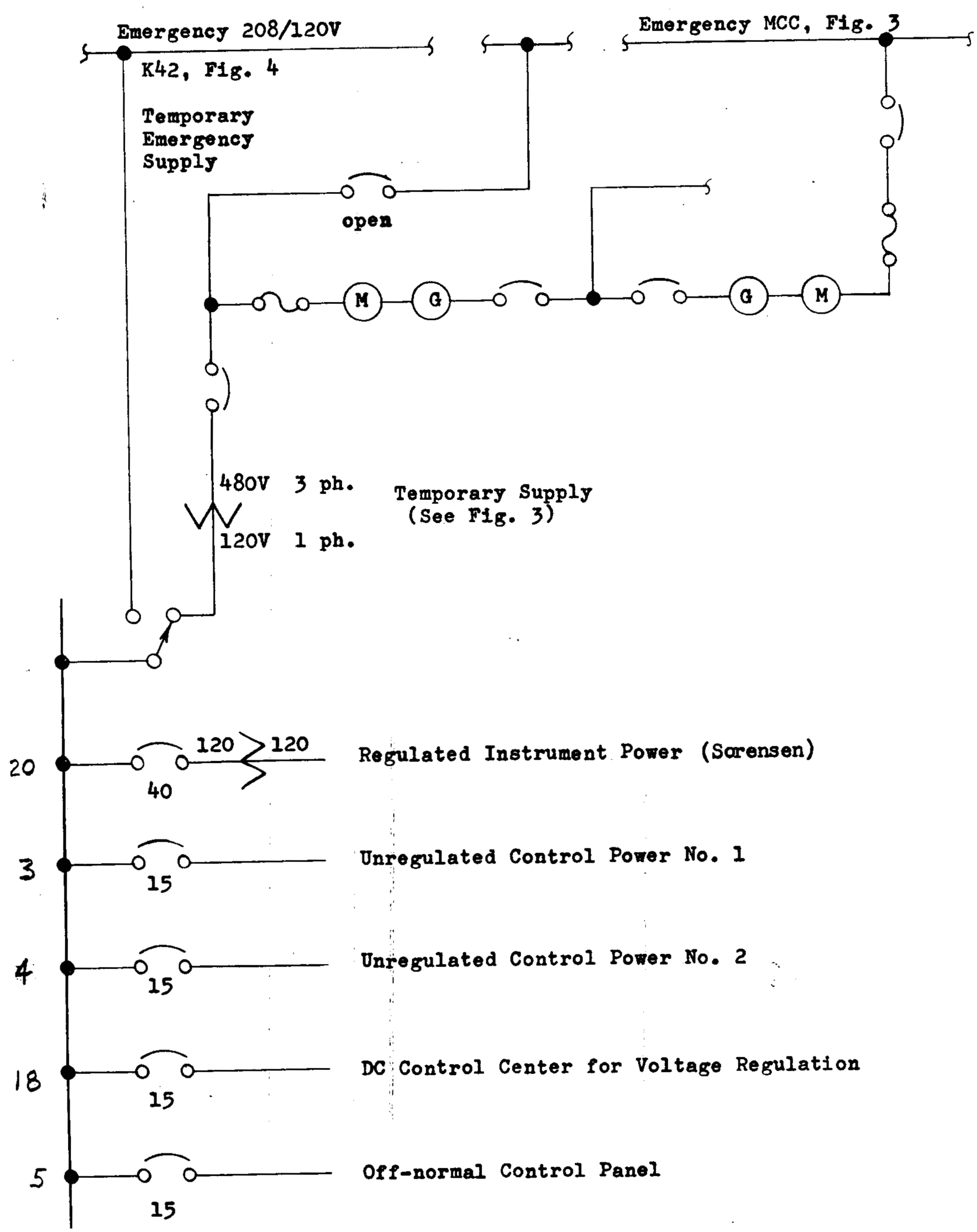


Figure No. 17

Eddy Current Brake Control Power

Location: High Bay Area

Power: 120V, 1 ph., AC

Ref.: SRE-72204-A, Fig. 5

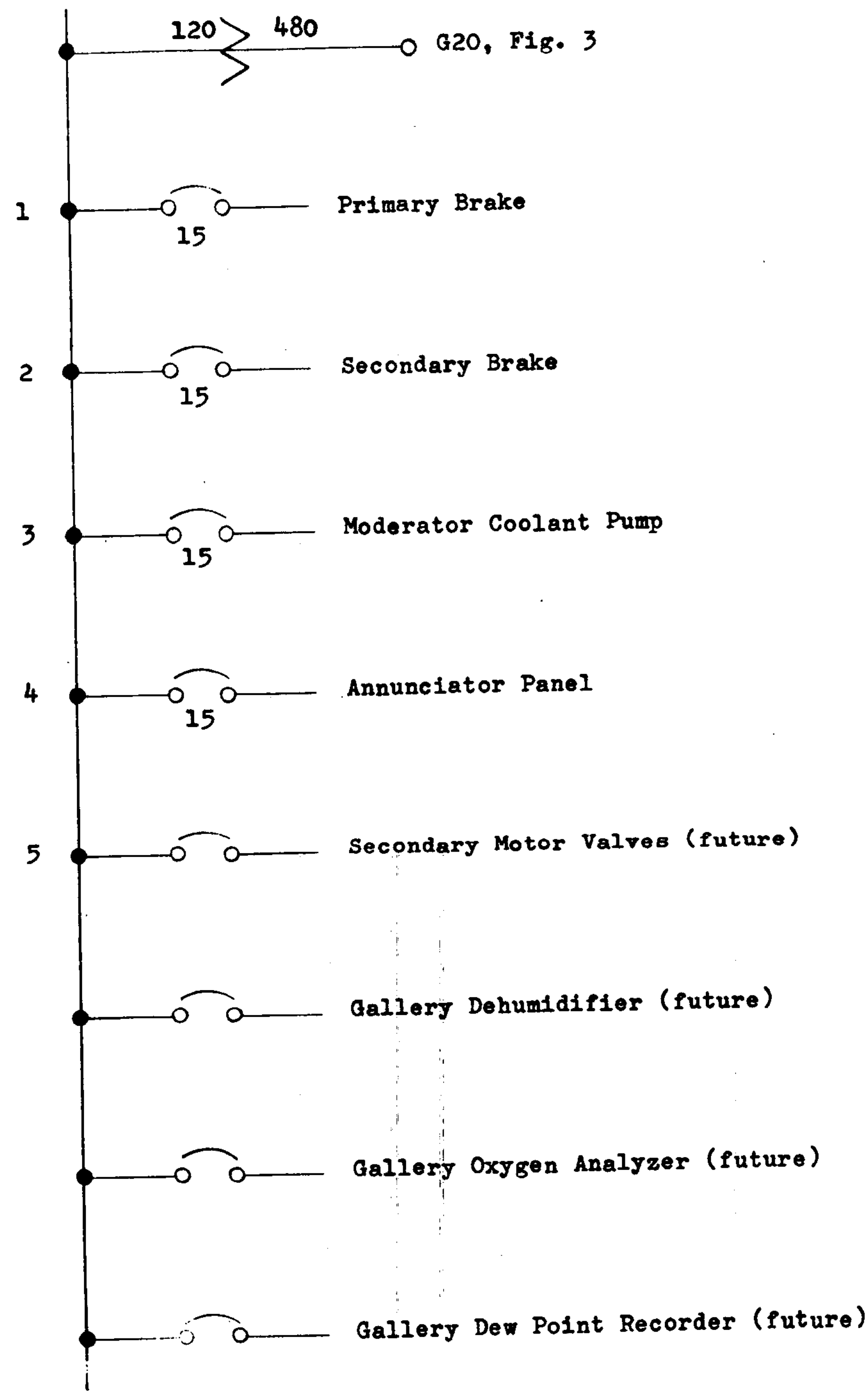


Figure No. 20

240V Heater Feeder

Location: Electrical Equipment Room **Power:** 240V, 3 ph.

Reference: 9693-77226, 77227, 77228

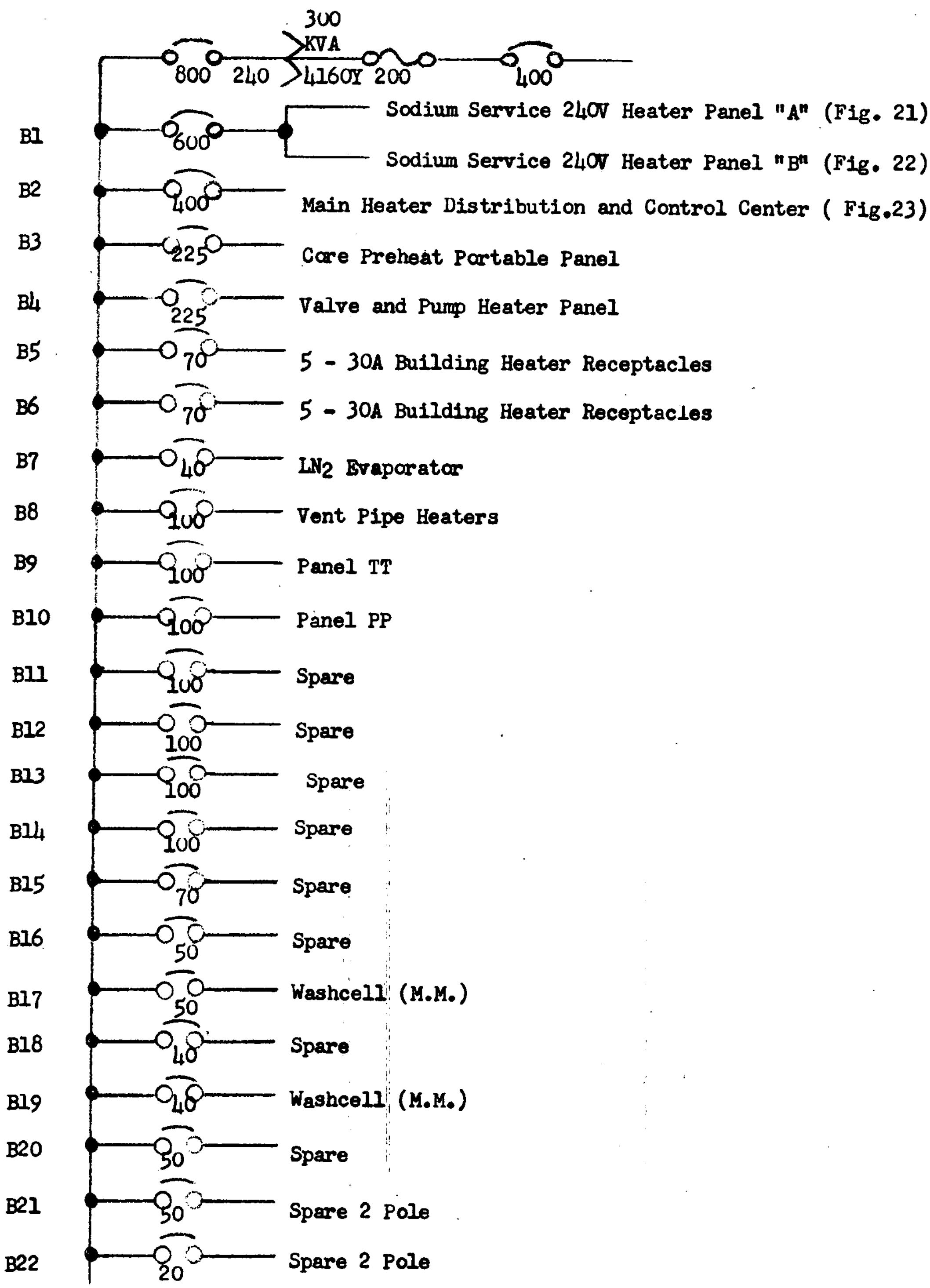


Figure No. 21

Sodium Service 240V Heater Panel A West

Location: Sodium Service Building **Power:** 240V, 3 ph.

Ref.: 9693-77226

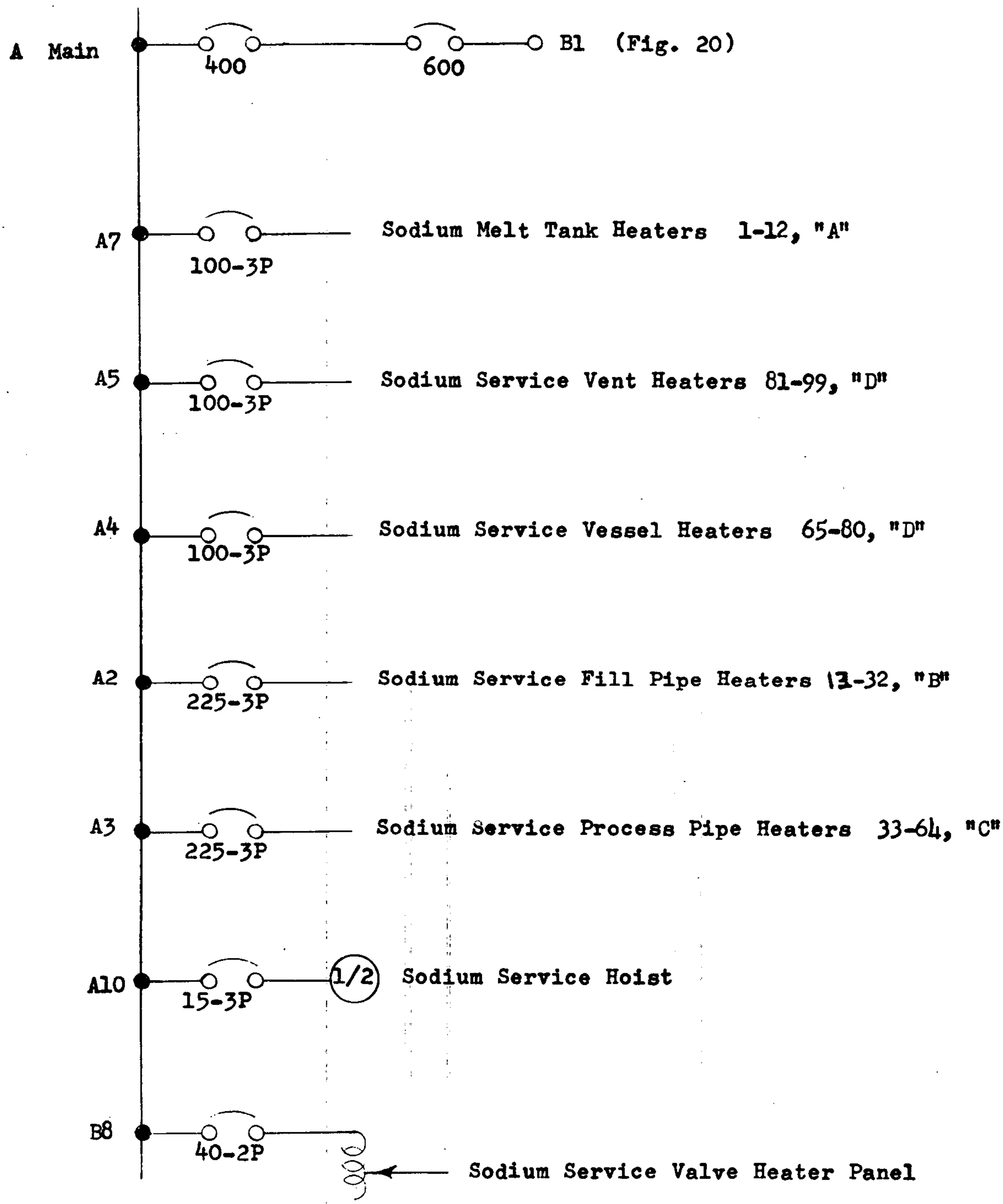


Figure No. 22

Sodium Service 240V Heater Panel B

Location: Sodium Service Building **Power:** 240V, 3 ph.

Ref.: 9693-77226

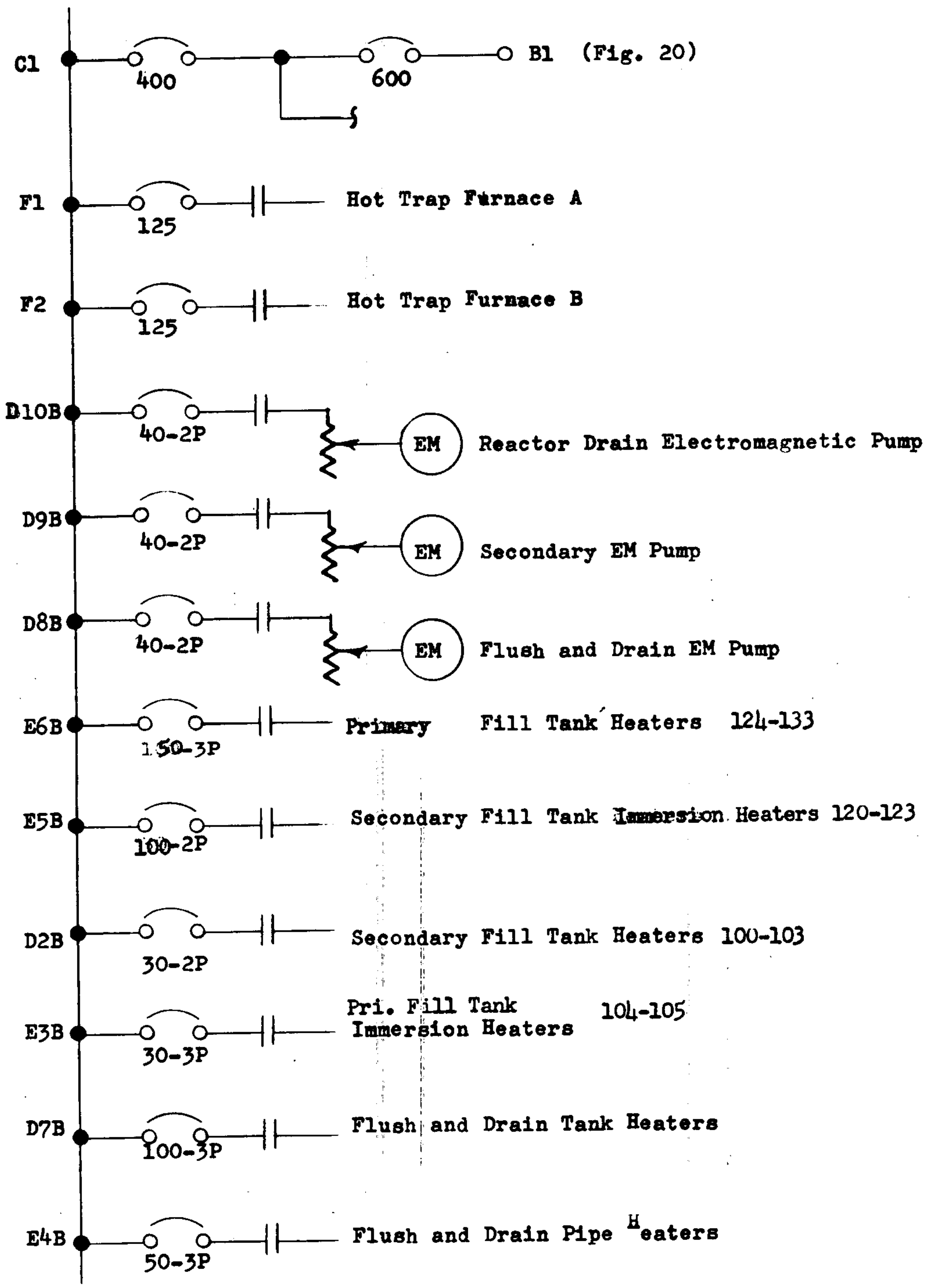
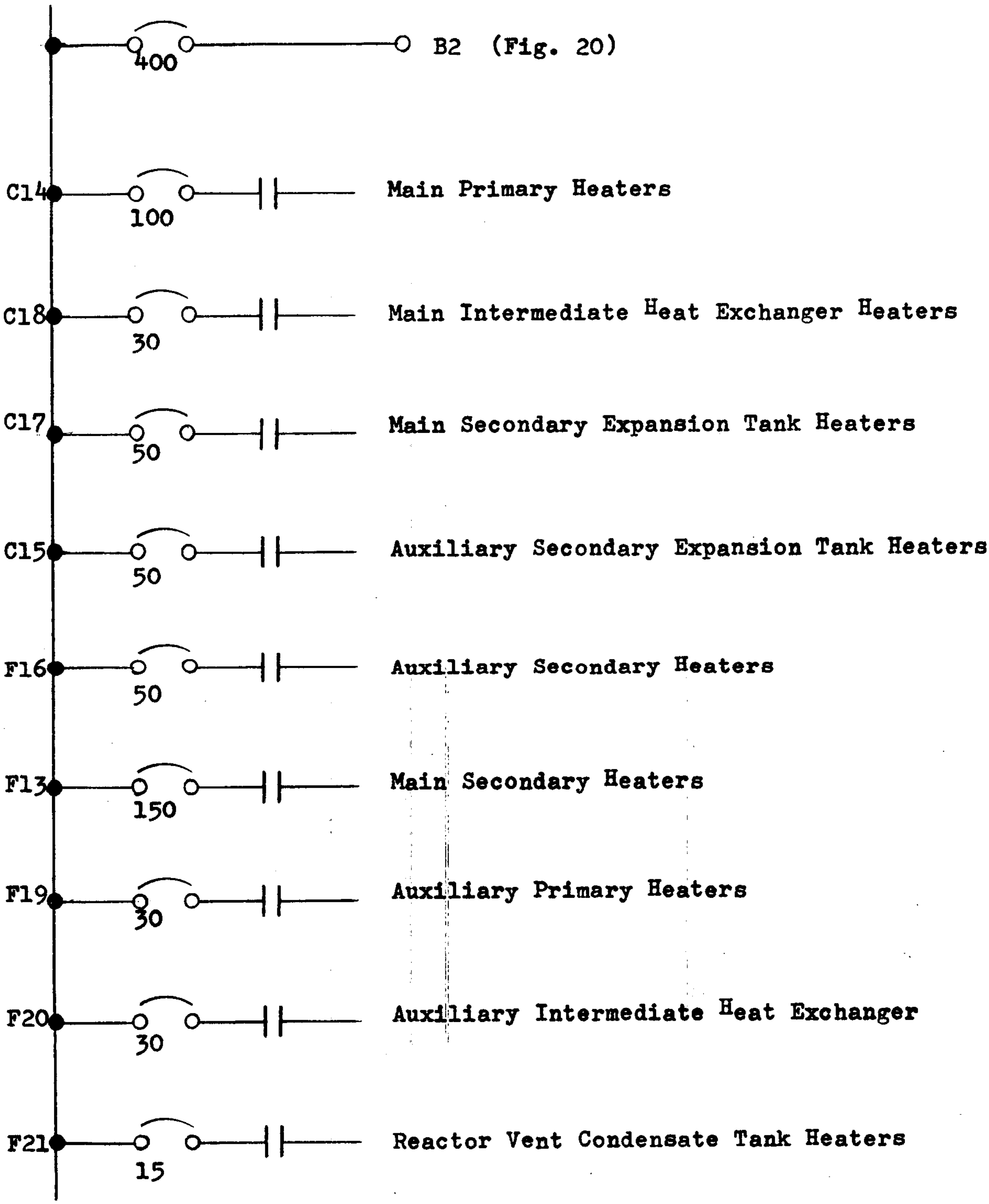


Figure No. 23

Main Heater Distribution Panel

Location: Electrical Equipment Room **Power:** 240V, 3 ph.

Ref.: 9693-77226

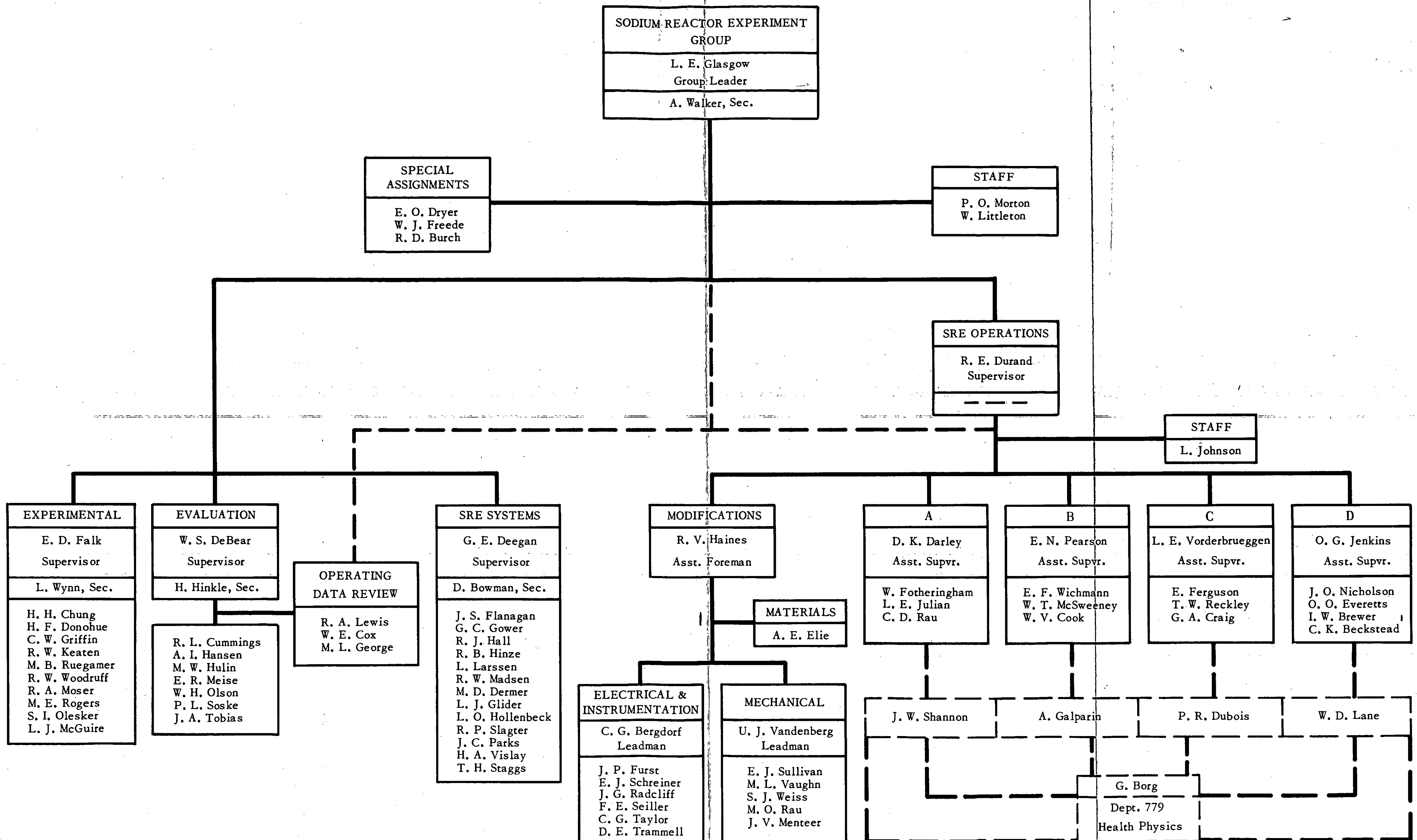


APPENDIX III. SRE GROUP ORGANIZATION

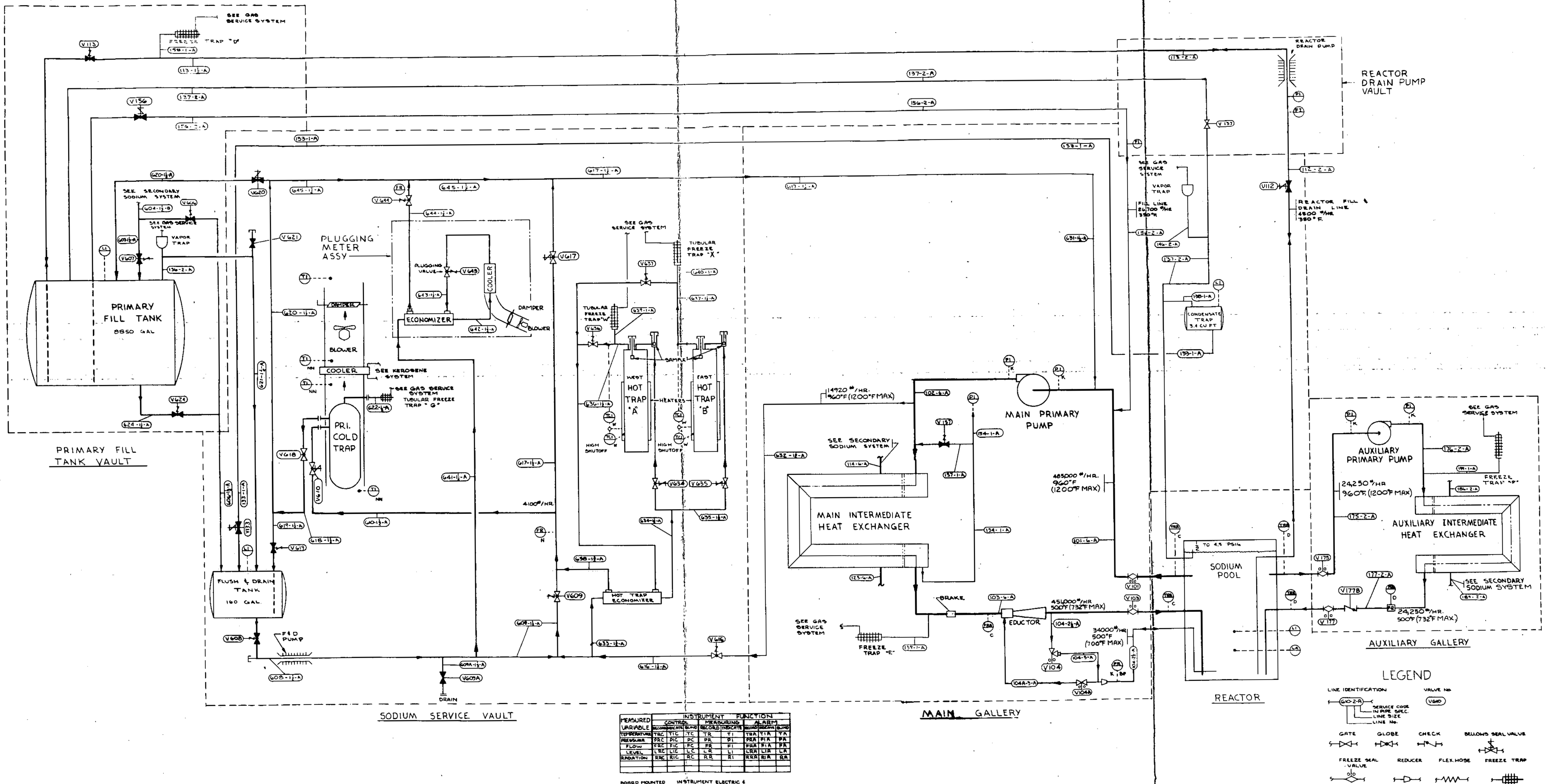
June 27, 1960

APPENDIX IV: DRAWINGS

June 27, 1960



Appendix III. Sodium Reactor Experiment Group Organization



MEASURED VARIABLE	INSTRUMENT FUNCTION							
	CONTROL			MEASURING		ALARM		
	RECORD	INDICATE	BLIND	RECORD	INDICATE	RECORD	INDICATE	BLIND
TEMPERATURE	TRC	TIC	TC	TR	TI	TRA	TIA	TA
PRESSURE	PRC	PIC	PC	PR	PI	PRA	PIA	PA
FLOW	FRC	FIC	FC	FR	FI	FRA	FIA	FA
LEVEL	LRC	LIC	LC	LR	LI	LRA	LIA	LA
RADIATION	RRC	RIC	RC	RR	RI	RRA	RIA	RA

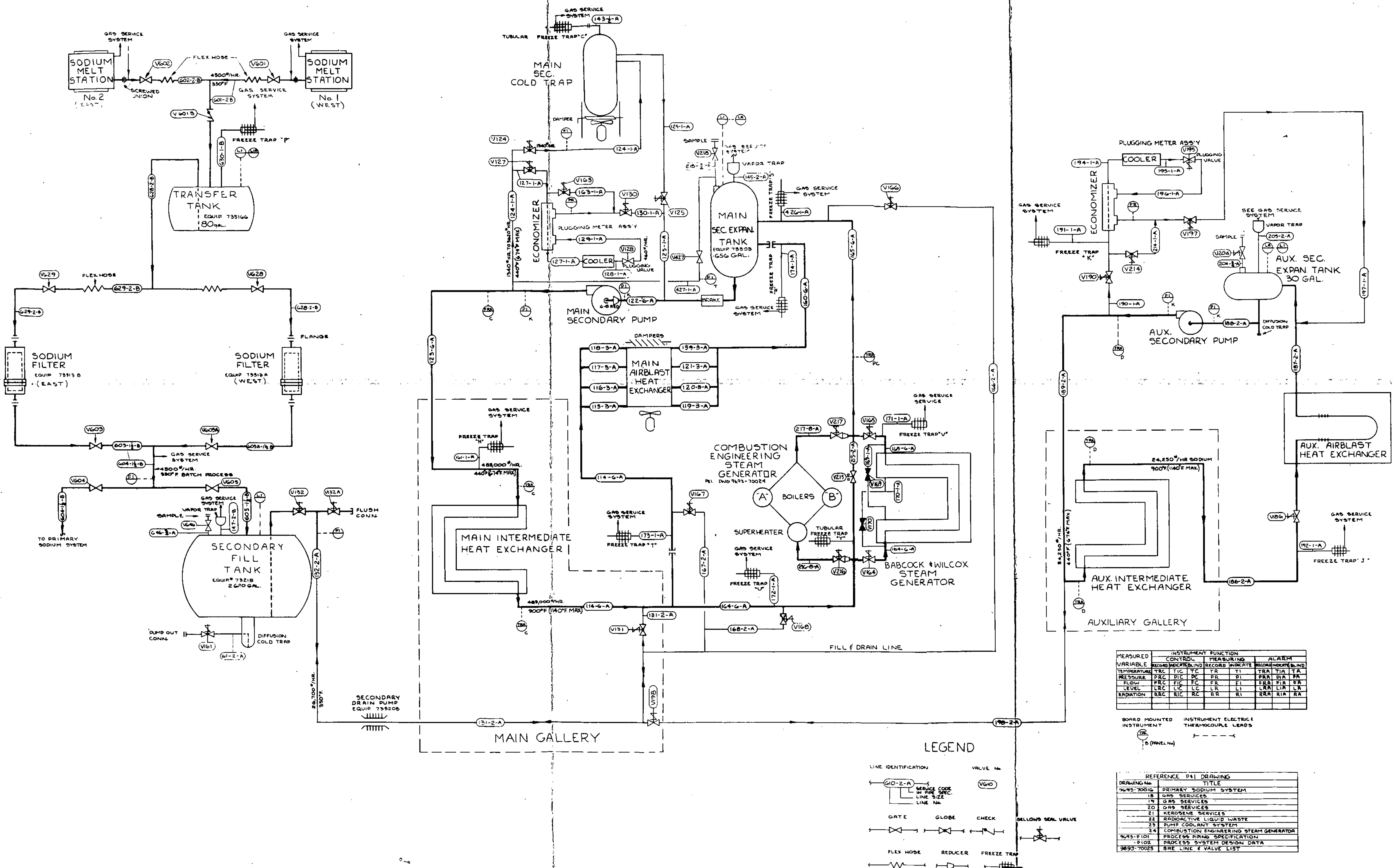
BOARD MOUNTED INSTRUMENT

TRC
6 (PANEL No)

INSTRUMENT ELECTRIC & THERMOCOUPLE LEADS

REFERENCE P&I DRAWINGS	
DRAWING No	TITLE
9693-70017	SECONDARY SODIUM SYSTEM
18	GAS SERVICES
19	GAS SERVICES
20	GAS SERVICES
21	KEROSENE SERVICES
22	RADIOACTIVE LIQUID WASTE SYSTEM
23	PUMP COOLANT SYSTEM
24	COMBUSTION ENGINEERING STEAM GENERATOR
9693-P101	PROCESS PIPING SPECIFICATION
-P102	PROCESS SYSTEMS DESIGN DATA
9693-70025	SRE LINE & VALVE LIST

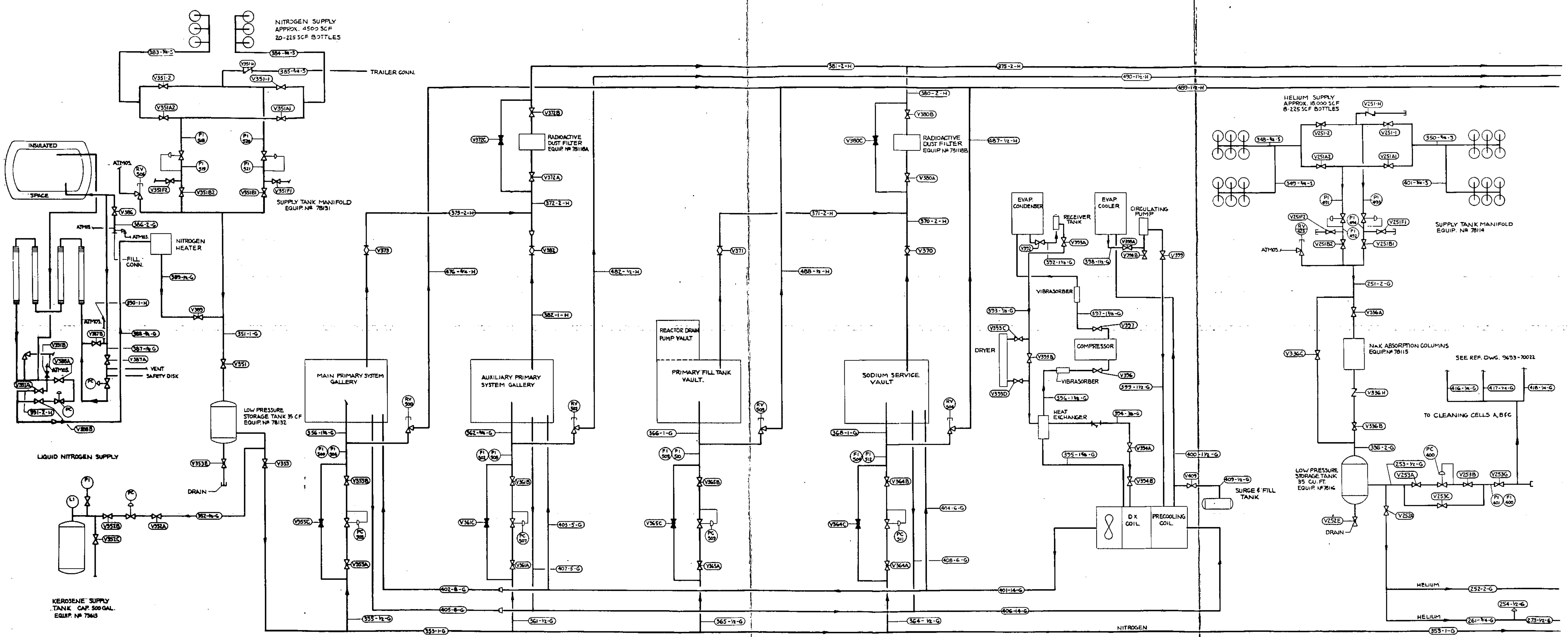
Figure A-IV-1. Primary-Sodium System, P and I Diagram (9693-70016)



MEASURED VARIABLE	INSTRUMENT FUNCTION							
	CONTROL			MEASURING		ALARM		
	RECORD	INDICATE	BLIND	RECORD	INDICATE	RECORD	INDICATE	BLIND
TEMPERATURE	TRC	TIC	TC	TR	TI	TRA	TIA	TA
PRESSURE	PRC	PIC	PC	PR	PI	PRA	PIA	PA
FLOW	FRC	FIC	FC	FR	FI	FRA	FIA	FA
LEVEL	LRC	LIC	LC	LR	LI	LRA	LIA	LA
RADIATION	RRC	RIC	RC	RR	RI	RRA	RIA	RA

REFERENCE P&I DRAWING	
DRAWING No.	TITLE
9693-70016	PRIMARY SODIUM SYSTEM
18	GAS SERVICES
19	GAS SERVICES
20	GAS SERVICES
21	KEROSENE SERVICES
22	RADIOACTIVE LIQUID WASTE
23	PUMP COOLANT SYSTEM
24	COMBUSTION ENGINEERING STEAM GENERATOR
9693-P101	PROCESS PIPING SPECIFICATION
-P102	PROCESS SYSTEM DESIGN DATA
9693-70025	SRE LINE & VALVE LIST

Figure A-IV-2. Secondary-Sodium System, P and I Diagram (9693-70017)



MEASURED VARIABLE	INSTRUMENT FUNCTION							
	CONTROL			MEASURING		ALARM		
	RECORD	INDICATE	BLIND	RECORD	INDICATE	RECORD	INDICATE	BLIND
TEMPERATURE								
PRESSURE								
FLOW								
LEVEL								
RADIATION								

REFERENCE P&I DRAWINGS	
DRAWING Nº	TITLE
9693-70016	PRIMARY SODIUM SYSTEM
17	SECONDARY SODIUM SYSTEM
19	GAS SERVICES
20	GAS SERVICES
21	KEROSENE SERVICES
22	RADIOACTIVE LIQUID WASTE
23	PUMP COOLANT SYSTEM
24	COMBUSTION ENGINEERING STEAM GENERATOR
9693-P101	PROCESS PIPING SPECIFICATION
P102	PROCESS SYSTEM DESIGN DATA
9693-70025	SRE LINE & VALVE LIST

Figure A-IV-3. Gas Services, P and I Diagram (Sheet 1 of 3; 9693-70018)

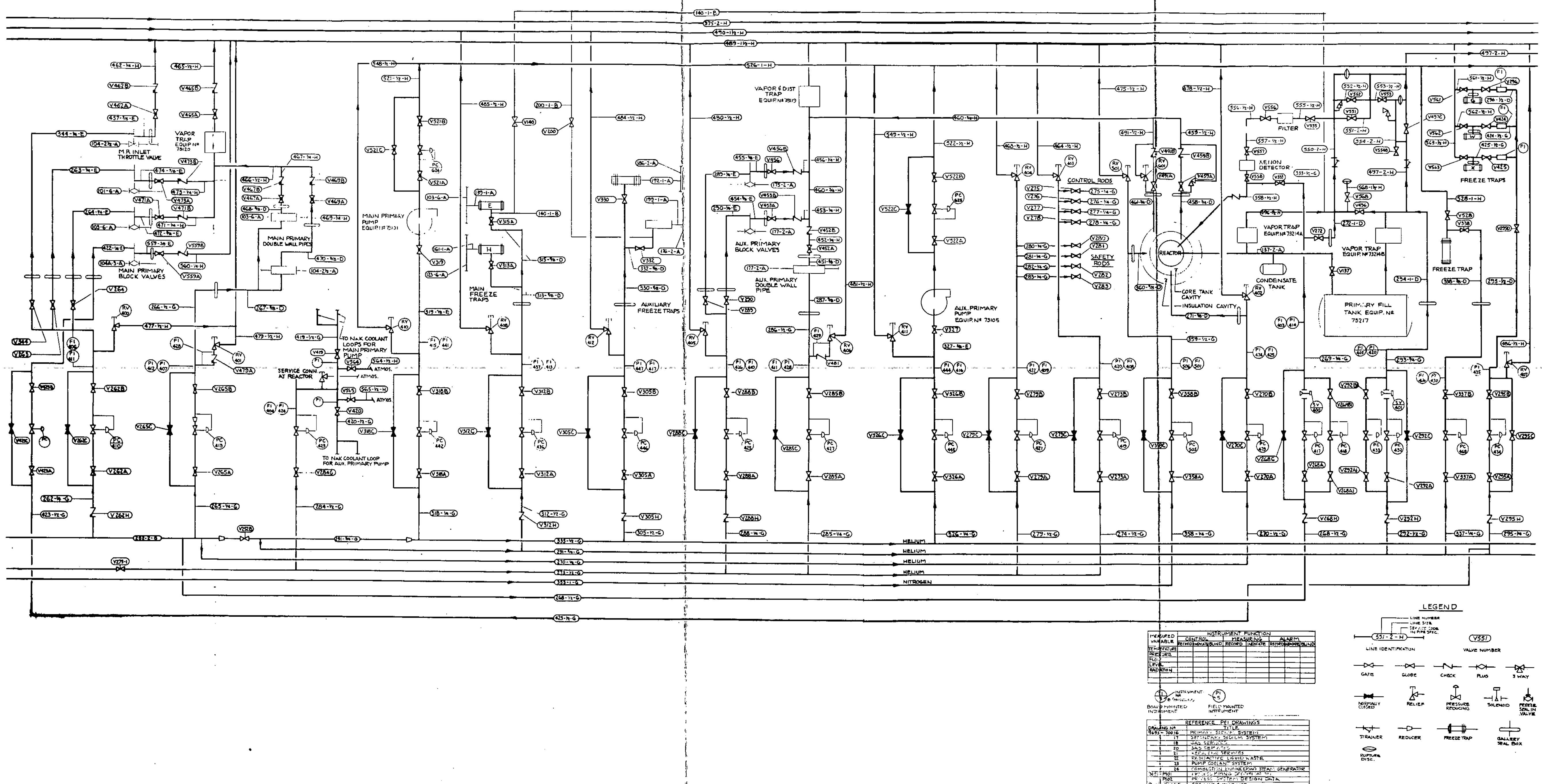


Figure A-IV-3. Gas Services, P and I Diagram (Sheet 2 of 3; 9693-70019)

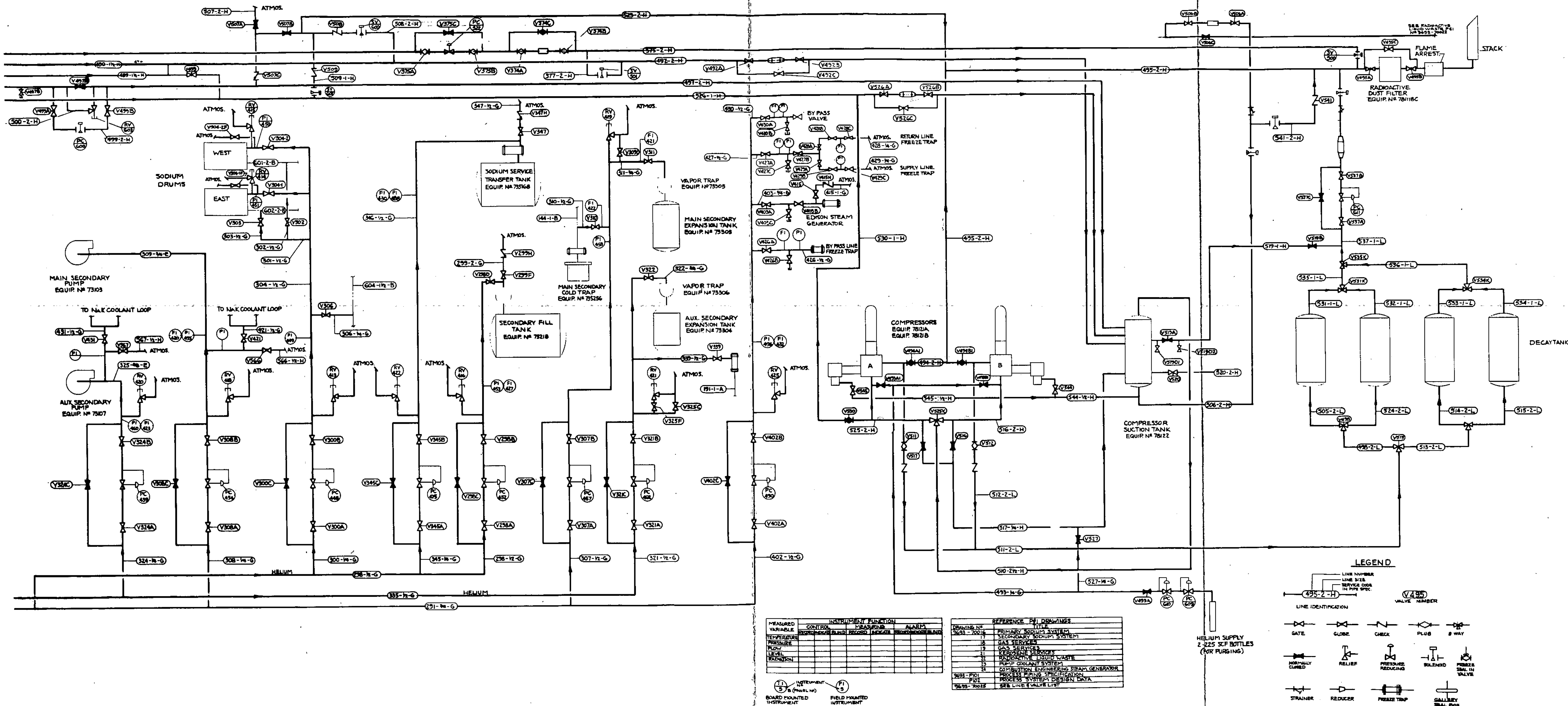
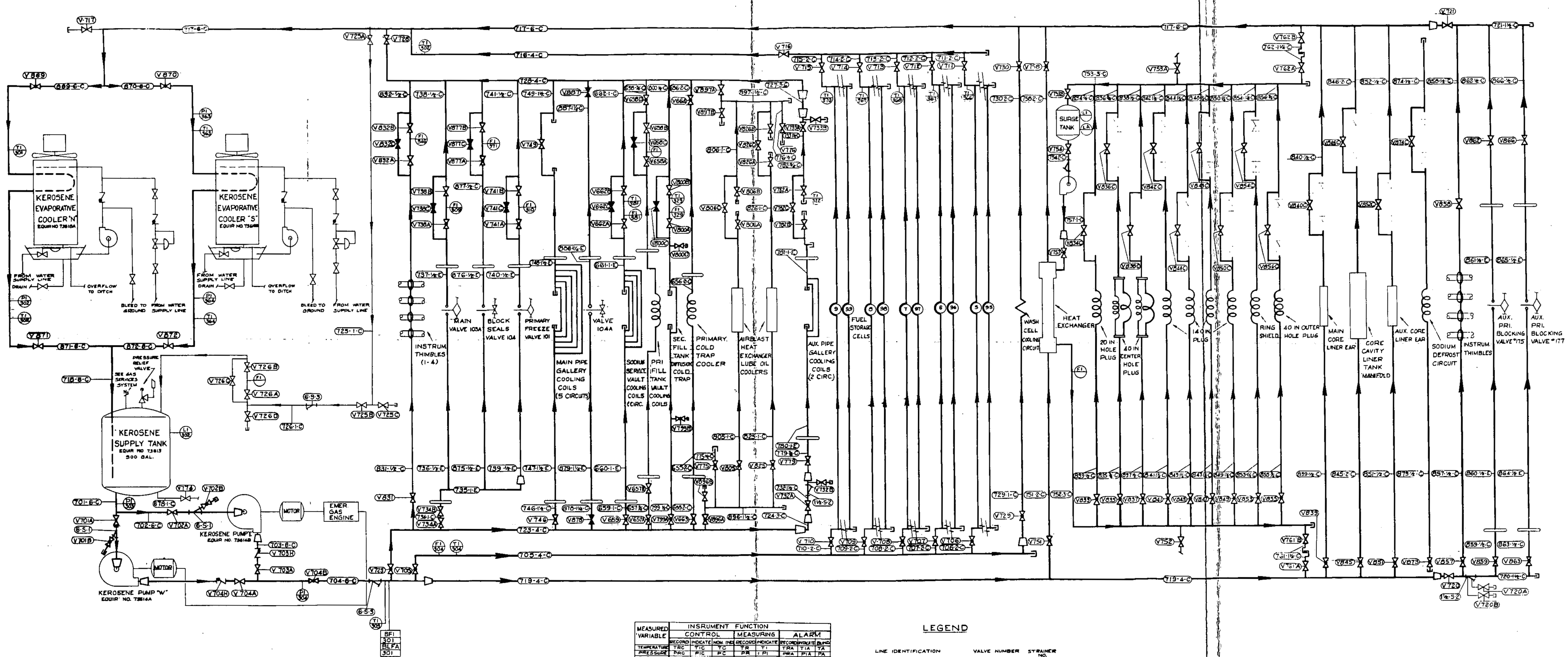


Figure A-IV-3. Gas Services, P and I Diagram (Sheet 3 of 3; 9693-70020)



MEASURED VARIABLE	INSRUMENT FUNCTION							
	CONTROL			MEASURING		ALARM		
	RECORD	INDICATE	NOM. IND	RECORD	INDICATE	RECORD	INDICATE	BLIND
TEMPERATURE	TRC	TIC	TC	TR	TI	TRA	TIA	TA
PRESSURE	PRC	PIC	PC	PR	PI	PRA	PIA	PA
FLOW	FRC	FIC	FC	FR	FI	FRA	FIA	FA
LEVEL	LRC	LIC	LC	LR	LI	LRA	LIA	LA
RADIATION				RR	RI	RRA	RIA	RA

TI — INSTRUMENT NUMBER — TR
FIELD MOUNTED INSTRUMENT — BOARD MOUNTED INSTRUMENT

REFERENCE P & I DRAWINGS	
DRAWING NO.	TITLE
9693-70016	PRIMARY SODIUM SYSTEM
17	SECONDARY SODIUM SYSTEM
18	GAS SERVICES
19	GAS SERVICES
20	GAS SERVICES
22	RADIOACTIVE LIQUID WASTE SYSTEM
23	PUMP COOLANT SYSTEM
24	COMBUSTION ENGINEERING STEAM GENERATOR
9693-P101	PROCESS PIPING SPECIFICATION
-P102	PROCESS SYSTEMS DESIGN DATA
9693-70025	SRE LINE & VALVE LIST

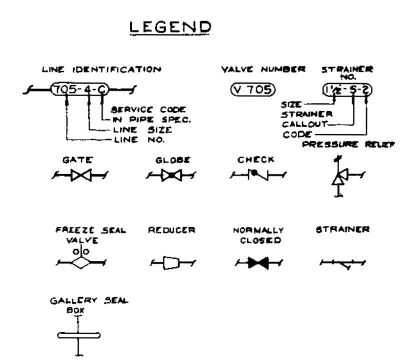


Figure A-IV-4. Service Coolant System, P and I Diagram (9693-70021)

June 27, 1960

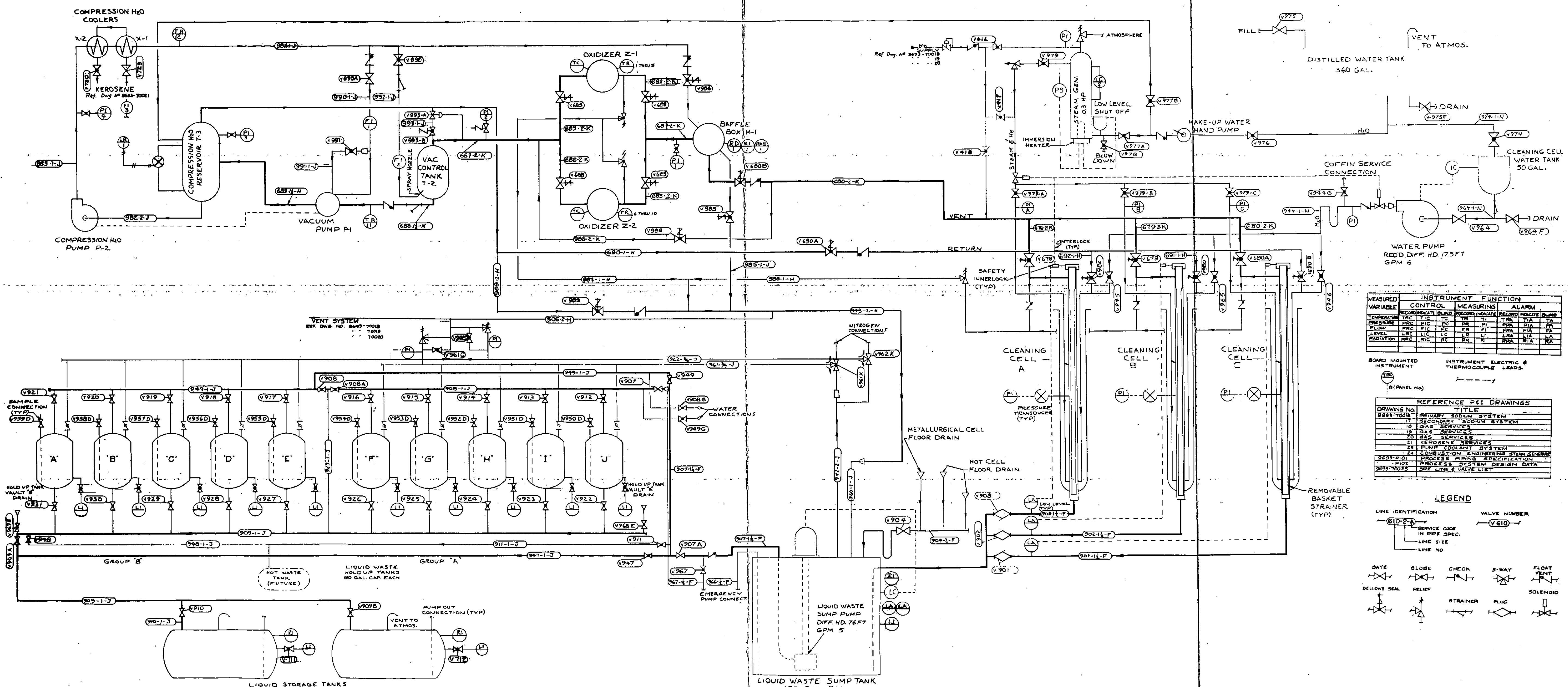
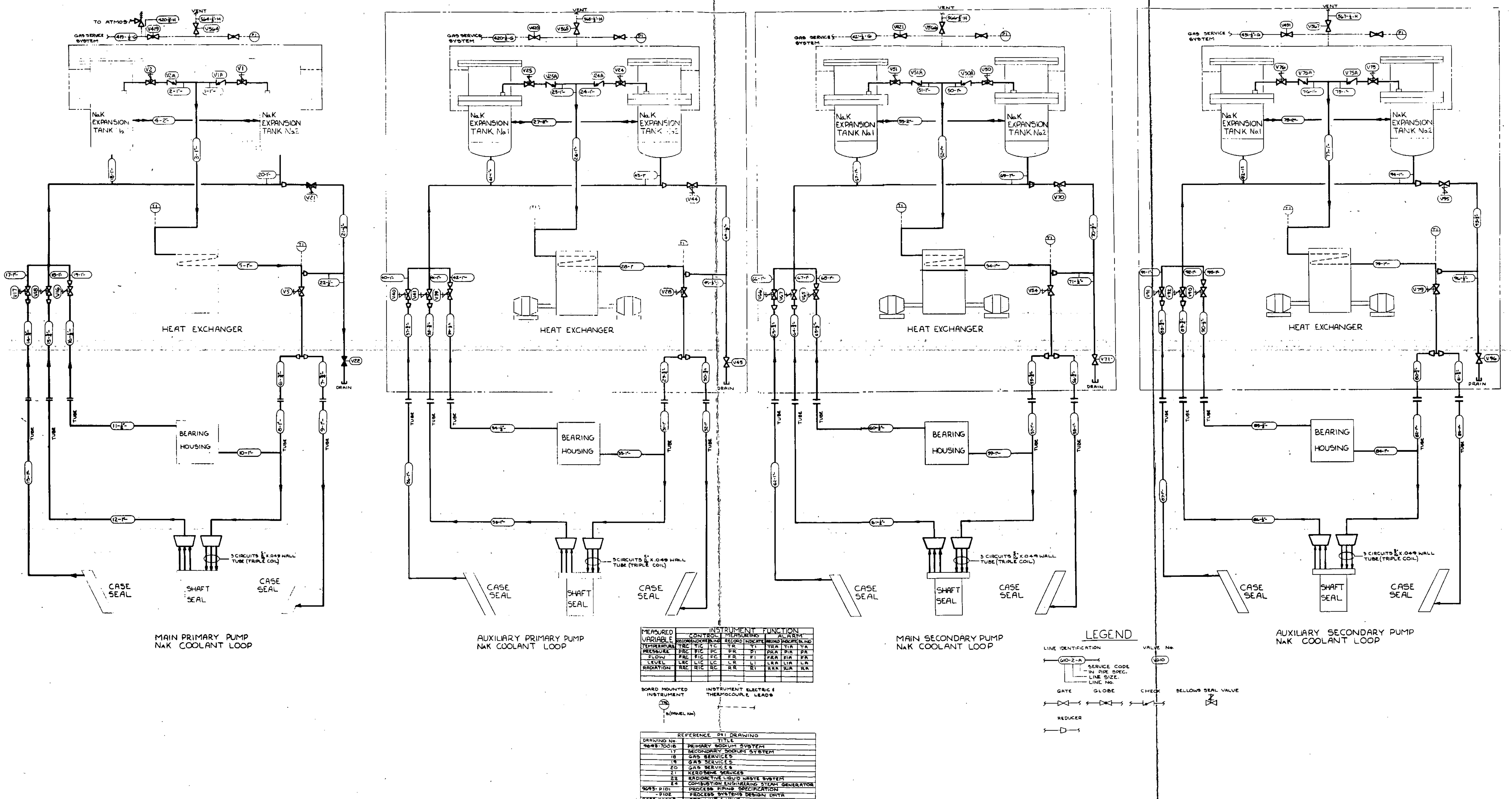


Figure A-IV-5. Radioactive-Liquid-Waste System, P and I Diagram (9693-70022)



MEASURED VARIABLE	INSTRUMENT FUNCTION							
	CONTROL			MEASURING		ALARM		
	RECORD	INDICATE	BLIND	RECORD	INDICATE	RECORD	INDICATE	BLIND
TEMPERATURE	TRC	TIC	TC	TR	TI	TRA	TIA	TA
PRESSURE	PRC	PIC	PC	PR	PI	PRA	PIA	PA
FLOW	FRC	FIC	FC	FR	FI	FRA	FIA	FA
LEVEL	LRC	LIC	LC	LR	LI	LRA	LIA	LA
RADIATION	RRC	RIC	RC	RR	RI	RRA	RIA	RA

REFERENCE P&I DRAWING	
DRAWING No.	TITLE
9698-70016	PRIMARY SODIUM SYSTEM
17	SECONDARY SODIUM SYSTEM
18	GAS SERVICES
19	GAS SERVICES
20	GAS SERVICES
21	KEROSENE SERVICES
22	RADIOACTIVE LIQUID WASTE SYSTEM
24	COMBUSTION ENGINEERING STEAM GENERATOR
9693-P101	PROCESS PIPING SPECIFICATION
-P102	PROCESS SYSTEMS DESIGN DATA
9693-70025	SRE LINE & VALVE LIST

Figure A-IV-6. Pump Coolant System, P and I Diagram (9693-70023)

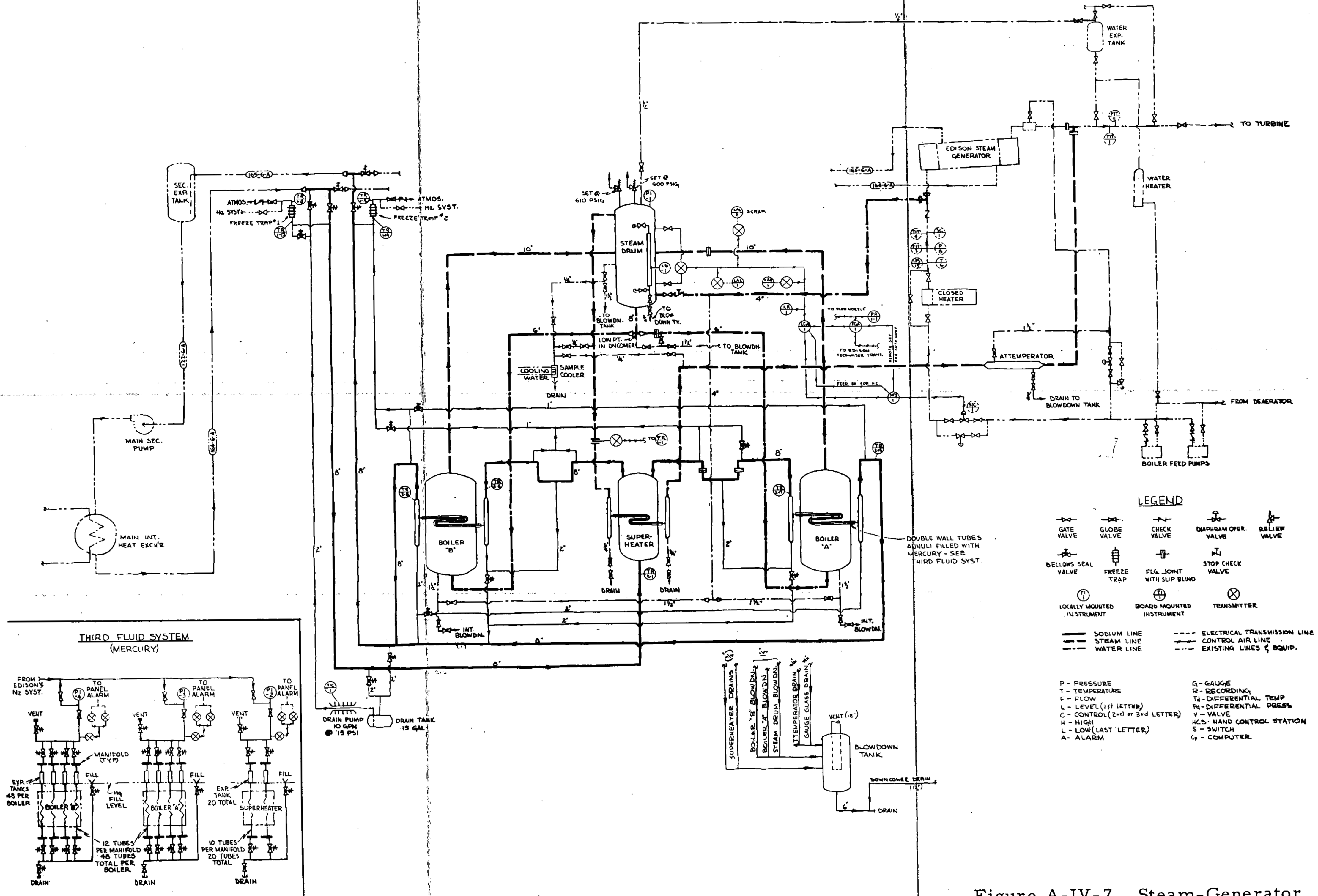


Figure A-IV-7. Steam-Generator Installation (9693-70024)

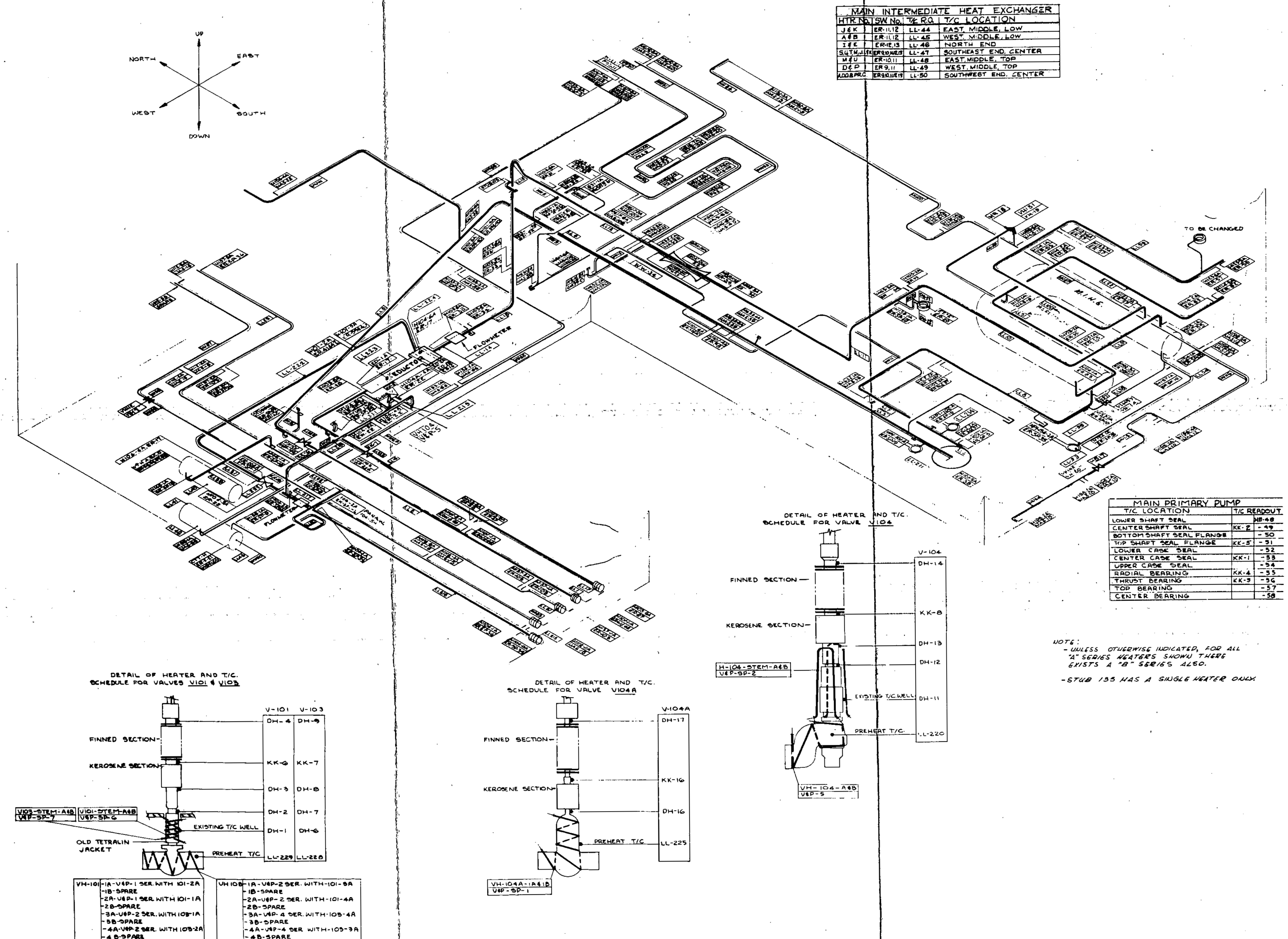


Figure A-IV-8. Main-Primary-Sodium-System Thermocouple and Heater Schedule (9693-70026)

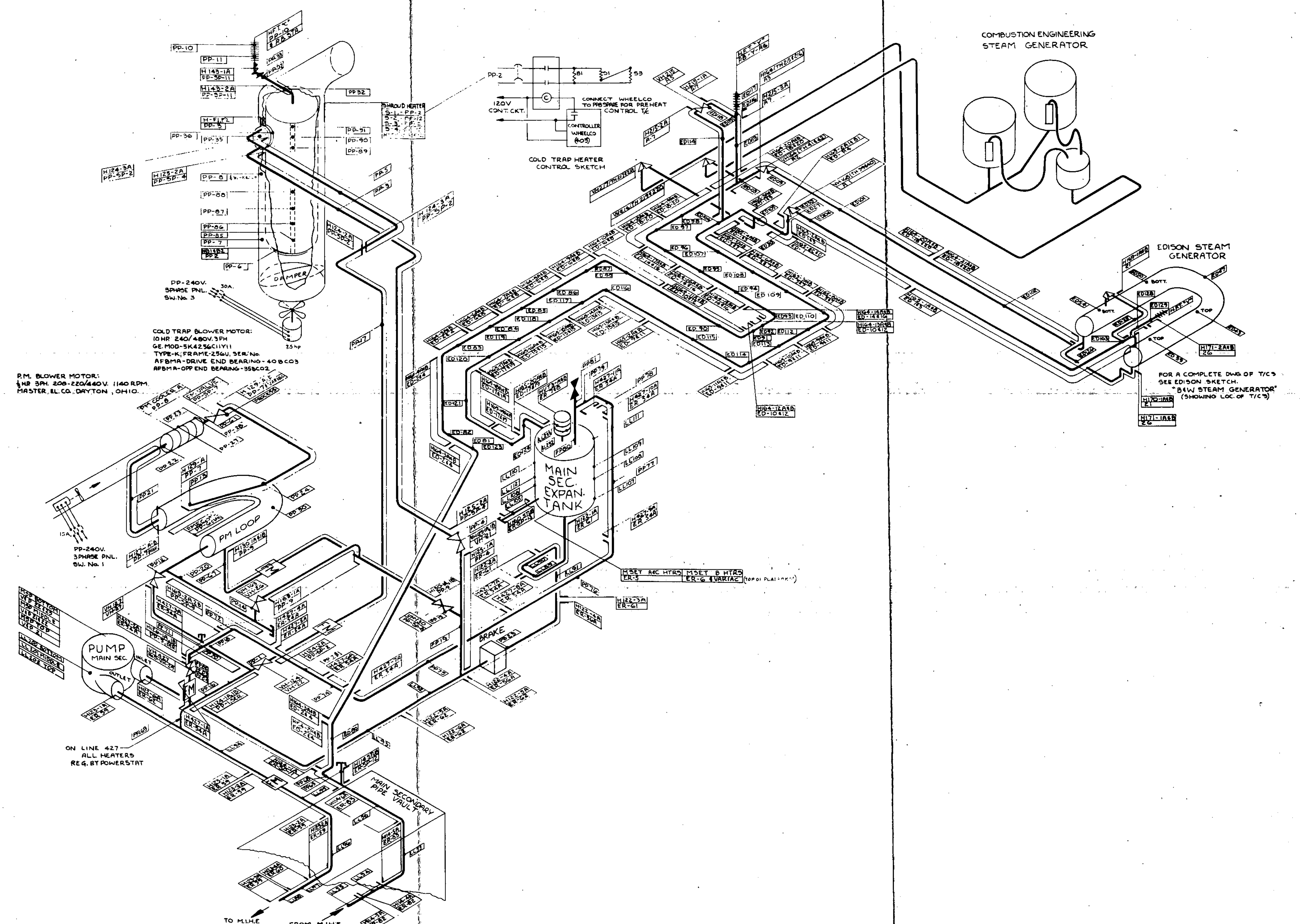
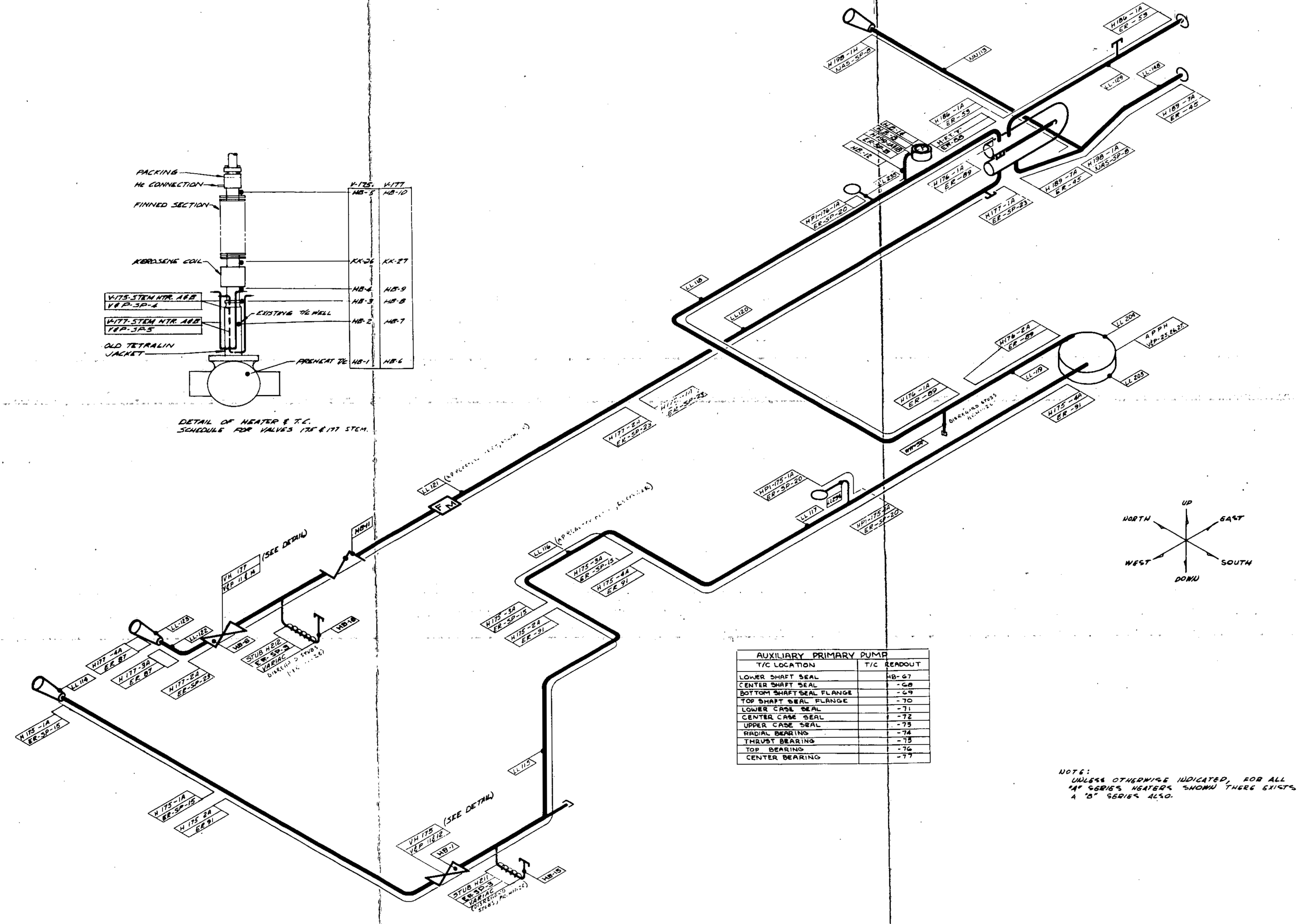


Figure A-IV-9. Main-Secondary-Sodium-System Thermocouple and Heater Schedule (9693-70027)



AUXILIARY PRIMARY PUMP	
T/C LOCATION	T/C READOUT
LOWER SHAFT SEAL	HB-67
CENTER SHAFT SEAL	-68
BOTTOM SHAFT SEAL FLANGE	-69
TOP SHAFT SEAL FLANGE	-70
LOWER CASE SEAL	-71
CENTER CASE SEAL	-72
UPPER CASE SEAL	-73
RADIAL BEARING	-74
THRUST BEARING	-75
TOP BEARING	-76
CENTER BEARING	-77

Figure A-IV-10. Auxiliary-Primary-Sodium-System Thermocouple and Heater Schedule (9693-70028)

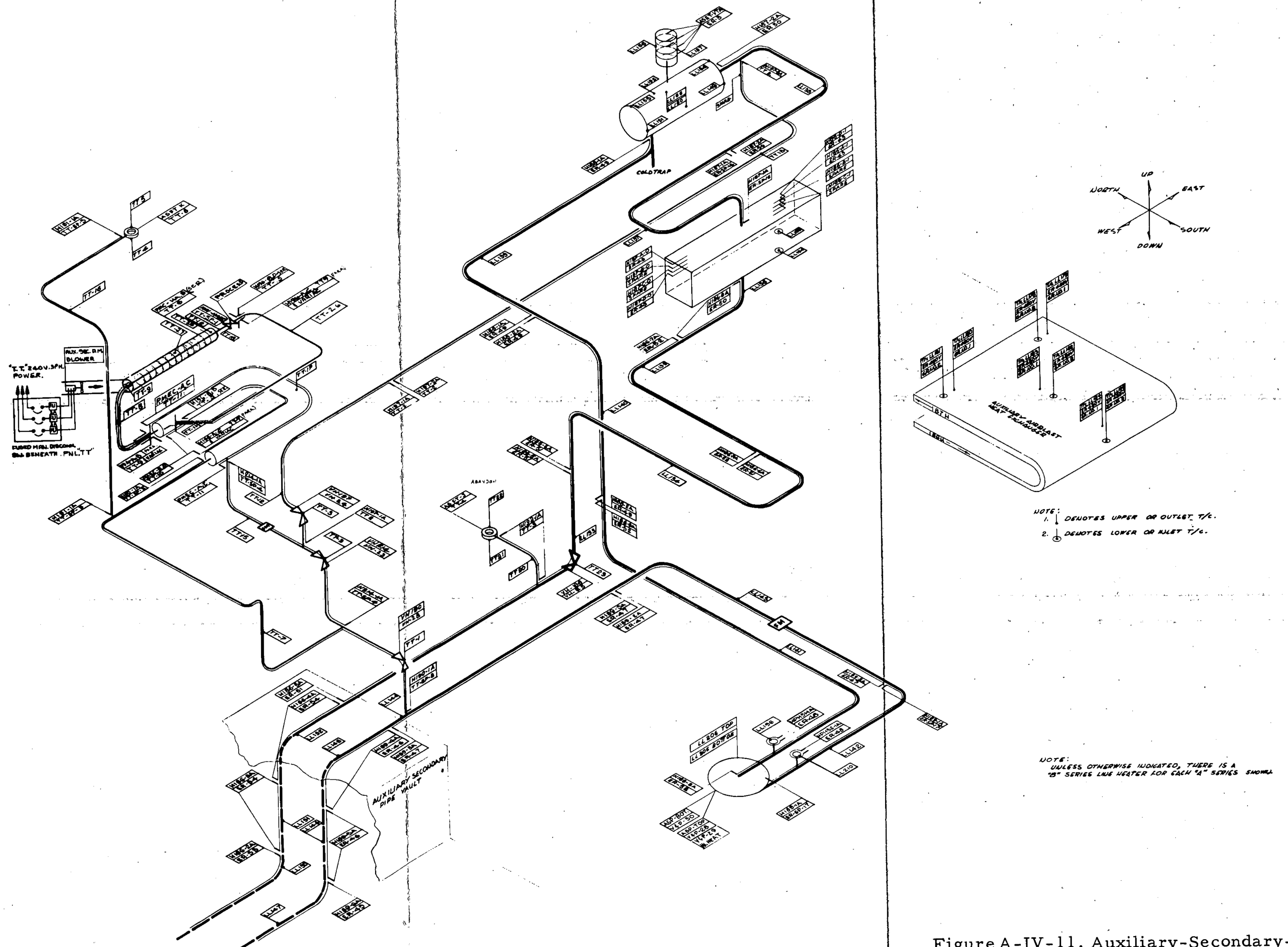


Figure A-IV-11. Auxiliary-Secondary-Vault Thermocouple and Heater Schedule (9693-70030)

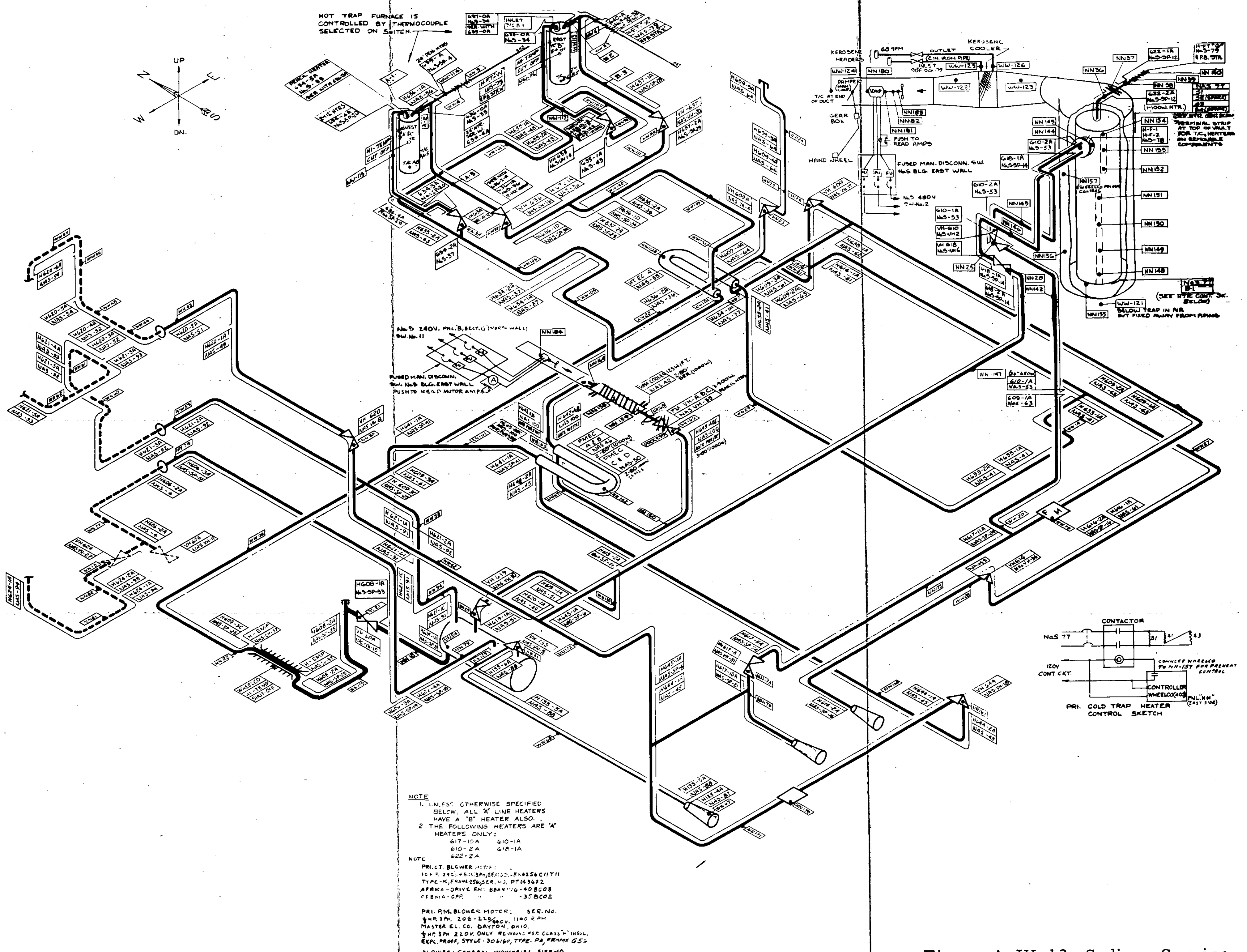
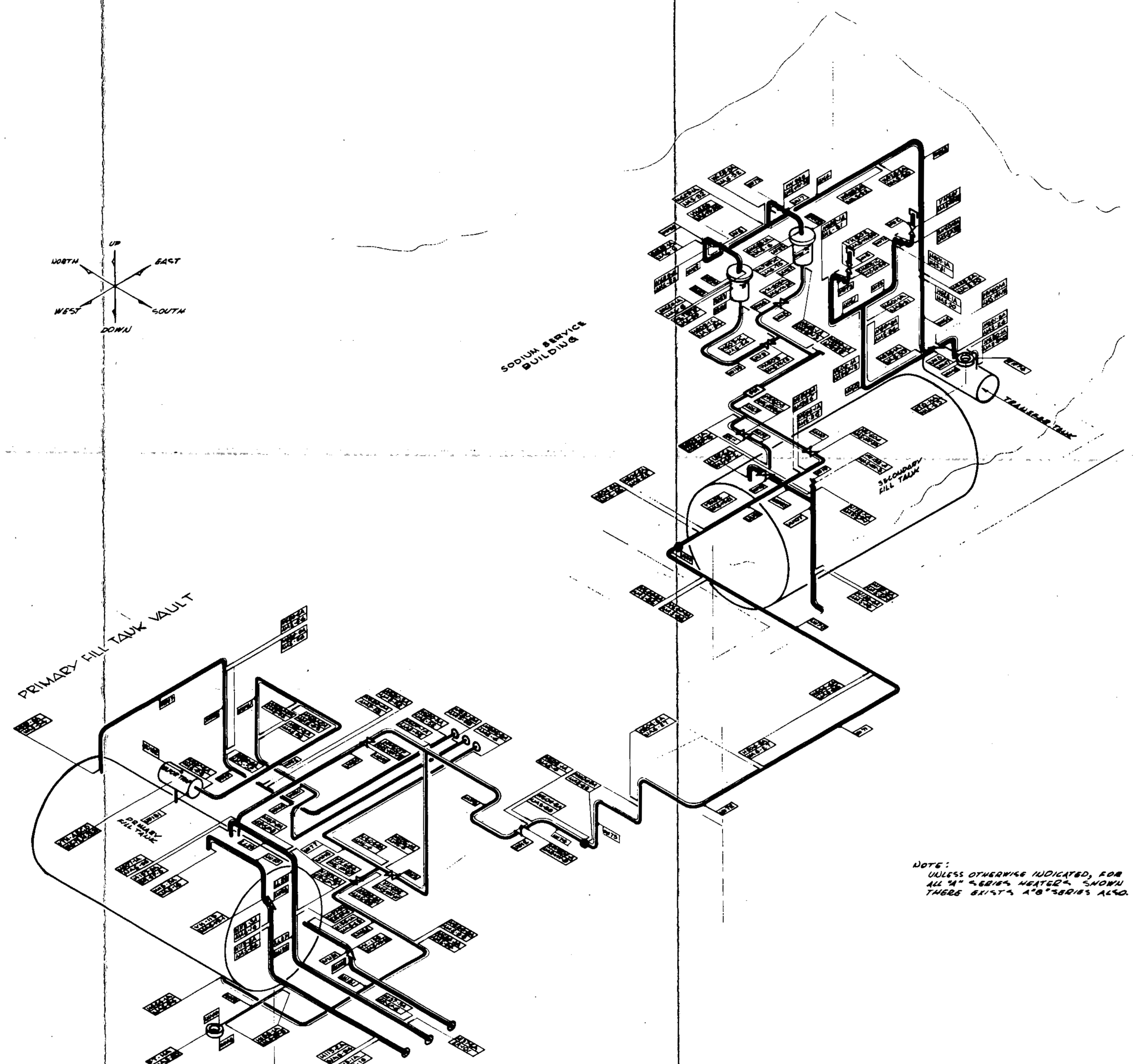


Figure A-IV-12. Sodium-Service-Vault Thermocouple and Heater Schedule (9693-70030)



NOTE:
UNLESS OTHERWISE INDICATED, FOR ALL "A" SERIES HEATERS SHOWN THERE EXISTS A "B" SERIES ALSO.

Figure A-IV-13. Sodium-Service-System Thermocouple and Heater Schedule (sheet 1 of 2; 9693-70031)

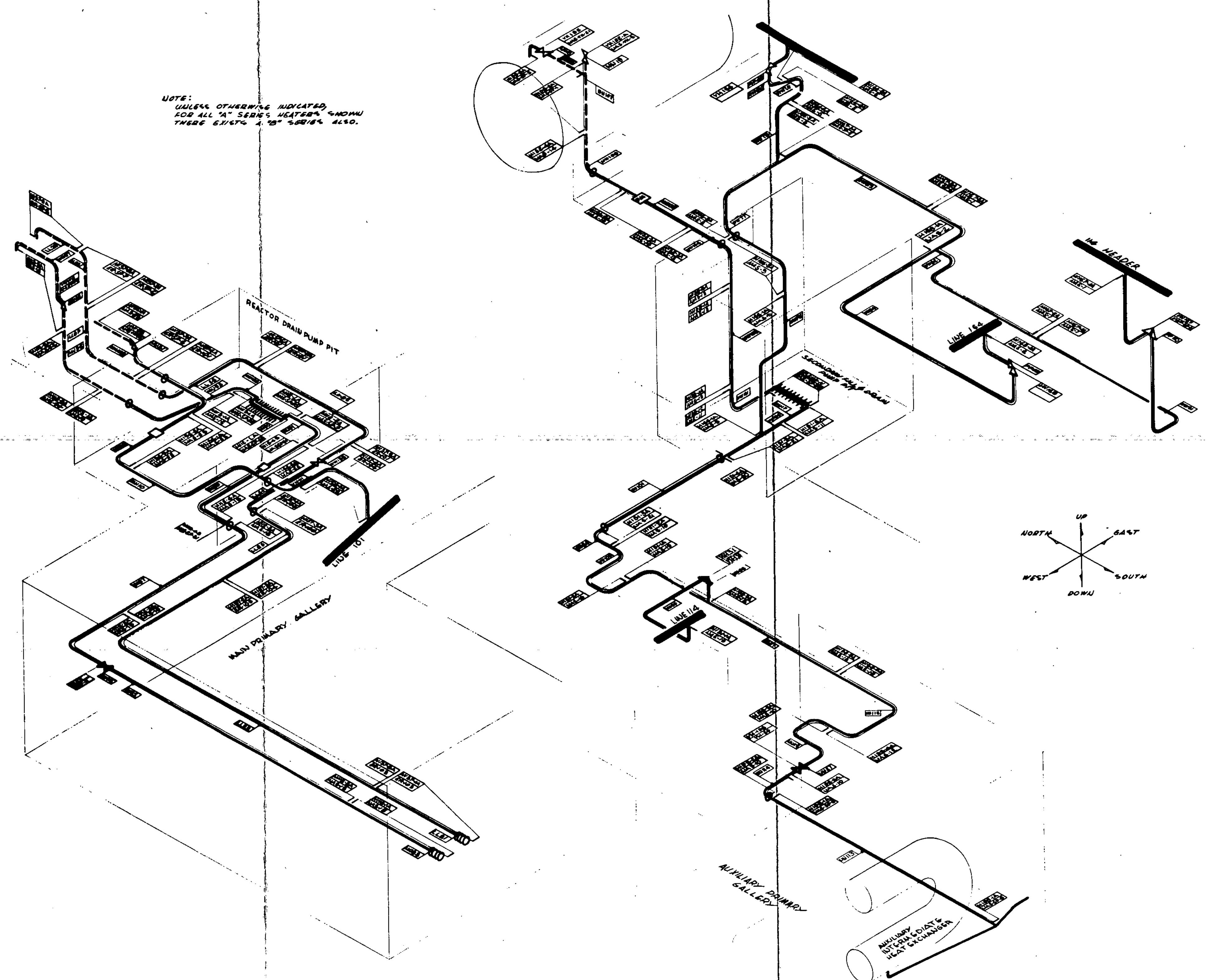


Figure A-IV-13. Sodium-Service-System Thermocouple and Heater Schedule (sheet 2 of 2; 9693-70032)