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HNPF Pump Test Loop Final System Design Description

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Liquid Metal Engineering Center

Operated for

the U.S. Atomic Energy Commission by Atomics International

A Division of North American Rockwell Corporation

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B. Steele
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FIGURE

1. North American Rockwell Nuclear Development Field Laboratory	20
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DRAWINGS

7508-SA121001 HNPF Pump Test Loop
P&I Diagram - Loop I and II

7508-SP121001 HNPF Pump Test Loop
Loop No. 1 - Piping - Isometric

7508-SP121002 HNPF Pump Test Loop
Loop No. 2 - Piping - Isometric

7508-EA121001 HNPF Pump Test Loops
Electrical Single Line Diagram

7508-EH121001 HNPF Pump Test Loop No. 1
Heater and Thermocouple Locations Isometric

7508-EH121002 HNPF Pump Test Loop No. 2
Heater and Thermocouple Locations - Isometric

1.0 INTRODUCTION

1.1 General

1.1.1 The existing Hallam Nuclear Power Facility (HNPF) pump test loop was built to test HNPF prototype pumps. The loop, in its current status, evolved from five separate test programs.

1.1.2 The first installation was erected for the purpose of testing a Byron Jackson freeze seal pump. This loop, which is designated as loop No. 1, consisted of a sodium storage tank, sodium expansion tank, the test pump, a pump cooling system, an inert gas and vent system, piping, and accessories.

1.1.3 The second installation was erected for the purpose of testing an Allis-Chalmers free surface pump. This loop, which is designated as loop No. 2, consisted of a sodium expansion tank, the test pump, piping and accessories. The sodium storage tank and the inert gas and vent system were common to both loops No. 1 and No. 2.

1.1.4 The third installation was the testing of a Byron Jackson free surface pump (the Hallam primary sodium pump). It was installed in loop No. 1, in place of the freeze seal test pump.

1.1.5 The fourth installation, an addition to loop No. 2, was erected for the purpose of testing shell-side heat transfer characteristics of sodium-to-sodium heat exchangers. A sodium purification system, an electric in-line heater, and a cooler were added to the loop for this experiment. However, the heater and cooler have since been removed. Twelve heat exchangers were designed to be tested, one at a time. The first heat exchanger was installed, but the program was terminated before any tests were run.

1.1.6 The fifth installation was the replacement of the free-surface pump in loop No. 2 by an Atomics International (AI) helical-rotor electromagnetic (EM) pump. The pump is installed but tests have not been performed.

1.1.7 The system design description that follows presents the original loop functions and capabilities. It describes the loop as it exists in July 1968 and points out missing items. In this way, existing loop capabilities can be fully assessed.

1.2 System Function

The HNPF test installation performs the following functions:

- 1) Provides the means of testing Hallam prototype freeze seal and free surface centrifugal pumps
- 2) Provides the means of testing a helical rotor EM pump
- 3) Provides the evaluation of shell-side heat transfer experiments on sodium-to-sodium heat exchangers
- 4) Provides the capability for calibration of sodium flowmeters
- 5) Provides for the testing of sodium components such as valves and coolers within pressure, flow, and temperature limits.

1.3 Summary Description

1.3.1 Site and Structure

1.3.1.1 The HNPF pump test loop is an existing facility. It is located on an AEC-optional portion of the North American Rockwell Nuclear Development Field Laboratory, Santa Susana, California.

1.3.1.2 The facility consists of two principal areas, the control room and the test pad. The test pad provides space and handling capacity for system components and piping. The control room provides space for control and data acquisition equipment.

1.3.1.3 The site layout provides accessibility for equipment maintenance. A 10-ton monorail joist which has a total lift of 50 ft provides for the handling and maintenance of sodium pumps.

1.3.1.4 A pump pit, 8 ft wide by 10 ft long by 13 ft deep, provides for the installation of a barometric dip leg for a sodium free surface pump.

1.3.1.5 The drain tank pit, 12 ft wide by 25 ft long by 12 ft deep, provides a low point for the complete drainage of the sodium systems. The pit is lined with steel plate to contain any sodium spillage.

1.3.2 Sodium Circulating System — Loop No. 1

The sodium circulating system in loop No. 1 consists of a surge tank, a hand control valve, a flowmeter, 12- and 16-in.-diameter pipe, and accessories.

Connections exist for the installation of the Hallam primary sodium pump, which was installed but has since been removed. The loop provides the capability of testing a pump at 1000°F to a flow of 7200 gpm against a 150-ft head. Flow and pressure drop can be regulated by varying pump speeds and by throttling the 12-in. ball valve. Instrumentation is provided to measure temperature, flow, and level.

1.3.3 Sodium Circulating System – Loop No. 2

1.3.3.1 The sodium circulating system in loop No. 2 consists of a helical rotor EM pump, a surge tank, an experimental shell-and-tube heat exchanger, valves, flowmeters, pipe and accessories. Connections exist for the installation of an air cooler, an electric heater and a gas-fired sodium heater, which were installed but have since been removed.

1.3.3.2 As it exists now, with repairs, the loop has the capability of circulating sodium from the helical-rotor EM pump to the surge tank, and back to the pump through a minimum pipe diameter of 3 in. With the installation of the heaters and cooler, the loop will have the capability of circulating sodium through the experimental heat exchanger at a maximum flow of 1000 gpm and at a maximum temperature of 1200°F.

1.3.3.3 This capability can be varied over a wide range of flow and temperature by manipulation of hand control valves to the heaters and the cooler. Flow can be measured by utilizing the two 4-in. flowmeters that are installed upstream of the heaters and cooler. Instrumentation is provided to measure temperature and pressure.

1.3.4 Electrical System

1.3.4.1 The essential features of the electrical system are shown on the Electrical Single Line Diagram, drawing 7508-EA121001. Basically, there are four distinct systems: a 4160-volt system and three separate 480-volt systems.

1.3.4.1.1 The 4160-volt system is fed in underground conduit from the high voltage pole line to a starter compartment. The underground wires are shorted out and the non-fused cutouts on the pole have been removed to isolate the system. The pothead, conduit and wire remain in place. Originally there were two 5-kv starters. One starter which served the loop No. 1 pump motor has been removed but the conduit only from the starter to the former pump position remains in place.

The 5-kv starter which served loop No.2 remains but has been modified and is used as a disconnect device for a feeder to a bank of three 2400-volt/480-volt transformers supplying an EM helical-rotor pump. The feeder from the starter to the transformer bank is not complete.

1.3.4.1.2 One of the 480-volt systems is fed by the bank of three 75-kva, 2400-to 480-volt transformers supplied by the 4160-volt system. This bank of transformers feeds a 200-hp helical-rotor pump motor through a 480-volt starter and feeder.

1.3.4.1.3 A second 480-volt system consists of a 500-amp underground feeder from a breaker in the distribution panel of the Sodium Component Test Installation (SCTI) substation No.756 to an externally operable disconnect switch in the facility control room. No further distribution is made of this power.

1.3.4.1.4 The third 480-volt system consists of a 300-amp underground feeder serving the 480-volt motor control center in the facility control room. This system is supplied by a breaker in the distribution panel of substation No.706. The system mainly supplies power to the facility lighting transformer, the sodium system preheaters, the tower crane, and the kerosene cooling system pump motor.

1.3.5 Instrumentation and Controls

1.3.5.1 Instrumentation and control systems were formerly installed, but have since been removed. All process control, preheat control, and associated instrumentation, panels, and cabinets have been removed from the control room. In addition, many of the field sensors, transmitters, and local instruments have also been removed. The existing sensors and field transmitters are typical for a simple dual sodium loop, including those required for an inert nitrogen cover gas subsystem and a kerosene cooling subsystem.

1.3.5.2 The process parameters, sensed and instrumented, include the following:

- 1) Flow
- 2) Tank levels
- 3) Temperatures
- 4) Pressures.

1.3.5.2.1 Flow is measured by means of permanent-magnet flowmeters in the sodium loops and Rotometer type local flowmeters for nitrogen and kerosene.

1.3.5.2.2 Sodium tank levels are measured by means of induction coils in sealed tank thimbles, with signals electrically transmitted.

1.3.5.2.3 Temperatures are universally measured by means of thermocouples only.

1.3.5.2.4 Pressures are measured by local pressure gages. Sodium pressures are measured by suitable NaK-filled capillary type high temperature gages.

1.3.5.2.5 Flow control in sodium loop No. 1 is normally obtained by variable pump output aided by a manually operated throttling valve.

1.3.5.2.6 Flow control in sodium loop No. 2 is obtained by a variable pump output and/or remote actuated pneumatic control valve complete with a recently added Conoflow Valve Positioner and cylinder type actuator.

1.3.6 Sodium Drain System

The sodium drain tank is located below the main loops, and is common to both loop No. 1 and loop No. 2. The tank has a 3700-gal capacity, and stores the complete inventory of sodium in both loops. In case of emergency, both loops are drained by gravity into the drain tank.

1.3.7 Nitrogen Gas System

The nitrogen gas system is common to both loops, and consists of a storage tank, a support structure for the installation of nitrogen gas bottles, and unconnected sections of piping. With the installation of the nitrogen bottle manifold and the interconnecting piping, the system will have the capability of supplying cover gas to the surge tanks and the storage tank, provide pressure to the storage tank for system filling, provide pressure to the surge tank to satisfy the NPSH requirements of the test pump, and provide pressure to the high point freeze traps and vapor traps for draining.

1.3.8 Vent System

The vent system consists of vapor traps located on top of the surge tanks and the sodium fill and drain tank, a freeze trap located at the system high point in loop No. 2, and piping which connects from the traps to atmosphere. The vent system provides for normal and emergency venting of the nitrogen cover gas while controlling sodium vapor emission from the loop.

1.3.9 Sodium Purification System

The sodium purification system consists of a cold trap, connections for the installation of a plugging meter, valves, and piping. The system is located in loop No.2 only, and has the capability of purifying the sodium by precipitating out sodium oxide impurities. This is accomplished by diverting a side stream of sodium through the cold trap, and returning the sodium back to the main loop. With the installation of the plugging meter, the loop will have the capability of monitoring the impurity content of the sodium.

1.3.10 Kerosene System

The kerosene system consists of a centrifugal pump, a storage tank, two shell-and-tube exchangers, a foundation pad for the installation of a second pump, and unconnected sections of piping and accessories. The original purpose of this system was to cool the freeze seals in the original freeze seal pump, valves, and the diffusion cold traps. The heat picked up by the kerosene cooling system was then rejected at the shell-and-tube exchanger which flowed cooling water in the shell. Since the original freeze seal pump no longer exists, and since the valves and diffusion cold traps are cooled adequately in an air atmosphere, this system performs no function.

1.4 System Design Requirements

1.4.1 Applicable Codes

All systems are designed and fabricated to the following codes, standards, and criteria:

- 1) State of California Administration Code, Division of Industrial Safety
- 2) State of California Construction Safety Orders and Electrical Safety Orders
- 3) Ventura County Building Code
- 4) Uniform Building Code
- 5) National Electrical Code
- 6) ASME Boiler and Pressure Vessel Code
 - a) Section VIII, Unfired Pressure Vessels
 - b) Section IX, Welding Qualifications

7) American Standard Code for Pressure Piping, ASA B31.1-1955

8) American Institute of Steel Construction

9) American Concrete Institute ACI 318 and ACI 315.

1.4.2 Site and Structures

1.4.2.1 Site. The site is designed to provide space for a control building and test equipment.

1.4.2.1.1 The site is paved with a reinforced concrete slab, and is designed for a 28-day ultimate strength of 3000 psi.

1.4.2.1.2 The site is designed to drain to the north. Drainage is accomplished by sloping the slab.

1.4.2.1.3 The site is fenced to provide safety and security.

1.4.2.2 Structures. Principal structures are the control room, test structure, and pipe and equipment supports.

1.4.2.2.1 Control Room. The control room is designed to contain electrical switchgear and limited operating space for personnel.

1.4.2.2.2 Test Structure. The test structure is designed to support pumps being tested and to support handling equipment. Provision is made for vehicle and equipment access by an open center bay. Principal design criteria are as follows:

1) Allowable soil bearing: 2000 psf

2) Concrete ultimate strength: $f'_c = 3000$ psi at 28 days

3) Structural steel: ASTM-A7

4) Handling equipment: The monorail hoist is designed for 10-ton capacity at 50-ft lift. The jib boom is designed for 1/2-ton capacity.

1.4.2.2.3 Pipe and Equipment Supports. Pipe and Equipment supports are designed for support of auxiliary components necessary to the conducting of tests. Principal design criteria are the same as for test structures.

1.4.3 Electrical

1.4.3.1 4160-Volt System. The existing 4160-volt pole line circuit has a maximum in-rush capability of 5000 kva. The feeder conduit is 3 in., suitable for up to three 350,000 circular mils, 5 kv, unshielded wires.

1.4.3.2 480-Volt Systems.

1.4.3.2.1 The 480-volt system serving the 200-hp helical rotor pump motor is designed specifically for that purpose. The transformer bank is rated for 225 kva, and the starter is rated for the 200-hp motor. The feeders from the transformer to the starter and from the starter to the motor are three 500,000 circular mil conductors rated to carry 380 amp, approximately 320 kva of power.

1.4.3.2.2 The 480-volt feeders extending from substation No. 706 to the 480-volt motor control center are six No. 4/0 type TW conductors, rated to carry 312 amp, approximately 260 kva of power.

1.4.3.3 Conduit and Wireways. Within the control room, conductors are routed in expanded metal trays. Outside of the control room, major routing of conductors is in weatherproof flange connected wireways with hinged, neoprene gasketed covers. Feeds to individual items of equipment are made in rigid conduit extensions from the wireways.

1.4.3.4 Wire and Cable.

1.4.3.4.1 New 4160-volt feeder wires should be unshielded corona and ozone resistant, rated for 5-kv service, at 90°C in either dry or wet locations.

1.4.3.4.2 480-volt system feeder wires are either type RHW, rated for 75°C service at 600-volts or type TW rated for 60°C service at 600 volts. With few exceptions, the 480-volt and lower voltage distribution circuits are type RH-RW or TW, rated for 60°C service at 600 volts.

1.4.3.5 Heaters. The heaters used for preheating the sodium system are round, tubular electric heaters, installed directly on the pipes and equipment. Wattage requirements vary according to the size of pipe and thickness of insulation, but in all cases wattage is adequate to preheat the pipes and equipment to 300°F in 8 hr. The heaters are rated at 480 volts, but are operated at 277 volts.

1.4.4 Sodium System

1.4.4.1 Flow. Sodium loop No. 1 is designed to test sodium pumps to maximum capacities of 7200 gpm. Sodium loop No. 2 is designed to test shell-side heat exchangers to a maximum of 1000 gpm.

1.4.4.2 Temperature and Pressure. Sodium loop No. 1 is designed for 1000°F and 50 psig. Sodium loop No. 2 was originally designed for 1000°F and 50 psig. With

the addition of the shell-side heat transfer experiment, loop No.2 design was upgraded to 1200°F and 75 psig.

1.4.4.3 Materials.

1.4.4.3.1 Equipment and piping in contact with sodium above the temperature of 850°F are fabricated from stainless steel. Where temperatures do not exceed 850°F, such as the storage tank, carbon steel is utilized.

1.4.4.3.2 All sodium equipment and piping are insulated against thermal loss. Insulation is moisture-free and nonreactive with sodium.

1.4.4.3.3 All equipment is suitable for outdoor service.

1.4.5 Nitrogen Gas System

The nitrogen gas system is designed for 150 psig at 100°F. Nitrogen cover gas is supplied to the surge tanks at a maximum pressure of 50 psig. The sodium loop is filled by pressurizing the storage tank with nitrogen at 25 psig. Equipment and piping are fabricated from carbon steel. Fillings are threaded forged carbon steel.

1.4.6 Kerosene System

The kerosene cooling system is designed for 50 psig at 300°F. Cooling is supplied to the freeze seals at a maximum flow of 60 gpm. Equipment and piping are fabricated from carbon steel. All fittings are threaded forged carbon steel.

1.4.7 Instrumentation

1.4.7.1 All control loops for the HNPF test loop are the open loop type except for temperature control. Pressures, levels, and flows are manually controlled and monitored by operator personnel. Pressures, plus nitrogen and kerosene flows, are locally indicated; all other parameters are electrically transmitted to the control room.

1.4.7.2 Temperatures for both preheating and process control are measured by thermocouples, and the dc millivolt control signals transmitted back to the now nonexistent on-off pyrometer type temperature controllers previously located in the control room.

1.4.7.3 Design requirements for the sensors and transmitters are as follows:

1) Thermocouples:

- a) Chromel-Alumel, range 0 to 1200°F, accuracy $\pm 3/4\%$, ISA calibration "K" speed of response 1 sec for surface mounted types, 3 sec for well mounted types
- b) Platinum, Platinum-10% Rhodium (Pt, Pt-10% Rh), range 0 to 1500°F, accuracy $\pm 1/2\%$, ISA calibration "S"

2) Pressure Gages:

- a) Direct action type, accuracy $\pm 1/2\%$
 - b) Capillary type with chemical seal, accuracy $\pm 1\%$
- 3) Magnetic Flowmeters: estimated accuracy $\pm 2\%$ (dependent on calibration technique)
- 4) Rotometer Flowmeters: accuracy $\pm 3\%$
- 5) Induction Level Transmitters: accuracy $\pm 3\%$.

2.0 DETAILED DESCRIPTION OF SYSTEMS

2.1 Facility

2.1.1 General Description

2.1.1.1 The HNPF Pump Test Facility is located on an AEC-optioned portion of the North American Rockwell Nuclear Development Field Laboratory in southeastern Ventura County, California. Figure 1 is a map of the area.

2.1.1.2 The facility consists of a control room, test structure, tank and equipment pits, and small pipe support structures; they are located on a paved site, adjacent to the SCTI and across "C" street from the Large Component Test Loop (LCTL).

2.1.2 Site

2.1.2.1 The site is approximately a rectangle, measuring 71 ft wide by 95 ft long. The area is fenced with a 6-ft-high chainlink fence. Vehicle access into the site is provided by a 10-ft rolling gate on the north, a 16-ft rolling gate on the south, and an 8-ft rolling gate on the west. Personnel access is through the control room and through a 3-ft hinged gate on the west.

2.1.2.2 The site is paved with a 6-in. slab of concrete, reinforced with welded wire mesh. The slab is sloped to provide drainage to the north.

2.1.3 Structures

2.1.3.1 Test Structure

2.1.3.1.1 The test structure is of cross-braced, structural steel construction. The principal structure is 20 ft wide (2 bays) by 30 ft long (3 bays) with the long side running east-west.

2.1.3.1.2 The covered portion of the test structure contains positions for two test pumps and drives. An open bay between the pumps provides service access for removal of either pump. The remainder of the test structure is used for pipe and tank support.

2.1.3.1.3 The south portion (10 ft wide by 30 ft long) of the structure is 50 ft high and contains a monorail hoist at the roof and an operations platform at the 23-1/2-ft level. This part of the structure is partially enclosed with corrugated sheet metal roofing and siding above the 23-1/2-ft level.

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2.1.3.1.4 The north portion of the structure is nominally 16 ft high and provides operating and equipment support platforms.

2.1.3.1.5 The foundation for the structure is of reinforced concrete construction. The footings are extended below grade approximately 8 ft and bear on cemented sandstone.

2.1.3.1.6 The center bay of the structure is unbraced below the operating floor to allow vehicle and equipment access to the area covered by the monorail.

2.1.3.1.7 Pipe and equipment supports have been added at various times since the initial construction was completed. Some of these appear to have been field designed or significantly modified, apparently without regard to sound engineering practice. These should be analyzed and modified, as required, prior to reuse.

2.1.3.1.8 Similarly, certain main bracing members were removed from the main test structure when interference with equipment or piping occurred. There is no evidence that any compensating bracing was installed. The effect of this bracing removal should be analyzed and new bracing installed where required.

2.1.3.2 Control Building

2.1.3.2.1 The control building is located at the southwest corner of the site. The building is 20 ft wide by 25 ft long with 10-ft eave height. Permanent operating equipment located in the building is limited to electrical breaker panels.

2.1.3.2.2 The building is of prefabricated construction. Roofing and siding are galvanized corrugated sheet metal. Three doors are provided, one opening onto "C" street and two opening onto the fenced site.

2.1.3.2.3 Ventilation is provided by three windows, louvers, and a motorized roof ventilator. Air conditioning is provided by a window-mounted unit.

2.1.3.3 Pits. Three pits exist on the site to contain tanks and equipment.

2.1.3.3.1 The pit containing the fill and drain tank is 12 ft wide by 25 ft long by 12 ft (nominal) deep. Walls and base slab are of reinforced concrete construction. The pit is lined with steel plate at the base and to a height of 3 ft on the walls.

2.1.3.3.2 The pit beneath the existing EM pump is 8 ft wide by 10 ft long by 13 ft deep. Walls and base slab are of reinforced concrete construction. This pit is also lined at the base and to a height of 3 ft on the walls with steel plate.

2.1.3.3.3 The expansion tank pit is 5 ft wide by 7 ft long by 4 ft-4 in. deep. Walls and base slab are of reinforced concrete construction. The pit is unlined.

2.1.3.4 Handling Equipment

2.1.3.4.1 Ten Ton Monorail. A 10-ton capacity monorail hoist is provided at the top of the high portion of the test structure. The hoist has a total lift of 50 ft with high-hook at approximately 45 ft above grade. The trolley is geared drive with hand chain operator. The hoist is capable of serving both pump locations.

2.1.3.4.2 One-Half Ton Jib Boom. A 1/2-ton capacity jib boom is located at the operating floor level. The boom has an effective length of approximately 12-1/2 ft, and a swing of about 135 degrees. An eyebolt is located at the outer end of the boom to allow attachment of a hoist. The boom is 6 ft above the operating platform at 22 ft-3 in. , or approximately 28 ft above grade.

2.2 Sodium Circulating System - Loop No. 1

The sodium circulating system in loop No. 1 is shown on P&I Drawing No. 7508-SA121001 and on isometric Drawing No. 7508-SP121001. A line list is shown in Table A-1. The components shown on the drawings are described in the following sections.

2.2.1 Piping

1) Pipe:

Size 12 in. and larger - schedule 20, welded, ASTM A-358
Type 304 SS

Size 6 in. and smaller - schedule 40, seamless, ASTM A-376
Type 304 SS

2) Fittings:

Size 12-in. and larger - schedule 20, welded ASTM A-376
Type 304 SS, beveled ends

3) Joints:

All sizes — butt weld

4) Valves:

A complete valve list is shown in Table A-2 of the Appendix.

2.2.2 Surge Tank T-1

The surge tank T-1 is a cylindrical, vertical tank which was fabricated according to the ASME Pressure Vessel Code Section VIII and received a code stamp. The tank is elevated so that its 6-in. overflow nozzle will connect to the overflow connection of the Hallam primary sodium pump, and the levels of the tank and pump will be the same. The tank is located in plan so that there is minimum pressure drop in the 16-in. pump suction pipe with adequate flexibility to withstand thermal expansion. The tank is 48 in. in diameter, 10 ft high, and has a capacity of 140 ft³. Internal baffles provide protection against the formation of a vortex, and provide for easy outgassing of the sodium. Two internal 1-in. pipe thimbles provide the capability to obtain level readings. The 12-in. inlet nozzle is located at the bottom head, and the 12-in. outlet nozzle is located on the side. The tank and support material is all stainless steel plate SA240.

Design Data

Operating pressure	50 psig
Design pressure	100 psig
Operating temperature	1000°F
Design temperature	1000°F.

Complete specifications and design can be found on Reference Drawing 7508-D49083.

2.2.3 Storage Tank T-3

Storage tank T-3 is a cylindrical, horizontal tank which was fabricated and code stamped according to the ASME Code for Pressure Vessels Section VIII. The tank is located in a pit at the low point of the system so that loop drainage can be accomplished by gravity. The tank is 72 in. in diameter, 20 ft long, and

has a capacity of 500 ft³. A 1-1/2-in. pipe connection provides the means of filling the tank with sodium from a portable melt station. The tank serves as both a fill and drain reservoir. Two internal 1-in. pipe thimbles provide the capability to obtain level readings. The tank and support material is carbon steel SA285 Grade "C". Electric heaters are strapped to the outside of the tank and covered with a protective metal jacket and thermal insulation.

Design Data

Operating pressure	25 psig
Design pressure	50 psig
Operating temperature	350°F
Design temperature	850°F.

Complete specifications and design can be found on Reference Drawing 7508-D49084.

2.2.4 Vapor Traps 2-1 and 2-3

Vapor trap 2-1 is located on top of surge tank T-1, and vapor trap 2-3 is located on top of storage tank T-3. Both traps serve as vents while controlling sodium vapor emission to the atmosphere. This function is accomplished by keeping a pressurized nitrogen gas cover on the tanks. In the event of a sodium pressure surge in the tanks, nitrogen gas is vented to atmosphere through pressure relief valves. The sodium vapor is condensed onto the inside wall of the vapor trap. Electric heaters, coiled around the outside wall, serve to melt the condensed sodium for drainage. Both vapor traps are fabricated from 6-in. stainless steel pipe and are 2 ft long. A complete detail and specification can be found on Reference Drawing 7508-D49087.

2.2.5 Free Surface Pump P-1 (formerly installed)

Pump P-1 was tested in loop No. 1, and shipped to the HNPF to serve as the primary sodium pump. Pump supports, the 6-in. overflow pipe, and the pump suction and discharge pipes are at the correct locations and elevations to receive the Hallam primary sodium pump, which is a diffuser-type, free surface, centrifugal, vertical, mechanical pump. It is supported from the top, and allowed to thermally expand downwards and radially with increases of temperature. Pressures at the pump suction and at the surge tank are approximately

the same due to common overflow and vent lines. This assures a common sodium level at both tank and pump.

Operating Data

Maximum flow	7200 gpm
Head	150 ft
Temperature	950°F of sodium
Motor	350 hp, 1100 rpm

2.2.6 Pipe Support Hangers

A complete spring hanger list is shown in Table A-3.

2.2.7 Thermal Insulation

Thermal insulation is applied to all sodium equipment, components, and piping. The insulation material and thicknesses are designed to maintain a maximum surface temperature of 150°F at a sodium temperature of 1200°F and an air temperature of 80°F. The insulation is applied over an inner reflector jacket which protects the pipe or equipment electrical heaters. An outer protective jacket is applied at equipment over the insulation for protection against damage. The insulating material is a rigid high temperature type applied in staggered multilayers.

2.3 Sodium Circulating System – Loop No. 2

The sodium circulating system in loop No. 2 is shown on P&I Drawing No. 7508-SA121001 and on isometric Drawing No. 7508-SP121002. A line list is shown in Table A-1. The components shown on the drawings are described in the following sections.

2.3.1 Piping

1) Pipe:

Free Surface Pump Installation – identical to loop No. 1 (see Section 2.2.1.)

Shell-Side Heat Transfer Addition

Size 12 in. and larger – schedule 20, welded, ASTM A-358
Type 304 SS

Size 6 in. and smaller — schedule 10, seamless, ASTM A-376
Type 304 SS

2) Fittings:

Free Surface Pump Installation — identical to loop No. 1 (see
Section 2.2.1).

Shell-Side Heat Transfer Addition

Size 12 in. and larger — schedule 20, welded, ASTM A-358
Type 304 SS beveled ends

Size 6 in. and smaller — schedule 10, seamless, ASTM A-376
Type 304 SS beveled ends

3) Joints:

All sizes — butt weld

4) Valves:

A complete valve list is shown in Table A-2.

2.3.2 Surge Tank T-2

Surge tank T-2 is almost identical to surge tank T-1 (2.2.2). The differences are:

- 1) Surge tank T-2 does not have a 6-in. overflow nozzle.
- 2) The baffles in tank T-2 are 12 in. shorter than those in tank T-1.

These differences are due to the fact that the free surface pump installed in loop No. 2 with surge tank T-2 utilized a barometric dip leg to maintain equal levels in the pump and tank. In all other respects, tanks T-1 and T-2 are identical.

2.3.3 Vapor Trap 2-2

Vapor trap 2-2 is located on top of surge tank T-2, and is identical to vapor traps 2-1 and 2-3 (2.2.4).

2.3.4 Diffusion Cold Traps CT-A and CT-B

Diffusion cold traps CT-A and CT-B were installed for the shell-side heater experiment. CT-A is located in the main heater supply line, and CT-B

is located in the cooler line. The heater and cooler have been removed, but the diffusion cold traps remain. The diffusion cold traps are located at low points and act as a cold source which entrap oxides. The oxide impurities migrate slowly to the cold part of the system and settle in the diffusion cold trap. CT-A is fabricated from stainless steel and CT-B is fabricated from carbon steel. Both items are made from 6-in. -diameter, 2-ft-long pipe encased in a cooling jacket made of 8-in. diameter pipe.

2.3.5 Freeze Trap FT-1 and FT-2

Freeze traps FT-1 and FT-2 are located at the high points of the sodium piping system. The purpose of the freeze traps is:

- 1) To maintain a seal at the high points of the sodium system during loop operation. The seal is formed by freezing the sodium in the freeze trap. The frozen sodium plug is maintained by heat transfer from the freeze trap to the atmosphere.
- 2) To provide a vent at the high points of the sodium system during filling operations.
- 3) To provide a source of inert gas for the sodium system during draining operations.

The freeze traps are fabricated from 1-in. and 1/2-in. stainless steel pipe with a heater inserted in the 1/2-in. pipe. The heater melts the sodium plug during draining operations to permit the introduction of nitrogen into the sodium loop.

2.3.6 Cold Trap CT-1

Cold trap CT-1 was installed for the shell-side heat transfer experiment. CT-1 is connected to a side loop which, in turn, forms a closed loop around a flow control valve located in the main sodium circulating system. The cold trap serves the function of precipitating out oxide impurities which are introduced into the system when experiments are removed and installed.

The cold trap is constructed of stainless steel, and is composed of three main sections: (1) the economizer section heats the outgoing sodium while cooling the entering sodium; (2) the main body of the cold trap is a storage place for precipitated oxides; and (3) the mesh section retains large sodium oxide particles that would otherwise be returned to the system. Cooling is attained

by a blower which directs ambient air between the outside of the cold trap housing and a cylindrical shroud.

2.3.7 Heat Exchanger X-1

Heat exchanger, X-1, is an experimental item which is one of 12 designs that were to be tested for shell-side flow characteristics. The exchanger consists of a rectangular shell section 2 ft in length with 55-3/4-in. OD tubes intersecting the shell at an angle. The exchanger is fabricated from stainless steel plate and tubes. It is located with the shell side in the vertical position. The piping is arranged to permit removal of the test exchanger and installation of another model.

2.3.8 Pump P-2

Pump P-2 is a helical-rotor EM pump designed for 2000 gpm at 25 psig and 625°F sodium. The pump was tested originally at the LCTL. It was then moved to the HNPF pump test loop, and installed in the vertical position. It was used to provide sodium to the shell-side heat transfer experiment, and to gain additional data on the operational characteristics of the pump.

2.3.9 Pipe Support Hangers

A complete spring hanger list is shown in Table A-4.

2.3.10 Thermal Insulation

Thermal insulation for loop No. 2 is identical to that described for loop No. 1 (2.2.7).

2.4 Nitrogen System

2.4.1 Piping

The nitrogen piping, which included a bottle manifold and interconnected piping, has been removed.

2.4.2 Nitrogen Storage Tank T-5

The nitrogen storage tank, T-5, is a carbon steel, cylindrical, vertically mounted tank, fabricated and code stamped per Section VIII of the ASME Pressure Vessel Code. It is designed for 150 psig, and has a capacity of 9 ft³. It is vented through a pressure relief valve set to open at 30 psig.

2.5 Kerosene System

The kerosene system was installed to cool the freeze seals in the original freeze-seal test pump (later removed), the diffusion cold traps, and the valve freeze seals. The need for cooling at the diffusion cold traps and the valves has since proven to be unnecessary. Since there is presently no need for a kerosene system, only a brief description of the kerosene system components will be presented.

2.5.1 Kerosene Storage Tank

The kerosene storage tank is designed for 50 psig at 300°F and a capacity of 125 gal. The tank is equipped with a gage glass, a fill connection, a drain connection, and a pressure relief system.

2.5.2 Kerosene Heat Exchangers

The two horizontal kerosene shell-and-tube heat exchangers are used to cool kerosene flowing through the tubes with raw water flowing through the shell.

Design Properties

Tube design pressure	50 psig
Tube design temperature	200°F
Shell design pressure	75 psig
Shell design temperature	200°F
Material	Carbon steel
Total heat transferred	3000,000 Btu/hr
Flow rate (tube side)	22,000 lb/hr
Flow rate (shell side)	15,000 lb/hr

2.5.3 Kerosene Pump

The kerosene pump (its standby has been removed) is a centrifugal pump, Peerless type DM, rated for 60 gpm at 150 ft and 3525 rpm. The motor is 7-1/2 hp, 3525 rpm, 220/440 volt, 3 phase, 60 cycle.

2.5.4 Kerosene Piping

All pipe is seamless carbon steel ASTM A-53, schedule 40. All fittings are 300-lb forged steel, screwed, ASTM A-105. All valves are 150-lb iron body, screwed ends, solid wedge gates, plug disc gloves, and swing checks. Large sections of pipe, fittings and valves have been removed leaving the existing kerosene system inoperative.

2.6 Instruments and Controls

2.6.1 History of Early Instrumentation

2.6.1.1 The original instrumentation, as installed for the HNPF test loop, is shown in block diagram form on Reference Drawing 7508-D490827. After a short testing period, the freeze seal pump in loop No. 1 was replaced with a free surface pump. Instrumentation for the new free surface pump was a carryover from the original freeze seal pump.

2.6.1.2 Upon completion of tests on the free surface pump in loop No. 2, this too was replaced by a helical-rotor EM pump. The EM pump is still in place. All other sodium pumps have been removed.

2.6.1.3 All control room instruments and panel boards have been removed and are no longer available.

2.6.2 Original Instrumentation Systems

2.6.2.1 The original instrumentation systems were divided into two main categories, process control and preheat control, each with a control room panel (now removed) and associated system-mounted sensors and transmitters. Each control panel was divided into three subsystems, identified as follows:

- 1) Sodium loop No. 1 Instrumentation and Control
- 2) Sodium loop No. 2 Instrumentation and Control
- 3) Common pump loop instrumentation and control shared between loops No. 1 and No. 2.

2.6.2.2 The process panel contained readouts and controls for temperature, flow, pressure, level, and strain (pressure) parameters. Exact descriptions and installation details are shown on Reference Drawing 7508-D490824.

2.6.2.3 The preheat panel contained readouts and instrumentation for temperature control only. Exact descriptions and installation details are shown on Reference Drawing 7508-D490822.

2.6.2.4 All instrumentation and controls were electrically sensed and electrically operated throughout the entire HNPF pump test loop. One exception was the 12-in. flow control valve FCV-1 in sodium loop No. 2. This large valve was pneumatically operated using compressed air or nitrogen in cylinders.

2.6.3 Sodium Loop Instrumentation

2.6.3.1 The function of the sodium instrumentation was to provide preheat and process control and information data for the sodium pump tests. Pump tests require good flow control at controlled temperatures to obtain significant pump data.

2.6.3.2 Sodium flow control was obtained primarily by the adjustment of pump rpm plus the use of the manually operated throttle valve V-105A, for loop No. 1. Flow in loop No. 2 was similar, aided by flow control valve FCV-1.

2.6.3.3 Sodium flow measurements were received by well-stabilized permanent magnet flowmeters in both loops and transmitted to the control room for readout and recording. It is believed that the flowmeter signals were also used as a feedback signal to the pump speed controller to maintain good speed regulation.

2.6.3.4 Sodium loop pressures were provided by the pump head plus that contributed by the nitrogen cover gas in the surge tanks. Sodium pressures were measured by means of capillary type pressure gages as exemplified by P1-7 and P1-8 measuring pump inlet and outlet pressures in loop No. 2.

2.6.3.5 Sodium temperatures were carefully controlled to prevent freezing during standby and preheat phases of the pump test. In addition, a further requirement for a controlled temperature was to maintain a specified sodium fluid density during the data measurement phases of the pump test. Temperature control and data were obtained by closed loop on-off pyrometer control of tanks and zoned piping utilizing over a hundred thermocouples.

2.6.3.6 Sodium levels in each surge and fill and drain tank were measured to maintain a sodium inventory.

2.6.4 Nitrogen Auxiliary System Instrumentation

2.6.4.1 The gaseous nitrogen system instrumentation was used to control the pressure and flow of cover gas. Pressure control was delegated to self-operating spring loaded pressure control valves.

2.6.4.2 Safety valves were located at each tank to provide overpressure blow-off for tank protection. Safety valves were set in the range of 15-50 psig depending on the maximum design pressure of the tank.

2.6.4.3 Nitrogen flow was regulated by means of a manual valve and a Rotometer type flowmeter. Under steady operating conditions this flow equaled the normal flow consumption of the equipment utilizing the nitrogen gas.

2.6.5 Kerosene Auxiliary System Instrumentation

The kerosene auxiliary system was used to provide cooling for the freeze seal pump when the loop was first constructed. Flow control was obtained by manual valve and Rotometer.

2.6.6 Existing Field Mounted Instrumentation

The location of existing field mounted instruments is shown on the new P&I diagram drawing 7508-SA121001; Table A-5 lists detailed information on the instruments and control valves. These existing sensors, detectors, transmitter, local gages, etc., are listed in paragraphs 2.6.6.1 through 2.6.6.7.

2.6.6.1 Temperature Sensors. All process temperature sensors (approximately 100) installed in loops No. 1 and No. 2, are chromel-alumel thermocouple type, ISA calibration "K", color coded red (-) and yellow (+). All test thermocouples (approximately 20) installed in loop No. 2 for the shell-side heat transfer test are Pt, Pt-10% Rh, ISA calibration "S", no standard color code. No extension wires for these thermocouples are in place. Normal procedure for Pt, Pt-10% Rh thermocouple extensions is to use copper and No. 11 alloy extension wire for considerable economic savings with very little loss of accuracy.

2.6.6.1.1 Chromel-Alumel Thermocouples. All surface-mounted chromel-alumel thermocouples are field fabricated using No. 16 gage thermocouple wires with asbestos-fiberglass insulation and a metallic ribbon overbraid. Hot junction attachment to the pipes, tanks, and vessels is by means of heliarc welding. All junctions are grounded. Thermocouple leads are brought out 4 to 12 in. outside the pipe insulation and left exposed. No thermocouple extension wire is in evidence. Typical installation techniques are shown on Reference Drawings 7508-D490832, 33, and 34.

2.6.6.1.1.1 Location of these chromel-alumel thermocouples is shown on drawings 7508-EH121001 (loop No. 1) and 7508-EH121002 (loop No. 2).

2.6.6.1.1.2 Immersion type chromel-alumel thermocouples complete with wells are also used in the sodium expansion and storage tanks. Requirements for these thermocouples are listed on instrument specifications 7508-4908-N407, pp 2, 3.

2.6.6.1.2 Platinum, Platinum-10% Rhodium Thermocouples. Tests of the shell-side heat transfer characteristics of the loop No. 2 heat exchanger required a higher accuracy temperature measurement than normally supplied by chromel-alumel thermocouples. This higher accuracy was achieved with Pt, Pt-10% Rh thermocouples coupled with a high accuracy cold reference junction (Tag number TJ-1). The Pt, Pt-10% Rh thermocouples are the field fabricated type, with the hot junctions brazed to the "X" type heat exchanger. The thermocouple wires are brought out through the heat insulation and extend out approximately 6 to 12 in. They were abruptly cut off and the leads are now left loose.

2.6.6.1.3 Platinum, Platinum-10% Rhodium Cold Reference Junctions. An existing thermocouple reference cold junction (controlled oven type) is located at the south end of loop No. 2 in close proximity to the shell-side heat exchanger. The reference cold junction is used with the Pt, Pt-10% Rh thermocouples to provide high accuracy readouts. The device is capable of referencing 100 thermocouples (Pt, Pt-10% Rh type only).

2.6.6.2 Pressure Gages. Two capillary type pressure gages, range 30 in. vacuum, 0 to 300 psig and 0 to 60 psig, are in place to locally indicate loop No. 2 main sodium pump inlet and outlet pressures respectively. The gages have

chemical protection seals at the point of attachment to the pipes. The 4-ft-long capillaries are NaK filled to withstand the high sodium temperatures. The gage indicators are 6-in. diameter, with red adjustable manual pointers (to indicate the normal position) as well as the usual pressure pointers. Gages are locally mounted, attached to the adjacent structure. Five conventional bourdon tube type pressure gages are in the nitrogen and kerosene auxiliary services loop. The gages are 4-1/2-in. diameter, metal or phenolic cases with 1/4-in. NPT bottom connections.

2.6.6.3 Flowmeters. All sodium flowmeters are the permanent magnetic type, designed and built by AI. The flowmeter dual-sensing electrodes are directly welded to the pipe. The large 12-in. diameter flowmeters are supported by pipe hangers. Smaller units are pipe mounted.

2.6.6.3.1 Flowmeter air gaps external to the pipe are accessible for magnetic flux measurements. Although air gap flux measurements external to the pipe do not have the accuracy available to a dead center measurement, nevertheless they can be utilized to indicate flux degrading and flow calibration downward shifts. Specifications are listed in 7508-5408-N307, pp 1, 2.

2.6.6.3.2 Flowmeters for nitrogen and kerosene service are the glass tube variable-area type (Rotometers). Specifications are listed in 7508-S4908-N318, p 3.

2.6.6.4 Pressure Control Valves. Four nitrogen pressure regulators exist. These regulators (Tagged PCV) are 1/2 in., rated at approximately 5 cfm and have a range of 0 to 25 psi output. Specifications are listed in 7508-S4908-N208, pp 1, 2.

2.6.6.5 Pressure Safety Valves. Three safety valves are in place protecting the nitrogen cover gas systems in both the interconnecting piping and the tanks. The safety valves are either the 3/4 to 1 in. or 1 to 1/2 in. Consolidated Valve type 1970T with screwed connections and relieve directly to atmosphere. Set pressures vary from 15 to 50 psig. Specifications for these devices are listed in 7508-S4908-N101, pp 1, 2.

2.6.6.6 Flow Control Valve (Tag No. FCV-1). A single 12-in. flow control valve is located in loop No. 2 to throttle the main sodium flow. The valve is a "PK" ball type, known for a favorable CV factor and designed for throttling

service. The valve is controlled with a 100-psig pneumatic cylinder and a Conoflow valve positioner. The pneumatic air supply is furnished by means of high pressure bottled nitrogen or air at 3000 psig and pressure reduced to 100 psi. At present no pressure bottle is in place.

2.6.6.7 Field Mounted Level Transmitter. Tank T-2 (Na expansion Tank, loop No. 2) contains a sodium level transmitter, induction coil type, of AI design and manufacture. Specifications for this device are listed in 7508-S4908-N535, p 2.

2.7 Electrical System

2.7.1 4160-Volt System

The 4160-volt system consists of an underground feeder from potheads on a pole in the existing 4160-volt pole line, through the one remaining (of two) former HNPF prototype pump motor starter cabinets, to a bank of 4160-volt, 480/240-volt transformers. Several items in the system have been removed:

- 1) The non-fused cutouts that would normally connect the pole line to the feeder line ahead of the potheads
- 2) One of the two prototype pump starters
- 3) The fused cutouts in the remaining pump starter cabinet
- 4) A portion of the conduit and feeder on the test loop tower structure, midway between the remaining starter and the transformers
- 5) The feeder conductors in the conduit between the pole line and the remaining starter remain in the conduit, but are shorted out and are not usable.

2.7.1.1 The 4160-volt feeder conduit is 3-in. trade size, suitable for up to three 350,000 circular mil feeder cables.

2.7.1.2 The starter is a metal enclosed, weatherproof, electrically operated 350-hp, 5-kv unit, employing cartridge fuses for line disconnection and short-circuit protection. The fuses have been removed, and the overload relay coils have been replaced to match the 200-hp helical-rotor, EM pump motor load being served by the 4160-volt system.

2.7.1.3 The transformer bank consists of three-75 kva, 2400-volt, 480/240-volt transformers connected wye-delta. These transformers are located in the test tower near the loop No. 2 helical rotor, EM pump motor.

2.7.2 480-Volt Systems

Three basic 480-volt systems serve the facility:

- 1) A supply for the helical rotor, EM pump motor, fed from the 4160-volt system
- 2) An isolated feeder from the SCTI substation No. 756 to a disconnect switch in the facility control room
- 3) A 480-volt motor control center, in the facility control room, and its related distribution circuits, supplied by a feeder from substation No. 706 outside building 006.

2.7.2.1 One of the 480-volt systems consists of the following components:

- 1) The bank of three 75-kva, 2400-volt, 480/240 volt transformers fed by the 4160-volt system
- 2) A combination 400-amp circuit breaker-starter enclosed in a free standing, weatherproof metal cabinet
- 3) A metal cabinet enclosing potential and current transformers for monitoring the system current and voltage
- 4) A 200-hp, 480-volt horizontal type, squirrel cage motor for driving the helical rotor, EM pump
- 5) The supply circuit from the transformers to the motor, consisting of three 500,000-circular-mil type RHW cables in a 3-in. conduit.

2.7.2.2 The transformers, the starter and the instrument transformer cabinet are all installed in the test tower, as closely interconnected as physically practical. Control and instrument leads are extended from the test tower to the control room.

2.7.2.3 The second 480-volt system is an isolated circuit. It consists of six 350,000-circular-mil cables in an underground 4-in. conduit, a 600-amp breaker in the SCTI substation No. 756 distribution panel, and a 600-amp, 600-volt non-fusible disconnect switch in the facility control room. No further distribution

is made of this power, though eight No. 4/0 cables are installed in the area of the former shell side experiment main heater, for which this circuit was installed. The distribution cables are disconnected at both ends.

2.7.2.4 The third 480-volt system is the main source of power for the facility. The feeders for this system are six No. 4/0 type TW cables in a 3-in. underground conduit, extending from a 500-amp circuit breaker in the substation No. 706 distribution panel to the 400-amp main breaker in the motor control center in the control room. Further distribution is made in the motor control center to circuit breakers and to combination circuit breaker-contactor units for distribution and control of the power to the sodium system preheaters, the tower crane, the facility lights and other miscellaneous power devices. This distribution is shown on the single line diagram, drawing 7508-EA121001.

2.7.3 120/208-Volt Systems

2.7.3.1 A 120/208-volt system is provided to supply facility lights, convenience receptacles, the fire alarm system, and the battery chargers of the emergency, battery-powered lights. Power is derived from a 20-kva, 480-120/208-volt, 3-phase, dry-type transformer, and is distributed through a 30-circuit lighting panel. A 6-circuit multibreaker panel is sub-fed from the lighting panel bus. The fire alarm system is fed from one of the breakers in this multibreaker panel.

2.7.3.2 A second 120/208-volt system is provided to supply power to several 120- and 208-volt heater loads. Power is obtained from a 75-kva, 480-120/208-volt, 3-phase, dry-type transformer. Distribution of power is made through a lighting panel with ten 3-pole breakers and six 1-pole breakers.

2.7.4 Lighting

2.7.4.1 Open, industrial type fluorescent fixtures are used for lights in the facility control room. In the test loop areas RIM industrial incandescent fixtures are installed for general illumination. Several high-intensity, weatherproof incandescent floodlights are also installed to augment the general illumination.

2.7.4.2 Emergency lighting is provided in the control room by a battery-operated light. The battery is a glass jar type, and is kept constantly charged by a rectifier power supply which is integral with the battery, and is fed from one of the 120-volt lighting panel circuits.

2.7.4.3 The lights are circuited from a 30-circuit lighting panel with a 100-amp main breaker. The lighting panel feeders are three No. 4 wires.

2.7.5 Preheating

2.7.5.1 Most of the pipes and vessels which may contain sodium are electrically preheated, using tubular electrical heaters. Heater and temperature-sensing thermocouple locations are shown on new isometric drawings 7508-EH121001 and 7508-EH121002. Table A-6 in the appendix gives a correlation between the heater and thermocouple numbers shown on the new isometric drawing and those previously assigned on the several original installation drawings listed in the Reference drawing list of the appendix.

2.7.5.2 A major exception to the electrical preheating is the portion of the 12-in. pipe loop No. 1, extending from near the former pump discharge to within a few feet of the loop expansion tank. This portion of the loop was previously heated by means of two large transformers, the pipe forming part of the secondary circuit. These transformers have been removed, and this portion of the loop remains unheated.

2.7.5.3 Because of the varied uses which have been made of different portions of the pipe loops, the configuration of heaters on the pipes varies considerably. The smaller drain and fill lines are traced with single lengths of heaters. Other lines are traced with two, three, and four heaters per section.

2.7.5.4 The heaters are attached directly to the outside of the pipe, and are covered with a reflective shield to prevent direct contact of the insulation with the heater.

2.7.5.5 The heater ends are provided with threaded terminals and double nuts. Circuit wire is bared at the end and attached to the heater terminal between the double nuts. Some circuit wire ends are provided with crimped ring terminals for attachment between the double nuts.

2.7.5.6 The expansion tanks and the storage tank are preheated by means of tubular electrical heaters installed longitudinally on the outer surface of the tanks. As with the pipe heaters, a stainless steel reflector jacket is installed over the heaters to prevent direct contact of the heater with the thermal insulation.

2.7.5.7 Some of the valves are traced with tubular heaters, others use cartridge type heaters strapped against the valve body. In either case, the heaters are shielded from direct contact with insulation by a stainless steel reflector jacket over the heaters.

2.7.6 Fire Alarm System

A fire alarm system is provided, consisting of combination fixed temperature-rate-of-rise detectors connected to the plant-wide alarm system. Power for operation of the system is derived from a 6-volt glass storage battery. The battery is kept continuously charged by a rectifier power supply circuited from a 20-amp breaker in the multi-circuit breaker panel which is sub-fed from the lighting panel.

2.7.7 Communications

2.7.7.1 The facility control room is provided with a dial telephone, connected to the company-wide telephone system, providing direct dialing service to any other telephone extension within the company and to most of the telephones in the greater Los Angeles Area.

2.7.7.2 A public address speaker is located in the control room. This speaker is connected to the public address system serving the AI Nuclear Field Laboratory.

2.7.8 Grounding

2.7.8.1 An equipment grounding system is provided for personnel protection. It consists of a ground loop of No. 3/0 bare copper wire connected to solid copper ground rods and to the plant cold water system. All of the main structural steel columns and the non-current carrying enclosures of electrical equipment are connected to the ground loop.

2.7.8.2 Lightning protection is provided by lightning rods on the roof of the facility tower, connected by means of copper cables to the ground loop.

2.7.9 Heaters

2.7.9.1 Heaters used on all of the piping and tanks are of the tubular electric type, consisting of a helical nichrome wire element centered in a stainless steel tube, and insulated from the tube with highly compressed magnesium oxide.

The heater element terminates at either end of the tube in a threaded terminal for attachment of circuit lead wires. The ends of the tube are sealed either with a silicone rubber plug or with an epoxy sealant.

2.7.9.2 All of the tubular heaters are rated for 480 volts. Some are operated at full voltage. Others are operated at half voltage by connecting two heaters in series across 480 volts. The heaters on all of the tanks are connected 3-phase wye, so that they operate at 277 volts. The heaters on the diffusion cold traps are operated at one-quarter voltage, on 120-volt circuits.

2.7.9.3 The cartridge heaters used on the valves are also fabricated of a nichrome wire element in a stainless steel jacket, and with magnesium oxide insulation. However, both ends of the element are brought out of one end of the tube. The other end of the tube is welded closed. Flexible lead wires with glass sleeve insulation are attached directly to the ends of the cartridge heater elements by the manufacturer.

2.7.9.4 The cartridge heaters are all rated at 240 volts. Some of them are connected directly to 120-volt circuits, others are connected two in series across 120 volts.

2.7.9.5 The heaters on most of the pipes and the tanks are circuited from breakers and contactors in the 480-volt motor control center or from breakers in 480-volt Panel H. Heaters on some of the valves and on some of the small pipes are circuited from 120/208-volt Panel G.

2.7.9.6 A number of the heaters are circuited through contactors in the motor control center, providing the possibility of remote pushbutton or automatic control. However, no automatic controllers are installed in the facility, and all heaters are manually controlled. Those heaters which are circuited through the contactors include:

- 1) Storage tank T-3 heaters
- 2) Loop No. 2 expansion tank heaters
- 3) Most of the main loop pipe heaters in both loops.

2.7.10 Conduit and Wireways

2.7.10.1 All power and instrument leads which extend from within the control room to equipment out of the control room are routed in expanded metal trays

in the control room and in weatherproof wireways outside the control room. The wireways are flange connected, with hinged, gasketed covers. From the wireways, minimum lengths of rigid conduit are run as necessary to extend the circuit leads to individual electrical components. Conduit for heater and thermocouple circuits extend only generally in the vicinity of the heaters and thermocouples, and the leads are routed exposed on the pipes to the thermocouples and heater terminals.

2.7.10.2 Within the control room 120-volt lighting and receptacle circuits are run in either rigid or thin-wall conduit.

3.0 PRINCIPLES OF OPERATION

3.1 Startup

The system (including both loops) is purged with nitrogen, and the electric heaters raise the piping and equipment to preheat temperatures. The sodium is forced from the storage tank by nitrogen pressure until the system is filled. The fill lines are valved off. The sodium is circulated to permit cold trapping until the desired purity is attained. The system is then brought up to operating temperature.

3.2 Normal Operation

3.2.1 Normal operation for testing in either loop No. 1 or No. 2 consists of pumping sodium through a closed loop. A flowmeter is used to record flow. Diaphragm type pressure gages readout pressures at the pump suction and discharge. A throttling valve is used to adjust flow. The sodium surge tank allows for temperature and pressure surges. Sodium height in the surge tank is indicated by an inductance coil liquid-level indicator. Temperature measurements are made with chromel-alumel thermocouples.

3.2.2 During operation in loop No. 1, sodium temperatures are varied from 350 to 1000°F by varying pump speeds. When the desired temperature is reached, isothermal conditions are maintained by adjusting the pump speed to the proper value. Pump performance characteristics are plotted by varying the sodium flow with the throttle valve over the range from zero to the maximum attainable within the capability of the pump.

3.2.3 During operation in loop No. 2, heat transfer characteristics of the test heat exchanger are determined under both steady-state and transient conditions. Transient conditions are attained by utilizing two bypass loops, one of which contains a cooler, and one of which contains a heater. Temperatures are varied from 350 to 1200°F at constant flow rates which can reach a maximum of 1000 gpm.

3.3 Shutdown

The system is cooled by convection and radiation heat loss. The system is drained by gravity and with the aid of nitrogen purge at the vapor traps and freeze traps. The temperature is allowed to reach ambient conditions after all the sodium has been drained to the storage tank.

4.0 SAFETY PRECAUTIONS

4.1 Hazards

4.1.1 The major hazards to personnel are typical of any sodium facility which operates at high temperature. A piping or component rupture or leak will release sodium which reacts with air and moisture to produce sodium hydroxide and hydrogen. This creates a fire hazard. The presence of sodium hydroxide, an alkali, creates a burn hazard to personnel.

4.1.2 Hazards to equipment include the following:

- 1) Pump cavitation due to loss of sodium level
- 2) Liquid hammer due to rapidly starting or stopping sodium flow
- 3) System overpressure.

4.2 Precautions

4.2.1 Heat sensors are strategically located to detect fires, and send an alarm signal to a remote control center. Fire and police facilities are close by. Emergency safety showers and eyewash stations are conveniently located for use by personnel exposed to sodium.

4.2.2 Protective devices to prevent damage of equipment include the following:

- 1) System overpressure is avoided by the use of safety relief valves, a sodium surge tank, and pressure alarms.
- 2) Pump cavitation is avoided by maintaining equal sodium levels in the pump and surge tank through the use of an overflow line. Pump shutdown is provided on indication of a low sodium level in the surge tank. Internal baffles in the surge tank avoid the formation of gas bubbles, and reduce the possibility of pump cavitation.
- 3) Liquid hammer is controlled by utilizing valves with sufficient opening and closing response time to reduce or avoid completely the hammer problem.

5.0 STATUS OF EXISTING EQUIPMENT

A complete evaluation of the condition of equipment and piping presently installed in loops No. 1 and No. 2 is difficult to determine by visual examination only. A proper investigation would include the following:

- 1) Metallurgical examination of pipe specimens
- 2) Removal of all sodium valves for testing and cleaning
- 3) A complete calculation of pipe hanger requirements to assure adequate loop support
- 4) A complete review of pipe thermal stress analyses
- 5) Testing of insulation resistance, and high potential testing of electrical equipment.

5.1 Visual Examination

A visual examination of both loops revealed the following:

- 1) Exposed steel surfaces require wire brushing and painting.
- 2) The pump structure requires the reinstallation of some cross bracing.
- 3) Loop No. 2 is open to the atmosphere, and will require an extensive cleaning operation.
- 4) The sodium in the storage tank will require purification treatment before it can be used in the loops.
- 5) Electrical equipment and circuits require thorough cleaning and insulation resistance and high potential testing.

5.2 Loop Configuration

Both loops were originally set up for the installation of free-surface centrifugal mechanical pumps. The elevations, and possibly the locations, of the surge tanks will change according to the requirements of the installed pump. The overflow line in loop No. 1 must be relocated to clear the surge tank and electrical wireways, and to adjust to the pump requirements. Loop No. 2 will require the installation of an overflow line and a new penetration into surge tank T-2.

5.3 Electrical Systems

5.3.1 4160-Volt System

The 4160-volt system feeder is shorted out in the conduit between the riser pole and the remaining HNPF pump starter cabinet. The system has been isolated from the pole line circuit by removal of the non-fused cutouts ahead of the pothead on the riser pole. In addition, in the pump starter cabinet, the fuses have also been removed. Other parts have been removed and changes have been made in the starter also, making it unserviceable in its present condition. A portion of both the conduit and feeder in the circuit between the starter cabinet and the transformers for the helical rotor pump motor have been removed, making this part of the system unserviceable. Major rework of the 4160-volt system is required to make it usable.

5.3.2 480-Volt Systems

5.3.2.1 The 480-volt system to the helical rotor pump motor appears to be in satisfactory condition. The motor, transformers, and starter require extensive cleaning and testing to determine their functional adequacy.

5.3.2.2 The 480-volt system from the SCTI substation No. 756 appears to be in good condition.

5.3.2.3 The 480-volt motor control center system is in good condition and is partially in use. However, the six No. 4/0 type TW feeder conductors are not suitably protected by the 400-amp main breaker in the motor control center. Also, several of the individual distribution circuits are in violation of good electrical practice and/or the State of California Electrical Safety Orders. They are as follows:

5.3.2.3.1 100-amp circuit breaker D-19 feeds two welding receptacle circuits, using two parallel-connected No. 6 type RHW circuit leads. Neither of these circuits is adequately protected by the 100-amp circuit breaker. It should be replaced with a 70-amp unit.

5.3.2.3.2 Combination circuit breaker-starter C-3, formerly feeding the cooler blower motor, has concealed overload reset buttons, not accessible for operation from outside the starter compartment. The starter cover should be modified to include a reset button assembly that will permit reset of the overloads with the starter compartment closed.

5.3.2.3.3 120/208-volt Panel G (misabeled 240 volt) has five 30-amp circuit breakers supplying No. 12 circuit leads which are not adequately protected. These circuit breakers (1, 5, 6, 7, and 9) should be changed to 20 amp.

5.3.2.3.4 The neutral feeder from the 75-kva transformer to Panel G is terminated on the panel grounding lug. Three No. 12 and one No. 8 leads are parallel connected from the grounding lug to the neutral bus. There appears to be no suitable ground established for this transformer. The parallel leads should be removed from the grounding lug and a suitable neutral installed. A ground wire should be installed connecting the transformer and panel to the ground grid.

5.3.2.3.5 Lighting Panel 30A circuit breaker 21 feeds two parallel-connected circuits, one of which is a No. 12 circuit lead which is not adequately protected. This lead should be recircuited to a 20-amp circuit breaker.

5.3.2.3.6 A number of block neutral leads are run exposed in the trays and wireways. They have been taped "white" at the neutral bus in the lighting panel but are not identified elsewhere where they are exposed. These should be replaced with white circuit wires.

5.3.2.4 Heaters

5.3.2.4.1 The existing heaters appear to be in good condition except for those which have been bent and otherwise damaged to clear pipes for cutting to remove the pumps, the main heater, the cooler, and the plugging meter. All heaters should be tested for insulation resistance, and any that are low in resistance should be dried by applying low voltage power to the circuit.

5.3.2.4.2 Any unheated portions of the sodium piping system should be heated with tubular electric heaters. The heaters should be sized and designed for single-tracing of the pipes. Heaters should be installed directly on the pipes, and should be covered with a thin, stainless steel reflector sheet to prevent direct contact of the thermal insulation with the heaters. The heaters and reflectors should be held in place using stainless steel bonds or the wire. Heaters should be rated at 480 volts, but should be sized to provide adequate heat when operated at 277 volts.

5.3.2.5 Heater Connections

5.3.2.5.1 Circuit connections to the heaters seem to be satisfactory. However, most circuit connections are made by clamping the circuit wire between double nuts on the threaded heater terminal. It is possible that some of these may be loose, or they may be oxidized sufficiently to cause excessive heating and burn-out of the heater terminal. These should be carefully checked before power is applied to the heaters.

5.3.2.5.2 Circuit connections to any new heaters should be made by welding the circuit leads directly to the heater terminals.

5.3.2.6 Heater Circuits. Heater circuit wires are extended unprotected from conduit terminations to the heater terminals. The heater terminal and any bare copper wire is taped, affording some measure of electrical insulation but not sufficient for the circuit voltage of 480 volts. Boxes should be installed to cover the heater terminals, and the circuit lead wires should be run in conduit from the present conduit terminations to the heater terminal boxes, thus providing both adequate mechanical and electrical protection.

5.3.2.7 Lights. All of the interior lights, and most of the exterior lights appear to be serviceable, except for many burned-out lamp bulbs. The exterior fixtures are somewhat rusted. It is possible that some of the circuit connections to the fixtures may be sufficiently oxidized to eventually result in burnout of the connections.

5.3.2.8 Conduit and Wireways. The trays within the control room are in good condition. The wireways outside of the control room are badly rusted, but are still serviceable.

5.3.2.9 Fire Detection System. The fire detection system appears to be serviceable, though the detector heads and fixtures are considerably corroded. The detector heads should be suitably tested and all circuit connections checked for functional adequacy.

5.4 Status of Existing Instrumentation

The condition of all existing instrumentation ranges from fair to good. Generally all equipment requires cleanup and recalibration. Although a large portion (85%) of the original instrumentation has been salvaged for use elsewhere,

the remaining 15% could be used at a rework cost of no more than 35% to 50% of its original cost. All new readout, control, and recording instrumentation in the remote control room is required.

5.4.1 Rework Recommendations on Instrumentation

1) Thermocouples

An ohmmeter check on a random dozen field-fabricated thermocouples has shown that 100% of those tested are in operating condition. With extensive rework effort on the weathered extension wire leads and a system calibration check (by operating the loop at a 600°F isothermal condition) the field-fabricated thermocouples should realize a useful second life.

However, it is estimated that when the loop goes to maximum temperature (above 1000°F), that 10% of the couples will fail due to stress, corrosion, and expansion factors.

The thermocouples are located every few feet, mounted on all sodium pipelines, tanks and valves. Due to the large number of thermocouples, no effort is specifically made to locate each thermocouple on the new P&I diagram.

2) Gages

All gages require cleanup and recalibration before reuse.

3) Pressure Control and Safety Valves

All valves in this category require setpoint calibration and a leak check before reuse.

4) Flowmeters

Rotometers require a complete cleanup before reuse. Magnetic flowmeters require a flux density measurement to determine the amount of deterioration from original calibration curve. If no calibration curves are available, the calibration may be calculated or the flowmeter may be recalibrated in place. To provide good sodium "wetting" action for a stable electrode voltage readout, the flowmeter pipe must be thoroughly cleaned.

5) Level Transmitter

The level transmitter merely requires a favorable continuity test and a high-pot test prior to reuse.

6) Flow Control Valve

The 12-in. flow control valve in loop No. 2 has marginal reuse value. For one thing, the condition of the internal valve parts is unknown. Secondly, the air cylinder actuator is damaged, probably beyond repair. Thirdly, the valve positioner is connected to the actuator by an unwieldy mechanical arrangement. All in all, this particular equipment had best be junked rather than reused.

REFERENCES

1. R. W. Atz, "Performance of HNPF Prototype Free-Surface Sodium Pump," NAA-SR-4336, June 30, 1960
2. R. W. Atz, "Testing of HNPF Freeze-Seal Pump," NAA-SR-4387, November 1, 1960
3. R. S. Baker, "Theory, Design, and Performance of Helical-Rotor, Electromagnetic Pump," NAA-SR-7455, May 31, 1963

APPENDIX

TABLE A-1
PIPE LINE LIST FOR HNPf PUMP TEST LOOPS NO. 1 AND NO. 2
(Sheet 1 of 2)

Pipe Designation	Description	Design Condition		Extent of Line	
		Pressure (psi)	Temperature (°F)	Origin	Termination
100-12-A	P-1 Inlet	50	1000	T-1	101-16-A
101-16-A	P-1 Inlet	50	1000	100-12-A	TSC*
102-6-A	P-1 Overflow	50	1000	TSC	T-1
103-2-A	P-1 Vent	50	1000	TSC	104-2-A
104-2-A	Inert gas fill and vent	50	1000	T-1	Z-1
105-12-A	P-1 Discharge	50	1000	TSC	T-1
106-2-A	P-1 Fill and drain	50	1000	107-4-A	105-12-A
107-4-A	Loop No. 1 fill and drain	50	1000	106-2-A	T-3
108-1-1/2-A	T-3 Fill line	50	1000	Filling connection	T-3
109-2-A	Inert gas fill and vent	50	1000	T-3	Z-3
110-2-A	Sodium drain connection	50	1000	TSC	107-4-A
111-1-A	Sodium drain connection	50	1000	108-1-1/2-A	Welded cap
200-12-A	P-2 Inlet	75	1200	T-2	P-2
201-12-A	P-2 Discharge	75	1200	P-2	202-6-A
202-6-A	P-2 Discharge	75	1200	201-12-A	203-4-A
203-4-A	P-2 Discharge (flow-meter section)	75	1200	202-6-A	204-6-A
204-6-A	P-2 Discharge	75	1200	203-4-A	TSC
205-3-A	Bypass	75	1200	202-6-A	228-4-A
206-4-A	P-2 Discharge	75	1200	204-6-A	Welded cap
207-6-A	P-2 Discharge	75	1200	201-12-A	208-4-A
208-4-A	P-2 Discharge (flow-meter section)	75	1200	207-6-A	209-6-A
209-6-A	P-2 Discharge	75	1200	208-4-A	TSC
210-3-A	Fill and drain	75	1200	207-6-A	237-4-A
211-2-1/2-A	Component bypass	75	1200	209-6-A	212-6-A
212-6-A	X-1 Sodium inlet	75	1200	TSC	213-4-A 214-4-A
213-4-A	X-1 Inlet or outlet	75	1200	212-6-A	215-6-A

*Temporary seal connection

TABLE A-1
PIPE LINE LIST FOR HNPf PUMP TEST LOOPS NO.1 AND NO.2
(Sheet 2 of 2)

Pipe Designation	Description	Design Condition		Extent of Line	
		Pressure (psi)	Temperature (°F)	Origin	Termination
214-4-A	X-1 Inlet or outlet	75	1200	212-6-A	215-6-A
215-6-A	X-1 Sodium outlet	75	1200	(213-4-A) (214-4-A)	229-12-A
216-3-A	Fill and drain	75	1200	213-4-A	217-3-A
217-3-A	Fill and drain	75	1200	214-4-A	237-4-A
218-4-A	X-1 Inlet or outlet	75	1200	213-4-A	X-1
219-4-A	X-1 Inlet or outlet	75	1200	214-4-A	X-1
220-4-A	X-1 Inlet or outlet	75	1200	X-1	222-4-A
221-4-A	X-1 Inlet or outlet	75	1200	X-1	223-4-A
222-4-A	X-1 Inlet or outlet	75	1200	224-6-A	225-6-A
223-4-A	X-1 Inlet or outlet	75	1200	224-6-A	225-6-A
224-6-A	X-1 Sodium inlet	75	1200	TSC	(222-4-A) (223-4-A)
225-6-A	X-1 Sodium outlet	75	1200	(222-4-A) (223-4-A)	229-12-A
226-4-A	X-1 Sodium outlet bypass	75	1200	212-6-A	229-12-A
227-4-A	X-1 Sodium inlet bypass	75	1200	224-6-A	229-12-A
228-4-A	T-2 Fill and drain	75	1200	229-12-A	237-4-A
229-12-A	T-2 Inlet	75	1200	(215-6-A) (225-6-A)	T-2
230-4-A	P-2 Fill and drain	75	1200	200-12-A	237-4-A
231-2-A	Inert gas fill and vent	75	1200	T-2	Z-2
232-2-A	Cold trap Na inlet	75	1200	201-12-A	233-2-A
233-2-A	Cold trap Na bypass	75	1200	232-2-A	234-2-A
234-2-A	Cold trap Na outlet	75	1200	233-2-A	201-12-A
235-1-A	High point vent	75	1200	222-4-A	FT-1
236-1-A	High point vent	75	1200	214-4-A	FT-2
237-4-A	Loop No.2 fill and drain	75	1200	107-4-A	Fill & drain header
238-1-A	Sodium drain connection	75	1200	217-3-A	Welded cap
239-1-A	Na to CT-1	75	1200	232-2-A	CT-1
240-1-A	Na from CT-1	75	1200	CT-1	234-2-A

TABLE A-2
VALVE LIST FOR HNPf PUMP TEST LOOP NO. 1
(Drawing No. 7508-SA121001)

Valve Number	Size (in.)	Type	Valve Stem Seal*	AI Specification	Manufacturer
V-105A	12	Ball	Freeze - Liquid Cool		PK
V-105B	1	Gate	-		Powell
V-107A	4	"Y"	Freeze - Liquid Cool		Alloyco
V-107B	4	"Y"	Freeze - Liquid Cool		Alloyco
V-108	1-1/2	"Y"	-		Powell
V-111	1	Gate	Freeze - Air Cool		
V-201A	12	Ball	Freeze - Liquid Cool		PK
V-201B	1	Gate	-		Alloyco
V-204	4	Gate	Freeze - Air Cool		Powell
V-205	3	Globe	Freeze - Air Cool	7518-S73404	
V-206	4	Gate	Freeze - Air Cool		Powell
V-207 [†]	6		Freeze - Liquid Cool		Alloyco
V-210	3	Globe	Bellows Seal	7518-S73404	Powell
V-211 [†]	2-1/2		Freeze - Air Cool		Cooper Alloy
V-213A	4	Gate	Freeze - Air Cool		Powell
V-213B	4	Gate	Freeze - Air Cool		Powell
V-214A	4	Gate	Freeze - Air Cool		Powell
V-214B	4	Gate	Freeze - Air Cool		Powell
V-216	3	Globe	Bellows Seal	7518-S73404	Powell
V-217	3	Globe	Bellows Seal	7518-S73404	Powell
V-222A	4	Gate	Freeze - Air Cool		Powell
V-222B	4	Gate	Freeze - Air Cool		Powell
V-223A	4	Gate	Freeze - Air Cool		Powell
V-223B	4	Gate	Freeze - Air Cool		Powell
V-226	4	Gate	Freeze - Air Cool		Powell
V-227	4	Gate	Freeze - Air Cool		Powell
V-228	4	"Y"	Freeze - Liquid Cool		Alloyco
V-230 [†]	4		Freeze - Air Cool		Pacific
V-232 [†]			Freeze - Air Cool Fins		
V-233 [†]			Freeze - Air Cool Fins		
V-238	1	Gate	-		Powell
V-239 [†]	1		-		
V-240	1		-		

*Valve stems were modified.

[†]Due to insulation, visual inspection was not sufficient to identify valve type and size.

TABLE A-3

PIPE HANGER LIST FOR HNPF PUMP TEST LOOP No. 1
(See Dwg. 7508-D49086 and 7518-D73002)

Hanger No.	Pipeline Designation	Rod Size (in.)	Grinnell Hanger Number - Size - Type	Load (lb)			Travel at Rated Load (in.)
				Minimum	Rated	Maximum	
SH-1	101-16-A	1	B-268-12-C	1575	2138	2700	1-1/4
SH-2	105-12-A	1	B-268-12-C	1575	2138	2700	1-1/4
SH-3	105-12-A	1	B-268-12-C	1575	2138	2700	1-1/4
RH-4	105-12-A	3/4				2710	0
RH-5	105-12-A	3/4				2710	0
SH-6	102-6-A	5/8	B-268-6-C	294	399	504	1-1/4
SH-6A	103-2-A	5/8	B-268-6-C	294	399	504	1-1/4
SH-7	101-16-A	3/4	B-268-10-C	910	1235	1560	1-1/4
SH-8	100-12-A	3/4	B-268-10-C	910	1235	1560	1-1/4
SH-9	100-12-A	3/4	B-268-9-C	700	950	1200	1-1/4
SH-9A	102-6-A	3/4	B-268-9-C	700	950	1200	1-1/4
SH-10	107-4-A	1/2	B-268-5-A	221	299	378	1-1/4
SH-11	107-4-A	1/2	B-268-5-A	221	299	378	1-1/4
SH-12	107-4-A	1/2	B-268-5-A	221	299	378	1-1/4
SH-13	107-4-A	1/2	B-268-5-A	221	299	378	1-1/4
SH-14	107-4-A	1/2	B-268-5-A	221	299	378	1-1/4
SH-15	107-4-A	1/2	B-268-5-A	221	299	378	1-1/4
SH-20	105-12-A	5/8	B-268-8-C	525	713	900	1-1/4

TABLE A-4

PIPE HANGER LIST FOR HNPFP PUMP TEST LOOP NO. 2
(See Dwg. 7508-D490843 and 7519-446814)

Hanger No.	Pipeline Designation	Rod Size (in.)	Grinnell Hanger Number - Size - Type	Load (lb)			Travel at Rated Load (in.)
				Minimum	Rated	Maximum	
SH-16	237-4-A	5/8	B-268-6-A	294	399	504	1-1/4
RH-17	237-4-A	1/2				1130	0
RH-18	237-4-A	1/2				1130	0
RH-19	237-4-A	1/2				1130	0
RH-20	237-4-A	1/2				1130	0
SH-21	237-4-A	1/2	B-268-5-A	221	299	378	1-1/4
SH-22	237-4-A	1/2	B-268-5-A	221	299	378	1-1/4
SH-24	In place	1/2	B-268-1-A	74	100	126	1-1/4
SH-28	201-12-A	7/8	B-268-11-C	1190	1615	2040	1-1/4
RH-29	201-12-A	3/4				2710	0
RH-30	201-12-A	3/4	(two rods)			2710	0
RH-31	201-12-A	3/4				2710	0
RH-32	201-12-A	3/4				2710	0
SH-33	200-12-A	5/8	B-268-6-G	294	399	504	1-1/4
CSH-39	In place	1/2	71-2		150		3 total
CSH-40	In place	1/2	71-1		80		3 total
SH-51	207-6-A	Base	B-268-5-F	221	299	378	1-1/4
SH-52	208-4-A	1/2	B-268-5-A	221	299	378	1-1/4
SH-53	209-6-A	5/8	B-268-6-A	294	399	504	1-1/4
RH-54	212-6-A	5/8				1810	0
RH-55	212-6-A	5/8				1810	0
RH-56	212-6-A	5/8				1810	0
RH-57	212-6-A	5/8				1810	0
SH-58	212-6-A	1/2	B-268-5-A	221	299	378	1-1/4
SH-59	227-4-A	1/2	B-268-4-D	165	223	282	1-1/4
SH-60	213-4-A	Base	B-268-6-F	294	399	504	1-1/4
SH-61	213-4-A	Base	B-268-7-F	392	532	672	1-1/4
SH-62	214-4-A	Base	B-268-7-F	392	532	672	1-1/4
SH-63	215-6-A	Base	B-268-6-F	294	399	504	1-1/4
SH-64	202-6-A	5/8	B-268-6-A	294	399	504	1-1/4
SH-65	204-6-A	1/2	B-268-5-A	221	299	378	1-1/4
SH-66	204-6-A	5/8	B-268-6-D	294	399	504	1-1/4
SH-67	204-6-A	5/8	B-268-6-D	294	399	504	1-1/4
RH-68	204-6-A	1/2				1130	0
RH-70	224-6-A	1/2				1130	0
SH-71	227-4-A	5/8	B-268-6-D	294	399	504	1-1/4
SH-72	224-6-A	5/8	98-7-D	392	532	672	2-1/2
SH-73	222-4-A	1/2	98-5-D	221	299	378	2-1/2
SH-74	222-4-A	1/2	98-5-D	221	299	378	2-1/2
SH-75	223-4-A	1/2	98-5-D	221	299	378	2-1/2
SH-76	223-4-A	1/2	98-5-D	221	299	378	2-1/2
SH-77	225-6-A	5/8	98-8-D	525	713	900	2-1/2
SH-78	225-6-A	Base	B-268-6-F	294	399	504	1-1/4
SH-79	229-12-A	Base	B-268-9-F	700	950	1200	1-1/4
RH-80	224-6-A	1/2				1130	0
SH-81	217-3-A	1/2	B-268-4-A	165	223	282	1-1/4
SH-82	228-4-A	1/2	B-268-3-A	123	166	210	1-1/4
SH-83	210-3-A	1/2	B-268-2-A	95	128	162	1-1/4
SH-84	207-6-A	Base	B-268-7-F	392	532	672	1-1/4
SH-85	207-6-A	1/2	B-268-5-A	221	299	378	1-1/4

TABLE A-5
INSTRUMENT AND CONTROL VALVE LIST*

Tag No.	Quantity	Description	Range	Service	Accuracy	Instrument Spec. No.	Manufacturer	Remarks
TE-1 through TC-100	100	Chromel Alumel Thermocouples	0-1200°F	Sodium Loops No. 1 & 2	±3/4%	-	Field-Fabricated	Piping: 7508-EH121001, EH121002
TE-101 TE-102	2	Chromel Alumel	0-1200°F	Sodium expansion & storage tanks Loop No. 2 only	±3/4%	7508-4909-N407, p 2-3	Honeywell - Immersion type	
TE-103 through TE-123	20	Pt, Pt-10% Rh Thermocouples	0-1500°F	Sodium heat exchanger Loop No. 2 only	±1/2%	-	Field-Fabricated	For shell-side heat transfer tests only
TJ-1	1	Thermocouple Cold Junction	1000°F	Sodium heat exchanger Loop No. 2 only	±1°F	-	Pace Engineering North Hollywood, California	For shell-side heat transfer tests only
P1-1 through P1-5	5	Pressure gages	0-100 psi 0-60 psi 0-30 psi	Nitrogen and kerosene service	±1/2%	-	Ashcroft and United States Gage	
FE-1 through FE-3	3	Magnetic flowmeters	-	Sodium Loops No. 1 & 2	±2%	7508-54908-N307, p 1-2	AI design	
F1-1	1	Rotometer flowmeter	0-5 scfm	Nitrogen service	±3%	7508-54908-N318, p 3	Fischer & Porter	
P1-7 P1-8	2	Capillary type pressure gage	30-0-30 psi 0-60 psi	Sodium pump inlet and outlet Loop No. 2	±1%	-	Bogart-Bullock Co.	
L1-1T	1	Inductive level transmitter	3-7 ft level	Sodium expansion tank Loop No. 2	±3 in.	7508-54908-N535, p 2	AI design	
PCV-1 through PCV-4	4	Pressure regulators	0-25 psig outputs	Nitrogen service	-	7508-54908-N208, p 1	Conoflow Company	
PSV-1 through PSV-3	3	Safety valves	Set at 15-50 psig blowoff	Nitrogen service	-	7508-54908-N101, p 1-2	Consolidated Safety Valve	
FCV-1	1	Flow control valve	Throttling service	Sodium Loop No. 2	-	-	PK Valve	Complete with Conoflow Positioner

*Refer to P&I diagram 7508-SA121001

LMEC-Memo-68-21
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TABLE A-6
HEATER AND THERMOCOUPLE NUMBER SCHEDULE
(Sheet 1 of 8)

New Number	Old Number	New Number	Old Number
<u>Heaters</u>			
H-100-1A	12-4A	H-106-2B	-
H-100-1B	12-4B	H-107-1A	401-3A
H-100-2A	12-3A	H-107-1B	401-3B
H-100-2B	12-3B	H-107-2A	401-4A
H-100-3A	12-2A	H-107-2B	401-4B
H-100-3B	12-2B	VH-107A-A	V-41
H-101-1A (NG)	16-1A	VH-107A-3A	401-2A
H-101-1B (NG)	16-1B	VH-107A-3B	401-2B
H-102-1A (NG)	6-1A	VH-107A-4A	401-1A
H-102-1B (NG)	6-1B	VH-107A-4B	401-1B
H-102-2A	6-2A	VH-107A-5A	-
H-102-2B	6-2B	VH-107A-5B	-
H-102-3A	6-3A	VH-107B-A	V-42
H-102-3B	6-3B	H-108-1A	V-42-A
H-102-4A	6-4A	H-108-1B	V-42-B
H-102-4B	6-4B	H-109-1A	-
H-102-5A	6-5A	H-110-1A	-
H-102-5B	6-5B	H-200-1A	1206-A
H-103-3A (NG)	2-3A	H-200-1B	1206-B
H-103-3B (NG)	2-3B	H-200-1C	1206-C
H-103-4A	2-4A	H-200-1D	1206-D
H-103-4B	2-4B	H-200-2A	1207-A
H-105-1A	12-6A	H-200-2B	1207-B
H-105-1B	12-6B	H-200-2C	1207-C
H-105-2A	12-7A	H-200-2D	1207-D
H-105-2B	12-7B	H-200-3A	-
H-106-1A	2-7A	H-200-3B	-
H-106-1B	2-7B	H-200-3C	-
H-106-2A	-	H-201-1A	-

TABLE A-6
HEATER AND THERMOCOUPLE NUMBER SCHEDULE
(Sheet 2 of 8)

New Number	Old Number	New Number	Old Number
H-201-2A	-	H-205-1A	L-32-1A
H-201-2B	-	H-205-1B	L-32-2A
H-201-3A	-	H-205-1C	L-32-3A
H-201-3B	-	H-205-1D	L-32-4A
H-201-4A	-	H-205-A	V-33-1
H-201-4B	-	H-205-B	V-33-2
H-201-5A	-	H-205-2A	L-32A-1A
H-201-5B	-	VH-206-A (NG)	V-42-1
H-201-6A	-	VH-206-B (NG)	V-42-2
H-201-6B	-	H-207-1A	L-68-1A
H-201-6C	-	H-207-1B	L-68-1B
H-201-7A	-	VH-207-A	V-61-1
H-201-7B	-	VH-207-B	V-61-2
H-201-7C	-	VH-207-C	V-61-3
H-201-8A	-	VH-207-D	V-61-4
H-201-8B	-	H-207-2A	L-67-4A
H-201-8C	-	H-207-2B	L-67-4B
H-200-1A	L-62-5A	H-207-3A	L-67-3A
H-200-1B	L-62-5B	H-207-3B	L-67-3B
H-203-1A	L-42-1A	H-208-1A	L-48-1A
H-204-1A	L-62-4A	H-209-1A	L-67-2A
H-204-1B	L-62-4B	H-209-1B	L-67-2B
H-204-2A	L-62-3A	H-209-2A	L-67-1A
H-204-2B	L-62-3B	H-209-2B	L-67-1B
H-204-3A	L-62-2A	H-209-3A (NG)	L-67
H-204-3B	L-62-2B	H-210-1A	L-33A-1A
VH-204-A	V-41-1	VH-210-A	V-34-1
VH-204-B	V-41-2	VH-210-B	V-34-2
H-204-4A (NG)	L-62-1A	H-210-2A	L-33B-1
H-204-4B (NG)	L-62-1B	H-211-1A (NG)	L-21-1A

TABLE A-6
HEATER AND THERMOCOUPLE NUMBER SCHEDULE
(Sheet 3 of 8)

New Number	Old Number	New Number	Old Number
VH-211-A (NG)	V-34-1	VH-217-B	V-31-2
VH-211-B (NG)	V-34-2	H-217-1A	L-31-1A
H-212-1A (NG)	L-66-6A	H-217-2A	L-31-2A
H-212-1B (NG)	L-66-6B	H-218-1A	-
H-212-2A	L-66-5A	H-218-1B	-
H-212-2B	L-66-5B	H-219-1A	L-46-1A
H-212-3A	L-66-4A	H-220-1A	-
H-212-3B	L-66-4B	H-220-1B	-
H-212-4A	L-66-3A	H-221-1A	-
H-212-4B	L-66-3B	H-221-1B	-
H-212-5A	L-66-2A	H-222-1A	L-65A-1A
H-212-5B	L-66-2B	H-222-1B	L-65A-1B
H-212-6A	L-66-1A	VH-222A-A	V-45-1
H-212-6B	L-66-1B	VH-222A-B	V-45-2
VH-213A-A	V-413-1	H-222-2A	L-45-1A
VH-213A-B	V-413-2	VH-222B-A	V-47-1
H-213-1A	L-44-1A	VH-222B-B	V-47-2
VH-213B-A	V-412-1	VH-223A-A	V-44-1
VH-213B-B	V-412-2	VH-223A-B	V-44-2
H-204-1A	-	H-223-1A	L-43-1A
VH214A-A	V-48-1	VH-223B-A	V-46-1
VH-214A-B	V-48-2	VH-223B-B	V-46-2
VH-214B-A	V-49-1	H-224-1A	L-61-1A
VH-214B-B	V-49-2	H-224-1B	L-61-1B
H-215-1A	L-64B-1A	H-224-2A	L-61-2A
H-215-1B	L-64B-1B	H-224-2B	L-61-2B
VH-216-A	V-32-1	H-224-3A	-
VH-216-B	V-32-2	H-224-3B	-
H-217-3A	L-31-3A	H-225-1A	L-63-2A
VH-217-A	V-31-1	H-225-1B	L-63-2B

TABLE A-6
HEATER AND THERMOCOUPLE NUMBER SCHEDULE
(Sheet 4 of 8)

New Number	Old Number	New Number	Old Number
H-225-2A	L-63-1A	H-237-2B	405-B
H-225-2B	L-63-1B	H-237-3A	404-A
H-226-1A	L-64A-1A	H-237-3B	404-B
H-226-1B	L-64A-1B	H-237-4A	403-A
VH-226-A	V-411-1	H-237-4B	403-B
VH-226-B	V-411-2	H-237-5A	402-A
H-227-1A	L-41-1A	H-237-5B	402-B
VH-227-A	V-410-1	H-237-6A	401-A
VH-227-B	V-410-2	H-237-6B	401-B
H-228-1A	L-47-1A	H-239-1A	-
H-228-2A	407-A	H-240-1A	-
VH-228-4	V-45	H2-1-A	2-2
H-229-1A	-	H2-2-A	2-1
H-229-1B	-	HT-1-A	T-1-1
H-229-1C	-	through	through
H-229-2A	-	HT-1-2	T-1-12
H-229-2B	-	Ht-2-A	T-2-1
H-229-2C	-	through	through
H-230-1A	-	HT-2-L	T-2-12
H-232-1A	-	HT-3-A	T-3-1
H-232-1B	-	through	through
H-232-2A	-	HT-3-Y	T-3-25
H-232-2B	-	HT-3-51	T-3-51
H-232-3A	-	through	through
H-232-3B	-	HT-3-56	T-3-56
H-234-1A	-	HFT-1-A	-
H-234-1B	-	HFT-2-A	-
H-237-1A	406-A	HCT-1-A	-
H-237-1B	406-B	through	-
H-237-2A	405-A	HCT-1-D	-
		HZ-3-A	-
		HPM-1-A	-
		HPM-1-B	-
		HX-1-A	-
		through	-
		HX-1-D	-

TABLE A-6
HEATER AND THERMOCOUPLE NUMBER SCHEDULE
(Sheet 5 of 8)

New Number	Old Number	New Number	Old Number
<u>Thermocouples</u>			
TC-100-1A	T1-3-26C	TCV-105-E	-
TC-100-1B	T1-3-2B	TCV-105-F	-
TC-100-2A	TC-9	TC-106-1A	-
TC-100-2B	TC-8	TC-106-2A	-
TC-100-3A	TC-7	TC-107-1A	-
TC-100-3B	TC-6	TC-107-3A	-
TC-100-3C	TC-5	TC-107-3B	-
TC-101-1A	TC-4	TC-107-4A	-
TC-101-1B	TC-3	TC-107-5A	-
TC-102-1A	TC-11/T1-3-5B	TCV-107A-A	-
TC-102-2A	TC-13/T1-3-6B	TCV-107B-A	-
TC-102-2B	TC-12	TC-108-1A	-
TC-102-3A	TC-14/T1-307B	TC-108-1B	-
TC-102-4A	TC-15	TCV-108-A	-
TC-102-5A	TC-16	TCV-108-B	-
TC-103-3A	TC-19	TC-109-1A	-
TC-103-4A	TC-18	TC-109-1B	-
TC-103-4B	TC-17	TC-200-1A	-
TC-105-2A	T1-3-27B	TC-200-1B	-
TC-105-3A	-	TC-200-2A	-
TC-105-5A	TC-12	TC-200-2B	-
TC-105-10A	-	TC-200-3A	-
TC-105-10B	-	TC-200-3B	-
TC-105-10C	-	TC-200-3C	-
TC-105-11A	T1-3-4B	TC-200-3D	-
TCV-105-A	-	TC-200-3E	-
TCV-105-B	-	TC-201-1A	-
TCV-105-C	-	TC-201-1B	-
TCV-105-D	-	TC-201-1C	-

TABLE A-6
HEATER AND THERMOCOUPLE NUMBER SCHEDULE
(Sheet 6 of 8)

New Number	Old Number	New Number	Old Number
TC-201-1D	-	TCV-207-A	TC-43
TC-201-3A	-	TCV-207-B	TC-44
TC-201-5A	-	TC-207-2A	T/C-15A
TC-201-5B	-	TC-207-2B	T/C-15B
TC-201-6A	-	TC-207-3A	T/C-14A
TC-201-7A	-	TC-207-3B	T/C-14B
TCV-201-A	-	TC-208-1A	TC-33A
TCV-201-B	-	TC-208-1B	TC-33B
TCV-201-C	-	TC-209-1A	TC-13A
TC-202-1A	TC-5A	TC-209-1B	TC-13B
TC-202-1B	TC-5B	TC-209-2A	TC-12A
TC-203-1A	TC-34-A	TC-209-2B	TC-12B
TC-203-1B	TC-34-B	TC-210-1A	TC-40A
TC-204-1A	TC-4A	TC-210-2A	-
TC-204-1B	TC-4B	TCV-210-A	TC-111
TC-204-2A	TC-3A	TCV-210-B	TC-112
TC-204-2B	TC-3B	TC-211-1A	-
TC-204-3A	TC-2A	TCV-211-A	-
TC-204-3B	TC-2B	TC-212-1A	TC-11A
TCV-204-A	TC-45	TC-212-1B	TC-11B
TCV-204-B	TC-46	TC-212-2A	TC-10A
-	TC-47	TC-212-2B	TC-10B
-	TC-48	TC-212-3A	TC-9A
-	TC-49	TC-212-3B	TC-9B
TC-205-12	-	TC-212-4A	TC-8A
TCV-205-A	TC-109	TC-212-4B	TC-8B
TCV-205-B	TC-110	TC-212-5A	TC-7A
TC-205-2A	TC-38A	TC-212-5B	TC-7B
TC-207-1A	TC-24A	TC-212-6A	TC-6A
TC-207-1B	TC-24B	TC-212-6B	TC-6B

TABLE A-6
HEATER AND THERMOCOUPLE NUMBER SCHEDULE
(Sheet 7 of 8)

New Number	Old Number	New Number	Old Number
TCV-213A-A through TCV-213A-E	TC-100 through TC-104	TC-220-1C	-
TC-213-1A	TC-28A	TC-221-1A	-
TC-213-1B	TC-28B	TC-221-1B	-
TCV-213B-A through TCV-213B-E	TC-95 through TC-99	TC-222-1A	TC-22A
TCV-214A-A through TCV-214A-E	TC-80 through TC-84	TC-222-1B	TC-22B
TCV-214B-A through TCV-214B-E	TC-85 through TC-89	TCV-222A-A through TCV-222A-E	TC-65 through TC-69
TC-215-1A	CT-21A	TCV-22-2A	TC-29A
TC-215-1B	CT-21B	TCV-22-3A	TC-29B
TCV-216-A	TC-107	TCV-222B-A through TCV-222B-E	TC-75 through TC-79
TCV-216-B	TC-108	TCV-223A-A through TCV-223A-E	TC-60 through TC-64
TC-217-3A	TC-37A	TC-223-1A	TC-26A
TC-217-3B	TC-37B	TC-223-1B	TC-26B
TCV-217-A	TC-105	TCV-223B-A through TCV-223B-E	TC-70 through TC-74
TCV-217-B	TC-106	TC-224-1A	TC-16A
TC-217-1A	TC-35A	TC-224-1B	TC-16B
TC-217-1B	TC-35B	TC-224-2A	TC-17A
TC-217-2A	TC-36A	TC-224-2B	TC-17B
TC-217-2B	TC-36B	TC-224-3A	-
TC-218-1A	-	TC-224-3B	-
TC-218-1B	-	TC-225-1A	TC-19A
TC-219-1A	-	TC-225-1B	TC-19B
TC-219-1B	-	TC-225-1C	-
TC-219-1C	-	TC-225-2A	TC-18A
TC-220-1A	-	TC-225-2B	TC-18B
TC-220-1B	-	TC-226-1A	TC-20A

TABLE A-6
HEATER AND THERMOCOUPLE NUMBER SCHEDULE
(Sheet 8 of 8)

New Number	Old Number	New Number	Old Number
TC-226-1B	TC-20B	TCV-239-A	-
TCV-226-A	TC-27	TCV-239-B	-
TCV-226-B	TC-32	TC-240-1A	-
TC-227-1A	TC-25A	TC-240-1B	-
TC-227-1B	TC-25B	TCV-240-A	-
TCV-227-A through TCV-227-E	TC-90 through TC-94	TCV-240-B	-
TC-228-1A	TC-31A	TC-CT-1-A through TC-CT-1-F	-
TCV-228-A	-	TC-PM-1-A	-
TCV-228-B	-	TC-Z-1-A	-
TC-229-1A	-	TC-Z-1-B	-
TC-230-1A	-	TC-Z-2-A	-
TC-230-1B	-	TC-Z-2-B	-
TCV-230-A	-	TC-Z-3-A	-
TC-232-1A	-	TC-Z-3-B	-
TCV-232-A	-	TCX-1-A through TCX-1-R	-
TC-232-3A	-		
TCV-233-A	-		
TCV-233-B	-		
TC-234-1A	-		
TC-237-2A	-		
TC-237-3A	-		
TC-237-4A	-		
TC-237-4B	-		
TC-237-5A	-		
TC-237-6A	-		
TC-239-1A	-		
TC-239-1B	-		

HNPF PUMP TEST LOOP

Reference Drawings and Specifications

<u>Number</u>	<u>Title</u>
<u>Piping and Equipment</u>	
9693-735177	Freeze Trap
9693-735661	Cold Trap
7518-D73002	Sodium Piping System
7519-446812	Bundle No. 12 Heat Exchanger
7519-446826	Bundle No. 12 Nozzle Assembly
7519-446814	Na Piping and Equipment Arrangement
7519-446815	Miscellaneous Details and Pipe Supports
7519-446822	Diffusion Cold Trap
7508-D49083	Sodium Expansion Tank (T-1 and T-2)
7508-D44084	Sodium Storage Tank (T-3)
7508-D49086	Sodium Piping System
7508-D49087	Pipe Support and Miscellaneous Details
7508-D49088	Tetralin Supply Tank (T-4)
7508-D490812	Tetralin and Nitrogen System
7508-D490813	Nitrogen Storage Tank (T-5)
7508-D490844	Pipe Supports and Miscellaneous Details
7508-S4908-1	Specification for HNPF Pump Test Loop
7508-S4908-2	Specification for Electrical, Instrumentation, and Insulation
7508-S4908-3	Specification for HNPF Pump Test Loop No. 2
7519-4468-1	Specification for Shell-Side Heat Transfer Experiment
7518-S79317	Specification for Free Surface Pump Installation
AT5-363	Equipment Specification Tetralin Circulation Pump
AT5-366	Equipment Specification Tetralin Cooling System Heat Exchanger
7519-81012	Rotary EM Pump - Mounting Frame
7519-81015	Rotary EM Pump - Rotary Assembly
7519-81016	Rotary EM Pump - Stator Assembly
7519-81017	Rotary EM Pump - Annulus
7519-81018	Rotary EM Pump - Transition Tube
<u>Civil - Structural (Test Loop No. 1)</u>	
7508-D490814	Foundation Plan and Site Location
7508-D490815	Details of Foundations and Concrete Pits
7508-D490816	Structural Support Tower
7508-D490817	Control Building
<u>Civil - Structural (Test Loop No. 2)</u>	
7508-D490848	Foundation Plan and Site Location
7508-D490849	Structural Support Tower
7518-D79316	Structure - Sodium Pump Test Loop Modification
7519-446316	Structural Support Tower

HNPF PUMP TEST LOOP (Continued)

<u>Number</u>	<u>Title</u>
<u>Electrical</u>	
7519-446817	Heater and Thermocouple Installation – Places, Details, Schedules
7519-446818	Heater and Thermocouple Installation – Sections and Details
7518-D794146	Heater and Thermocouple Installation – HNPF Test Loop
7508-D49103	Heater Installation – HNPF Test Loop
7508-D490857	Heater Installation – HNPF Test Loop No. 2
7508-D490856	Heater Installation Details – HNPF Test Loop No. 2
7508-D490832	Thermocouple Location – HNPF Test Loop
7508-D490860	Thermocouple Location – Free Surface Pump Test Loop
7508-D490833	Heater and Thermocouple Installation – Expansion Tank T-1
7508-D490834	Heater and Thermocouple Installation – Storage Tank T-3
7508-D490850	Heater and Thermocouple Installation – Expansion Tank T-2
7519-446820	Electrical Plan and Sections, Shell-Side Heat Transfer Experiment
7519-446821	Single Line and Control Diagrams Shell-Side Heat Transfer Experiment
7508-490864	Conduit, Wiring Diagrams, and Details – HNPF Test Loop
7508-490864	Heater Wiring Diagrams – HNPF Test Loop
7508-D490851	Heater Wiring Diagrams – HNPF Test Loop No. 2
7508-D490841	Control Diagrams, Device Schedules – HNPF Test Loop
7508-D490855	Control Diagrams, Device Schedules – HNPF Test Loop No. 2
7508-D490830	Instrument Installation – HNPF Test Loop
7508-D490859	Instrument Installation – HNPF Test Loop No. 2
303-357-E1	Existing Conduit and Grounding Plan and New Pole Line – HNPF Test Loop
303-357-E2	Lighting Plan – HNPF Test Loop
303-357-E3	Electrical Equipment Schedules and Typical Details
303-357-E4	Pump Drive Excitation Alarm System
303-357-E5	Sodium Heater Installation
303-357-E6	Lighting Plan, HNPF Test Loop No. 2
303-357-E7	Electrical Gutter and Equipment Layout, HNPF Test Loop No. 2
303-357-E8	Conduit and Grounding Plan
303-357-E9	Electrical Gutter and Equipment Layout, HNPF Test Loop
303-357-E10	200-hp Motor Power Plan – Shell-Side Heat Transfer Experiment
303-357-E11	Power Plan – Axial Buckling and Stayed Head Test
<u>Instrumentation</u>	
7508-D490827	Instrumentation Block Diagram
7508-D490824	Process Panel
7508-D490822	Preheat Panel
7508-4908-N407	Thermocouple Specification
7508-S4908-N318	Rotometer Specifications
7508-S4908-N208	Pressure Regulators Specifications
7508-S4908-N101	Safety Valve Specifications
7508-S4908-N535	Sodium Level Transmitter Specification
7508-490833	Thermocouple Installation Plan Expansion Tank
7508-490834	Thermocouple Installation Plan Storage Tank

REVISIONS		DATE	APPROVED
SYN	ZONE	DESCRIPTION	

LEGEND

LINE

LINE NO.
LINE SIZE
LINE CLASS

130-8-A

PRINCIPAL FLOW
AUXILIARY FLOW
INSTRUMENT AIR LINE
INSTRUMENT PRIMARY LINE
INSTRUMENT CAPILLARY TUBING
INSTRUMENT ELECTRIC AND THERMOCOUPLE LEADS
INSTRUMENT RESISTANCE LEADS
DUPLICATED PIPING (SEE REFERENCE DRAWING)
GUARDED PIPING

VALVES

V-235 VALVE NO.

RATE
GLOBE
CHECK
PLUS
BUTTERFLY
ANGLE
THREE-WAY
BELLWELL SEAL
MANUAL REMOTE OPERATED

FITTINGS

REDUCER
WELDED CAP
SCREWED OR SOCKET WELDED CAP
TEMPORARY SEAL

PIPING SPECIALTIES

VAPOR TRAP
FREEZE TRAP
STEAM TRAP
RUPTURE DISC
FUNNEL
SPECTACLE BLIND
EXPANSION JOINT
WYE STRAINER
HOSE CONNECTION
FLEXIBLE CONNECTION
STRESS RELIEVING JOINT

CONTROL VALVES

TEMPERATURE
FLOW
LEVEL
PRESSURE
RELIEF
MANUAL
DIAPHRAGM OPERATED

INSTRUMENTATION

NOZZLE
ORIFICE
IN THE LINE
FLOW IND.
RESTRICTING ORIFICE
BOARD MOUNTED INSTR.
LOCAL MOUNTED INSTR.
THERMAL ELEMENTS
THERMOWELL TYPE (TYPICAL)
LOCAL MOUNTED TRANSMITTER
BOARD MOUNTED TRANSMITTER

LETTER	FIRST LETTER	MEANING IF USED AS	LETTER	FIRST LETTER	MEANING IF USED AS	LETTER	FIRST LETTER	MEANING IF USED AS
A	ANALYZE	ALARM	F	FLOW	FLOW TO PWR COMP	P	PERIOD	POWER
B	BURNING	BURNING	G	GRAVITY	GRAVITY	R	RECORD	RECORDED
C	CONDUCTIVITY	CONTROLLER	H	HAND	HAND	S	SAFETY OR SWITCH	SCANNER
D	DENSITY	DETECTOR	I	INDICATOR	INDICATOR	T	TEMPERATURE	TEMPERATURE
E	ERROR	ELEMENT	J	JUNCTION	JUNCTION	V	VALVE	VALVE
F	FLOW	FLOW TO PWR COMP	K	KEYS	KEYS	W	WEIGHT	WELL
G	GRAVITY	GRAVITY	L	LEVEL	LEVEL	X	EXHAUST	EXHAUST
H	HAND	HAND	M	MONITOR	MONITOR	Y	YIELD	YIELD
I	INDICATOR	INDICATOR	N	NEUTRON	NEUTRON	Z	ZERO	ZERO
J	JUNCTION	JUNCTION	O	ORIFICE	ORIFICE			
K	KEYS	KEYS						
L	LEVEL	LEVEL						
M	MONITOR	MONITOR						
N	NEUTRON	NEUTRON						
O	ORIFICE	ORIFICE						

NOTE: WHEN REQUIRED, THE FOLLOWING MAY BE USED OPTIONALLY AS A FIRST LETTER FOR PROCESS VARIABLES:
(1) READY, RECOGNIZED, SELF-DEFINING CHEMICAL SYMBOLS SUCH AS CO₂, O₂, ETC., MAY BE USED FOR THESE SPECIFIC ANALYSIS INSTRUMENTS.

① DUAL THIMBLES IN ALL SODIUM TANKS ARE USED TO CONTAIN THE FOLLOWING:
1-PERMANENT, INDUCTION TYPE Na LEVEL TRANSMITTER.
2-CALIBRATION OF PERMANENT INDUCTION LEVEL TRANSMITTER WITH A PORTABLE "TRI-COIL" PROBE.

NOTE: TE-1 THRU TE-125 THERMOCOUPLES NOT SHOWN.

- Z-1**
VAPOR TRAP
DWG. 7508-D49087
- T-1**
Na EXPANSION TANK
DWG. 7508-D49083
(48" DIA. x 10'-0" L)
1000 GAL.
- T-3**
Na STORAGE TANK
DWG. 7508-D49084
(72" DIA. x 11'-0" L)
3700 GAL.
- FT-1 & FT-2**
FREEZE TRAP
DWG. 9693-735177
- Z-3**
VAPOR TRAP
DWG. 7508-D49087
- X-1**
HEAT EXCHANGER
DWG. 7519-446812 &
7519-446826.
- CT-A**
DIFFUSION COLD TRAP
DWG. 7519-446822
- T-2**
Na EXPANSION TANK
DWG. 7508-D49083
(48" DIA. x 10'-0" L)
1000 GAL.
- Z-2**
VAPOR TRAP
DWG. 7508-D49084
- CT-1**
COLD TRAP
DWG. 9693-735641
- CT-B**
DIFFUSION COLD TRAP
DWG. 7519-446822

Liquid Metal Engineering Center

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a Division of Atomic Energy Systems, Inc.

HNPFP PUMP TEST LOOP

P-1 DIAGRAM - LOOP I & II

DRAWN: A.S. 10/5/54
CHECKED: 10/5/54
ENGINEER: 10/5/54
APPROVED: 10/5/54

SIZE: E
SCALE: 1" = 10'-0"

SHEET NO. 1 OF 1

7508-SA121001

REVISIONS			
SYN	ZONE	DESCRIPTION	DATE

- NOTES:
- ① SODIUM FILL AND DRAIN, FOR CONTINUATION SEE LOOP #2 DWG. 7508-SPI21002.
 - ② PIPE WAS CUT AT THIS POINT FOR EQUIPMENT OR COMPONENT REMOVAL. CUT ENDS ARE TEMPORARILY SEALED.

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HNP TEST LOOP LOOP #1 - PIPING - ISOMETRIC			
DRAWN A. S. KATZBERG	CHECKED J. E. HARRIS	DATE 1-15-68	DWG. NO. 7508-SPI21001
ENGINEER J. E. HARRIS	SCALE 1/2" = 1'-0"	SHEET NO. 1 OF 1	REVISIONS 1. 1-15-68

7508-SPI21001

REVISIONS			
SYN	ZONE	DESCRIPTION	DATE APPROVED

- NOTES:
- ① SODIUM FILL AND DRAIN, FOR CONTINUATION SEE LOOP #1 DWG. 7508-SPI21001.
 - ② PIPE WAS CUT AT THIS POINT FOR EQUIPMENT OR COMPONENT REMOVAL. CUT ENDS ARE TEMPORARILY SEALED.

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HNP PUMP TEST LOOP Loop #2 - PIPING - ISOMETRIC			
DRAWN A.S. KAPLAN	CHECKED J.E. KAPLAN	DATE 12/1/68	SHEET NO. 1 OF 1
APPROVED J.E. KAPLAN		SCALE 1" = 10'-0"	

7508-SPI21002

REVISIONS			
SYN	ZONE	DESCRIPTION	DATE

UNLESS OTHERWISE NOTED:
 - CONTACTORS AND STARTERS ARE SIZE 1
 - ALL 480V CIRCUIT BREAKERS ARE 3 POLE EXCEPT PANEL H BREAKERS ARE 2 POLE IN 3 POLE FRAME.

Liquid Metal Engineering Center

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HNPF PUMP TEST LOOPS

ELECTRICAL SINGLE LINE DIAGRAM

DRAWN: J.W. JOHNSON

CHECKED: J.W. JOHNSON

ENGINEER: J.W. JOHNSON

APPROVED: J.W. JOHNSON

DATE: 10/1/75

SCALE: AS SHOWN

SHEET NO. 1 OF 1

7508-EA121001

REVISIONS		DATE	APPROVED
SYM	ZONE	DESCRIPTION

NOTES

1. FOR HEATERS & THERMOCOUPLES ON EXPANSION TANK T1, SEE DWG. 7508-D490833.
2. FOR HEATERS & THERMOCOUPLES ON STORAGE TANK T3, SEE DWG. 7508-D490834.
3. FOR HEATERS & THERMOCOUPLES ON PIPING LOOP #2, SEE DWG. 7508-EH21002.
4. FOR HEATER & THERMOCOUPLE SCHEDULES & DETAILS, SEE DWGS. 7519-444817, 7519-444818, 7518-D794146, 7518-D794147, 7508-D49103, 7508-D490832, 7508-D490852, 7508-D490857, 7508-D490840.
5. FOR CORRELATION BETWEEN OLD & NEW HEATER & THERMOCOUPLE NUMBERS, SEE TABLE #6 IN APPENDIX OF HNP PUMP TEST LOOP FSDD.

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HNP PUMP TEST LOOP #1 HEATER AND THERMOCOUPLE LOCATIONS-ISOMETRIC	
DRAWN: W. JOHNSON CHECKED: [] ENGINEER: [] APPROVED: []	DATE: [] SCALE: [] SHEET NO.: [] OF []

7508-EH21001