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UCC
Post Office Box X
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SUBJECT: Preliminary Design Report for the NMSR Pressurized Water Loop at ORR

TO: A. L. Boch

FROM: I. T. Dudley, D. B. Trauger, and H. W. Savage

Abstract

The design criteria, description, flow diagrams, and some drawings of a pressurized water loop in which reactor operation conditions can be simulated are presented. The primary purpose of this test facility is irradiation testing of various versions of fuel elements for use in the Merchant Ship Reactor Program.

The loop proper is designed for operation at 625°F and 2250 psi with a water flow rate of 90 gpm. Heat exchanger capacity is 150 Kw at 300°F system water temperature. Loop construction is of 300 series stainless steels throughout. A by-pass purification system provides for continuous water chemistry control.

Fuel pin specimens are to be irradiated in the space provided by two tubes, 1.5 ID x 24" long, of the "hairpin" type in positions A1 and A2 of the ORR core. The average unperturbed neutron flux at this point in the reactor is estimated to be 5×10^{13} thermal.

DISCLAIMER

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1.0 Introduction

Lattice positions A-1 and A-2 in the Oak Ridge Research Reactor have been chosen for the in-pile location of this experiment. The average unperturbed flux at this point in the reactor is estimated to be 5×10^{13} thermal.

The test loop proper will be designed to recirculate water at pressures as high as 2250 psi and temperatures as high as 625°F. The initial in-pile section will be designed for operation at MSR condition of 1750 psi and 500°F, and subsequent tests involving pressures and temperatures higher than the MSR test conditions will require a different in-pile section. The water will be circulated past two sets of test samples, each consisting of six fuel pin specimens. One set will be located in the in-pile portion of the loop and the other in a section of the loop external to the reactor for control purposes. The remainder of the equipment required to maintain recirculation at the desired operating conditions will be located within a cubicle in the basement of the ORR building. The water loop will be constructed of 347 stainless steel to minimize the effects of corrosion and eliminate the necessity of heat treatment of welds. Other 300 series stainless steels may be used in components wherever use of 347 SS is not practical.

2.0 Objectives

The test loop will provide a facility in which fuel and other materials can be subjected to radiation and other environmental conditions simulating a pressurized water reactor. The objectives of the test program are:

2.1 Prototype testing of fuel pins proposed for use in the first nuclear-powered merchant ship(N.S. Savannah).

2.2 Development and testing of other fuel element designs.

2.3 Development and testing of structural and control materials of interest in water-moderated reactors.

2.4 Studies of water-chemistry and activity buildup in pressurized water system.

2.5 Other studies of a basic or applied nature which require the combined environment of radiation and high-temperature water.

3.0 Loop Design Criteria

NMSR PRESSURIZED WATER LOOP DESIGN CRITERIA

		Test Loop Design	N.M.S.R. Fuel Element Test Conditions	N.M.S.R. Operating Conditions
A.	**Pressure**			
	Loop	2250 psig (max)	1750 psig	1750 psig
B.	**Temperature** (1)			
	In-Pile Tube Inlet	--	500°F	--
	Mean	--	508°F	508°F
	In-Pile Tube Outlet	625°F (max)	516°F	--
C.	**Fluid Flow**			
	In-Pile Tube ("U" Tube)	--	1.5" I.D.	--
	Effective Flow Area	--	0.393 $in.^2$/pin	0.185 $in.^2$/pin
	Velocity First Pass	--	10.00 ft/sec	9.66 ft/sec
	Flow Rate	0 - 90 GPM (2)	40 GPM	--
	System Pressure Drop 40 gpm 90 gpm	--	62 ft 305 ft (3)	--
D.	**Duration of Tests**	Total Time Unlimited	1 month to 1 year	3 years
E.	**Fuel Pins**			
	UO_2 Pellets	--	0.4265 Dia x 0.5" long	0.4265 Dia x 0.5" long
	SS Clad Thickness	--	0.035	0.035

	Test Loop Design	N.M.S.R. Fuel Element Test Conditions	N.M.S.R. Operating Conditions
E. Fuel Pins (Cont'd)			
Clad Outer Diameter	--	0.5"	0.5"
Active Length	--	16.5"	66.0"
Overall Length	--	18.0	--
Pins Per Test	--	6 (3 each leg)	--
Pin Configuration (4)	--	0.612 x 60° Pitch	0.612 x sq. Pitch
F. Heat Generation Rate			
At NMSR Avg 7.89 watts/gm	--	18 Kw	--
At NMSR max 34.6 watts/gm	--	77 Kw	--
Gamma Heat 10 watts/gm (In-Pile Tube)	67.0 Kw	67.0 Kw	--
Total	150.0 Kw (5)	144.0 Kw (max)	--
G. Heat Exchanger Capacity (Water-Cooled)	150.0 Kw (5)	--	--
H. Electric Line Heater Capacity	60 Kw	--	--
I. Loop Piping	1-1/2 IPS Sch 80 347 SS	--	--
J. Water Chemistry			
PH Range	6.5 to 11.0	7.5 to 8.5	7.5 to 8.5
Hydrogen Content	0 to 4 ppm	3.6 ppm	3.6 ppm
Total Max Allowable Solids	--	5 ppm	5 ppm

	Test Loop Design	N.M.S.R. Fuel Element Test Conditions	N.M.S.R. Operating Conditions
J. Water Chemistry (Cont'd)			
Max Oxygen Content	.05 ppm	.05 ppm	.05 ppm
Max Chlorine Content	.1 ppm	.1 ppm	.1 ppm
Flow Rate Through Purification System	0 - 1.25%	0.20% - 1.00%	0.20% - 0.25%

(1) Loop temperature may be varied by heat exchanger and electric heater controls.
(2) Flow Rate may be varied by main throttle valve control.
(3) System head curve intersects Westinghouse Model 150D head curve at this point.
(4) Test Pin dimensions may be varied within limitations of in-pile tube.
(5) Heat exchanger rated at 150.0 KW with inlet temperature of 300°F.

4.0 Description

The test loop will consist of an in-pile test section, a main heat exchanger to remove heat from the water, Westinghouse Type 150D canned rotor pumps for circulation, 60 KW of electric heat for temperature control, a surge tank and make-up system, purification system and an out-of-pile control test specimen section. All process equipment except the in-pile section make-up pump and sampling station is to be located in a shielded room in the basement of the ORR. Refer to Section 5.0 for process flow diagram.

4.1 In-Pile Section

The in-pile section, to be located in lattice position A-1 and A-2 of the ORR, is to consist of a "U" tube of 1-1/2 inch I.D. pipe. This "U" tube is to contain up to six fuel pin test specimens, three in each leg. The fuel pin specimens, 0.5 inch diameter, 18 inches long, will be mounted in specially designed holders which will position them in the center of the reactor lattice. Fuel pin specimens having different diameters and lengths may be tested by use of appropriately designed holders. The cooling water will flow through the "U" tube and over the specimens.

The in-pile section of piping will enter the reactor through the refueling flange directly over lattice positions A-1 and A-2. A stainless steel vacuum jacket around the in-pile piping will serve as a thermal insulator. An aluminum sleeve which fits over the vacuum jacket and into a lattice position will be designed to agree with the cross sectional configuration of an ORR fuel element. Reactor cooling water flow rates will not be altered by the substitution of this in-pile section for reactor fuel elements.

Each leg of the in-pile section will be provided with an "O" ring sealed plug above the reactor to provide for insertion and removal of test specimens. There will be at least six feet of reactor pool water over the test specimens during removal; thus, no additional shielding will be required during this operation.

Design pressure and temperature of the in-pile section was set at 2250 psig and 625°F. Combined thermal and pressure stresses will be limited to values specified by the ASA Code for piping.

4.2 Heat Exchanger

A water cooled heat exchanger will be used to remove heat generated within the system by fission and gamma heating and for emergency cooling. Capacity of the heat exchanger will be based on 500,000 Btu/hr heat transfer with the system operating at a reduced temperature of 300°F. The unit will then have excess capacity at operating temperatures of 625°F.

A direct water-to-water heat exchanger is preferred for use in this test loop in order to reduce the cubicle space requirements and to simplify the controls required. Two Griscom - Russel Co. size No. C-72 heat exchanger units have been selected and are to be used in series.

4.3 Pumps

The three primary system water pumps will be water cooled canned rotor Westinghouse Model A-150D. These pumps are to be in parallel in the system with one normally operating and the other two as standby.

4.4 Line Heaters

The line heater section will be an especially machined section of pipe with clam shell type electrical heaters clamped to its surface. These heaters will furnish up to 54 KW of heat to the system. There are 60 KW of line heater capacity in the system, but the heater output is limited to 54 KW to maintain a reserve capacity of line heater power in the event of the loss of a section of the line heaters. The heat can be added at a controllable rate so as to maintain the desired recirculating water temperature. The clamp-on type heater is preferred to the immersion type heater because a leak in the immersion heater could contaminate the system. These heaters also will serve to maintain loop temperatures when the reactor is down to minimize thermal cycling and start-up time.

4.5 Surge Tank

The surge tank is required to absorb volume changes during heating or cooling of the system and also to provide and maintain the desired system pressure. The volume of the surge tank will be large enough to handle changes in water volume due to the contraction of the water such as encountered during emergency cooling of the entire system from operating conditions. The surge tank heaters are to be clamped to four pipe legs which extend from the sides of the tank and re-enter the tank at the bottom. The heaters are to be clam shell type, similar to the line heaters. This method of heating the surge tank water will be used because high thermal stresses would be encountered in attempting to heat the vessel itself.

4.6 Make-Up System

The make-up system will provide purified water for loop filling and to replace loop losses during operation. Demineralized water, furnished by the ORR reactor utilities system, is to be used for the make-up. This water will enter the make-up tank, where it will be heated to 300°F and then degassed by blowing off about 10% of the water. After degassing, the water will pass through a deoxygenating system before being added to the loop. The deoxygenating system consists of two resin beds and a conductivity cell. The first bed is a sulfite deoxygenating resin and the second an ion exchange resin. The condition of the ion exchange resin bed will be monitored by the conductivity cell. The effectiveness of the deoxygenating resin is to be checked periodically by performing an oxygen analysis of the make-up water. All make-up water to maintain the proper surge tank level will pass through the deoxygenating system. The deoxygenating system will be by-passed and the water taken directly from the make-up tanks when large amounts of water are required, such as after the loop has been drained. The make-up tank will have sufficient capacity to fill the entire loop with degassed water on the initial start-up.

The make-up water will be injected into the system by a Milton Roy Company 18-8 stainless steel Simplex Controlled Volume MDI-53-74-5 pump. This pump is also to be used for pressure testing the loop.

4.7 Ion Exchange System

A by-pass type ion exchange system will be provided for the control of water purity in the loop. A portion of the recirculating water is to be diverted from the main system to the ion exchange resin bed. The water will pass through a regenerative type cooler and water cooled heat exchanger before entering the ion exchanger. The entering water will have been cooled down to a temperature of approximately 95°F in order to prevent damage to the ion exchange resin. The water leaving the column will pass through the regenerative heater before being returned to the loop. Conductivity cells will be placed before and after the ion exchange column to measure its efficiency.

4.8 Out-Of-Pile Test Section

Control samples will be exposed to an environment similar to the in-pile specimens except for the absence of neutron and gamma irradiation and a temperature differential between the element surface and the water. The out-of-pile test section will be identical to the in-pile section except that it will be horizontal instead of vertical. This section will be located inside the cubicle.

4.9 Degassifier System

A by-pass degassifier system is to be provided for controlling the concentration of dissolved gases in the recirculating water. This system will be used mainly during start-up and after additions of large quantities of make-up water. A portion of the water will be taken from the loop and fed into a degassifier located in the vapor phase of the surge tank. The gas will be removed from the water by the scrubbing action of the steam as the water passes through the degassifier nozzle. The degassed water will then return to the circulating system through the pressure equalizing line from the surge tank to the system.

4.10 Sampling System

The sample station or system will rpovide a means for obtaining water samples during operation from various points in the system such as the pump inlet, in-pile inlet, surge tank bottom, ion exchange column, etc. All of the sample lines which will contain water over 200°F while the loop is in operation will run through a small cooler before entering the sample station. Any test or measurements to be run in the sample station must be done at atmospheric conditions. If high pressure and temperature samples are desired, the sample cooler will be by-passed and each sample will be taken in a special high pressure sample bomb. The high pressure bombs are also to be used for the addition of special materials for controlling the loop water chemistry. Water is to be circulated through the bomb by using the differential pressure obtained from sample points at the pump suction and discharge. Evacuated sample bombs may be used as required.

4.11 Reactor Cooling Water System

Provisions are to be made in the loop for the switchover to reactor cooling water circulation in the event that circulation of water through the loop is stopped. Water flow past the sample is required at all times when the reactor is at power to prevent burnout of the sample and the pressure tube. The reactor cooling water is the water that flows through the active lattice and other parts of the reactor that require water cooling. Reactor cooling water use is to be kept to a minimum, for it would have undesirable effects upon the controlled conditions of the test and may also accelerate the corrosion in the in-pile tube. The switchover to reactor cooling water operation must be done while the reactor is down. The switch is to be made by closing the valves which isolate the in-pile section from the remainder of the loop, opening the process water entry and return valves and starting one of the two reactor cooling water pumps.

4.12 Filters and Particle Collectors

In addition to the ion exchanger system, there are to be two full flow strainers to collect foreign particles and corrosion products from the system. One strainer will be located at the inlet to one of the pumps to be used at start-up for collection of extraneous particles and then for standby only. Another strainer will be located in the line downstream of the pump discharge header as protection for the in-pile section in case of pump impeller disintegration.

4.13 Instrumentation and Controls

The instrumentation on the loop will be designed with specific objectives in mind. These objectives are (1) protection of the reactor and loop at all times from damage, (2) as fully automatic control of the loop as is practical, and (3) indication or recording of all necessary data. The instrument panel boards will contain instruments for the control, measurement, and monitoring of pressure, temperature, flow, surge tank level, water activity and saturation. Flow rates will be manually controlled. Consideration must be given to determining the most effective monitoring system to detect failures in the fuel elements under test.

A. Pressure Control

The loop pressure is to be maintained by the steam pressure formed in the surge tank. The head of steam is formed by the 24 Kw capacity of electrical heaters of the clam shell type which are strapped to pipe legs on the bottom of the surge tank. The pressure will be controlled by a pressure controller and a pneumatic positioner operated variac which controls the power to the heaters. The current to the heaters is to be measured by an ammeter. The maximum power is to be limited to 20 Kw for safety purposes. The pressure in the surge tank, in-pile section and pump discharge manifold are to be monitored by pressure transmitters. The in-pile pressure monitoring system will include dual transmitters and scram circuits so as to afford maximum protection.

Other pressure gauges monitor the pressure of the process water, demineralized water, flushing steam, and make-up water. There will be differential pressure gauges on the panel board with which to measure the pressure drop across the pumps, in-pile section, out-of-pile section, and surge tank water level.

B. Temperature Control

The loop temperature will be controlled by a water-cooled heat exchanger and electric heaters on the loop piping. Control of the heat exchanger by-pass flow rate will provide only an approximate temperature adjustment. More exact temperature control will be maintained by the electric line heaters. In order to utilize the line heaters as the temperature control an excess of heat will be removed by the heat exchanger. The control of the electrical power to the line heaters will originate from a potentiometer type indicator controller which receives its input signal from an iron constatan thermocouple at the outlet of the line heater section. The temperature controller operates a pneumatic positioner operated variac which controls the heater power. This system should maintain the loop temperature with very little variation.

A portion of the line heater capacity (24 Kw) is manually controlled and is to be turned on in two steps of 12Kw each. Fine adjustments of power requirements will be maintained by the pneumatic positioner operated variac.

Thermocouples are to be located at all points where it is considered necessary to monitor or record temperatures. The one thermocouple, that reads the highest temperature of the in-pile tube is to be connected to a single point temperature recorder so as to have a continuous record of the in-pile tube tmeperature. The recorder will have a scram switch which is set at a suitable value above the operating temperature so that should the in-pile pressure tube temperature rise to a dangerous value, a reactor scram will be initiated.

C. Flow Control and Measurement

Circulation of water must be maintained in the loop at all times to cool the test elements and in-pile tube. In order to maintain the required flow with an adequate measure of safety three pumps are to be provided. The pumps are to be in parallel with one operating and the other two as standby. The flow is to be controlled by a hand operated flow control valve and measured with a venturi and flow recorder. Duplicate DP cells for measuring the flow will be required for safety considerations. Two pressure switches are to be operated from each of the flow signals emitted by the DP cells. One pressure switch is to produce an alarm and turn on the first standby pump at low flow conditions and the other to produce a reactor scram at a very low flow condition.

When the loop is operating on reactor cooling water, the flow will be measured by another orifice plate or venturi and DP cells. For safety considerations the system of reactor cooling water flow measurement, signal transmission, recording, and pressure switch for scram circuit is similar to that of the main water flow system except for the pressure rating of the DP cells. Two reactor cooling water pumps will be installed in parallel. One pump to serve as standby.

The cooling water flow to the system water pumps and the ion exchanger system flow rate, are to measured by rotameters.

D. Electrical System

The main pumps are to be connected to a battery driven motor generator set and the reactor emergency power system to insure against interruption or loss of electrical power. The battery driven motor generator set is necessary to supply power during the period of time required to put the reactor emergency power system into operation. The 240V battery system will be located over the operating area and the M.G. set will be located directly behind the instrument panel.

Line heaters will be connected to the reactor emergency power. A brief interruption of heater power is not considered serious. Surge tank heaters to be connected to battery emergency power.

E. Surge Tank Liquid Level

The surge tank liquid level is to be indicated and recorded on a DP cell recorder. The signal to the recorder is to be transmitted by two tubing runs from the surge tank. The signal to the high side of the instrument will come from a standpipe connected to the top of the surge tank and is the reference or cold leg. The reference leg will be cooled and maintained full at all times to provide a constant water level and density. The signal to the low side of the instrument will come from the bottom of the surge tank and will vary with the level of the water in the tank. A slight correction must be made in the level readings to compensate for density differences between the reference and measuring legs.

F. Activity Monitoring System

The activity of the main system is to be monitored and recorded. The recorder is to be equipped with an alarm point so that in the event of an excessive increase in water activity, such as encountered during a fuel element rupture, the operators will be notified and the loop will be shut down.

Provision will also be made for monitoring activity in the purification system, off gases, cubicle sampling station, and operating area.

4.14 Safety Features

A. Annunciator and Automatic Control Circuits

Automatic control circuits will initiate corrective action to rectify extremely critical abnormalities when they occur and if necessary initiate a reactor scram.

The ten abnormal conditions which will cause an annunciation and the corrective action required are as follows:

(a) Low Primary System Water Flow - The operating pump will be stopped and an automatic switchover made to the first standby pump. If the first standby pump does not resume normal flow in two seconds, the first standby pump is to be stopped and the switch-over made to the second standby pump. If the normal flow is not resumed in another two seconds, the reactor will be scrammed and the heat exchanger turned on to full capacity.

(b) Low Pump Cooling Water Flow - The operating cooling water pump will be automatically stopped, the standby pump started, and the line heater cut off. If the flow does not return to normal within two seconds, the reactor will be scrammed and the heat exchanger turned on to full capacity.

(c) High Ion Column Temperature - Alarm only.

(d) Approaching Steam Saturation Conditions - This occurs when the loop water conditions approach saturation during a decrease in loop pressure, or increase in loop temperature. If this condition is not rectified the line heater is to be cut off and if it still continues, the heat exchanger will be turned on to full capacity and an alarm will be sounded. If loop conditions continue to approach the saturation point by pressure drop or temperature rise, the reactor will be scrammed. Alarm set points located in the pressure and temperature recorders will be manually set for specific operating conditions. During start-up and shut down the alarm set points will require step adjustments by the operator.

(e) High System Pressure - During a high pressure condition the surge tank heaters are to be cut off and are to be automatically turned on when the pressure returns to normal.

(f) Surge Tank Water Level - The make-up pump will be turned on and off automatically to maintain the water level. If the level drops below the desired operating level, the surge tank heaters are to be automatically turned off and at high surge tank level, the make-up pump control circuit will be broken to prevent the addition of water to the system by manual controls.

(g) Main Water Pump Overload - An indication of electrical overload on the operating pump will transfer load to a standby pump.

(h) High Water Activity - Alarm only.

(i) High Reactor In-Pile Tube Temperature - When the temperature of the in-pile tube exceeds a preset point, the reactor is to be scrammed.

(j) Low In-Pile Reactor Cooling Water Flow - This station is operative only when the in-pile tube is using reactor cooling water. Should a low reactor cooling water condition exist, an alarm is given. If the flow should continue to drop, a second alarm point will be reached and the reactor scrammed.

The operating cooling water pump will be automatically stopped and the standby pump started. If the flow does not return to normal within two seconds, the reactor will be scrammed.

B. Relief Valves

There are to be four relief valves on the system. They will be located on (a) the surge tank, in the event of a failure of the automatic control circuit which governs high pressure, (b) the in-pile tube, to provide protection in the event this portion of the system is isolated from the ramainder of the system and there is sufficient heat generation in the reactor tube to cause excessive pressure, (c) the make-up tank, to provide protection in the event of failure of the heater controls, (d) the make-up pump, to prevent excessive pressures if the pump is operated while the discharge valves are closed.

C. Radiation Protection

The loop operating personnel are to be protected from radiation from the water activity by placing all the external equipment inside a cubicle which has the equivalent of barytes concrete walls twenty-four inches thick. The piping connecting the reactor tube to the external system is to be shielded with twenty-four (24) inches of barytes concrete or equivalent. The cubicle will be enclosed and connected to the reactor stack exhaust system so that if there is a leak or rupture inside the cubicle, the radioactive steam will be vented to the stack instead of contaminating the reactor basement or causing an evacuation of the building due to high air activity.

4.15 Test Equipment and Specimens

A. Charging and Discharging Equipment

When a test specimen is to be discharged or removed from the reactor tube, the in-pile piping will be isolated from the remainder of the system by closing isolation valves. The plug locking device will be removed from the top of the in-pile section and fixtures attached to the "O" ring sealed plugs. Test specimens are attached to each of these plugs by specimen holders and are withdrawn from the in-pile section by the upward movement of the plugs. The specimens will be shielded by the pool water and no additional shielding will be required. Specimens will be stored in the reactor pool until ready for inspection within the hot cell. Reactor pool water and test loop water will be free to mix during fuel pin charging or discharging operations.

The out-of-pile specimen can be withdrawn in the same manner except that it will be drawn into a length of pipe to prevent spread of contamination. The out-of-pile elements will not be irradiated and the only activity would result from radioactive corrosion products on the element surface.

B. Test Specimens For Initial Experiments

The specimens will be similar to those designed for the MSR except the length will be 18" instead of 66". The specimen outer diameter will be 0.500 in. and will be spaced on a pitch of 0.612 in. x 60°. This configuration was chosen to permit three pins to be tested at one time in each leg of the in-pile section. A total of six pins may be irradiated at one time.

Irradiation tests will be performed with a water velocity of 10 feet per second across the test specimens in order to duplicate the NMSR water velocity. Water velocities may be varied as required for specific test conditions by use of the flow control valve.

4.16 Instrument Panel

The panel will be located facing the cubicle wall so that valve handles can be extended through the wall and operated in view of the panel. This arrangement can be accommodated in the space allocated for the experiment.

4.17 Operation

The loop and its control system will be designed to minimize attention by the operating personnel. To provide for a minimum of coverage, it is important that manual operations be limited to data taking and monitoring of conditions and to removal of samples for analysis. It may be desirable or necessary to arrange for back-up assistance from Reactor Operations at those times when emergency situations arise.

4.18 Hot Cell Analysis

Fuel elements removed from the loop would be loaded into casks for removal to a suitable hot cell for examination. This transfer can be accomplished either in the reactor canal or in the ORR canal hot cell. Removal of the specimen holder would be necessary before closing the cask.

Examination of the specimens will include dimensional measurements for swelling, or distortion, metallographic examination of welds and/or fraying, possible analysis of fission gases, removal of the oxide pellets and examination for cracking and other damage and for burnup. Other analysis may be required on occasion such as analysis of induced activity of structural materials or foils to determine radiation dose and examination of thermocouple attachment after irradiation.

Since these elements are of relatively low enrichment, the cells for opening the capsules and examining the oxide must be capable of handling plutonium.

4.19 Components Descriptions

Specifications List

1. Specification XIW-S1 Welding Quality Requirements Stainless Steel Processing Equipment

2. Procedure Specification PS-13 For D.C. Inert Arc Welding of Type 304, 316, 321, and 347 Stainless Steel Pipe, Plate and Fittings

3. JS-P3-74 Specifications for Hermetically Sealed Pump

4. JS-P3-76 Specifications For Water-Cooled Heat Exchanger

5. JS-P3-77 Specifications for Purification System Heat Exchanger

6. JS-P3-80 Specifications for Electric Heater

7. JS-P3-82 Specifications for Surge Tank

8. Specifications for MSR Loop - Vacuum Pump, Make-Up Pump, and Condensate Return Unit

9. Specifications for Hot Water Storage Heater

Excerpts From Specifications For Components

Sections of Job Specification JS-P3-74, Specifications For Hermetically Sealed Pump

Section 4 - Design and Operating Requirements

4-A Operating Conditions

The pump is intended for service in a nuclear reactor experimental facility. Demineralized water will be pumped through the test section. The water is subject to radioactive contamination and no leakage to ambient can be tolerated. It is imperative that a high degree of quality be incorporated in the design, materials and workmanship.

The pump shall be capable of operating under all conditions set forth herein:

1.	Operating Temp Range at Pump Inlet	60°F - 650
2.	System Pressure	2500 psig (max)
3.	Pumped Fluid	Demineralized water
4.	Pump Cooling Water Temp	100°
5.	Pump Cooling Water Flow	10 gpm (max)
6.	Pump Characteristics	Stable operation from 0 to 100 gpm with min total head of 300 feet

4-B Construction

1. The heat exchanger shall be an integral part of the pump.

2. The pumped fluid shall serve as the bearing lubricant.

3. The rotor windings shall be hermetically sealed inside of a close fitting stainless steel container.

4. The stator windings shall be isolated from the pumped fluid by a stainless steel container.

5. A labyrinth seal and thermal barrier between motor and impeller shall be provided to reduce fluid flow and heat transfer between pump casing and motor cavity.

6. The pump is to be totally enclosed and sealed by renewable weld joints so as to permit no leakage of the pumped fluid.

7. Pump casing suction discharge nozzles to be designed for butt weld joints to system piping.

   Suction nozzle pipe size: 3" IPS Sch. 160
   Discharge Nozzle pipe size: 2-1/2" IPS Sch. 160

8. Motor and impeller shall be removable as a unit from the volute without removing volute from system. Provision shall be made for renewable seal welds.

4-C <u>Materials of Construction</u>

1. All surfaces in contact with the pumped fluid shall be a stainless steel of the 300 series (bearings excepted). The final selection of stainless steels to be subject to the Buyer's written approval.

<u>Sections of Job Specification JS-P3-76, Specifications for Water-Cooled Heat Exchanger</u>

<u>Section 5 - Design and Operation Requirements</u>

5-A <u>Design and Operating Conditions</u>

The heat exchanger is to be used for service in a nuclear reactor experimental facility. Demineralized water will be circulated through a system in which the heat exchanger is used to adjust and control the temperature of the water exiting from the experimental section of the facility. The water is subject to radioactive contamination and no leakage to ambient can be tolerated. It is imperative that a high degree of quality be incorporated in design materials and workmanship.

The heat exchanger shall be designed to fulfill the following service requirements and conditions:

1. Design Conditions

a.	System Water Pressure	2500 psig
b.	System Water Temp	650°F
c.	System Water Flow	90 gpm
d.	System Water Delta P Through the Heat Exchanger	10 psi (max)

e. System water to be demineralized, filtered and have pH range from 6 to 11.

f. Cooling water to be demineralized

g.	Cooling Water Pressure	150 psi
h.	Cooling Water Temp (Inlet)	80°F-120°F
i.	Cooling Water Temp (Outlet)	200°F
j.	Cooling Water Delta P	10 psi (Max)
k.	Thermal Cycles	2500
l.	Accumulative Operating Duty	20,000 hrs

2. Normal Operation Conditions

a.	System Water Pressure	2250 psig
b.	System Water Temp (Inlet)	300°F
c.	Heat to be Removed	500,000 Btu/hr
d.	System Water Flow Rate	40 gpm
e.	Cooling Water Temp (Inlet)	80°F-120°F
f.	Cooling Water Temp (Outlet)	200°F (max)
g.	Coolant Water Flow	40 gpm (max)
h.	Cooling Water Pressure	100 psi
i.	Ambient Temperature	60°F-120°F

Provisions shall be made for adequate venting and draining of the heat exchanger.

Section 6 - Materials

6-A Materials of construction shall be type 347 stainless steel. The type 347 stainless steel shall conform to the requirements of Union Carbide Nuclear Company Specification XIM-Sla which is a part of this specification.

Section 7 - Welding

7-A Requirements

No welding shall be performed until the Company has given approval to Fabricator's proposed welding procedure.

Welding shall, as a minimum, be equivalent to the requirements of Parts UW, UG and UHA of Section VIII, and Section IX of the ASME Boiler and Pressure Vessel Code, latest edition, subsequent interpretations, modifications and addenda, and shall also meet the additional requirements stated herein.

All welds joining parts contacting the system water shall be full-penetration double welds or single groove welds with backing beads, or equivalent. The portion of the stainless steel weld which will be in contact with system water shall preferably be made using the inert gas shielded-arc non-consumable electrode technique, with filler metal added in each pass. Metal arc welding on the coolant side may be used if the weld is proven sound by penetrant inspection. Backing rings may be used only if subsequently they are completely removed and the weld reinforcement is ground flush and penetrant inspected. In cases where the weld is made from one side only, as in the final closure weld, the weld shall be made full penetration, the root and two subsequent passes shall be made by the TIG process with complete inert gas back-up and filler metal added in all passes. Particular efforts shall be made to insure that the inaccessible surface of such welds meets the requirement of Paragraph 9-F 2b.

Sections From Job Specifications JS-P3-77, Specifications For Purification System Heat Exchanger

Section 5 - Design and Operating Requirements

5-A Design and Operating Conditions

The heat exchanger is to be used for service in a nuclear reactor experimental facility. Demineralized water will be circulated through a system in which the heat exchanger is used to lower the temperature of the water exiting from the experimental section of the facility. The water is subject to radioactive contamination and no leakage to ambient can be tolerated. It is imperative that a high degree of quality be incorporated in design, materials and workmanship.

The heat exchanger shall be designed to meet the following service requirements and conditions:

1. Design Conditions

a.	System Water Pressure	2500 psig
b.	System Water Temp	350°F
c.	System Water Temp (Outlet)	100°F (max)
d.	System Water Flow	3 gpm (max)
e.	System Water Delta P Through Ht. Exch.	10 psi (max)
f.	System water to be demineralized, filtered with pH range from 6 to 11.	
g.	Cooling water to be potable water	
h.	Cooling Water Pressure	100 psig
i.	Cooling Water Temp (Inlet)	60°F-85°F
j.	Cooling Water Temp (Outlet)	200°F (max)
k.	Cooling Water Flow	10 gpm (max)
l.	Cooling Water Delta P	30 psi (max)
m.	Thermal Cycles	2500
n.	Accumulated Operating Duty	20,000 hrs

2. Normal Operation Conditions

a.	System Water Pressure	2250 psig
b.	System Water Temp (Inlet)	300°F
c.	System Water Temp (Outlet)	80°F-100°F
d.	System Water Flow	1.0 gpm
e.	Cooling Water Temp	60°F-85°F
f.	Cooling Water Pressure	100 psig
h.	Cooling Water Flow	10 gpm (max)

i. Provisions shall be made for adequate venting and draining of the heat exchanger.

5-B <u>Dimensions and Nozzle Arrangement</u>

1. The heat exchanger must be compactly arranged so as to occupy a minimum space. Final layout shall be subject to Company's approval.

2. System water side of heat exchanger shall be designed for butt type weld joint with 1/4" IPS Schedule 40 pipe. Nozzle ends shall be beveled for butt welding to Company's approval.

3. An adequate means for mounting shall be provided.

Section 6 - Materials

6-A The heat exchanger shall be of type 347 stainless steel. The materials shall conform to the requirements of material specification SIM-Sla which is part of this specification.

Sections From Job Specification JS-P3-80, Specifications For Electric Heater

II Equipment Included

Equipment to be furnished includes two (2) semi-cylindrical electric heater units in accordance with requirements specified herein and Drawing D-2-02-054-7297.

III Description, Operating Conditions and Requirements

A. Description

The heater shall consist of two semi-cylindrical units tubular heaters cast in cast iron or aluminum bronze (ASTM B148-52 or equal). The total effective heater unit dimensions and electrical rating shall be in accordance with Drawing D-2-02-054-7297.

B. Operating Conditions

The heater unit is intended for service in a nuclear reactor experimental facility. Demineralized water will be circulated in a closed system in which the heater is used to adjust and control the temperature of the water supplied to the experimental section of the facility. The heater will be normally operated in a non-corrosive atmosphere.

C. Requirements

1. Heater electrical ratings, dimensions, and tolerances shall be in accordance with Drawing D-2-02-054-7297.

2. Minimum bending radius of the embedded tubular heater to be twice the diameter of the sheath.

3. Embedded tubular heater shall have an approximate outside diameter of 0.315 in., with a helical coil of high qaulity resistance wire centered in the sheath packed with high quality magnesium oxide for electrical insulation between the coil

and the sheath. The sheath shall be capable of operating at rated voltage with a sheath temperature of 1500°F continuously. Heat density of tubular heater shall be 40 watts/in.^{2} of heater surface area. Each terminal end of the tubular heater shall have a non-heating section approximately seven (7) in. long.

4. Heater terminal ends shall have standard threads with double nut and washers, with mica or other suitable insulation.

5. The heater unit shall be capable of operating at design voltage and at design sheath temperature for a minimum of 10,000 hours operation.

Sections From Job Specification JS-P3-82, Specifications For Surge Tank

Section 1 - Scope of Work

1-A Scope

This specification covers the fabrication, inspection, testing and delivery of a surge tank to meet the conditions and requirements specified herein and as shown on the design drawings listed below and the related detail drawings.

E-2-02-054-7119	Surge Tank
E-2-02-054-7225	Surge Tank Assembly

Section 2 - Code Selection

2-A Fabrication of the surge tank shall be in accordance with the ASME-UPV Code, except where the design drawings or this specification deviate from this Code, in which case the design drawings or this specification shall take precedence. Changes or variations from Code, Specification or Design Drawings shall be submitted for approval by the Company.

2-B The vessel shall be inspected in accordance with Section 7 herein, and Paragraphs UG-90 through UG-97 of the ASME-UPV Code. Application of Code Stamp in accordance with Paragraphs UG-115 through UG 120 is required.

2-C Piping external to the vessel shall be in accordance with ASA Code for pressure piping and additional requirements as specified herein.

Section 4 - Design and Operating Requirements

4-A Design and Operating Conditions

The surge tank is to be used for service in a nuclear reactor experimental facility. Demineralized water will be circulated through a system in which the surge tank will be used to absorb volume changes during heating and cooling of the system and also to provide and maintain the desired system pressure. The water which is circulated through the surge tank is subject to radioactive contamination; therefore, no leakage to ambient can be tolerated. It is imperative that a high degree of quality be incorporated in the materials, fabrication, and inspection of this vessel.

The surge tank will have clam-shell type heaters clamped to the four pipe legs which extend from the sides of the tank and re-enter the tank at the bottom.

4-B Dimensions and Nozzle Arrangement

The surge tank dimensions shall be in accordance with the design and detail drawings, except for the inside diameter of the surge tank. The diameter as shown is a minimum diameter; if 12" IPS Schedule 160 seamless pipe is not available a larger diameter may be substituted provided all applicable aspects of ASME-UPV Code are met.

Section 5 - Materials

5-A The surge tank shall be constructed of type 347 stainless steel. The stainless steel shall conform to the requirements of material specification XIM-Sla which is attached and forms a part of this specification.

5-B The Company's Bill of Material BM-7225 is included in this specification for reference only. Seller shall furnish all material required to complete fabrication of the surge tank in strict accordance with the design drawings and this specification.

Specification for MSR Loop

Vacuum Pump

Vacuum pump shall be a mechanical pump, oil lubricated, water-cooled, electrically dirven with a V-belt drive. The vacuum pump shall be single stage construction with a free air displacement of 27 cubic feet per minute. It shall be capable of an ultimate pressure of 10 microns measured by a McLeod gage. There shall be an air-oil separating tank, with a swirl type separator, mounted on the pump base with the pump exhausting into the separator tank. Piping connecting the tank to the pump both for oil supply to the pump and the pump exhaust shall be supplied and connected. Adequate valves for control shall be a part of the oil supply line including a solenoid valve for automatic control of the oil supply. The pump, motor, separating tank, and piping shall be a complete unit, mounted on a base plate. The motor shall be for 440 volt, 3 phase, 60 cycle current. The unit shall be a single stage, simplex design Kinney high vacuum pump Model KS-27, or equal.

Make-Up Pump

Pump shall be a piston type injection pump with means for adjusting capacity by adjusting stroke length. Inlet and outlet connections shall be threaded. Unit shall be complete with pump, motor, and drive mounted on a single base plate. Motor shall be totally enclosed and be for 440V, 3 phase, 60 cycle current. The pump is to handle clear, demineralized water at 50°F - 75°F. Pump shall have a maximum capacity of 3.5 gallons per hour and maximum pressure of 3750 psi.

Pump shall be a Milton Roy Company 18-8 stainless steel simplex controlled volume MDI-53-74-S injection pump, or an approved equal.

Condensate Return Unit

Unit is to be a combination receiver tank with condensate pump, motor, and controls. Receiver tank shall have a capacity of 14 gallons; pump shall deliver 6 gpm against a head of 20 psi. Receiver tank shall be cast iron; pump shall be bronze with a stainless steel shaft. A double pole enclosed type float switch with brass rod and copper float shall be furnished. Motor shall be vertical ball bearing type, 1 phase, 60 cycle, 120 volts. Unit shall be Aurora Apco-Matic Model LR3442 condensate return unit, or approved equal.

Specification for Hot Water Storage Heater

I. Scope

A. This specification covers the design, fabrication, testing, and delivery of one (1) water storage heater to meet the operating conditions and specifications given herein.

B. Alternate on Manufacturers Standard Design

Consideration will be given to a heater of a manufacturer's standard design provided all deviations in the manufacturer's standard design and construction from the requirements herein specified are fully described in his proposal and provided such design and construction meets the approval of the purchaser.

II. General Specifications

A. Work Conditions

The unit is to be used for heating and storing demineralized water using a steam coil heating element immersed in the water as a heat source. Temperature of the demineralized water supply will be within the limits of 40°F minimum to 75°F maximum. Steam supplied to the coil will be at 125 psig, saturated. The water is to be heated to a temperature of 300°F. Maximum working conditions for the tank shall be 125 psig and 353°F.

B. Design

The heater shall be a vertical tank type with dimensions and appurtenances as shown by the sketch in Fig. 1. Design and construction of the heater shall be in accordance with the American Society of Mechanical Engineers Code for Unfired Pressure Vessels except where otherwise stated by specifications. Design and construction drawings for the heater and tank shall be submitted to the Purchaser for approval. Construction before the purchaser's approval shall be at the Manufacturer's risk.

4.20 Design Calculations

Preliminary design calculations have been made on this loop; however, at the time of writing of this report more detailed calculations are being made. These calculations will be presented in a later report.

5.0 Loop Flow Diagrams and Drawings

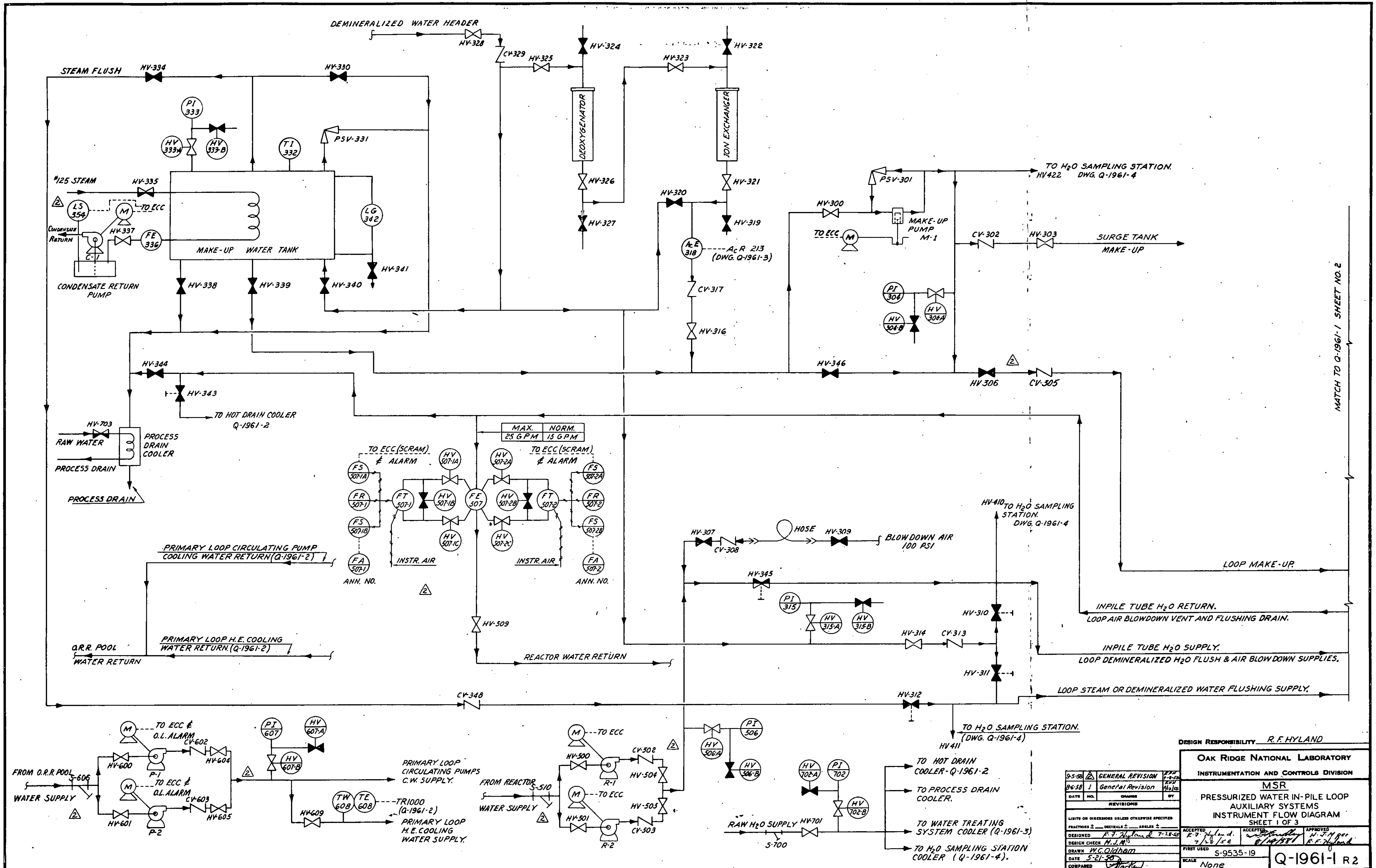
The following drawings included in this report are preliminary:

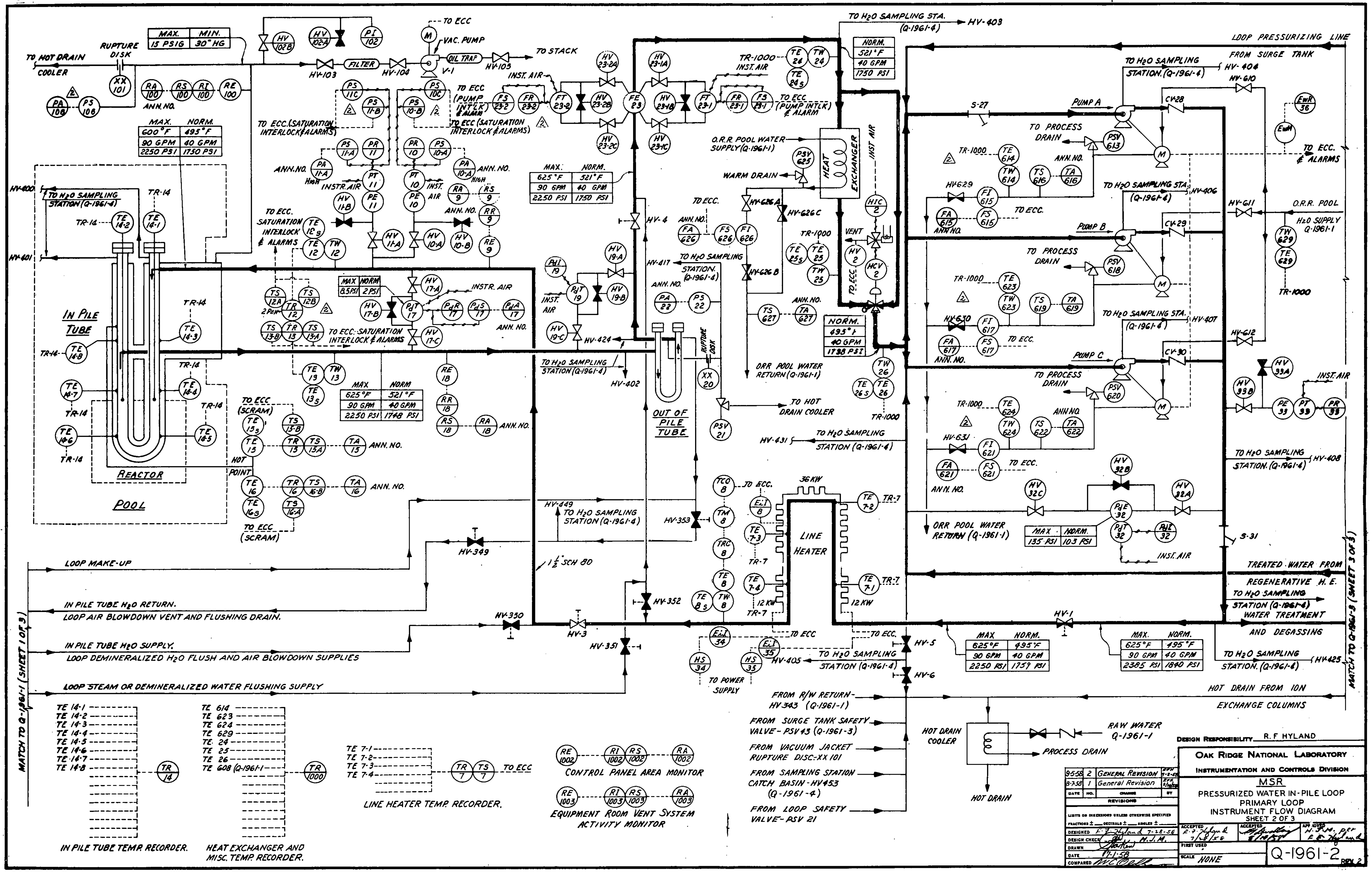
Q-1961-1	MSR Pressurized Water In-Pile Loop Auxiliary Systems Instrument Flow Diagram
Q-1961-2	MSR Pressurized Water In-Pile Loop Preimary Loop Instrument Flow Diagram
Q1961-3	MSR Pressurized Water In-Pile Loop Pressurizer and H_2O Treatment Systems Instrument Flow Sheet
Q-1961-4	MSR Pressurized Water In-Pile Loop Water Sampling Station Instrument Flow Diagram
D-32874	Equipment Arrangement Plan and Section
D-2-02-054-6985	Layout Within South Stand Pipe
D-2-02-054-6991	Fuel Pin and Suspension
D-2-02-054-7097	Assembly - Disconnect For Piping In Pool
D-2-02-054-7442	Elevation MSR Pressurized Water Test Loop
E-2-02-054-7008	Subassembly - In-Pile Section
F-2-02-054-7098	Manifold Above Reactor Vessel

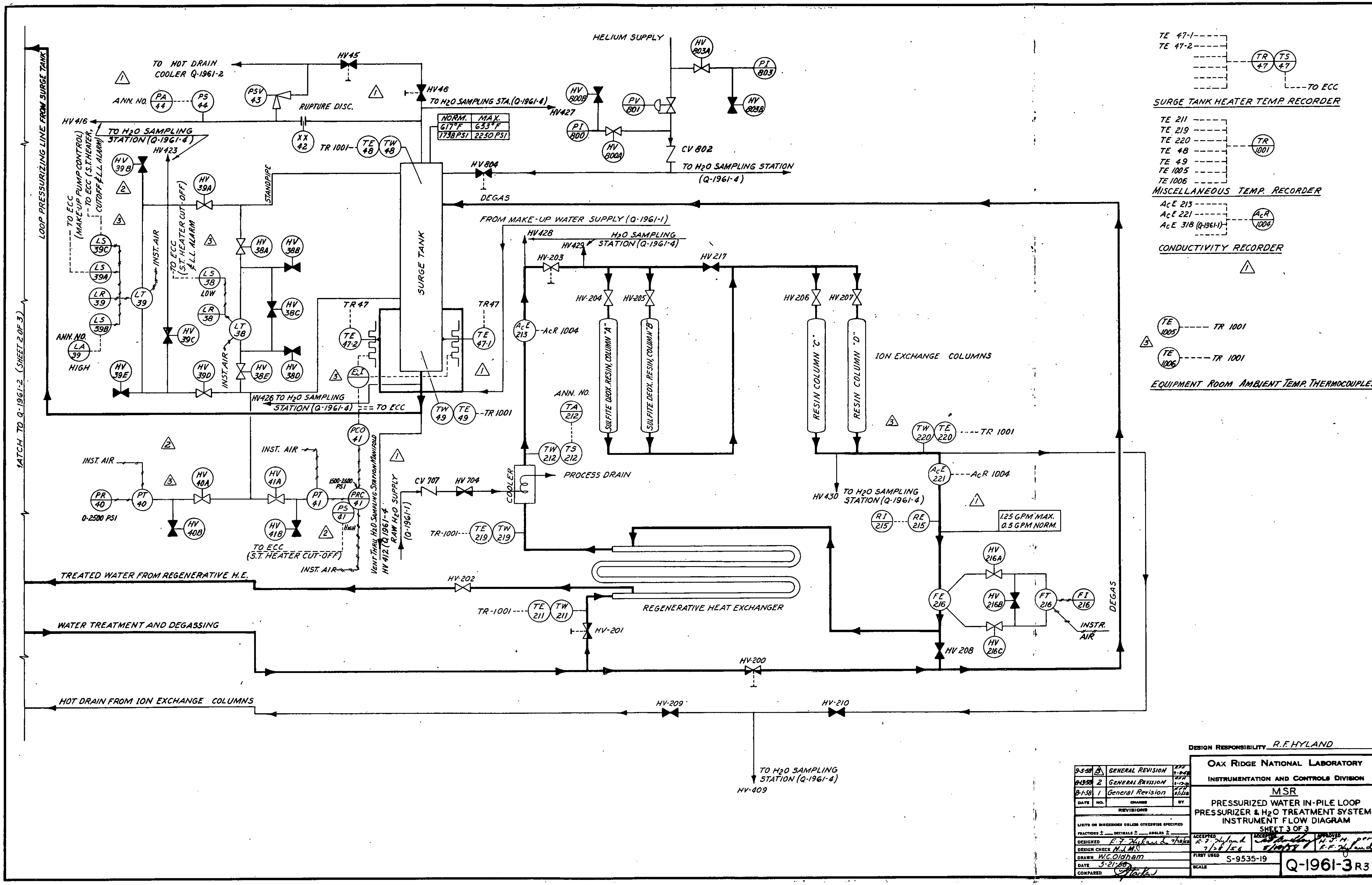
6.0 Acknowledgements

The following people have contributed extensively to the design presented in this report: A. A. Abbatiello, R. C. Daniels, R. F. Hyland, A. P. Marquardt, G. W. Renfro.

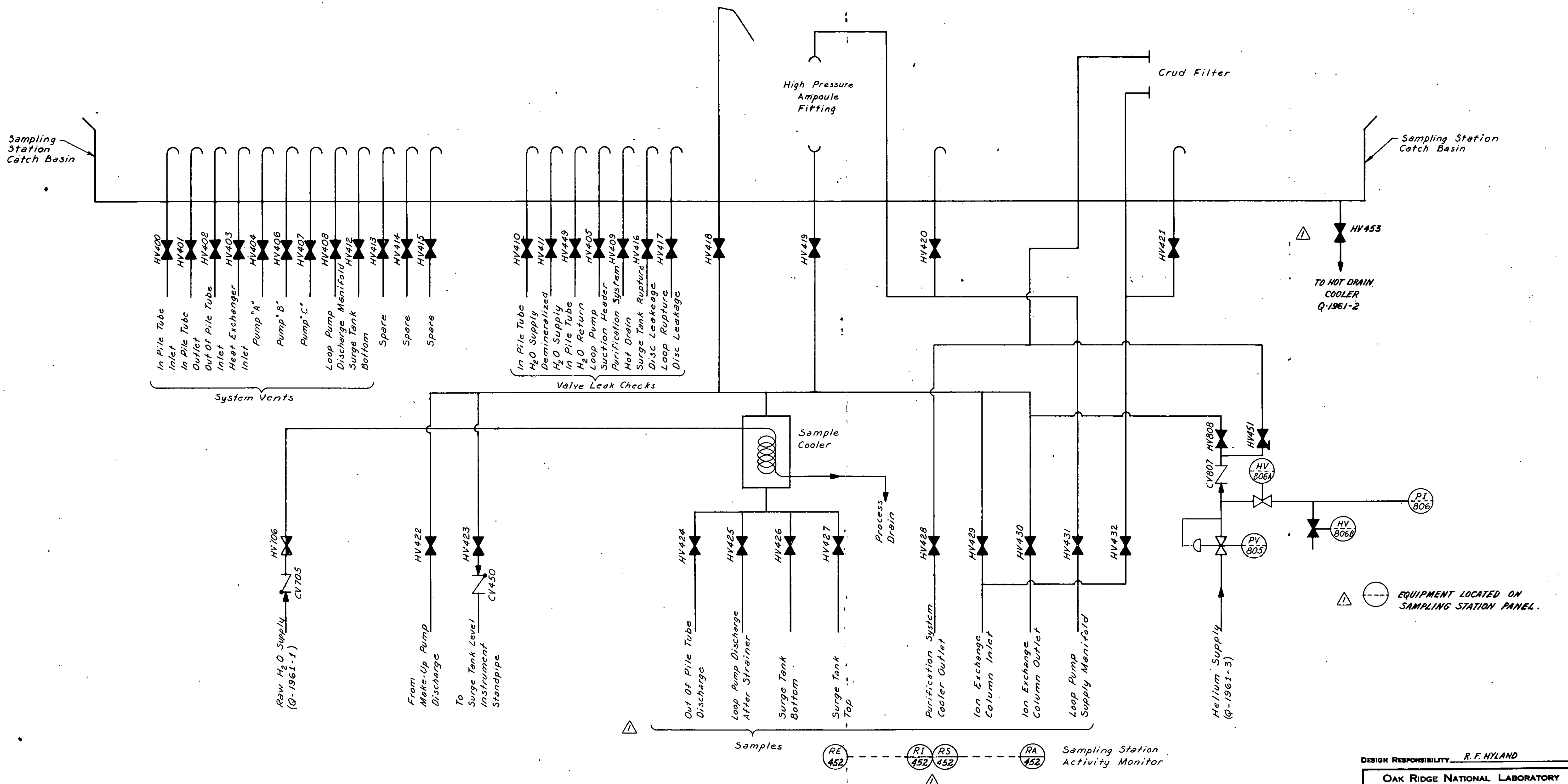
Much useful information pertaining to this loop was obtained from other installations having prior experience in pressurized water irradiations. Among those contributing were L. W. From, and E. L. Martinec of ANL; Walt Schwartz, P. A. Dailey and G. A. Weddell of WAPD; R. L. Simon of KAPL; E. E. Sinclair of USAEC; and William Prosser of AECL, Chalk River, Canada.


DEMINERALIZED WATER HEADER
HV-328
CV-329
HV-325
HV-324
HV-323
HV-322
STEAM FLUSH
HV-334
HV-330
PI 333
HV 333-A
HV 333-B
TI 332
PSV-331
DEOXYGENATOR
ION EXCHANGER
#125 STEAM
HV-335
LS 354
M
TO ECC
CONDENSATE RETURN
HV-337
FE 336
C-1
LG 342
MAKE-UP WATER TANK
CONDENSATE RETURN PUMP
HV-338
HV-339
HV-340
HV-341
HV-326
HV-327
HV-321
HV-320
HV-319
AcE 318
AcR 213 (DWG. Q-1961-3)
CV-317
HV-316
PSV-301
TO H2O SAMPLING STATION. HV422 DWG. Q-1961-4
HV-300
MAKE-UP PUMP M-1
TO ECC
CV-302
HV-303
SURGE TANK MAKE-UP
PI 304
HV 304-B
HV 304-A
HV-344
HV-343
TO HOT DRAIN COOLER Q-1961-2
HV-346
HV 306
CV-305
MATCH TO Q-1961-1 SHEET NO. 2
HV-703
RAW WATER
PROCESS DRAIN COOLER
PROCESS DRAIN
PROCESS DRAIN
MAX. 25 GPM
NORM. 15 GPM
TO ECC (SCRAM) & ALARM
FS 507-1A
FR 507-1
FS 507-1B
FT 507-1
HV 507-1A
HV 507-1B
HV 507-1C
FE 507
HV 507-2A
HV 507-2B
HV 507-2C
FT 507-2
FS 507-2A
FR 507-2
FS 507-2B
FA 507-1
FA 507-2
ANN. NO.
INSTR. AIR
HV410 TO H2O SAMPLING STATION DWG. Q-1961-4
HV-307
CV-308
HOSE
HV-309
BLOWDOWN AIR 100 PSI
PRIMARY LOOP CIRCULATING PUMP COOLING WATER RETURN (Q-1961-2)
HV-345
LOOP MAKE-UP
PI 315
HV 315-A
HV 315-B
HV-310
INPILE TUBE H2O RETURN.
LOOP AIR BLOWDOWN VENT AND FLUSHING DRAIN.
HV-509
HV-314
CV-313
O.R.R. POOL WATER RETURN
PRIMARY LOOP H.E. COOLING WATER RETURN (Q-1961-2)
REACTOR WATER RETURN
INPILE TUBE H2O SUPPLY.
LOOP DEMINERALIZED H2O FLUSH & AIR BLOWDOWN SUPPLIES.
HV-311
LOOP STEAM OR DEMINERALIZED WATER FLUSHING SUPPLY.
CV-348
HV-312
TO H2O SAMPLING STATION. (DWG. Q-1961-4)
HV411
TO ECC & O.L. ALARM
CV-602
HV-604
HV-600
P-1
FROM O.R.R. POOL WATER SUPPLY
S-606
CV-603
HV-605
HV-601
P-2
PI 607
HV 607-A
HV 607-B
PRIMARY LOOP CIRCULATING PUMPS C.W. SUPPLY.
HV-609
TW 608
TE 608
TR1000 (Q-1961-2)
PRIMARY LOOP H.E. COOLING WATER SUPPLY.
TO ECC
HV-500
R-1
CV-502
HV-504
FROM REACTOR WATER SUPPLY
S-510
HV-505
HV-501
R-2
CV-503
PI 506
HV 506-A
HV 506-B
HV 702-A
PI 702
HV 702-B
RAW H2O SUPPLY
HV-701
S-700
TO HOT DRAIN COOLER-Q-1961-2
TO PROCESS DRAIN COOLER.
TO WATER TREATING SYSTEM COOLER (Q-1961-3)
TO H2O SAMPLING STATION COOLER (Q-1961-4).
DESIGN RESPONSIBILITY R.F. HYLAND
OAK RIDGE NATIONAL LABORATORY
INSTRUMENTATION AND CONTROLS DIVISION
MSR
PRESSURIZED WATER IN-PILE LOOP
AUXILIARY SYSTEMS
INSTRUMENT FLOW DIAGRAM
SHEET 1 OF 3
9-5-58 GENERAL REVISION
8-6-58 1 General Revision
REVISIONS
DESIGNED R.F. Hyland
DESIGN CHECK H.J.M.
DRAWN W.C. Oldham
DATE 5-21-58
S-9535-19
SCALE None
Q-1961-1 R2


TO HOT DRAIN COOLER
RUPTURE DISK
TO STACK
VAC. PUMP
FILTER
OIL TRAP
TO H2O SAMPLING STA. (Q-1961-4)
LOOP PRESSURIZING LINE
FROM SURGE TANK
HEAT EXCHANGER
O.R.R. POOL WATER SUPPLY (Q-1961-1)
WARM DRAIN
INST. AIR
PUMP A
PUMP B
PUMP C
TO PROCESS DRAIN
TO ECC. & ALARMS
O.R.R. POOL
H2O SUPPLY Q-1961-1
IN PILE TUBE
REACTOR
POOL
OUT OF PILE TUBE
TO HOT DRAIN COOLER
ORR POOL WATER RETURN (Q-1961-1)
LINE HEATER
36 KW
12 KW
LOOP MAKE-UP
IN PILE TUBE H2O RETURN.
LOOP AIR BLOWDOWN VENT AND FLUSHING DRAIN.
IN PILE TUBE H2O SUPPLY.
LOOP DEMINERALIZED H2O FLUSH AND AIR BLOWDOWN SUPPLIES
LOOP STEAM OR DEMINERALIZED WATER FLUSHING SUPPLY
MATCH TO Q-1961-1 (SHEET 1 OF 3)
MATCH TO Q-1961-3 (SHEET 3 OF 3)
TREATED WATER FROM REGENERATIVE H. E.
TO H2O SAMPLING STATION (Q-1961-4)
WATER TREATMENT AND DEGASSING
HOT DRAIN FROM ION EXCHANGE COLUMNS
FROM R/W RETURN-HV 343 (Q-1961-1)
FROM SURGE TANK SAFETY VALVE-PSV 43 (Q-1961-3)
FROM VACUUM JACKET RUPTURE DISC-XX 101
FROM SAMPLING STATION CATCH BASIN-HV 453 (Q-1961-4)
FROM LOOP SAFETY VALVE-PSV 21
HOT DRAIN COOLER
RAW WATER Q-1961-1
PROCESS DRAIN
HOT DRAIN
TO POWER SUPPLY
IN PILE TUBE TEMP. RECORDER.
HEAT EXCHANGER AND MISC. TEMP. RECORDER.
LINE HEATER TEMP. RECORDER.
CONTROL PANEL AREA MONITOR
EQUIPMENT ROOM VENT SYSTEM ACTIVITY MONITOR
DESIGN RESPONSIBILITY R. F. HYLAND
OAK RIDGE NATIONAL LABORATORY
INSTRUMENTATION AND CONTROLS DIVISION
MSR
PRESSURIZED WATER IN-PILE LOOP
PRIMARY LOOP
INSTRUMENT FLOW DIAGRAM
SHEET 2 OF 3
SCALE NONE
Q-1961-2
REV. 2



SURGE TANK
HELIUM SUPPLY
TO HOT DRAIN COOLER Q-1961-2
RUPTURE DISC.
TO H2O SAMPLING STA.(Q-1961-4)
NORM. 617°F 1738 PSI
MAX. 653°F 2250 PSI
TO H2O SAMPLING STATION (Q-1961-4)
STANDPIPE
DEGAS
FROM MAKE-UP WATER SUPPLY (Q-1961-1)
H2O SAMPLING STATION (Q-1961-4)
LOOP PRESSURIZING LINE FROM SURGE TANK
ATTACH TO Q-1961-2 (SHEET 2 OF 3)
TO ECC (MAKE-UP PUMP CONTROL)
TO ECC (S.T. HEATER CUTOFF & L.L. ALARM)
TO ECC (S.T. HEATER CUT-OFF) & L.L. ALARM
INST. AIR
ANN. NO.
HIGH
LOW
HV 426 TO H2O SAMPLING STATION (Q-1961-4)
TO ECC
0-2500 PSI
1500-2500 PSI
TO ECC (S.T. HEATER CUT-OFF)
VENT THRU H2O SAMPLING STATION MANIFOLD HV 412 (Q-1961-4)
RAW H2O SUPPLY (Q-1961-1)
COOLER
PROCESS DRAIN
SULFITE DEOX. RESIN, COLUMN "A"
SULFITE DEOX. RESIN, COLUMN "B"
RESIN COLUMN "C"
RESIN COLUMN "D"
ION EXCHANGE COLUMNS
TO H2O SAMPLING STATION (Q-1961-4)
1.25 GPM MAX. 0.5 GPM NORM.
REGENERATIVE HEAT EXCHANGER
INSTR. AIR
TREATED WATER FROM REGENERATIVE H.E.
WATER TREATMENT AND DEGASSING
HOT DRAIN FROM ION EXCHANGE COLUMNS
TO H2O SAMPLING STATION (Q-1961-4)
HV-409
TO ECC
SURGE TANK HEATER TEMP. RECORDER
MISCELLANEOUS TEMP. RECORDER
CONDUCTIVITY RECORDER
EQUIPMENT ROOM AMBIENT TEMP. THERMOCOUPLES.
DESIGN RESPONSIBILITY R.F. HYLAND
OAK RIDGE NATIONAL LABORATORY
INSTRUMENTATION AND CONTROLS DIVISION
MSR
PRESSURIZED WATER IN-PILE LOOP
PRESSURIZER & H2O TREATMENT SYSTEMS
INSTRUMENT FLOW DIAGRAM
SHEET 3 OF 3
9-5-58 3 GENERAL REVISION
8-13-58 2 GENERAL REVISION
8-1-58 1 General Revision
REVISIONS
DRAWN W.C. Oldham
DATE 5-21-58
S-9535-19
Q-1961-3 R3



DESIGN RESPONSIBILITY R. F. HYLAND

OAK RIDGE NATIONAL LABORATORY
INSTRUMENTATION AND CONTROLS DIVISION

MSR
PRESSURIZED WATER IN-PILE LOOP
WATER SAMPLING STATION
INSTRUMENT FLOW DIAGRAM

DATE	NO.	CHANGE	BY
9-5-58	1	GENERAL REVISION	

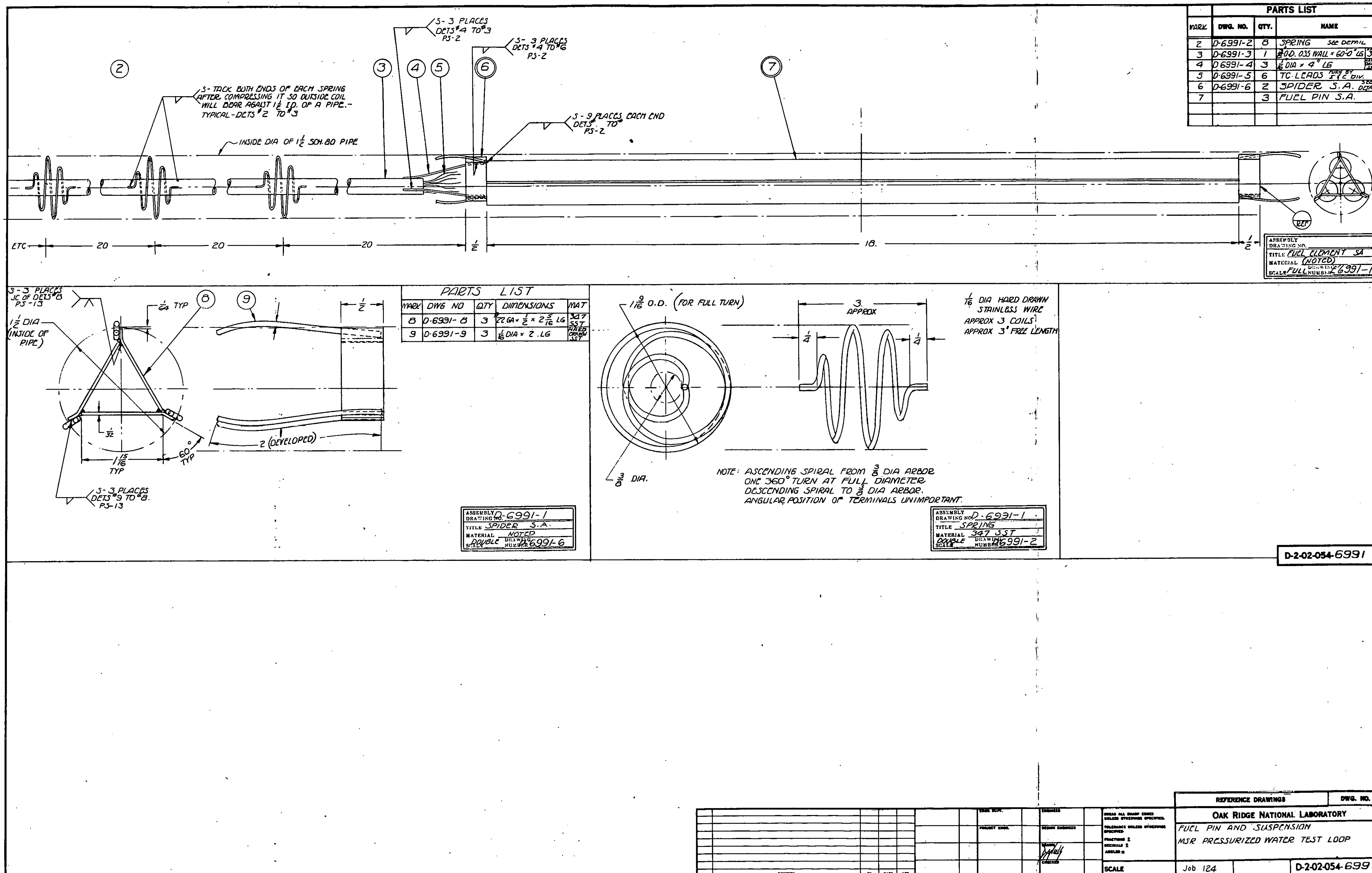
REVISIONS

LIMITS ON DIMENSIONS UNLESS OTHERWISE SPECIFIED FRACTIONS ± — DECIMALS ± — ANGLES ± —

DESIGNED R. F. Hyland 8-13-58
DESIGN CHECK
DRAWN
DATE 7-31-58
COMPARED

ACCEPTED R. F. Hyland 8/14/58
APPROVED N. J. Hyper R.F.H.
FIRST USED
SCALE NONE

Q-1961-4 R1

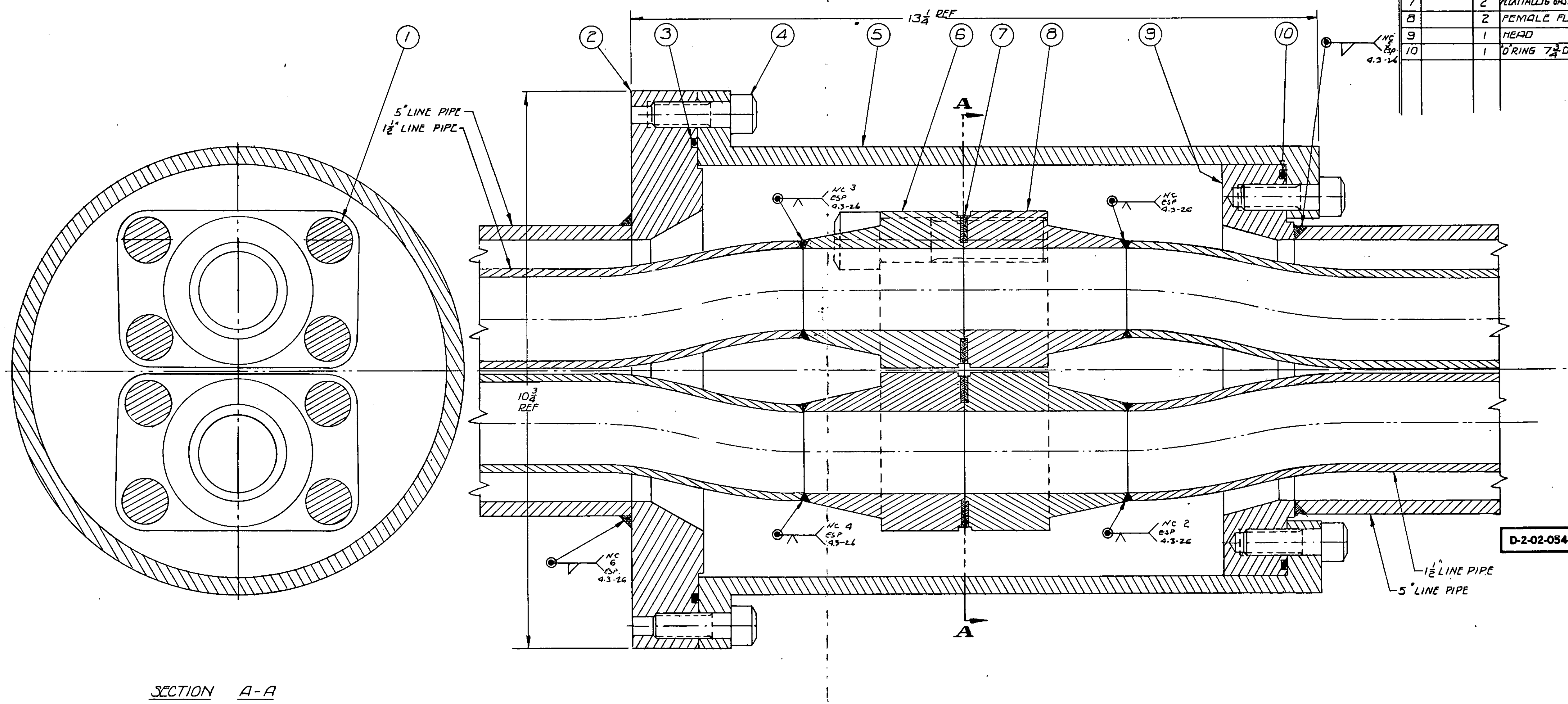


PARTS LIST

MARK	DWG. NO.	QTY.	NAME	
2	D-6991-2	8	SPRING SEE DETAIL	
3	D-6991-3	1	½ O.D. .035 WALL × 60'-0" LG	347
4	D-6991-4	3	1/16 DIA × 4" LG	[illegible]
5	D-6991-5	6	TC LEADS FURN BY I&C DIV.	
6	D-6991-6	2	SPIDER S.A. SEE DETAIL	
7		3	FUEL PIN S.A.	

PARTS LIST

MARK	DWG NO	QTY	DIMENSIONS	MAT
8	D-6991-8	3	22 GA × ½ × 2 5/16 LG	347 SST
9	D-6991-9	3	1/16 DIA × 2. LG	HARD DRAWN SST



MK	DWG. NO.	QTY.	NAME	
1		8	SOC HD SCR 7/8-9×3	STL
2		1	HEAD	SST
3		1	"O"RING 10 DIA × 1/8 SEC	Neopr.
4		24	SOC HD SCR 1/2-13 × 1 1/2	SST
5		1	SLEEVE	SST
6		2	MALE FLANGE	SST
7		2	FLEXITALLIC GASK. R1-25-F	—
8		2	FEMALE FLANGE	SST
9		1	HEAD	SST
10		1	"O"RING 7 3/4 DIA 1/8 SEC.	Neopr.

PARTS LIST

D-2-02-054-7097

REFERENCE DRAWINGS | DWG. NO.

OAK RIDGE NATIONAL LABORATORY

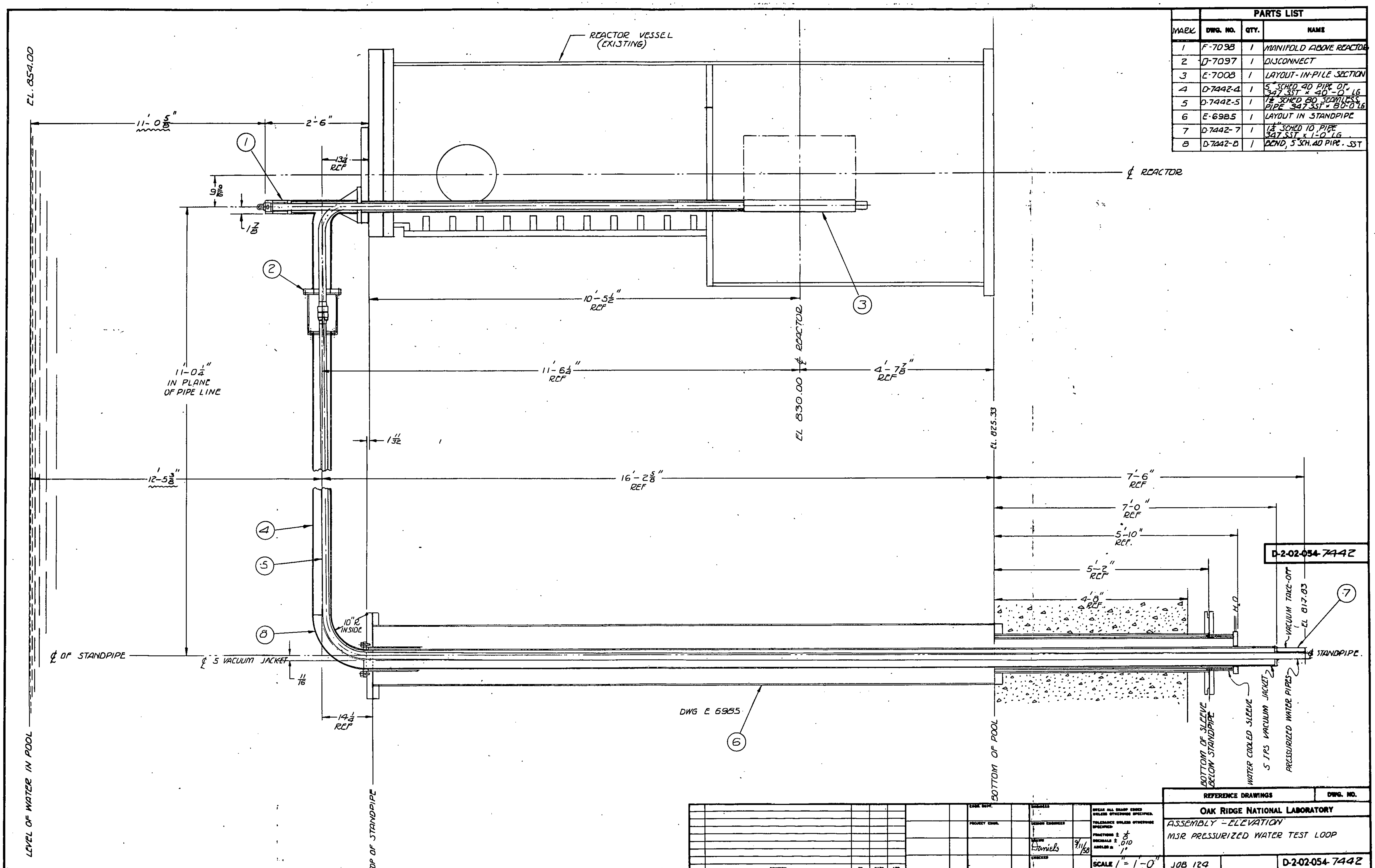
ASSEMBLY
DISCONNECT-FOR PIPING IN POOL
MSR PRESSURIZED WATER TEST LOOP

TOLERANCE UNLESS OTHERWISE SPECIFIED: FRACTIONS ± 1/64, DECIMALS ± .005, ANGLES ± 1°

SCALE FULL

D-2-02-054-7097

018 036



PARTS LIST

MARK	DWG. NO.	QTY.	NAME
1	F-7098	1	MANIFOLD ABOVE REACTOR
2	D-7097	1	DISCONNECT
3	E-7008	1	LAYOUT-IN-PILE SECTION
4	D-7442-4	1	5" SCHED 40 PIPE OF, 347 SST × 40'-0" LG
5	D-7442-5	1	1 1/2 SCHED 80 SEAMLESS PIPE 347 SST × 80'-0 LG
6	E-6985	1	LAYOUT IN STANDPIPE
7	D-7442-7	1	1 1/2 SCHED 10 PIPE 347 SST × 1'-0" LG.
8	D-7442-8	1	BEND, 5 SCH. 40 PIPE. SST

REFERENCE DRAWINGS | DWG. NO.

OAK RIDGE NATIONAL LABORATORY

ASSEMBLY - ELEVATION

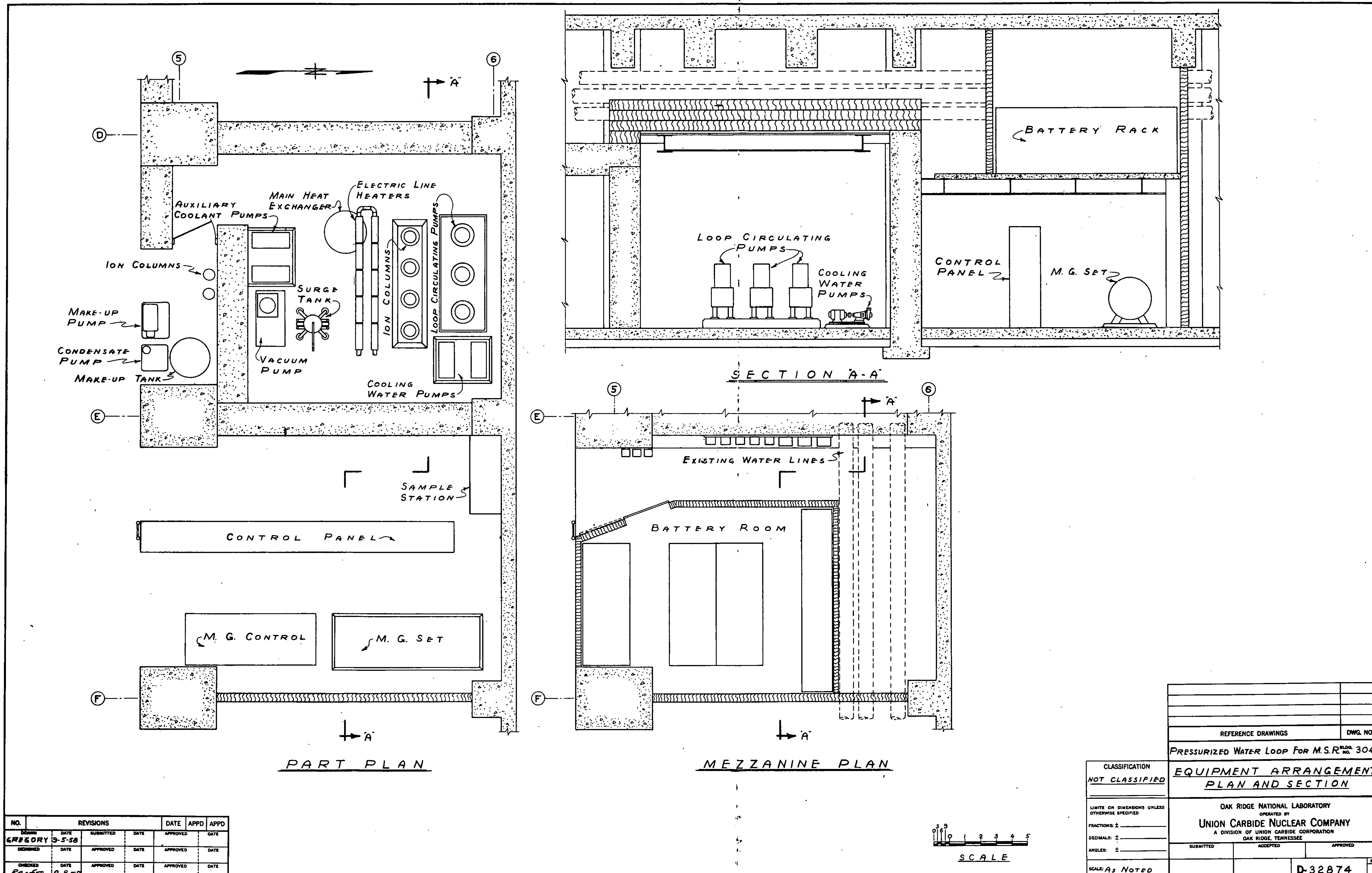
MSR PRESSURIZED WATER TEST LOOP

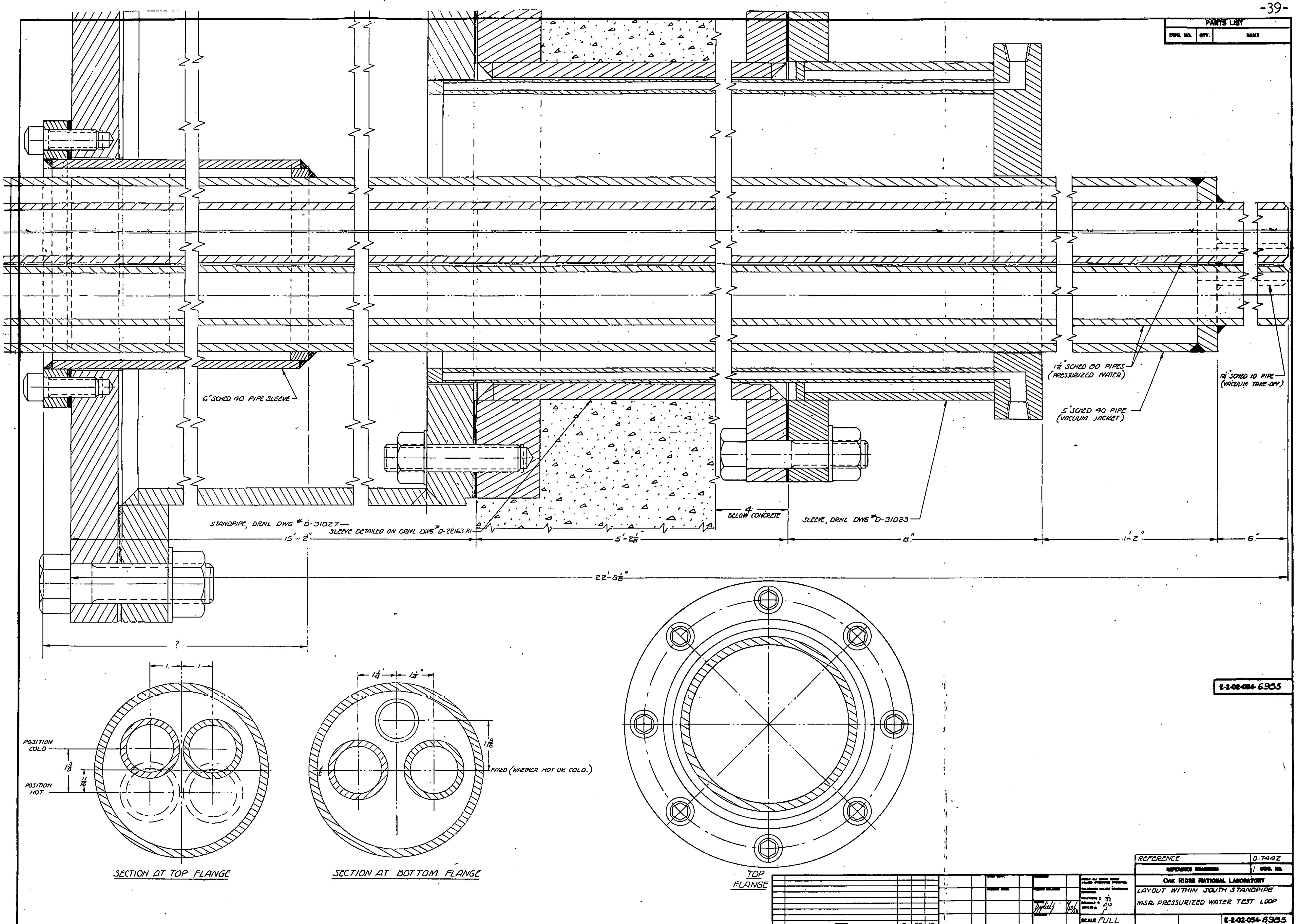
Daniels 9/11/58

SCALE 1" = 1'-0"

JOB 124

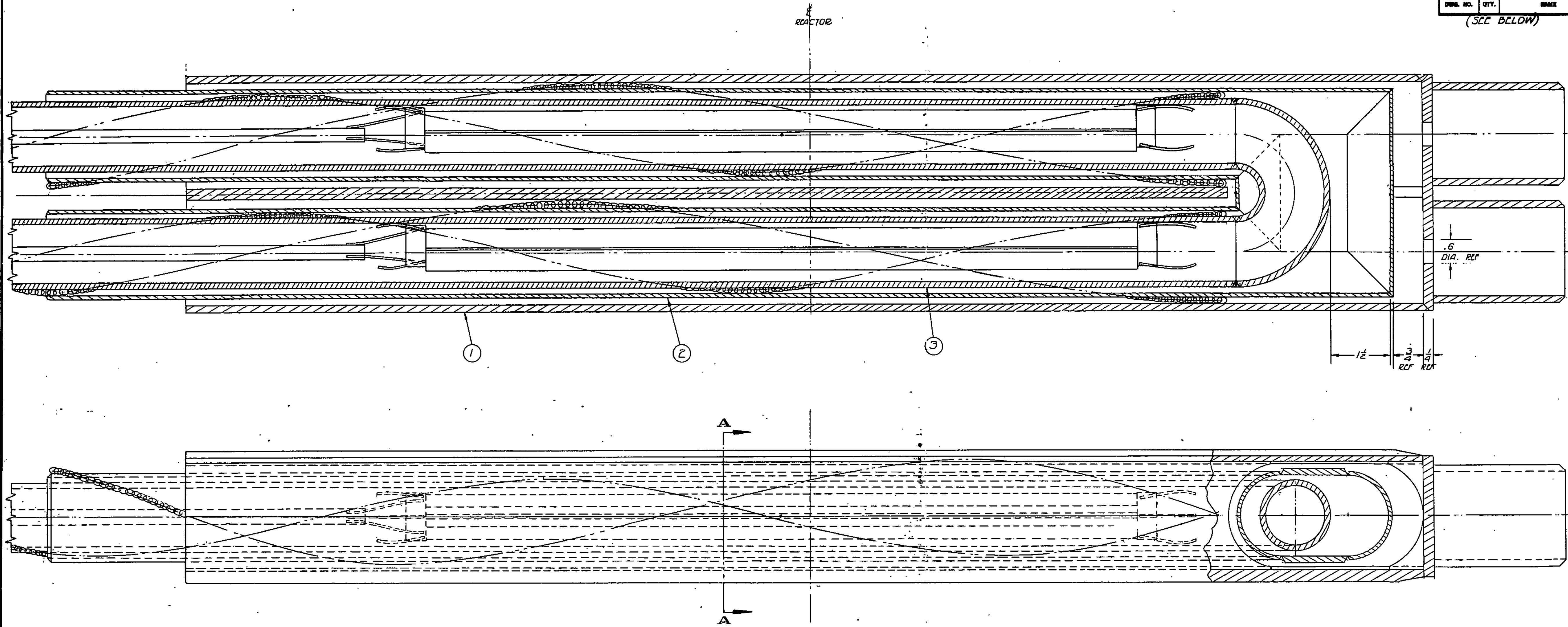
D-2-02-054-7442

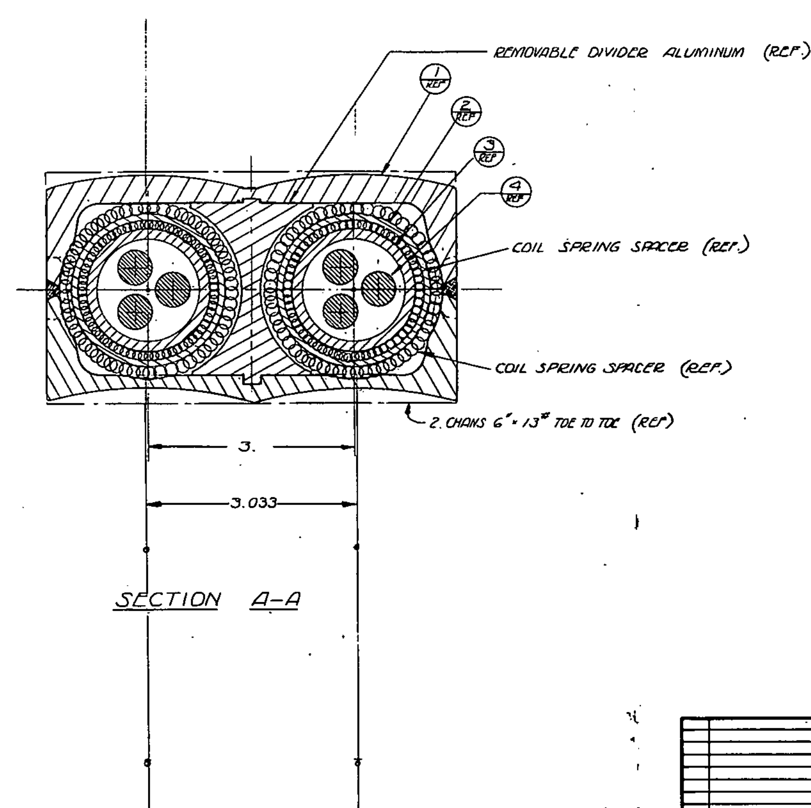

5
6
D
E
F
A
Auxiliary Coolant Pumps
Main Heat Exchanger
Electric Line Heaters
Ion Columns
Make-up Pump
Condensate Pump
Make-up Tank
Surge Tank
Vacuum Pump
Ion Columns
Loop Circulating Pumps
Cooling Water Pumps
Sample Station
Control Panel
M. G. Control
M. G. Set
PART PLAN
Battery Rack
Loop Circulating Pumps
Cooling Water Pumps
Control Panel
M. G. Set
SECTION "A-A"
Existing Water Lines
Battery Room
MEZZANINE PLAN
SCALE
0 1 2 3 4 5
NO.
REVISIONS
DATE
APPD
APPD
DRAWN Gregory DATE 3-5-58
SUBMITTED
APPROVED
DESIGNED
CHECKED Renfro DATE 9-9-58
REFERENCE DRAWINGS
DWG. NO.
Pressurized Water Loop For M.S.R. BLDG. NO. 3042
CLASSIFICATION
NOT CLASSIFIED
EQUIPMENT ARRANGEMENT
PLAN AND SECTION
OAK RIDGE NATIONAL LABORATORY
OPERATED BY
UNION CARBIDE NUCLEAR COMPANY
A DIVISION OF UNION CARBIDE CORPORATION
OAK RIDGE, TENNESSEE
LIMITS ON DIMENSIONS UNLESS OTHERWISE SPECIFIED
FRACTIONS: ±
DECIMALS: ±
ANGLES: ±
SCALE: As Noted
SUBMITTED
ACCEPTED
APPROVED
D-32874
REV


PARTS LIST
DWG. NO.
QTY.
NAME
6" SCHED 40 PIPE SLEEVE
STANDPIPE, ORNL DWG # D-31027
SLEEVE DETAILED ON ORNL DWG # D-22163 R1
4" BELOW CONCRETE
SLEEVE, ORNL DWG # D-31023
1½" SCHED 80 PIPES (PRESSURIZED WATER)
1½" SCHED 10 PIPE (VACUUM TAKE-OFF)
5" SCHED 40 PIPE (VACUUM JACKET)
15'-2"
5'-2⅞"
8"
1'-2"
6"
22'-8½"
?
POSITION COLD
POSITION HOT
FIXED (WHETHER HOT OR COLD.)
SECTION AT TOP FLANGE
SECTION AT BOTTOM FLANGE
TOP FLANGE
E-2-02-054-6965
REFERENCE
D-7442
OAK RIDGE NATIONAL LABORATORY
LAYOUT WITHIN SOUTH STANDPIPE
MSR PRESSURIZED WATER TEST LOOP
SCALE FULL
E-2-02-054-6965

PARTS LIST

DWG. NO.	QTY.	NAME
(SEE BELOW)		





PARTS LIST.				
MARK	DWG NO	QTY	DESCRIPTION	MAT
1	D-7010	1	BOX WELDMENT	ALUM
2		1	VACUUM JACKET WELD'T	SST
3		1	PRESSURE PIPE WELDT	SST
4	D-6991	2	FUEL PIN ASS'T	—

E-2-02-054-7008

REFERENCE DRAWINGS | DWG. NO.

OAK RIDGE NATIONAL LABORATORY

SUB-ASS'Y.—IN-PILE SECTION.

MSR PRESSURIZED WATER TEST LOOP

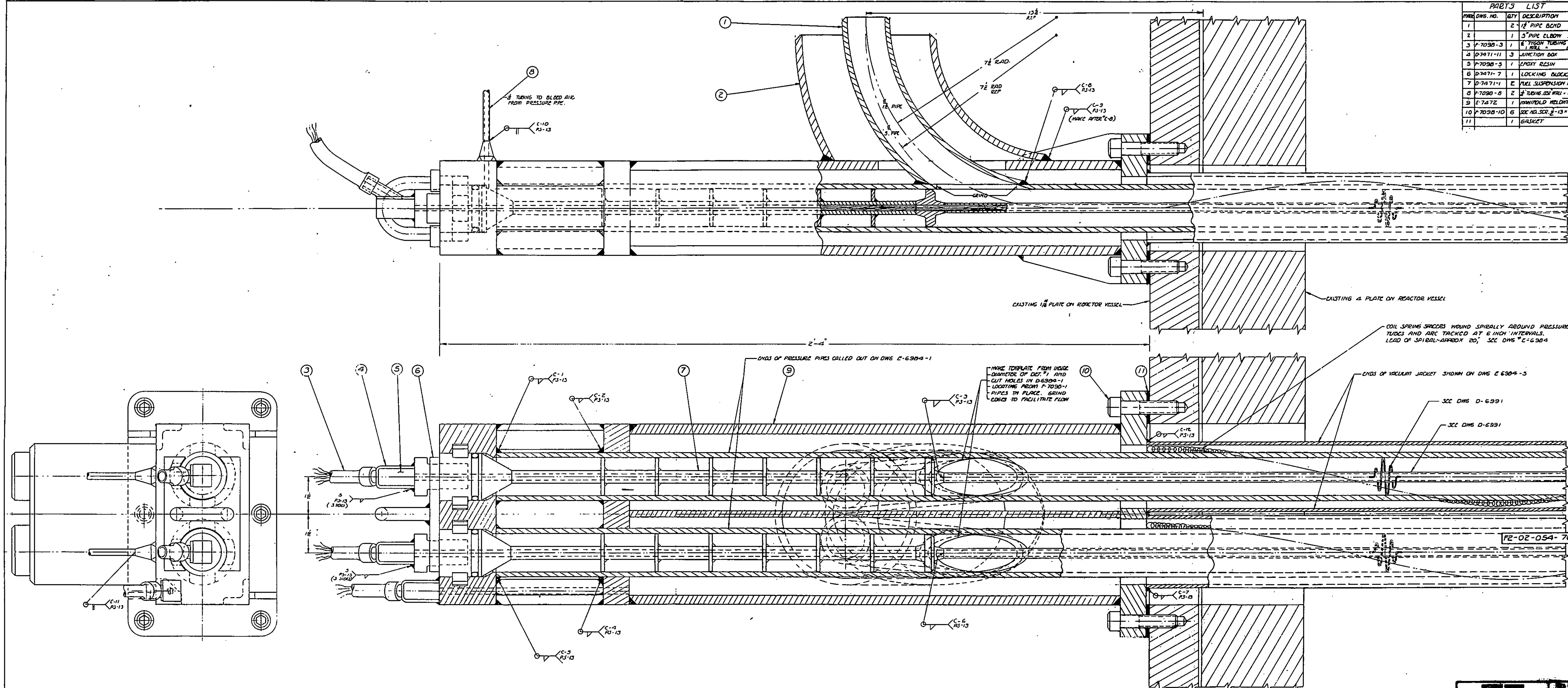
FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES ± 1°

SCALE FULL

JOB 124

E-2-02-054-7008

PARTS LIST				
MARK	DWG. NO.	QTY	DESCRIPTION	MAT.
1		2	1½" PIPE BEND	SEE DET.
2		1	5" PIPE ELBOW	SEE DET.
3	F-7098-3	1	¼" TYGON TUBING 1 WALL × LG.	TYGON
4	D-7471-11	3	JUNCTION BOX	SEE DET.
5	F-7098-5	1	EPOXY RESIN	
6	D-7471-7	1	LOCKING BLOCK	SEE DET.
7	D-7471-1	2	FUEL SUSPENSION HEAD	SEE DET.
8	F-7098-8	2	¼" TUBING .032 WALL × 15'-0 LG.	SST
9	E-7472	1	MANIFOLD WELDMENT	SEE DET.
10	F-7098-10	6	SOC. HD. SCR. ½-13 × 2¼ LG.	SST
11		1	GASKET	SEE DET.



MANIFOLD ABOVE REACTOR VESSEL

MSR PRESSURIZED WATER TEST LOOP

FULL

Job 184

C18 041

Distribution

1. A. A. Abbatiello
2. R. J. Beaver
3. O. S. Billington
4. F. T. Binford
5-6. A. L. Boch
7. W. F. Boudreau
8. E. J. Breeding
9. R. B. Briggs
10. R. K. Browning
11. W. R. Casto
12. T. E. Cole
13. R. L. Clarke
14. J. A. Conlin
15. W. B. Cottrell
16. J. E. Cox
17. J. H. Crawford
18. C. W. Cunningham
19. F. W. Drosten
20-23. I. T. Dudley
24-27. P. P. Eddy
28. E. P. Epler
29. A. P. Fraas
30. R. M. Fuller
31. R. P. Godwin
32. H. W. Hoffman
33. R. F. Hyland
34. W. H. Jordan
35. H. V. Klaus
36. W. J. Larkin
37-38. H. C. McCurdy
39. H. F. McDuffie
40. W. B. McDonald
41. H. G. MacPherson
42. F. C. Maienschein
43. W. D. Manly
44. W. D. Manly
44. A. J. Miller
45. E. C. Miller
46. H. J. Metz
47. W. R. Osborn
48. G. W. Renfro
49. J. T. Roberts
50. H. W. Savage
51. O. Sisman
52. J. A. Swartout
53. D. E. Tidwell
54. D. B. Trauger
55. W. C. Thurber
56. A. M. Weinberg
57. J. C. White
58. C. E. Winters
59-60. C. R. Library
61. Document Reference
62-67. Laboratory Records
68. ORNL-RC
69. M. J. Skinner