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FINAL SPECIFICATIONS FOR GOVERNMENT-PURCHASED EQUIPMENT
FOR ARGONNE LOW POWER REACTOR (ALPR)

by

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Reactor Engineering Division

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PREFACE

The final specifications for Government-purchased equipment for the ALPR contained herein were prepared from the original bid specifications, proposals submitted on the equipment purchased, and purchase orders. In addition, each specification includes data pertaining to the equipment purchased, revisions made during the shop fabrication, reference drawing list, vendor's name, and purchase order numbers.

The erection of the equipment, and installation with associated equipment, is specified in the document: "Specifications for General Contractor."

The original equipment bid specifications were prepared by the Pioneer Service and Engineering Company, contracted as Architect-Engineers, in collaboration with H. H. Hooker, and E. E. Hamer, who also compiled the contents herein.

All Argonne National Laboratory, Lasker Boiler and Engineering Co., and Pioneer Service and Engineering Co. drawings referenced in this report are available as indicated in report TID-4100 (and its revisions and supplements). All other drawings are available from the respective vendors.

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SECTION 1

AIR-COOLED HEAT TRANSFER COILS

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I. GENERAL

The intent of these Specifications is to state the requirements and conditions for the furnishing and delivery of the following heat transfer coils:

- 1 - Steam Condenser
- 1 - Air Pre-cooler
- 1 - Air-Cooled After-Condenser
- 1 - Turbine Oil Cooler
- 1 - Hot Well Vent Condenser

Installation of this equipment will be at the National Reactor Testing Station, ALPR site, Scoville, Idaho, and will be performed under separate contract by others.

All quotations shall be f.o.b. motor freight, National Reactor Testing Station, Scoville, Idaho, and shall be complete with the enclosed technical data sheets.

II. DESIGN, MATERIALS, AND WORKMANSHIP

All heat transfer coils shall be of the finned-tube type, and shall be of a proven design and construction using materials of first class quality which has proven successful in similar service. The workmanship used for the fabrication and construction of these coils shall be of the highest quality in every detail.

The design shall be consistent with the "package" concept, i.e., complete factory assembly of equipment with no single crated item to exceed $7\frac{1}{2}$ ft x 9 ft x 20 ft in dimensions and 20,000 lb in weight. No uncrated item shall exceed 5 ft x $4\frac{1}{2}$ ft x 17 ft. There shall be a minimum number of "packages."

The materials shall conform to Specifications for Aluminum-Alloy Drawn Seamless Tubes for Condensers and Heat Exchangers, ASME SB-234, which is identical with ASME Material Specification, Section II. The air-cooled Turbine Oil Cooler shall be of standard design and materials for that service.

The type of construction and method of fabrication shall be approved by the Purchaser. The approved construction and fabrication shall meet all applicable codes.

III. INSPECTIONS, TESTS, AND CLEANING

The integrity of materials and design shall be established by applicable testing methods acceptable to the Purchaser for all stages of manufacturing.

During the fabrication and construction of all equipment, the Manufacturer shall provide for inspection by the Purchaser and/or his delegates. The Purchaser must be informed of all proposed testing sufficiently in advance to be able to witness the testing. Certified copies of all test data shall be furnished to the Purchaser.

The Steam Condenser, Air Precooler, Air-Cooled After-Condenser, and Hot Well Vent Condenser shall be hydrostatically tested at 50 psig. The Turbine Oil Cooler shall be hydrostatically tested at $1\frac{1}{2}$ times the maximum pump discharge pressure. No leakage is allowable during the test period of 48 hours duration.

Other test to be performed: All applicable tests in the referenced ASTM and ASME specifications including chemical analysis of material and physical properties of each lot of material.

All heat transfer coils shall be thoroughly cleaned before assembly. Prior to shipment, the coils shall be degreased inside and out by prior approved methods. The openings then should be closed securely by approved means to prevent entrance of any foreign materials.

IV. SHIPPING

All components shall be protected during shipment and storage from rust and entry of dirt and water. All protective coatings and their application, shall be subject to prior approval by the Purchaser. All surfaces shall be adequately protected against marring or damage. Loose parts, i.e., bolts, shall be adequately fastened to the equipment or boxed, and all parts shall be identified with indestructible tags or markings.

V. DETAIL SPECIFICATIONS

Schematics of the cooling air flow, the location of the heat transfer coils with respect to other equipment, the space limitations for the coils, and a flow diagram, are shown on the following pages.

At all times, when the outside air temperature is below 40° F, the quantities of recirculated and outside air will be automatically controlled to maintain the air temperature entering the heat transfer coils at approximately 40° F. Outside air at temperatures as low as -60° F will be used.

PLAN SHOWING EQUIPMENT LOCATION

AIR FLOW

PLAN

ARGONNE LOW POWER REACTOR ELEVATION

ARGONNE LOW POWER REACTOR HEAT TRANSFER COILS - FLOW DIAGRAM

Although a recirculating air system is provided, it is anticipated that slugs of insufficiently mixed air may pass through the air mixing chamber to the heat transfer surface. At all times when the outside air temperature is 40°F or above, the system will operate with 100% outside air. As the steam load on the condenser varies, a temperature controller on the effluent air side will automatically vary the quantity of cooling air circulated through the condenser.

The Air Pre-cooler and After-Condenser, and the Oil Cooler can be located on the cooling air inlet side of the condenser, or adjacent to the condenser. The After-Condenser shall be located on the coldest air side; however the Air Pre-cooler and the Oil Cooler may be sandwiched vertically between condenser sections, provided their design conditions and the condenser design conditions are met, and the over-all space required does not exceed the limits shown on the sketches.

A. Steam Condenser and Air Pre-cooler

The Condenser shall be capable of maintaining an internal temperature of 135°F when condensing 7,500,000 Btu/hr from saturated steam at 5.16 in. Hg using 115,740 cfm of standard air entering at 60°F.

Note: The flow of steam to the Condenser will vary with the turbine and space heating requirements. This variation will be between 1,400 lb/hr (minimum) and 10,000 lb/hr (maximum). During transient load changes and plant start-up, superheated steam will enter the Condenser. This steam under start-up and emergency turbine trip-out conditions could have an inlet temperature of approximately 320°F. For other normally expected transients, the steam temperature at the condenser should not exceed 200°F.

The Condenser shall have additional heat exchange surface built-in as an integral part of the Condenser, or a separate heat exchanger shall be designed, which shall have the capacity to cool 15 lb/hr of air entrained in the steam to a final temperature of 100°F before it is taken to the air ejector.

The steam pressure drop through the Condenser shall not exceed 1 in. Hg. The air friction drop shall not exceed 1.20 in. W.G. at 115,740 cfm of standard air flow.

The Condenser and Air Pre-cooler shall be of all-aluminum construction which shall meet the ASME Code requirements. The tube connections into the headers, the inlet and outlet connections, and all headers and framing members shall be of all-welded or approved rolled construction.

The Condenser shall be arranged in a bank with tubes vertical; cooling air flow will be horizontal.

Inlet, outlet, and air connections may be located and spaced to suit the manufacturer's design except that there shall be no connections directly above or below condensers. All external connections $1\frac{1}{2}$ in. and larger shall be 125-lb standard flanged.

The air leaving the Pre-cooler will be piped to an air ejector which will have the capacity to pull a vacuum of 25 in. Hg (5 in. Hg absolute). All condensate from the Condenser and Pre-cooler will be drained to a hot well (supplied by others).

The Condenser shall be designed to allow for expansion and contraction between tubes and tube supporting members.

The Condenser shall be built up of sections to suit the Manufacturer's requirements and/or previously stated shipping limitations.

B. Air-Cooled After-Condenser

In order to minimize the escape of water vapor from the system, an air-vapor mixture to air aftercooler shall be furnished to condense moisture out of the air leaving the air-ejector after-condenser (by others).

The After-Condenser shall have the capacity to cool 72 lb/hr of saturated air at 150°F to 72°F when using cooling air at 40°F. The maximum pressure drop on the saturated air side shall not exceed 2 in. Hg.

The material, fabrication, and construction shall be as specified for the Condenser and Pre-cooler. The effluent air at 72°F will be piped to the atmosphere. The condensed vapor will be drained into a condensate system (supplied by others).

C. Turbine Oil Cooler

The Oil Cooler shall have the capacity to remove 55,000 Btu/hr from 17 gpm of turbine oil. The effluent oil temperature shall not exceed 120°F when using cooling air at 60°F. (Turbine oil is rated at 250 to 350 Saybolt viscosity seconds at 100°F, and 47 to 60 Saybolt viscosity seconds at 210°F.) The maximum oil pressure drop shall not exceed 30 psig.

The Oil Cooler shall be constructed of the Manufacturer's standard materials for this type of service.

D. Hot Well Vent Condenser

The Hot Well Vent Condenser shall have the capacity to condense steam formed in the Hot Well by flashing. It shall be mounted in parallel with the air flow through the Main Steam Condenser and Pre-cooler. Appropriate connections for steam inlet piping, drain piping, and air-removal piping shall be supplied. The steam line to the Vent Condenser will be 2-inch Schedule 40 stainless steel pipe. The Vent Condenser shall be of all-aluminum welded construction. It shall not exceed 10 ft in length by 8 in. high. No restriction is placed on the depth except that the available pressure differential for air flow is governed by the design of the Main Steam Condenser and Pre-cooler. The Vent Condenser shall be provided with duct connection flanges and mounting brackets similar to those provided on the Oil Cooler and After-Condenser.

VI. TECHNICAL DATA

A. Steam Condenser and Pre-Cooler

1. General

Mfr. Coil Type and Model No.	Special; EPR-1306
Over-all Size	
Condenser with Pre-cooler	$1\frac{1}{2} \times 11\frac{1}{2} \times 17$ ft
Condenser	$1 \times 11\frac{1}{2} \times 17$ ft
Pre-cooler	$4\frac{1}{2}$ in. $\times 11\frac{1}{2}$ ft $\times 17$ ft
No. of Sections	5
Size per Section (Condenser with Pre-cooler)	$1\frac{1}{2}$ ft $\times 11\frac{1}{2}$ ft $\times 3$ ft - 4 in.
Tube type	Round Seamless Aluminum Tubes with extended surface.
Type of Extended Surface	Plate-Type Fins
Tube Sizes	1.000 in. $\times$ 0.049 in. wall
Header Sizes	1 in. wrought aluminum alloy plate.
Tube and Header Connections	Rolled + Welded + Stainless Steel insert.

1. General (Cont'd.)

Extended Surface Sizes and Spacing	0.014 in. x 2 in. wide fin stock
Extended Surface and Tube	Tubes mechanically expanded into fins.
Support Members	Channel Shaped
Connections, Size and Class	
Inlet	8 in. IPS. Equiv. 125-lb flanged.
Outlet	1 $\frac{1}{4}$ in. IPS. Heavy duty flanged and 1 in. IPS screwed.
Materials	
Tubes	Aluminum, Type 3003-H1
Headers	Aluminum, Type 6061-T6
Extended Surface	Aluminum, Type 3003-H12 or H14
Support Members	Aluminum, Type 2011-T3 or 2017-T4.
Inlet and Outlet Connections	Aluminum, Type 356-T6 or 43-F
Construction	
<u>Note:</u> Headers and connections must be sized to accommodate a maximum flow of 10,000 lb/hr.	
General Arrangement Drawings (Showing interconnection between sections)	Others to provide 20 in. IPS main with 8 in. IPS branches on 3 ft-4 $\frac{1}{2}$ in. centers.
Outline of Welding Procedure	Heli-arc. Details to be shown on production drawings.
ASME Code	UPV, Sec. VIII
How is Tube and Header Expansion and Differential Expansion between Tube and Support Members provided for?	Split top header. Support members arranged similar to standard blast coils.
Testing Materials and Procedure	Details with production drawings.
Hydrostatic Test	50 psig.
Blow-off Pressure	30 psig.

Shipping Dimensions (Each of 5; combined with Pre-cooler)	2 ft-6 in. x 4 ft x 13 ft
Total Net Weight	8,000 lb
Total Net Weight per Section	1,600 lb
Total Shipping Weight	10,500 lb
Total Shipping Weight per Section	2,100 lb

2. Condenser

Tubes

Rows of Tubes Deep per Section	4
No. of Tubes per Row per Section	5
No. of Tubes	100
Total Heat Transfer Surface	
Metal to Air	24,400 sq ft
Steam to Metal	890 sq ft

Inside Tubes (Inlet air temp. = 60°F)

Heat Exchange Capacity, Btu/hr	7,500,000	6,750,000 (Condenser)
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(Design Requirement for the
following design conditions)

Steam Pressure at Inlet Header, in. Hg abs	5.16	Total Pressure=5.172
Steam Temperature at Inlet Header, °F	135	135
Quantity of Air in Steam, lb/hr	15	15
Average Condenser Pressure, in. Hg abs		4.85
Average Condenser Temper- ature, °F		132.6
Average Condenser Temper- ature at Design Conditions with 40°F inlet air, °F		127.9
Average Condenser Temper- ature at Maximum Steam Flow Conditions with 40°F Inlet air(10,300,000 Btu/hr), °F		119.5

Outside Tubes

Design Air Quantity, scfm	115,740	115,740
Air Inlet Temperature, °F	60	69.1
Air Outlet Temperature, °F		123.1
Pressure Drop, in. W.G.		1.35
Net Face Velocity, fpm		75.5

3. Air Pre-CoolerTubes

Rows of Tubes Deep per Section	1
No. of Tubes per Row per Section	5
No. of Tubes	25
Total Heat Transfer Surface	
Metal to Air	6,100 sq ft
Air-Vapor Mixture to Metal	220 sq ft

Inside Tubes

Quantity of Dry Air in Saturated Mixture, lb/hr	15 (At exit of Main Steam Condenser)
Maximum Heat Exchanged, Btu/hr	1,140,000
Inlet Temperature, °F	(129.9) Comparable to temperature at con- densate drains of main steam condenser.
Outlet Temperature, °F	100
Inlet Pressure, in. Hg abs	(4.5) Comparable to pressure at conden- sate drains of main steam condenser.
Outlet Pressure, in. Hg abs	4.17

Outside Tubes

Design Air Quantity, scfm	115,740
Air Inlet Temperature, °F	60.0
Air Outlet Temperature, °F	69.1
Pressure Drop, in. W.G.	0.37
Net Face Velocity, fpm	75.5

B. Air-Cooled After-Condenser

Mfr. Type and Model No.	Special Brazed Alumi- num Air-Air Unit. EPR-1308
Over-all Size	Approx. 7 in.x16 in.x20 in.
Number of Sections	1
Size per Section	7 in. x 16 in. x 20 in.
Rows of Tubes Deep per Section	1 (Unit channel con- struction; not tubes)

Number of Tubes per Row per Section	18 (Channels, not tubes)
Number of Passes on Air- Vapor Side	1
Tube Type (Plain or Ex- tended Surface)	Extended
Type of Surface	Corrugated on both sides.
Total Heat Transfer Surface	
Metal to Air	102 sq ft
Air-Vapor Mixture to Metal	70 sq ft

Inside Tubes

Quantity of Air-Vapor Mixture, lb/hr	72
Maximum Heat Exchanged, Btu/hr	10,525
Inlet Temperature, °F	150
Outlet Temperature, °F	72
Pressure Drop, in. Hg abs	3.35 psi or 6.85 in. Hg

Outside Tubes

Design Air Quantity, cfm standard	535
Air Inlet Temperature, °F	40
Air Outlet Temperature, °F	58.4
Pressure Drop, in W.G.	1.22, at an air density of 0.075 lb/cu ft
Net Face Velocity, fpm	535

Materials

Tubes	Aluminum, Type 3003-#12 Brazeing Sheet
Headers	Aluminum, Type 3003-H14

Extended Surface	Aluminum, Type 3003-H12 or H14
Support Members	Aluminum, Type 3003-H14
Inlet and Outlet Connections	Aluminum, Type 3003 or 6061

Construction

Tube Sizes	Brazed Aluminum Plate Type
Header Sizes	Cooler having extended surfaces on both sides.
Tube and Header Connections	Dip-brazed core with welded tanks and connections.
Extended Surface Sizes and Spacing	Condensate drain located in bottom tank.
Extended Surface and Tube	

Connections

Support Members	Part of cooler construction.
Inlet Connections, Sizes and Class	Minimum 3/4 in. IPS couplings welded to tanks for supply and exhaust.
Outlet Connections, Size and Class	Minimum 3/4 in. IPS couplings welded to tanks for supply and exhaust.

General

Outline of Welding Procedure	To be shown later on production drawings.
ASME Code	UPV, Sec. VIII
How is tube and header expansion and differential expansion between tube and support members provided for?	Support members brazed to cooler. Piping to take up thermal expansion.
Testing Materials and Procedure	With production drawings.
General Arrangement Drawings (Showing interconnection between sections)	None required.

Shipping Dimensions	Approx. 12 in. by 20 in. by 24 in.
Total Net Weight	Approx. 18 lb
Total Net Weight per Section	Approx. 18 lb
Total Shipping Weight	Approx. 35 lb
Total Shipping Weight per Section	Approx. 35 lb

C. Turbine Oil Cooler

Mfg. Type and Model No.	Special Brazed Aluminum. Air Cooled Oil Cooler EPR-1307
Over-all Size	Approx. 4 in. by 14 in. by 20 in.
Number of Sections	1
Size per Section	4 in. by 14 in. by 20 in.
Rows of Tubes Deep per Section	1 (Channels, not tubes)
Number of Tubes per Row Section	32 (Channels, not tubes)
Number of Passes on Oil Side	1
Tube Type (Plain or Extended Surface)	Extended
Type of Extended Surface	Strip fins on oil side. Cor- rugated air side fins.
Total Heat Transfer Surface	
Metal to Air	66.8 sq ft
Oil to Metal	41.6 sq ft
<u>Inside Tubes</u>	
Quantity of Oil, gpm	17
Maximum Heat Exchange, Btu/hr	55,000
Inlet Temperature, °F	127.9
Outlet Temperature, °F	120 (Maximum)

Pressure Drop, psig	30 (Maximum); 9 psi (actual)
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Outside Tubes

Design Air Quantity, cfm standard	1720
Air Inlet Temperature, °F	60
Air Outlet Temperature, °F	89.6
Pressure Drop, in.W.G.	1.22 at air density of 0.075 lb/cu ft
Net Face Velocity, fpm	1410

Materials

Tubes	Aluminum, Type 3003-#12, Brazing Sheet
Headers	Aluminum, Type 3003-H14
Extended Surface	Aluminum, Type 3003-H12 or H14
Support Members	Aluminum, Type 3003-H14
Inlet and Outlet Connections	Aluminum, Type 3003 or 6061

Construction

Tube Sizes	Brazed Aluminum, Plate Type
Header Sizes	Cooler having extended sur- faces on both sides.
Tube and Header Connections	2 in. IPS Couplings (Alumi- num)
Extended Surface Sizes and Spacing	Condensate drain located in bottom tank.
Extended Surface and Tube	

Connections

Support Members	Part of cooler construction
Inlet Connections, Size and Class	Minimum 3/4 in. IPS coup- lings welded

Outlet Connections, Size and Class	Welded to tanks for supply and exhaust
Outline of Welding Procedure	Details to be shown on production drawings
ASME Code	UPV, Sec VIII
How is tube and header expansion and differential expansion between tube and support member provided for?	Support members brazed to cooler. Piping to take up thermal expansion.
Testing Materials and Procedure	With production drawings.
General Arrangement Drawings (Showing interconnection between sections)	None Required
Shipping Dimensions	Approx. 6 in. by 24 in. by 24 in.
Total Net Weight	Approx. 23 lb
Total Net Weight per Section	Approx. 23 lb
Total Shipping Weight	Approx. 40 lb
Total Shipping Weight per Section	Approx. 40 lb

D. Hot Well Vent Condenser

Duty	Condensing Steam
Inlet Conditions	Saturated steam at approximately 4.15 in. Hg absolute with a small amount (less than 5 lb/hr) of entrained air and other gases.
Outlet	Attached to air ejector line operated at 4 in. Hg abs.
Drain	Returned to Hot Well Tank with 12 ft static head available.
Capacity	100,000 Btu/hr
Inlet Air	60°F

VII. REFERENCE DRAWINGS

EPR-1307-C (Turbine Oil Cooler)
EPR-1308-C (After Condenser)
EPR-1395-C (Hot Well Vent Condenser)
IE-1099-G (Condenser and Pre-cooler)
IE-1099 (Performance Curve - Condenser)

VIII. VENDOR

Modine Manufacturing Company
Racine, Wisconsin

IX. PURCHASE ORDER

Argonne National Laboratory AL-224414

SECTION 2
ELECTRICAL SWITCHGEAR ASSEMBLIES
FOR
TURBINE-GENERATOR UNIT

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I. INTENT

These specifications describe the requirements and conditions for the furnishing and delivery of three assemblies of indoor metal-enclosed, low-voltage switchgear for the operation and control of a 300-kw, 208-volt, synchronous generator and certain associated equipment.

II. SERVICE CONDITIONS

The equipment normally will be operated in an ambient temperature range of 5°C to 50°C. Equipment may be exposed (non-operating) to a temperature as low as -50°C.

Equipment shall be designed for operation at an altitude of approximately 5100 ft above sea level.

III. DESIGN - GENERAL REQUIREMENTS

The equipment shall consist of modern metal enclosed components of the 0-600-volt class and shall be designed, manufactured and tested in accordance with the latest applicable standards of ASA, AIEE, and NEMA. Design of switchgear shall be such that it can be erected, installed, and operated in compliance with such parts of the "National Electric Code" and the "National Electric Safety Code" that might apply.

Equipment included in this specification shall be capable of continuous operation at the full designed load without undue noise, vibration, or impairment of durability or efficiency. Equipment shall be the best of the respective manufacture and type for the service conditions. No equipment will be considered which is in any way experimental or of an experimental nature.

Only equipment and material manufactured and assembled within the continental limits of the United States will be considered.

Each switchgear assembly shall be completely assembled and wired at the factory. Rigid inspection before and after assembly shall assure correctness of design and workmanship. After assembly, each standard unit shall be tested at the factory for operation under simulated service conditions by the Contractor. This is to assure accuracy of wiring, correctness of the control scheme and functioning of the equipment.

IV. TRANSPORTATION AND DELIVERY

A. Packing for Shipment

No single unit when crated for shipment shall exceed the dimensions of 7½ ft x 9 ft x 20 ft and a weight of 10 ton.

B. Location and Conditions

The equipment is to be installed at the ALPR site in the National Reactor Testing Station near Scoville, Idaho.

V. INSTALLATION

Switchgear will be installed by the Purchaser. Any supports for anchoring and providing proper alignment of the switchgear units will be provided and installed by the Purchaser.

VI. EQUIPMENT - GENERAL SPECIFICATIONS

All power buses shall be made of high-conductivity copper bar. The copper at each main bus joint and each tap joint shall be silver plated and tightly clamped with through bolts to insure maximum conductivity. The bus bars shall be mounted on insulated supports and shall have coordinated dielectric properties, and strength to withstand magnetic stresses developed by a short circuit current of 20,000 amperes unless noted to the contrary.

A ground bus, having a rating as described for each switchgear assembly, and having sufficient mechanical strength to withstand short circuit current of 25,000 amperes, shall extend the length of each switchgear assembly. Each housing shall be grounded directly to this bus. The frame of each drawout circuit breaker shall be grounded through a reliable ground contact shoe at all times except when the primary disconnecting devices are separated a safe distance. Provision shall be included for connecting the load neutral connection and/or the generator neutral connection to the ground bus as required.

Indicating instruments, in general, shall be of the square type, semi-flush mounted, with concentric scales. Case of instrument shall have dull black finish. Scales shall have black markings on white background.

Watt-hour meters and panel mounted relays shall be semi-flush drawout type with built-in testing facilities.

All instrument, synchronizing and breaker control switches shall be of the rotary-operated type with positive means for maintaining contact pressure. Contacts shall be silver-to-silver and enclosed in easily removable protective covers.

Indicating lamps (except motor running lamps) shall be of the 24-volt slide base-type, with series resistors when required, and shall be accessible from the front of the panel. Motor running lamps (a-c) shall be 6-volt type with built-in transformer for use with 120 or 208 volts as required.

Control wiring shall be flameproof-type, 600-volt insulation, not less than #12 AWG solid or #14 AWG stranded, per NEMA standards for switchboard use. All groups of control wires leaving the shipped assembled switchgear units shall be provided with terminal blocks correctly marked with suitable marker strips.

All metal surfaces of the switchgear shall be chemically cleaned and painted with a rust-resisting primer coat of paint followed by a finish, both exterior and interior, coat of #ASA 61 light-gray paint.

VII. SWITCHGEAR INDEX

The switchgear covered by this Specification shall consist of three separate assemblies itemized as follows:

Item I

Metal-enclosed low-voltage air circuit breaker switchgear for the control, metering, protection, voltage regulation and power output switching of the generator.

Item II

Metal-enclosed, low-voltage distribution-type switchboard for the control of the electrical loading of the generator; power and lighting distribution for generating plant support facilities; and switching facilities for certain stand-by power interconnection.

Item III

Metal-enclosed centralized control center for the control and protection of the auxiliary motors associated with the steam generator, turbine and electrical generator in this installation.

Item IV

Metal-enclosed centralized control center for the control and protection of the control rod drive motors.

VIII. EQUIPMENT - DETAILED SPECIFICATIONSItem No. 1

This metal-clad switchgear assembly shall consist of three metal-enclosed units assembled into one continuous assembly and arranged in accordance with drawing No. HD-1740.

Three 208-volt, 3-phase buses shall be supplied in the switchgear. The upper bus, designated as "equipment" bus, shall extend across the two units covered by Items 1A and 1B. The middle bus, designated as "utility" bus, shall extend across all three units (Items 1A, 1B and 1C). The lower bus, designated "main generator" bus, shall extend across all three units (Items 1A, 1B and 1C). All three buses shall be rated 1200 amperes. A ground bus, rated 600 amperes, shall extend across all three units. The three units of the switchgear are detailed below as sub-items 1A, 1B and 1C.

<u>ITEM NO.</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
1A	1 Lot	Metal-clad switchgear unit for mounting 2 dead front, manually-operated knife switches, 6 air circuit breakers, power buses and interconnecting buses as listed below.
1A1	3 Sets	3-phase buses rated 1200 ampere minimum (lower set - main generator bus; middle set - utility bus; upper set - equipment bus).

<u>ITEM NO.</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
1A2	1	<p>Dead front, manually-operated knife switch, 3-pole 3-position, double-throw, (center "OFF") rear connected, 240-volt a-c, 1200-ampere (not fused). Switch to be mounted on insulated base behind the front panel and operated by a handle lever projecting through the front panel, or a cover plate on the front panel. Two auxiliary microswitches SPDT shall be supplied on these knife switches. One switch operates when handle is in "UP" position, and one switch operates when handle is in "DOWN" position. Both auxiliary switches non-operated in center "OFF" position. Handle shall latch in all three positions. Handle shall be equipped with a "Kirk" or similar key interlock so that the switch cannot be moved from one position to the other except when the generator breaker (covered by Item 1C2) is <u>open</u>. Barkeley Elec. Manufacturing Co. type WAC or approved equal.</p>
1A3	1	<p>Dead front, manually-operated knife switch, 3-pole two-position, single-throw rear connected, 240-volt a-c, 1200-ampere (not fused) with handle through front panel similar to Item 1A2. One auxiliary microswitch SPDT shall be supplied on this knife switch. Auxiliary switch to operate when handle is in "CLOSED" position. Handle to latch in both positions and shall be equipped with a "Kirk" or similar key interlock so that the switch cannot be opened or closed except when the bus tie breaker (Item 1B2) is <u>open</u>. Barkeley Electric Manufacturing Co. type WAC or approved equal.</p>

<u>ITEM NO.</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
1A4	1 Lot	Interconnecting bus work and cables between transfer switches, breakers, and main buses as required.
The following items are mounted on the top section of the front panel:		
1A5	2	Air-circuit breakers, 3-pole single-throw, manually-operated, moulded-case-type, mechanically interlocked so both cannot be closed simultaneously; interrupting rating 20,000 ampere a-c at 240-volt; continuous rating, 70 ampere; equipped with thermal magnetic trip elements and one normally open auxiliary contact on each breaker. Westinghouse type AB size F or approved equal.
1A6	2	Air-circuit breakers, duplicate of Item 1A5.
1A7	2	Air-circuit breakers, 3-pole single-throw, manually-operated, moulded-case-type, mechanically interlocked so both cannot be closed simultaneously; interrupting rating 20,000 ampere; continuous rating 400 ampere, 240-volt a-c equipped with thermal-magnetic trip element and one normally open auxiliary contact on each breaker. Westinghouse type AB size KL or approved equal.
1B	1 Lot	Metal-clad switchgear unit with divided front and rear compartments and hinged instrument panel on front compartment with following equipment mounted inside or on the hinged panel.
1B1	1	Breaker compartment complete with stationary and removable element including mechanical interlocks, primary and secondary disconnecting devices.

<u>ITEM NO.</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
1B2	1	Power-operated air-circuit breaker, 3-pole, single-throw, electrically operated, 240-volt a-c, 300-ampere continuous rating, 25,000-ampere interrupting rating, complete with 125-volt d-c closing mechanism and potential trip coil and 4-pole auxiliary switch. Each pole of breaker to be equipped with a dual-magnetic series overcurrent tripping device; short-time tripping element to be set to pick up at 600 amperes, with a time delay of approximately 16 cycles at 250% of pick up (1500 amperes); instantaneous tripping element setting to be 2000 amperes. Key interlock as described under Item 1A3 is to be provided. G.E.-type AK-1-25, or approved equal.
1B3	3	Current transformers, 300/5 ampere ratio to be mounted in compartment between incoming cables (from Item 1A3) and lower terminals of air circuit breaker.
1B4	3 Sets	3-phase buses rated 1200 ampere minimum (lower set - main generator bus, middle set - utility bus, upper set - equipment bus).
1B5	1	Ground bus rated 600 ampere minimum.
1B6	1 Lot	Primary connections for incoming 208-volt power cables, with clamp-type lugs and cable supports for three 4/0 insulated cables entering compartment from top. Three 4/0 cables (1 per phase) outgoing to "equipment" load connect to "equipment" (upper) bus.

<u>ITEM NO.</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
The following items are mounted on hinged instrument panel on front of this switchgear unit:		
1B7	1	Ammeter, a-c indicating, 0-300 ampere scale.
1B8	1	Wattmeter, 4-wire, 3-phase indicating (3 current and 2 potential coils) 5-ampere, 120-volt, scale 0-120 kw for use with 300/5-amp current transformers and 208/120-volt, 60-cycle "equipment" bus potential.
1B9	2	Voltmeter, a-c indicating, scale 0-150 volt (1 meter connected phase-to-neutral on 208/120-volt equipment bus and 1 meter connected to volt meter switch covered by Item 1B14).
1B10	3	Generator percentage differential relay, 5-ampere, 60-cycle, 25% sensitivity, G.E.-type IJD52 or approved equal.
1B11	1	Lockout switch, hand reset, hand and electric (125-volt d-c) trip. Four normally open and two normally closed contacts (in reset position) Westinghouse type WL, or approved equal.
1B12	1	Ammeter switch, three phase, with knurled handle.
1B13	1	Synchronizing switch, with circuit breaker interlock using same removable handle as synchronizing switch in Item 1C21.
1B14	1	Voltmeter switch, 3-phase (phase-to-neutral) with knurled handle.
1B15	1	Circuit breaker control switch with pistol-grip handle and including red and green indicating lamps (125-volt d-c lamp supply):

<u>ITEM NO.</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
1B16	5	Indicating lamps 120 volt (used in mimic bus layout) with white lenses.
1B17	7	Indicating lamps, 125 volt d-c (used in mimic bus layout) with red lenses.
1B18	1 Lot	Mimic bus layout of 1/4 in. to 3/8 in. wide extruded copper, or equal, arranged as shown on drawing No. HD-1740.
1B19	1 Lot	Necessary terminal blocks, fuses, wiring, instrument buses, hardware, etc.
1C	1 Lot	Metal-clad switchgear unit with divided front and rear compartments and hinged instrument panel on front compartment with the following equipment mounted inside compartments or on the hinged instrument panel.
1C1	1	Breaker compartment complete with stationary and removable element including mechanical interlocks, primary and secondary disconnecting devices and key interlock with load transfer switch (see Item 1A2).
1C2	1	Power-operated air-circuit breaker, 3-pole, single-throw electrically operated, 240-volt a-c, 1200 ampere continuous rating; 25,000 ampere interrupting rating, complete with 125-volt d-c closing mechanism and potential trip coil, and an eight pole auxiliary switch assembly. Each pole of breaker to be equipped with a magnetic series over-current tripping device; time delay tripping to be set to pick up at 2000 amperes, with time delay of approximately 25 cycles at 250% of pick up (5000 amperes). No instantaneous tripping is to be used. G.E.-type AK-1-50, or approved equal.

<u>ITEM NO.</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
1C3	6	Current transformers, 1200/5 ampere ratio. Three are to be mounted in rear compartment (between generator breaker and bus). Three are to be supplied <u>unmounted</u> for use in the external wye connection of the generator by Purchaser.
1C4	2 Sets	Three phase buses, rated 1200 ampere minimum. (Lower set - main generator bus, upper set - utility bus).
1C5	1	Ground bus, continuous rating 600 ampere minimum.
1C6	1 Lot	Primary connections for incoming 208-volt power cables, with clamp-type lugs and cable supports for twelve 750-MCM and two 300-MCM insulated cables entering compartment from top. Six 750-MCM cables (2 per phase) incoming from the generator connect to the lower terminals of the generator breaker. Six 750-MCM (2 per phase) outgoing to load connect to utility (upper) bus. Two 300-MCM (one to generator and one to load) connect to ground bus.

The following items are to be mounted in the front compartment or on the hinged instrument panel:

1C7	1	Ammeter, a-c indicating, 0-1200-ampere scale.
1C8	1	Wattmeter, 4-wire, 3-phase indicating (three current and two potential coils), 5-ampere, 120-volt, scale 0-500-kw for use with 1200/5-ampere current transformers and 208/120-volt, 60-cycle, 3-phase "generator" potential.

<u>ITEM NO.</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
1C9	2	Voltmeter, a-c indicating, scale 0-150 volt (1 meter connected phase-to-neutral on 208/120-volt, 60-cycle generator bus, 1 meter connected to voltmeter switch covered by Item 1C22).
1C10	2	Frequency meters, a-c indicating, scale 56-65-cycle, 120-volt, complete with external impeders. (One meter on generator leads, one meter on generator bus.)
1C11	1	Power factor meter, a-c indicating, 4-wire, 3-phase, 5-ampere, 208-volt, 60-cycle, scale 0-1-0, for use with 1200/5-ampere current transformer and complete with external resistor unit for 208-volt phase-to-phase potential (from generator leads).
1C12	1	Synchroscope, 120-volt, 60-cycle, (connected phase-to-neutral on 208/120-volt circuits by synchronizing switches covered by Items 1B13 and 1C21).
1C13	1	Voltmeter, d-c indicating, scale 0-150 volts (connected to exciter bus).
1C14	1	Ammeter, d-c indicating, scale 0-40 ampere, self-contained (exciter ammeter) on 5-kw, 125-volt exciter.
1C15	1	Watthour meter, 4-wire, 3-phase, (three current coils and two potential coils), 5-ampere, 120-volt for use with 1200/5-current transformers on 208/120-volt, 60-cycle, 3-phase circuit.
1C16	1	Time meter, 120-volt, 60-cycle, register in hours, register capacity 99,999 hours. 3 in. (approximately) square face.

<u>ITEM NO.</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
1C17	2	Synchronizing lamps, 120-volt, 15-watt, clear glass bulb, semi-flush mounted with round bezel around hole in panel.
1C18	1	Field circuit breaker, moulded case air circuit breaker, manually operated, 100-ampere, 125-volt rating, 3-pole frame with two poles (non-automatic) for field circuit and one pole for field discharge contact closing as field contacts open and vice versa. Discharge contact need not be designed for load interruption. Breaker must be accessible for manual operation from front of panel. Breaker to be equipped with 125-volt d-c shunt trip attachment. Westinghouse type AB, size F, or approved equal.
1C19	1 Lot	Space for mounting and wiring exciter manual field rheostat and field discharge resistor. Also drilling for tachometer speed indicator. (Rheostat, speed indicator, and resistor supplied by generator manufacturer and mounted by Purchaser.)
1C20	1	Ammeter switch, 3-phase with knurled handle.
1C21	1	Synchronizing switch, including oval removable handle, with circuit breaker closing circuit interlock.
1C22	1	Voltmeter switch, 3-phase (phase-to-neutral) with knurled handle.
1C23	1	Circuit breaker control switch, with pistol grip handle and including red and green indicating lamps (125-volt, d-c lamp supply).
1C24	1	Governor control switch, spring return, for operating one-phase split field (120-volt a-c) governor motor.

<u>ITEM NO.</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
1C25	1	Voltage regulator, direct rheostatic type, for use with generator described in first part of this Specification. Regulator sensitivity of normal a-c voltage $\pm 1.5\%$ or less. Regulator to include necessary auxiliary unit. Regulator to connect phase-to-phase on 208-volt, 60-cycle circuit. 208/120-volt potential transformer to be supplied. Regulator to be surface mounted inside front compartment with manually operated regulator voltage-adjusting rheostat mounted on front instrument panel. G.E.-type GDA-31, or approved equal.
1C26	1 Lot	Necessary terminal blocks, fuses, wiring, instrument buses, hardware, etc.

Item No. II

This metal-enclosed low voltage switchboard "Generator Loading and Power Distribution Switchgear" shall consist of five sections. The first section shall house single- and three-phase circuit breakers for lighting and power distribution. The second, third and fourth sections shall be vertically subdivided into two or more cells, each cell housing one or more non-drawout air circuit breakers, double throw power transfer switches or other miscellaneous equipment. The fifth section shall be divided into five cells, each designed to house a drawout-type combination motor line starter, as required.

Two 208-volt, 3-phase buses shall be supplied in the switchboard. The upper bus designated "Equipment Bus," rated 600-ampere minimum, shall extend across the top of sections 3 and 4. The lower bus designated "Utility Bus," rated 1200-ampere minimum, shall extend across the bottom of sections 2, 3, 4 and 5. Vertical three-phase risers shall be provided as required in each section as shown on drawing No. HD-1741. A ground bus rated 600 ampere (minimum) shall extend across all five sections.

The five sections of this switchboard are detailed below as sub-items 2A, 2B, 2C, 2D and 2E:

<u>ITEM NO.</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
2A	1 Lot	Switchgear section #1 containing combined lighting and power panel board unit for 120-volt, single-phase and 208-volt, three-phase power distribution. This section to be equipped with dead front trim. Provision shall be included for identifying each circuit.
2A1	1	<p>Panel board unit 3-phase, 4-wire, 120/208-volt, 60-cycle with solid neutral bar, 400-ampere mains and containing 30 single-phase 20-ampere "E" frame breakers and 13 three-phase breakers. Following three-phase breakers shall be provided:</p> <ul style="list-style-type: none"> (4) - 70-amp breakers 3-phase "E" frame (1) - 100-amp breaker 3-phase "E" frame (2) - 50-amp breakers 3-phase "E" frame (4) - 30-amp breakers 3-phase "E" frame (1) - 125-amp breaker 3-phase "J" frame (1) - 15-amp breaker 3-phase "E" frame <p>Breakers shall be arranged in two vertical rows. Single-phase breakers shall be equally divided on all three phases. Westinghouse-type NDP or approved equal.</p>

<u>ITEM NO.</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
2B	1 Lot	<p>Switchgear section #2, divided vertically into three cells, with upper cell housing (inside) a 3-pole disconnecting fuse for connecting the reserve power source to the power and lighting distribution section (covered by item 2A). Door of upper cell to contain miscellaneous control switches, indicating lamps and indicating instruments. Middle cell of this section to house manual air circuit breaker and current transformers for connecting main reserve power source to power and lighting distribution section and also the "utility" bus. Lower cell of this section to house electrically-operated air-circuit breaker for connecting reserve power source to "utility" bus in this switchgear.</p>
2B1	1 Set	<p>Disconnecting, high-interrupting capacity, current limiting device consisting of three Chase-Shawmut amp-trap type 5 or approved equal fuses, 250-volt a-c, 400-amp, mounted on rear connected contacts. (2 Cat.#B400 P contacts per fuse.) Contacts to be mounted on insulated sub-panel with insulated barriers between fuses.</p>
2B2	1 Set	<p>3-phase, 208-volt a-c, primary connections for incoming power leads from reserve source power transformer, connecting to upper terminals of 1000-amp breaker (through current transformers) with clamp-type lugs for six 400-MCM (2 per phase) insulated cables entering compartment from bottom.</p>

<u>ITEM NO.</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
2B3	1	Air-circuit breaker 3-pole, single-throw, manually-operated, 240-volt a-c, continuous rating 1000 amp, interrupting rating 50,000 amp, equipped with dual-magnetic trip element. G.E.-type AK-1-50 or approved equal.
2B4	1	Power-operated air-circuit breaker, 3-pole, single-throw, electrically-operated, 240-volt a-c, 600 amp continuous rating, 25,000 amp interrupting rating, complete with 125-volt d-c closing mechanism, and potential trip coil and 4-pole auxiliary switch. Each pole of breaker to be equipped with a dual-magnetic series over-current tripping device; short-time tripping element to be set to pick up at 1200 amp, with a time delay of approximately 16 cycles at 250% of pick up (3000 amp). Instantaneous tripping element to be set to pick up at 2500 amp. G.E.-type AK-1-25 or approved equal.
2B5	3	Current transformers, 800/5 ampere ratio to be mounted in compartment (between incoming stand-by power supply cables and terminals of 1000-ampere air-circuit breaker).

The following items are mounted on hinged front panel of the upper cell of Section No. 2:

<u>ITEM NO.</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
2B6	3	a-c indicating voltmeter scale 0-150 for phase-to-neutral connection on 208/120-volt, 60-cycle, 3-phase circuits. One meter connected to "utility" bus; one meter connected to incoming stand-by power supply (from utility company); and 1 meter connected to "Equipment" bus.

<u>ITEM NO.</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
2B7	1	a-c synchroscope, 120-volt, 60-cycle for synchronizing incoming stand-by power supply to "utility" bus.
2B8	2	Synchronizing lamps, 120-volt, 15-watt clear glass bulb, semi-flush mounted with round bezel around hole in panel.
2B9	1	Wattmeter 4-wire, 3-phase indicating (three current and two potential coils) 5-amp, 120-volt, scale 250-0-250 kw for use with 800/5-ampere current transformers and potential from 208/120-volt, 60-cycle "utility" bus.
2B10	1	Circuit breaker control switch with pistol-grip handle and including red and green indicating lamps (125-volt d-c lamp supply).
2B11	1	Synchronizing switch, including oval <u>non-removable</u> handle with circuit breaker closing circuit interlock.
2C	1 Lot	Switchgear Section #3 divided vertically into three cells with upper cell housing a double throw transfer switch and entrance cable connections from stand-by diesel generator. Middle cell to contain three moulded case air circuit breakers. Bottom cell to contain incoming cable connections to the "utility" bus. Equipment to be as detailed below.

<u>ITEM NO.</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
2C1	1	Dead front manually-operated knife switch, 3-pole, 3-position, double-throw (center "OFF") 240-volt a-c, 400-ampere (not fused) switch to be mounted on insulated base in upper cell of this section behind the front panel and operated by a handle mounted on the front panel or a cover plate on front panel. Handle shall latch in all three positions. Handle shall be equipped with a "Kirk" key interlock. Barkeley Electric Manufacturing Co. Type H or approved equal.
2C2	1 Set	Primary connections for incoming 208-volt power cable with clamp-type lugs for connecting three 4/0 (1 per phase) cables entering compartment from top. These cables incoming from the diesel-driven 60-kw generator connect to the center terminals of the transfer switch.
2C3	3	Moulded case air circuit breakers, 3-pole, single-throw, manually-operated, 240-volt a-c, continuous rating 225-amp, interrupting rating 20,000 amp, equipped with thermal-magnetic trip elements and under-voltage trip element. Breakers mount in middle cell of this section. Westinghouse Type AB Size K or approved equal.
2C4	1 Set	Primary connections for incoming 208-volt power cables with clamp-type lugs for connecting six 500-MCM incoming cables (2 per phase entering compartment from top) to the "utility" bus.

<u>ITEM NO.</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
2D	1 Lot	Switchgear section #4 divided vertically into three cells with upper cell housing double throw transfer switch, and bottom two cells housing fourteen moulded case air-circuit breakers. Equipment to be as detailed below.
2D1	1 Set	3-phase primary connections for incoming power leads connecting to "equipment" bus with clamp-type lugs and supports for three 4/0 (1 per phase) insulated cables entering compartment from top.
2D2	1	Dead front manually-operated knife switch same as Item C except omitting "Kirk" key interlock feature.
2D3	14	Moulded case air-circuit breakers, 3-pole single-throw, manually-operated, 240-volt a-c, continuous rating 40 amp, interrupting rating, 20,000 amp equipped with thermal-magnetic trip elements. Eight breakers mounted in center cell and connected to the center terminals of the transfer switch in the top cell (covered by Item 2C1). Six breakers mounted in the lower cell and connected to the "utility" bus. Outgoing leads to the loads connected to each circuit breaker will enter section from the bottom. Westinghouse Type AB, Size F or approved equal.

<u>ITEM NO.</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
2E	1 Lot	Switchgear section #5, a motor control section, shall be divided vertically into five cells, each cell capable of housing a drawout combination motor line starter unit, NEMA size 1 or 2. Provision shall be made on front of each cell door to start and stop motor, operate line circuit breaker and obtain running (red) pilot lamp indication. Section #5 shall be completely wired (NEMA type C construction) to terminal blocks at top of section. See Item III for additional general specifications applying also to this item. Section shall be equipped with combination line starters as follows:
2E1	2	Combination line starter full voltage non-reversing NEMA Size 1 for 208-volt, 3-phase, 3-hp motor control with air-circuit breaker and overload relays. Starter to be equipped with momentary contact "START" and "STOP" buttons and red (running) indicating lamp. No remote start-stop pushbuttons are required. (Control of fin fan blowers on simulated heat load radiator.)
2E2	1	Combination line starter, same as Item 2E1 except for 208-volt, 3-phase, 5-hp motor. (Control of water pump on simulated heat load system.)
2E3	1	Combination line starter, same as Item 2E1, except spare for 208-volt, 3-phase motor. Starter to be equipped with red (running) indicating lamp and three position selector control switch marked "MANUAL-OFF-AUTO."

Item No. III

This metal-enclosed centralized motor control center shall consist of four units assembled into one continuous assembly and arranged generally in accordance with drawing No. HB-579.

A main horizontal 3-phase bus rated 208-volt, 600-ampere shall extend across all five units with suitable 3-phase vertical risers in each unit. A grounding bus shall also extend horizontally across the five units.

All combination motor starters mounted in this control center shall be magnetic type with thermal overload relays, externally manually reset. Except where noted to the contrary, magnetic starters shall have operating coils designed for 120-volt, 60-cycle operation. Each starter unit shall include a circuit breaker, manually-operated, trip-free from the handle and provided with inverse time thermal element overload and instantaneous magnetic short circuit protection as required for each motor and interrupting rating of at least 15,000 amp rms. Starter units and associated circuit breaker shall be drawout construction unless noted otherwise. All equipment in the control center shall be capable of withstanding short circuits of 15,000 amp.

Removable unit enclosures shall be constructed of heavy gauge sheet steel and provide isolation and baffling of each unit from the others. Plug-in stabs for power connection to the vertical bus shall be fabricated of high spring strength, high conductivity, silver plated material. Units shall have guide rails for accurate alignment both horizontally and vertically within the structure to eliminate possible damage to bus or stab units.

All doors shall be hinged and held closed with screw or "speed" type fasteners. Starter unit doors shall be interlocked so that circuit breaker must be tripped before door can be opened. Special emergency bypass of this interlock may be included.

NEMA type "C" wiring to master terminal boards at the top of each section shall be provided including any interconnecting wiring between sections.

Nameplates to properly identify each motor being controlled shall be provided on the cell doors near the pushbutton units.

<u>ITEM NO.</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
3A	1 Lot	Combination starter section #1, to be equipped as follows.
3A1	1	Lighting panel board unit consisting of twelve single-pole, 20-ampere breakers, one 3-phase 20-ampere breaker, and one 3-phase 30-ampere breaker. Breakers to be arranged in two vertical rows with single pole breakers equally divided on all three phases. Two 120-volt red indicating lamps and one momentary contact "START-STOP" pushbutton station, shall be installed on compartment door for connection to the load side of two of the panel board circuit breakers and with wiring provision for remote indicating lamps.
3A2	1	Combination line starter unit NEMA Size 1 for control and protection of 3/4-hp, 208-volt, 3-phase motor, L.V.P. (low voltage protection), control with red (running) indication lamp and wiring provision for remote mounted "START" and "STOP" push-buttons and running lamps. (Purification Water Pump Motor.)
3A3	1	Combination line starter unit, NEMA Size 1 for control and protection of 3/4-hp, 208-volt, 3-phase motor, L.V.P. control with momentary contact "START" and "STOP" pushbutton and red (running) indicating lamp. (Instrument Well Exhaust Fan.)
3A4	1	Drawout unit containing two air circuit breakers for feeds to crane motors. Line starting equipments are mounted on cranes. Breaker #1 protects a 7½-hp, 208-volt, 3-phase, full-voltage starting, monorail crane motor. Breaker #2 protects two 2-hp, 208-volt, 3-phase, full-voltage starting motors on an overhead traveling crane.

<u>ITEM NO.</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
3A5	1	Combination line starter unit NEMA Size 1 for control and protection of 3/4-hp, 208-volt, 3-phase motor, L.V.R. (low voltage release) control with selector switch, three position, marked "HAND-OFF-AUTO" and red running lamp and connections to remote level control switch (for "AUTO" control). Also wiring provision for remote mounted running lamp. (Condensate Return Pump - Low Pressure.)
3A6	1	Combination line starter unit NEMA Size 1 for 3/4-hp motor same as Item 3A5. (Condensate Return Pump - High Pressure.)
3B	1 Lot	Combination starter section #2, to be equipped as follows:
3B1	1	Combination line starter unit NEMA Size 1 for control and protection of 1½-hp, 208-volt, 3-phase motor, L.V.R. control with red (running) lamp. Wiring provision for remote mounted pushbutton station, and running lamp. (Shield Cooler Pump.)
3B2	1	Combination line starter unit, NEMA Size 1, for control and protection of 3/4-hp, 208-volt, 3-phase motor, L.V.P. control with red (running) lamp and wiring provision for remote mounted "START" and "STOP" pushbuttons and running lamp. (Retention Tank Pump.)

<u>ITEM NO.</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
3B3	1	Combination line starter unit, NEMA Size 3, reduced voltage, non-reversing, 2 point, autotransformer type for control and protection of 15-hp, 208-volt 3-phase motor. Starter to include two extra auxiliary contacts, one normally open and one normally closed. This line starter unit to be fixed mounting. The following control equipment to be mounted and wired with the line starter in this compartment, in addition to equipment normally required for reduced voltage starting.
3B3a	1	Stop pushbutton momentary contact DPDT.
3B3b	1	Start pushbutton momentary contact (one normally open contact).
3B3c	1	Red (running) lamp.
3B3d	1-	General purpose multi-pole auxiliary relay, front connected, mechanically held, NEMA Size 00, 120-volt, 60-cycle (continuous duty) operating coil; 125-volt d-c (momentary duty) reset coil; 4 normally open contacts, convertible to normally closed, if necessary. (Device 43-1.)
3B3e	1	General purpose multi-pole auxiliary relay, front connected self-reset, 120-volt, 60-cycle (continuous duty) coil; four contacts, two normally open and two normally closed. (Device PSX-1.)

<u>ITEM NO.</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
3B3f	1	<p>Time delay relay, pneumatic type, front connected adjustable time delay on de-energization. 0.2 to 180 sec, 120-volt, 60-cycle coil; two contacts, one normally open and one normally closed. (Device 27-1.)</p> <p>Interconnecting wiring between the above mentioned equipment (Item 3B3 and like equipment in the section covered by Item 3C3, and provision for connection to remote mounted control devices shall be provided in accordance with detail E on Drawing AA-77840. (Feed-water Pump #1.)</p>
3C	1 Lot	Combination starter section #3, to be equipped as follows:
3C1	1	<p>Combination line starter unit, NEMA Size 1, for control and protection of $1\frac{1}{2}$-hp, 208-volt, 3-phase motor, L.V.R. control, with maintaining contact "START" and "STOP" pushbuttons, red (running) lamp and wiring provision for remote running lamp. Starter to also include one auxiliary normally closed contact for operating remote 125-volt green (not running) lamp. (Condensate Circulating Pump.)</p>
3C2	1	<p>Combination line starter unit, NEMA Size 1 for control and protection of 1-hp, 208-volt, 3-phase motor, L.V.R. control with maintained contact "START-STOP" pushbutton and red (running) lamp and wiring provision for remote mounted pressure switch connections. Also included in, or near, cell shall be a general purpose auxiliary relay, same as Item 3B3e for use as device PSX as shown on Detail G of Drawing AA-77840. (Standby Turbine Oil Pump.)</p>

<u>ITEM NO.</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>
3C3	1	Combination line starter NEMA Size 3, duplicate of equipment covered by Item 3B3 (including Items 3B3a to 3B3f inclusive). (Feed-water Pump #2.)
3D	1 Lot	Starter section #5 completely filled by one Size 5 reduced voltage starter as follows:
3D1	1	Combination line starter unit, NEMA Size 5 reduced voltage, non-reversing, 2-point, autotransformer-type for control and protection of 75-hp, 208-volt, 3-phase motor. Starter to be fixed mounting and include one auxiliary normally closed contact for operating a remotely mounted 125-volt green (not running) lamp, and one extra normally open auxiliary contact. Starter coils to be for 125-volt d-c operation. Momentary contact "START" and "STOP" pushbuttons, and red (running) lamp shall be mounted and wired in this compartment. (Condenser Circulating Air Fan.)
3D2	1	Current transformer 200-5 ampere installed on one of 75-hp motor leads. Secondary leads shall be wired to terminals for connection to remote ammeter.

Item No IV

This metal-enclosed motor control center shall consist of a single unit containing nine plug-in combination starters with "F" frame breakers and size 00 reversing magnetic starters. Starters shall be equipped with thermal overload relays suitable for jogging service with 1/8-hp, 208-volt, 3-phase induction motors. Wiring shall be NEMA Type "B" for top conduit entrance.

IX. REFERENCE DRAWINGS

Nelson Electric Manufacturing Company:

HB-579 Assembly - Motor Control Center (Plant Motors)
HB-585 Assembly - Motor Control Center (Single Front)
HD-1740 Assembly - Generator Control Switchgear
HD-1741 Assembly - Loading Cubicle - Control Center
HD-1743 Wiring Diagram - Loading Cubicle - Control Center
HD-1820 Wiring Diagram - Motor Control Center
HK-529 Wiring Diagram - Generator Control Switchgear

Pioneer Service and Engineering Company:

AA-76936 Single Line Diagram, Including Metering and
Relaying - Sheet 1
AA-77840 Plant Motors - Control Center

X. VENDOR

Nelson Electric Manufacturing Company
Tulsa, Oklahoma

XI. PURCHASE ORDER

Argonne National Laboratory AL-227156
Nelson Electric Mfg. Co. AU-972-S

SECTION 3

FEED-WATER PUMPS

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I. INTENT

The intent of this specification is to state the requirements and conditions for the furnishing and delivery of two (2) single suction, vertical centrifugal pumps to be used for feed-water service. The pump will serve as a hot well and boiler-feed pump in the system, taking condensate from the condenser hot-well and discharging the same as feedwater into the boiler.

II. DESIGN

The pumps shall be of modern design and construction that has proved its reliability, durability and efficiency. They shall be of rugged construction and shall have the highest possible sustained economy consistent with reliability.

The pumps shall be capable of operating with either steady or varying load and without undue vibration or noise. The design and construction shall conform to the latest standards of ASA, AIEE, and NEMA.

III. MATERIALS AND WORKMANSHIP

The casing, impeller, casing ring, shaft sleeve, shaft, intermediate sleeve, channel ring, and all parts in contact with the water shall be made from ASTM-A296, CA-15, 13% chromium steel or equivalent corrosion resistant chromium steel material.

The workmanship shall be of high quality in every detail.

IV. FACTORY TESTS

The pumps shall be tested at the factory before shipment. This should include mechanical and hydraulic performance tests. All test data shall become the property of the Purchaser.

V. FEATURES AND ACCESSORIES

The pumps shall be provided with the following features and accessories:

- (1) Greaseless boiler-feed packing with provisions for a liquid seal to avoid air leakage in and/or primary water leakage out.
- (2) 1-inch Muffed Orifice for pump overheating protection.
- (3) Rigid adjustable self-aligning coupling from driver to pump.

- (4) Electric motor drive.
- (5) Set of any special dismantling tools required.
- (6) Internal lubrication must be the working fluid only.

VI. SHIPPING

All parts shall be carefully boxed or otherwise suitably prepared for shipment to protect the equipment against damage while in transit. All exposed surfaces of the unit shall be painted before shipment. All components of the unit shall be protected during shipment and storage from rust and entry of dirt and water. All flanges shall be closed tightly by adequate covers bolted in place. Internal protection should be by an approved rust preventative or rust-inhibited ethylene glycol. All separate parts shall have indestructible identification tags.

The equipment is to be installed at the National Reactor Testing Station located near Scoville, Idaho at an elevation of 5100 ft above sea level.

Complete equipment shall be shipped f.o.b., Motor Freight, ALPR Site, National Reactor Testing Station.

VII. RATING AND DESIGN CONDITIONS

The pump shall be designed for a capacity of 21 gpm when pumping condensate at 5 in. Hg. abs. against a discharge head of 800 ft and with a net positive suction head of 6.0 ft. (All values based on water at 135°F.)

VIII. TECHNICAL DATA

A. Application

One pump will be on continuous duty service. The second pump will be arranged to operate automatically if the pressure drops in the system header indicating loss of the pump in service.

B. Design

Liquid to be Pumped	Condensate
Temperature of Liquid	
Normal	135°F
Maximum	275°F
Condenser Pressure	
Normal	5 in. Hg. abs.
Maximum	30 psig

Capacity	
Normal	19 gpm
Maximum	24 gpm
Discharge Head	
Normal	780 ft
Shutoff	850 ft
Net Positive Suction Head	
Normal	7½ ft
Minimum	6 ft

C. Pump Data

Type of Pump	Double Case-Vertical Centrifugal
Number of Stages	6
Capacity at 135F	21 gpm
Total Dynamic Head	835 ft
Shutoff Head	850 ft
Efficiency	34%
Brake Horsepower	13.3 hp
Internal Lubrication	Condensate
Type of Seal	Greaseless Boiler-Feed Packing
Seal Cooling	1/2 gpm Condensate at 10 psi above suction pressure
Inlet Connection	2-inch, 150-lb ASA Flanged
Outlet Connection	1½-inch, 400-lb ASA Flanged
Materials of Construction	
Casing	338 COM
Impeller	338 COM
Casing Rings	20 H
Shaft Sleeve	20 K
Shaft	20 COM
Liquid Seal Cage	20 COM
Gland - 2 Halves	338 COM
Bearing Bushing - Lower	386 H
Intermediate Sleeve	20 COM
Channel Ring	338 COM
Retaining Ring	20 COM
Coupling Nut - Pump	
Shaft	20 COM
Journal Sleeve	20 K
Stuffing Box Bushing	20 COM
Split Rings	20 COM
Discharge Head	338 COM
Inner Casing Cover	338 COM

Throttling Sleeve	386 H
Throttling Bushing	386 H
Pressure Bolting	314
Pressure Nuts	377

Material Description

338 COM	ASTM-A296, CA-15, 13% chromium, steel casting
20 COM	AISI-Type 416, free-machining, 13% chromium, stainless steel
20 K	Same as 20 COM except hardened to about 350 Brinell
20 H	Same as 20 COM except hardened to about 300 Brinell
386 H	AISI-Type 501, hardened 5% chromium, 0.5% molybdenum, stainless steel.
314	ASTM-A193, Grade B7, carbon steel
377	ASTM-A194, Grade 2H, carbon steel

D. Motor Data

Type of Motor	Electric, induction, squirrel cage
Horsepower	15 hp
Speed	3515 rpm
Current characteristics	208 volts, 60 cycle, 3 phase
Housing	Drip Proof
Mounting	Vertical
Temperature Rise	40°C at 5100-foot elevation (above sea level)
Duty	Continuous
NEMA Designation	Design B
Shaft	Solid Shaft, direct connected with up and down rated thrust bearing.

IX. RECOMMENDED SPARE PARTS

<u>Quantity</u>	<u>Part Number</u>	<u>Description</u>
1	Y-125S8APX1	Shaft Sleeve
2 rings	64A-804B	Packing (1/8 in. square x 1 $\frac{13}{32}$ in. OD)
1 set	Y-1VP64X1-SK-A	Packing (Greaseless)
1	Y-1VP24AX1	Bearing Bushing
6	Y-250D4AX2	Impeller Rings
6	Y-2RV6CX13	Casing Rings

X. REFERENCES

Instructions for Installing and Operating Centrifugal Pumps

Drawing No. X-IVP-86X182-A - Elevation, No. IVP-6 - Stage Pump

Drawing No. 352 (Louis Allis Co.) - Motor Terminal Markings

Drawing No. Y-3HMTA438AX1 - Orifice Assembly

Curve No. 33824 - Characteristic Curve

XI. VENDOR

Ingersoll-Rand Co.
400 West Madison St.
Chicago 6, Illinois

XII. PURCHASE ORDER

Argonne National Laboratory AL-222411

Ingersoll-Rand No. 02-19420

ALPR
FEEDWATER PUMP
INSTALLATION

SECTION 4
MOTOR-GENERATOR AND ASSOCIATED CONTROL SWITCHGEAR
FOR
CONTINUOUS A-C SUPPLY

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I. INTENT

This specification is intended to describe the requirements and conditions for the furnishing and delivery of a motor-generator set and associated control switchgear required to provide continuous 3-phase, 208/120-volt, 4-wire, 60-cycle a-c supply of 6.25 kva capacity. Normal source will be an a-c bus of 3-phase 208/120-volt 60-cycle rating, and emergency source will be a 125-volt d-c battery. During normal operation equipment shall be designed to keep battery in fully charged condition.

II. SERVICE CONDITIONS

The equipment described in this specification normally will be operated in an ambient temperature range of 5°C to 50°C. Equipment may be exposed (nonoperating) to a temperature as low as -50°C.

Equipment shall be designed for operation at an altitude of approximately 5100 ft above sea level.

III. DESIGN-GENERAL REQUIREMENTS

The equipment described in this specification shall consist of modern equipments of the 0-600 volts class and shall be designed, manufactured and tested in accordance with the latest applicable standards of ASA, AIEE, and NEMA. Design of equipment shall be such that it can be erected, installed and operated in compliance with the "National Electrical Code" and "National Electric Safety Code" as applicable.

Equipment included in this specification shall be capable of continuous operation at the full designed load without undue noise, vibration or impairment of durability or efficiency. Equipment shall be the best of the respective manufacture and type for the service conditions. No equipment will be considered which is in any way experimental or of an experimental nature.

Only equipment and material manufactured and assembled within the continental limits of the United States will be considered.

Each component shall be completely assembled and wired at the factory. Rigid inspection before and after assembly shall assure correctness of design and workmanship. After assembly, each standard unit shall be performance tested at the factory under simulated service conditions by the Contractor to assure accuracy of wiring, correctness of the control scheme and functioning of the equipment.

IV. TRANSPORTATION AND DELIVERY

A. Packing for Shipment

No single unit when crated for shipment shall exceed the dimensions of $7\frac{1}{2}$ ft x 9 ft x 20 ft and a weight of 10 tons.

B. Location and Conditions

The equipment is to be installed at the ALPR site in the National Reactor Testing Station near Scoville, Idaho.

V. EQUIPMENT - GENERAL SPECIFICATIONS

All metal surfaces of switchgear and motor-generator shall be chemically cleaned and painted with a rust resisting primer coat of paint followed by a finish coat of ASA No. 61 light gray paint.

Switchgear control wiring shall be flameproof-type 600-volt insulation, and in accordance with NEMA standards for switchboard use. All control wire leaving the switchgear shall be provided with terminal blocks correctly marked with suitable marker strips. All control and power wiring will enter switchgear from top.

Nameplates shall be provided for each instrument control switch, push button or other device whose function might not otherwise be clearly understood.

Indicating instruments must be semi-flush mounted, accuracy rating of 2% of full scale or better, minimum scale length 2.8 in. Scales to have black markings on white background.

Battery, supplied by purchaser, will be 125-volt, 92 cell, 82 AH, nickel cadmium type.

VI. EQUIPMENT-DETAILED SPECIFICATIONS

A. Requirements of Emergency Power Supply

Voltage: 3-phase 60-cycle, 208/120-volt, 4-wire.

Rated full load: 6.25 kva (0.8 Power Factor).

Voltage regulation: $\pm 2\%$ no load to full load.

Frequency regulation with d-c drive: Not less than 57 cycles at full load, steady state variation not over $\pm 2\%$.

B. Controls

Provision shall be made to automatically switch over from a-c drive to d-c drive without interruption of a-c output circuit.

Provision shall be made to automatically return from d-c drive to a-c drive when normal a-c supply bus is restored.

Provision shall be made to supply constant voltage charging of the battery (up to maximum of 3 kw) at a voltage level that can be manually preset in the range of 125 to 140 volt, d-c.

A-C driving motor starter shall include motor overload protection and necessary manual and automatic controls. A 3-pole safety switch shall be provided ahead of the a-c motor starter (for personnel protection when maintaining motor-generator which will be located in room separate from the control cubicle).

D-C contactor between battery and d-c motor shall include motor overload protection and necessary manual controls.

C. Meters and Relays Required

A-C voltmeter, scale 0-300, on output of a-c generator.

D-C charge-discharge ammeter (and shunt) on battery, scale 30-0-120 amp.

D-C voltmeter, scale 0-150, with transfer switch (spring return to battery) for reading either battery voltage or d-c generator output.

A-C frequency meter (vibrating reed type) on output of a-c generator.

A-C undervoltage alarm relay on output of a-c generator, adjustable range 140-120 volt.

D-C battery undervoltage alarm relay, adjustable range 100-130 volt, including 12-volt d-c alarm bell, 12-volt d-c bell cut-off auxiliary relay, and bell cut-off pushbutton.

D. Motor-Generator Set

Motor-generator set shall be supplied on a common base, with various units coupled without use of gears, chains or belts. Bearings shall be of ball type.

Motor-generator set shall consist of synchronous a-c drive motor coupled to an a-c generator (which supplies the load) and to a d-c unit which serves either as d-c driving motor or d-c battery-charging generator.

E. Control-Switchgear Cabinet

Cabinet shall be designed for floor mounting against wall, with hinged front panel and with all parts accessible from front of cabinet. Cabinet dimensions shall not exceed 28 in. (width or depth); height may be as required up to 90 in.

VII. REFERENCE DRAWINGS

B-20698 Dimension Outline

D-11056 Control Cubicle Assembly

D-11057 Schematic Diagram

D-11058 Wiring Diagram

VIII. VENDOR

Bogue Electric Co.
Paterson, New Jersey

IX. PURCHASE ORDER

Argonne National Laboratory AL-236448

Bogue Electric Co. No. 4406

SECTION 5
NUCLEAR INSTRUMENTATION
AND
CONTROL DRIVE ACCESSORIES

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I. INTENT

It is the intent of these specifications to describe the requirements and conditions for the furnishing and delivery of components for a complete nuclear instrumentation and control rod drive control system. Except as noted specifically to the contrary, it is intended that these components shall be individually complete in every respect, ready for field installation and connection to related systems and devices.

II. SCOPE OF WORK

The work includes provision of the following:

- (1) Components for nuclear instrument Channels I through VIII, inclusive. (Items A to G, Section IX)
- (2) A high voltage supply Panel in which are mounted and wired certain of the above components. (Item H, Section IX).
- (3) A nuclear instrumentation and control cubicle consisting of a panel structure in which are mounted and wired certain of the above components in addition to other components and devices as specified. (Item I, Section IX).

All terminals and connectors necessary for terminating interconnecting wiring at the panels or devices listed above shall be furnished and installed by the Contractor. This includes field installation of all connectors on coaxial cables.

The following will be furnished and/or installed by others:

- (1) Installation of the specified completed panels, and components which are situated external to the panels.
- (2) Rod drive motor control center, including reversing starters and motor branch circuit
- (3) Rod drive mechanisms, including:
 - a. Rod drive motors and brakes
 - b. Rod drive clutches
 - c. Rod position synchro transmitters
 - d. Rod drive limit switches, LS11, LS12, LS21, etc.
- (4) Instruments associated with the nuclear annunciator, and their contacts shown on Drawings B-CID-486-A34, A35, and A36, unless specified herein.
- (5) All external wiring, including coaxial cables, extending between the panels and externally situated components, and between the panels and the sources of electrical supply.

III. SERVICE CONDITIONS

The equipment described in this specification normally will be operated in an ambient temperature range of 5°C to 50°C. It may be exposed (non-operating) to a temperature as low as -50°C.

The equipment shall be designed for operation at an elevation of approximately 5100 ft above sea level.

IV. GENERAL

Equipment shall have performance characteristics equal or superior to the manufacturer's item specified. Exceptions are subject to prior approval by the Purchaser.

One year's supply of charts and ink, based on the lowest chart speed, shall be furnished with each recorder.

All vacuum tubes shall be of the "long-life" or "premium" type in applications for which such types are available.

Name plates, made from black phenolic, 1 in. wide, 3 in. long, and 1/8 in. thick, having beveled edges and white engraved lettering shall be supplied and attached to all panel-mounted instruments, meters, indicating lamps, and control devices. In the case of components such as high-voltage supplies, pulse amplifiers and the like, a single name plate identifying the component as to function, instrument channel number, etc. is sufficient. Nameplate lettering shall be submitted for approval prior to engraving.

Each panel shall be completely assembled and wired at the factory in accordance with the latest applicable ASA, AIEE, and NEMA standards. Workmanship shall be of the highest quality so that completed assemblies will have a neat and trim appearance. Rigid inspection before and after assembly shall assure correctness of design and workmanship.

V. PANEL WIRING

All power and control wiring within the panels shall be performed with No. 14 AWG, Type AVB or TA wire except where larger conductors are required for current-carrying capacity or where smaller conductors are necessary in order to make proper connection to small terminals, or soldering lugs. All wiring shall have flame-retardent, 600-volt insulation.

Except where coaxial cable connectors are employed for radiation detector high voltage supply and signal leads, all circuits extending outside

the panels shall be terminated on suitable molded-type terminal blocks, correctly marked with suitable marker strips. These terminals shall be readily accessible for wiring from the top of the Reactor Control Center, and from the bottom rear of the Preamplifier Panel.

To facilitate removal and replacement of rack-mounting high-voltage supplies, pulse amplifiers, etc., all connections to these components shall be made by means of flexible cords and separable connectors.

A sufficient number of 120-volt receptacles shall be installed in the Preamplifier Panel and Reactor Control Center to accommodate all rack-mounting nuclear instruments, with at least two spare receptacles for each vertical stack of instruments. Receptacles energized from the automatic voltage regulators, AVR1 and AVR2 shall be connected in such a manner as to apply approximately equal loads to each supply. Plugs and receptacles used for different voltages shall be non-interchangeable.

The 120-volt a-c supply for the Preamplifier Panel will be obtained from one of the above voltage regulators and will supply both the instruments and the cooling fan unit.

VI. PAINTING

All panels shall be cleaned and primed both inside and outside. Outside surfaces, including the panels of component rack-mounting instruments, shall be finished in ASA61 color paint. Inside panel surfaces shall be finished in light gray paint. Unless otherwise noted, meters, recorders, etc., shall have a black finish.

VII. FACTORY TESTS

The assembled equipment and wiring which during operation may be connected to the supply circuit, including the 120-volt a-c voltage regulator output terminals, shall be subjected to a dielectric test in which a potential of 1250 volts, 60 cycles is applied for one minute between all current-carrying parts and grounded metal supports, etc.

After complete assembly and wiring of the panels, the individual components and associated wiring shall be completely tested for proper overall operation. This test shall be made with the remote devices connected to the panel terminals where practicable, otherwise with their functions simulated.

VIII. TRANSPORTATION AND DELIVERY

No single unit when crated for shipment shall exceed the dimensions of $7\frac{1}{2}$ ft x 9 ft x 20 ft, and weight of 20,000 lb.

The equipment is to be installed at the ALPR Site, National Reactor Testing Station near Scoville, Idaho.

Complete equipment shall be shipped by truck, f.o.b., ALPR Site, National Reactor Testing Station, Scoville, Idaho.

IX. DETAILED SPECIFICATION OF COMPONENTS

Eight channels of radiation-sensitive instrumentation will be employed. These channels shall be made up of the components specified below. Certain components, together with other equipment shall be assembled in panels as specified.

A. Channel I (See Drawing No. RE-2-24952-B)

This channel shall consist of an ionization chamber, a microammeter, a sensitive microcurrent d-c relay, and a high-voltage supply connected in series. A level-trip auxiliary relay shall be connected so as to be deenergized by the microcurrent relay and so as to actuate the reactor shutdown circuits. Items A-3 to A-10 shall be assembled as a unit with a 7 in. by 19 in. rack-mounting panel.

1. Ionization Chamber

The ionization chamber shall be neutron-sensitive and non-gamma compensated Westinghouse WL-6937 or equal as follows:

- a. Type of coating on interior walls: Boron, enriched to to 96% B¹⁰.
- b. Minimum thermal neutron sensitivity: 4×10^{-14} amp/nv.
- c. Filling medium: Inert gas (such as argon).
- d. Gas pressure: One atmosphere.
- e. Maximum diameter: 4 in.
- f. Maximum length: 30 in.
- g. Connections for collector and high-voltage electrodes: Amphenol Series HN or equal. (No teflon shall be employed in the connector.)
- h. Sealing: Hermetic, by means of welding or soldering.
- i. Maximum neutron flux: 3.5×10^9 nv.
- j. Maximum saturation voltage at 3.5×10^9 nv: 300 volt d-c.

2. High-Voltage Supply

This shall be a regulated d-c power supply.

- a. Voltage output: 300 volt, approximately.
- b. Maximum ripple: 0.01%
- c. Maximum output voltage regulation: $\pm 2\%$.
- d. Supply voltage: 120 volt, 60 cycle.
- e. High-voltage interlock: Incorporated in the high-voltage supply chassis shall be an interlocking relay which shall be positively actuated when the supply terminal potential is 275 volt, and which shall operate continuously without injurious heating with a supply terminal potential of 350 volt. The relay shall be equipped with one pair of normally-open contacts.
- f. Output voltmeter: Mounted on front of panel of supply.
- g. Type of mounting: 19-in. relay rack.

3. Microammeter

This shall be G.E. Type DB-18 or equal, and as follows:

- a. Movement: D'Arsonval.
- b. Range: 0 to 20 microamp full scale.
- c. Mounting: Flush, panel.
- d. Size: 4 in. nominal.
- e. Scale: 270 degrees (nominal) preferred.
- f. Scale calibration: 0-150% full power.

4. Microcurrent Relay, K-1

This shall be similar to the Weston Model 705 Sensitrol Relay or equal as follows:

- a. Type of movement: D'Arsonval.
- b. Contacts: Single, normally open, at top of scale.
- c. Full-scale sensitivity: 5 microamp.
- d. Mounting: Flush, panel.
- e. Contact reset: Solenoid, to operate from 125-volt d-c circuit.

5. Range-Adjusting Resistors

See Drawing No. RE-2-24952-B.

6. Level Trip Auxiliary Relay, K-2

This shall be a small power relay similar to the Weston Model 712, suitable for operation in conjunction with relay K-1, and resistor, Item A-7, as follows:

- a. Coil Voltage: 6 volt d-c.
- b. Maximum coil current: To be compatible with rating of K-1 contacts.
- c. Contacts: Double pole, double throw.
- d. Minimum contact rating: 5 amp, 120 volt a-c.

7. Series Resistor, R-3

A wire-wound resistor shall be provided for use in conjunction with relay (Item A-6) having a resistance suited to the resistance of the relay K-2 operating coil and supply voltage. It shall have a power rating sufficient to permit continuous operation with a current equal to the rated relay coil current without overheating.

8. Fuse Holder

Panel-mounting, miniature, for Type 3AG fuse.

9. "Test" Pushbutton

This shall be a four-stage, momentary contact pushbutton. Its insulation and construction shall be such that leakage current from the 125-volt supply through the open pushbutton contacts will be less than 10^{-11} ampere.

10. Line Switch

B. Channel II (See Drawing No. RE-2-24952-B)

This channel is identical to Channel I, except that a multirange d-c microammeter is included in the ion chamber collector circuit to permit extended range level measurements.

1. Ionization Chamber

See Item A-1.

2. High Voltage Supply

See Item A-2.

3. Microammeter
See Item A-3.
4. Microcurrent Relay, K-3
See Item A-4.
5. Range Switch and Resistors
See Item A-5.
6. Level Trip Auxiliary Relay, K-4
See Item A-6.
7. Series Resistor, R-4
See Item A-7.
8. Fuse Holder
See Item A-8.
9. "Test" Pushbutton
See Item A-9.
10. Line Switch
11. Multi-Range d-c Microammeter

This amplifier shall be equal in all respects to the Leeds and Northrup Type 9836-D, except where indicated otherwise by the following:

- a. Ranges: (18) from 1, 2, 5×10^{-9} amp to 1, 2, 5×10^{-4} amp.
- b. Type of mounting: 19-in. relay rack.
- c. Input and output connectors, and ground terminal:
Mounted on rear of chassis.

C. Channel III

This channel shall consist of an ionization chamber, associated high-voltage supplies, a logarithmic amplifier, a period amplifier, and a log N indicating recorder. Contacts shall be provided to initiate reactor shut-down in the event of a reactor period shorter than a pre-set value.

1. Ionization Chamber

The ionization chamber shall be neutron-sensitive, and gamma-compensated, Westinghouse WL-6377 or equal as follows:

- a. Type of coating: Boron, enriched to 96% B¹⁰.
- b. Minimum thermal neutron sensitivity: 4×10^{-14} amp/nv.
- c. Minimum gamma compensation factor: 0.99.
- d. Filling medium: Inert gas (such as argon).
- e. Gas pressure: One atmosphere.
- f. Maximum diameter: 4 in.
- g. Maximum length: 30 in.
- h. Connections for collector and high voltage electrodes: Amphenol Series HN or equal. (No teflon shall be used in connectors.)
- i. Sealing: Hermetic, by means of welding or soldering.
- j. Maximum neutron flux: 3.5×10^9 nv.
- k. Maximum saturation voltage at 3.5×10^9 nv: Approximately 300 vdc.

2. High-Voltage Supply

This shall be a dual-voltage regulated d-c high-voltage supply intended for use with the above compensated ionization chamber as follows:

- a. Type of mounting: 19-in. relay rack.
- b. Supply voltage: 120 volt, 60 cycle.
- c. Maximum output voltage regulation: $\pm 0.5\%$.
- d. Ripple: 0.1 volt, peak to peak.
- e. Output voltage: To be matched to the requirements of the ion chamber, Item C-1. Positive voltage: 300 volt d-c. Negative voltage: Adj. 0-100 volt d-c.

3. Logarithmic Amplifier

This amplifier shall be an AEC ORNL-Q 915-1 type, or equal, and shall include as an integral feature all necessary test currents, switching, etc. for calibration and adjustment. Regulated power supply shall be included.

- a. Input current range: 5×10^{-11} to 1.5×10^{-4} amp.
- b. Supply: 120 volt, 60 cycle.
- c. Mounting: Relay rack $8\frac{3}{4}$ in. high by 19 in. wide.
- d. Output meters: Two - one for log N; one for period; both 4-in. panel meters.

- e. Output to recorder: Two - one 0-10 mv for log N recorder; and one -0.9 to 0 to +9.1 mv for period recorder or indicator with adjusting pots.
- f. Period trip: Adjustable from +3 to +30 seconds in period amplifier.
- g. Accuracy: $\pm 10\%$ of one decade log flux.

4. Log N Indicating Recorder

This shall be a standard millivolt recorder, self-balancing potentiometer type, Leeds and Northrup, Speedomax Type H, Model S, or equal as follows:

- a. Type of chart: Strip.
- b. Chart scale: Logarithmic, to correspond with log N indicating meter. 6.3 decade, calibrated 0.0001 to 300%.
- c. Chart speed: 6 in./hr.
- d. Accuracy: $\pm 0.5\%$ of range.
- e. Input voltage for full span: To be coordinated with logarithmic amplifier output, Item C-3.
- f. Supply: 120 volt, 60 cycle.
- g. Contacts: Two (2) SPDT snap-action contacts independently adjustable over full range.
- h. Mounting: Semi-flush, panel.
- i. Full-scale balancing time: 5 sec.

D. Channel IV

This channel shall consist of an ionization chamber, associated high-voltage supplies, an electrometer, and a linear level recorder.

1. Ionization Chamber

See Item C-1.

2. High-Voltage Supply

See Item C-2.

3. Electrometer

This shall be a d-c amplifier-type micro-microammeter designed for measurement of input currents between 10^{-3} amp, and 10^{-13} amp, in twenty ranges - Keithley, Model 410 or approved equal, complete with spare input assembly.

4. Linear Level Indicating Recorder

This shall be identical to Item C-4, except as follows:

- a. Chart scale: Linear, calibrated 0-100.
- b. Input voltage for full span: To be coordinated with output of electrometer, item D-3.

E. Channels V and VI

These channels will be identical and each shall consist of a neutron counter and associated high-voltage supply, preamplifier, pulse amplifier, and scaler-counter.

1. Counter Tube

Two required. Westinghouse WL-6307 BF, proportional counter or equal.

- a. Type: Boron-trifluoride, $B^{10}F_3$ 96% enriched.
- b. Sensitivity: 3 to 5 cps/nv.
- c. Maximum diameter: 1 in.
- d. Maximum length: 30 in.
- e. Gas pressure: 55 cm Hg.
- f. Connections: Amphenol Series HN (no teflon to be used in connector).
- g. Sealing: Hermetic, by means of welding or soldering.
- h. Voltage: 2000 volt d-c-

2. High-Voltage Supply

Two required. These shall be regulated d-c high-voltage supplies designed for use with counter tubes, Atomic Instrument Co. Model 318 or equal, and with characteristics as follows:

- a. Output voltage: Continuously adjustable from 500 to 2500 volt.
- b. Maximum output voltage regulation: $\pm 0.5\%$.
- c. Minimum rated output current: 250 microamp at 2500 volt.
- d. Type of mounting: 19-in. relay rack.
- e. Supply voltage: 120 volt, 60 cycle.
- f. Short circuiting relay: The supply to be arranged so that the output terminals are short-circuited when the supply circuit is de-energized.
- g. Ripple: Less than 0.1 volt, peak to peak.

3. Preamplifier

Two required. This preamplifier, Atomic Instrument Co. Model 219 or equal, designed for use with the linear amplifier (Item 4) and the BF₃ proportional counter to give necessary added gain, and suitable for operation 100 ft from linear amplifier. Complete with output cable. (Distance from counter is approximately 30 ft.)

- a. Gain: Approximately 30
- b. Rise time: Less than 0.2 microsec.
- c. Receptacles on preamplifier: Preamp signal input - Amphenol 82-805; High voltage - IPC 27,000; Power - AN3102-16S-1S.
- d. Output cable length: Approximately 100 ft.

4. Linear Pulse Amplifier

Two required. This amplifier, Atomic Instrument Co. Model 218 or equal, is designed to amplify low level pulses from the preamplifier (Item 3) to usable level to be acceptable by scaler (Item 5). Coarse and fine controls are provided for ease of output level choice. Complete with bandwidth selector, preamplifier filament and plate power (for 100 ft cable), and calibrated pulse amplitude discriminator.

- a. Gain: 2.0 mc bandwidth - 1,600
0.5 mc bandwidth - 6,000
0.1 mc bandwidth - 12,000
- b. Rise time: 2.0 mc bandwidth - 0.2 microsec
0.5 mc bandwidth - 0.7 microsec
0.1 mc bandwidth - 5.0 microsec
- c. Output: High - at least 90 volt (positive) into 1000 ohms
Low - at least 2.5 volt (positive)
Pulse Height Selector: at least 35 volt (negative) into 1000 ohms.
- d. Size: 8 $\frac{3}{4}$ in. high by 19 in. wide for rack mounting.
- e. Power supply: 120 volt, 60 cycle.
- f. Input and output connectors: To be mounted on rear of chassis.

5. Scaler No. 1

This instrument, Atomic Instrument Co. Model 1090-C or equal, accepts pulse signals from linear amplifier, Item 4 above, and electronically counts in decade fashion.

- a. Scaling factor: 10, 40, 100, 400, and 1000 selected by switch.
- b. Mechanical register: 4 digit register electrically reset.
- c. Discriminator: Every two volts from -50 to +100 volt.
- d. Resolution: 1 microsec.
- e. Timer: Included, Atomic Instrument Co. Model 960 or equal, complete with preset timer and elapsed timer.
- f. Power supply: 120 volt, 60 cycle.
- g. Size: $8\frac{3}{4}$ in. by 19 in. for rack mounting.

6. Scaler No. 2

Atomic Instrument Co. Model 1090 (same as Item 5 but without elapsed timer).

F. Channel VII

This channel shall consist of a photomultiplier scintillation probe - preamplifier assembly, high-voltage power supply, pulse amplifier, pulse analyzer, and log count rate meter.

1. Scintillation Probe and Preamplifier

Atomic Instrument Co. Model 812 or equal. For gamma-ray detection and counting by scintillation techniques.

- a. Crystal: NaI (thallium activated) 1-in. diameter by 1 in. long, canned in aluminum.
- b. Phototube: Dumont Type 6291.
- c. Optical coupling: DC-200 silicone.
- d. Magnetic shielding: Mu metal.
- e. Preamplifier: Built in, gain of 1.
- f. Power: 1400 volt d-c, 260 volt at 6 ma d-c, 6.3 volts a-c
- g. Receptacles: High voltage - IPC 27,000.
Preamp. - AN3102A - 16S-1S.

2. High-Voltage Power Supply

Atomic Instrument Co. Model 312 or equal. This instrument provides high voltage to scintillation probe.

- a. Stability: 0.02% per day.
- b. Line regulation: 0.1% for 100-130 volt.
- c. Maximum current output: 1 milliamp.
- d. d-c internal impedance: Approximately 4000 ohms.
- e. Range: 85 to 1450 volt in 17 steps.
- f. Size: $3\frac{1}{2}$ in. by 19 in. for rack mounting.
- g. Power supply: 115 volt, 60 cycle.

3. Linear Pulse Amplifier

Atomic Instrument Co. Model 218 or equal. (Same as Item E-4, Channel V and VI.)

4. Pulse Analyzer

Atomic Instrument Co. Model 510 or equal. This instrument allows only those input pulses falling in between two sets of amplitude levels to pass on through to the log count rate meter (Item 5).

- a. Input pulse: 0-100 volt, positive
- b. Output pulse: Approximately 15 volt, negative.
- c. Size: $8\frac{3}{4}$ in. by 19 in., for rack mounting.

5. Log Count Rate Amplifier

AEC Spec. ORNL-Q-751 or equal. This amplifier accepts pulses from pulse analyzer (Item 4) and displays an integrated counting rate from 1-10,000 cps on a 4-in. meter.

- a. Response time: Responds to pulses 0.4 microsec long.
- b. Input: 3-15 volt pulse.
- c. Size: $8\frac{3}{4}$ in. by 19 in., for rack mounting.
- d. Power: 120 volt, 60 cycle.

G. Channel VIII

This system is to provide five channels of area monitoring in the reactor building and shall consist of the following Victoreen Instrument Co. items, or equal:

1. Sensing Units

Four Model 716 units without check source for range from 0.1 mr/hr to 100 mr/hr. One Model 717A unit with check source for range from 10 mr/hr to 10 r/hr.

- a. Sealing: Hermetically sealed ionization chamber, tube sealed within chamber, immersion proof, independent of humidity.
- b. Temperature range: -20°F to 180°F.
- c. Output: 0-10 millivolt.

2. Plug-in Stations

Five required. In rack-mounting unit complete with power supply.

- a. Range: Four units: 0.1 mr/hr to 100 mr/hr (Model 715).
One unit: 10 mr/hr to 10 r/hr (Model 715B).
- b. Gamma energy response: Independent within $\pm 10\%$ from 80 kev to 1.3 Mev.
- c. Accuracy: $\pm 15\%$ of any radiation rate within range of detector.
- d. Stability: Within 5% for line voltage variations between 100 and 130 volt.
- e. Response time: Under eight seconds for 10 mr/hr and above for 90% indication.
- f. Power supply: 120 volt, 60 cycle.
- g. Dimensions: Approximately 19 in. wide by 7 in. high by $12\frac{1}{4}$ in. deep.

H. Preamplifier Panel

This shall be a welded steel cabinet in which shall be installed components specified above as follows:

<u>Channel</u>	<u>Component</u>
III	H. V. Supply
IV	H. V. Supply
V	H. V. Supply
VI	H. V. Supply
VII	H. V. Supply
V,VI	Preamplifiers

In addition a rack-mounting cooling fan assembly, complete with intake filter, delivering 300 cfm of air, equal in all respects to the Model 2E408, manufactured by McLean Engineering Laboratories of Princeton, New Jersey, shall be installed in the lowest portion of the cabinet.

A panel containing reactor shutdown, pushbutton, PB3, shown on Drawing No. B-CID-486-A32 shall be mounted and wired.

At least 14 in. of spare panel space shall be provided for future installation of additional equipment.

Cabinet shall include sufficient stiffening members to provide a strong, rigid assembly. Top, bottom, and sides of the cabinet shall be completely enclosed, except that: (1) Air exhaust louvres shall be provided near the top, of sufficient area to permit free flow of the ventilating air; (2) A removable plate to accommodate wiring shall be furnished on the bottom closure providing access to an opening 4 in. wide and 18 in. long across the width of the cabinet and 2 in. from the rear; and (3) a door, complete with hinges, bolt and handle, shall provide access to the entire cabinet from the rear.

Cabinet shall be 22 in. wide, 18 in. deep, and a maximum of 84 in. high.

Mounting bolt holes shall be provided in the base for mounting on a 2-inch wide angle iron frame measuring 22 in. by 18 in. (outside dimensions).

Adjustable chassis-support rails shall be provided for all chassis.

I. Reactor Control Center

A reactor control center shall be constructed in accordance with the drawings.

All rack-mounted components shall be set flush with the main cabinet panel. Adjustable chassis-supporting rails shall be provided for all chassis.

Cabinet shall provide a complete enclosure except that air exhaust louvres shall be provided near the tops of the doors to permit free passage of ventilating air. End closures shall not be used for ventilating openings.

Top panels shall be removable for drilling. Cables for external connections will enter from the top.

In addition to the previously specified components shown mounted in the cabinet, the following shall be provided and installed:

- (1) Two (2) automatic voltage regulators, Superior Stabiline Type 1E5102R or an approved equal.
- (2) Four (4) cooling fan units, McLean Model 2E408, or approved equal.
- (3) One (1) 8 in., 24-hour synchronous electric clock. Clock will be energized from a separate 120-volt, 60-cycle supply.
- (4) One (1) 18-point, 125-volt d-c, annunciator lamp panel, complete with lamp assemblies, 3 high by 6 wide, Panalarm Series 31 (light cabinet only). Relays associated with these annunciator lights will be mounted elsewhere and shall be connected in accordance with Drawing Nos. B-CID-486-A34, -A35, -A36.
- (5) Nine (9) indicators for control rod position, the construction of these indicator assemblies is shown on Drawing No. H-2267-10-4.

- (6) Rod indicator lights: 27 required; switch-gear type with dropping registers for 120-volt service; Westinghouse Round Minalite, Style No. 822 322 or equal, complete with bulbs, and red, green and amber lenses as shown on Drawing No. X-2267-10-A.
- (7) One Leeds and Northrup Cat-No. 10874-K Automatic Rod Control Servo Amplifier. The control signal for this unit is derived from the Pressure Deviation Indicator in the Process Panel. (See Item 122 of Specifications for Process Panel and Associated Instrumentation.)
- (8) An operating position panel section complete with the devices shown mounted thereon in Drawing No. X-2267-10-C, View A-A. These devices shall be as follows:
 - (a) 1K-1, 1K-2, 1K-3: Oil-tight type, two-position key-operated switches, key removable in c.c.w. position only. Square D, Class 9001, or equal. There shall be two "N.O." and two "N.C." contacts per switch. All are to be keyed alike.
 - (b) PB-11, PB-12, PB-5: Oil-tight type, momentary contact pushbutton units, black buttons, Square D, Class 9001, or equal, with two "N.O." and two "N.C." contacts per pushbutton.
 - (c) PB-4: Oil-tight type, momentary contact pushbutton unit, having red mushroom button. Square D, Class 9001 or equal with four "N.O." and four "N.C." contacts per pushbutton.
 - (d) 1-1, 1-2: Rotary, three-position switches with spring return to center position, and having contacts as shown on Drawing No. X-CID-486-1.
 - (e) Indicating Lights: Two, "Control Power On" and "Reactor on Auto"
 - (f) SS-1: Eight-point selector switch, having contacts as required by Drawing X-CID-486-1. Electro Switch Corporation, Type JR, or equal. Panel shall be labeled with position numbers as shown.
 - (g) PB-9: Selector switch, two-position, oil-tight type having four "N.O." and four "N.C." contacts, Square D, Class 9001 or equal.
 - (h) PB-6: Oil-tight type, momentary contact pushbutton unit, black button, having eight "N.C." contacts, Square D, Class 9001 or equal.
- (9) All relays, etc., required by the wiring diagrams shall be mounted within the cabinet.

X. REFERENCE DRAWINGS

H-2267-10-4	Assembly of Special Rod Position Indicator
J-2267-10-3	High-Voltage Supply Cabinet
X-2267-10	Plan and Base Angle Plan View - Neutron Instrumentation and Control Cubicle.
X-2267-10-A	Front and Internal View of Front Panel - Neutron Instrumentation and Control Cubicle.
X-2267-10-B	Rear View of Terminal Board Construction - Neutron Instrumentation and Control Cubicle.
X-2267-10-C	Hinged Control Panel - Neutron Instrumentation and Control Cubicle.
X-CID-486-HV	Wiring Diagram - High Voltage Supply Cabinet
X-CID-486-NF1	Wiring Diagram, Neutron Instrumentation and Control Cubicle, Front.
X-CID-486-NF1A	Wiring Diagram, Neutron Instrumentation and Control Cubicle, Front.
X-CID-486-NF2	Wiring Diagram, Neutron Instrumentation and Control Cubicle, Front.
X-CID-486-NF2A	Wiring Diagram, Neutron Instrumentation and Control Cubicle, Front.
X-CID-486-NT1	Wiring Diagram, Neutron Instrumentation and Control Cubicle, Terminal Boards.
X-CID-486-1	Wiring Diagram, Switch Developments, Drive Units, Junction Box, and Misc. Equipment.
RE-2-24932-B (ANL)	Elementary Wiring Diagram, Center Rod Auto Control Auxiliary Circuits - ALPR.
RE-2-24952-B (ANL)	Channels I and II - ALPR Scram/Indicator Panels Schematic Diagram.
B-CID-486-A21	Elementary Wiring Diagram - Control Rod No. 1
B-CID-486-A22	- Control Rod No. 2

B-CID-486-A23	Elementary Wiring Diagram - Control Rod No. 3
B-CID-486-A24	- Control Rod No. 4
B-CID-486-A25	- Control Rod No. 5
B-CID-486-A26	- Control Rod No. 6
B-CID-486-A27	- Control Rod No. 7
B-CID-486-A28	- Control Rod No. 8
B-CID-486-A30	- Center Rod
B-CID-486-A31	- Scram Circuit
B-CID-486-A32	- Scram Circuit (Cont'd.)
B-CID-486-A33	- Rod Clutch Control
B-CID-486-A34	- Nuclear Annuncia- tor System
B-CID-486-A35	- Nuclear Annuncia- tor System
B-CID-486-A36	- Nuclear Annuncia- tor System
B-CID-486-A37	- Log Power, Linear Power and Cooling Fans
B-CID-486-A38	- Channels I and II
B-CID-486-A39	- Channels III and IV
B-CID-486-A40	- Channel V
B-CID-486-A41	- Channel VI
B-CID-486-A42	- Channels VII and VIII

XI. VENDOR

Leeds and Northrup Co.
Philadelphia, Pennsylvania

XII. PURCHASE ORDER

Argonne National Laboratory AL-227801

Leeds and Northrup Co. No. 14800

SECTION 6

PRESSURE VESSEL AND ACCESSORY EQUIPMENT

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I. GENERAL

These specifications are intended to cover the furnishing of all materials and the shop fabrication of:

- (1) Stainless steel clad pressure vessel to function as a steam generator, equipped with an internal stainless steel thermal shield, piping, and nozzles, etc.
- (2) Thermal insulation; block type with magnesia base.
- (3) Insulation cover of 1/4 in. carbon steel plate, aluminum painted on the outside.
- (4) Special transport cradle for loading, unloading, and shipping.

Dimensions and arrangement of this equipment will be as generally shown on Lasker Boiler & Engineering Corporation Drawings Nos. 3995, 3996, 3997, 3998, 3999, 4001, and 4004.

Installation of this equipment will be at the ALPR Site, National Reactor Testing Station, Scoville, Idaho. Installation and/or erection will be performed under separate contracts.

All quotations shall be f.o.b., motor freight, ALPR Site, National Reactor Testing Station, Scoville, Idaho.

II. TECHNICAL DATA

A. Design

Number of pressure vessels required	1
Position of vessel	Vertical
Outside diameter of vessel	4 ft - 6 in.
Length, face of flange to inside of head	14 ft - 6 in.
Operating pressure	300 psig
Operating temperature	
Water and steam	420° F
Metal	470° F
Design pressure	400 psig

Design temperature	
Water and steam	450° F
Metal	500° F
Type of construction	All welded, in accordance with ASME Code for Unfired Pressure Vessels. Out-of-roundness shall be limited to $\pm 1/8$ in.
Materials	Type 304 stainless steel clad on ASTM Spec. A-300-54A T Class 1, A-212 Grade B, Firebox carbon steel (Lukens pressure bonded stainless steel cladding.)
Dished head	2:1 Elliptical
Thickness of dished head	Not less than the thickness of shell plates.
Pressure Vessel Flange	
Type of flange	Welding neck, ASTM type 105, Grade II, with Type 304 stainless steel clad on faces and inside surface.
Design loads	Flange shall be designed to support the vessel with the vessel full of water and suspended from the supporting cylinder as shown on the drawing. When the vessel is at 400 psig a static load of 1000 lb is present on each of the nine nozzles in the cover plate. When the vessel is at atmospheric pressure a load of 27,000 lb may be present on any 6-inch nozzle in the cover plate instead of the 1000-lb loadings.
Positioning and guiding of cover plate	Cover plate and flange shall be equipped with guide pins which will maintain proper orientation of the cover plate, core assembly, thermal shield, and facilitate the assembling to avoid damage to the bolts.

Flange facing	
Underside of flange	Underside of flange shall be faced for bearing on the supporting shield.
Flange face	Upper side of the flange shall be faced with two (2) gasket grooves. There shall be a continuous leak-off groove machined midway between the gasket grooves; the leak-off groove shall be provided with two (2) drain connections on the outer periphery, approximately 180° apart.
Flange drilling	Flange shall be drilled and tapped for bolt studs. Threads shall be Class 2 fit.
Gaskets	Special style "R" plated C.R.S. and Teflon filler (Spiral-wound) Alternate: Special style "R" plated C.R.S. asbestos filler (spiral-wound)
Cover plate	
Material	ASTM spec. A-300-54a T, Class 1, A212 Grade B, Firebox with underside clad with 3/16-inch thickness of Type 304 stainless steel applied by submerged arc welding. The method of application and electrodes used shall be such that the carbon content of the cladding does not exceed 0.08% (max.) for a depth of approximately 0.100 in. below the surface.
Facing	The facing in contact with the gasket shall be machined to a micro-inch finish of 32.

Design	Cover plate shall be designed for an internal pressure of 400 psig at 500°F, and an external loading of 1000 lb per nozzle on all of the nine 6-inch nozzles shown. The cover plate and nozzles shall be designed to support a load of 27,000 lb, on any one nozzle, when the vessel is at atmospheric pressure.
Cover plate bolting	
Studs	Type A-193, B-14 steel lubricated with graphite and oil mixture upon assembly with nuts.
Nuts	Type A-194 class 2H steel, Class 2 fit
Washers	Two (2) hardened flat washers per bolt with mating surfaces ground and prepared to prevent galling. Mating surfaces shall be lubricated with graphite and oil mixture upon assembly.
Nozzles	The cover plate shall be equipped with 11 nozzles.
Nominal size of nozzle	(9) 6-inch special (requires standard 5-inch gasket) (1) 4-inch special (requires standard 4-inch gasket) (1) 2½-inch special (requires standard 3-inch gasket)
Nozzle material	Type 304 stainless steel
Nozzle flanges	(9) 6-inch special, stainless steel Type 304. (1) 4-inch 400-psig, special, stainless steel Type 304 (1) 2½-inch, 400-psig, special, stainless steel Type 304

Blind flanges required	(4) 5-inch, 400-psi, shield plug-type as shown on the drawing.
Type of gasket required	Stainless steel, spiral-wound, asbestos filled.
Thermal shield	Type 304, stainless steel $\frac{3}{4}$ in. thick, fabricated in one (1) piece.
Piping	
Steam connections	There shall be a 4-inch Schedule 160 stainless steel Type 304, nozzle with end prepared for butt welding to 4-inch Schedule 40 pipe extending approximately 12 in. from the shell plate.
Feed connections to shell	Two, 2-inch Schedule 80, Type 304, stainless steel nozzles, for use as thermal sleeves, and extending approximately 8 in. from the shell plate.
Feed-water piping	Two, $1\frac{1}{4}$ -inch Schedule 40, stainless steel feed-water assemblies, extending approximately 12 in. from the shell plate. Feed-water temperature is approximately 135°F.
Water purification piping and spare	Two, 1-inch stainless steel piping assemblies - without thermal sleeves extending approximately 12 in. from shell plate.
Openings and reinforcement	Openings shall be reinforced, where necessary, to meet Code requirements.
Thermal insulation	The vessel shall be insulated with 3 in. of block-type, magnesia-base insulation securely attached to the vessel.

Insulation covering

Outside of the insulation there shall be installed a two-piece steel cover to retain the insulation in place. The steel cover shall be 1/4 in. ASTM Specification A-212-54a T Grade B Firebox. The cover shall be designed as a hollow column, with lap joints, 2-inch welds on 5-inch centers and capable of supporting the weight of the pressure vessel, flange, and insulation when the vessel is empty and the top cover plate is removed.

Out-of-roundness shall be limited to $\pm 1/8$ in. in place when fitted tight to the insulation.

For the purpose of shock-proof anchoring of pressure vessel in "saddles" during transportation, certain sections of insulation and the 1/4-inch covering must be removable.

The insulation covering shall be given a shop coat of aluminum paint on the outside.

Shipping limitations
(each crate)

Dimension (max)

7 ft-6 in. x 9 ft x 20 ft

Weight (max)

20,000 lb

Inspection

Material

Purchaser shall be furnished copies of all mill test reports, showing compliance with the specifications.

Shop inspection of fabrication	At the discretion of the Purchaser, or his authorized representative.
Code stamp	Vessel shall bear an ASME Code Stamp for the design conditions stated.
Radiographic inspection by fabricator	All welding on the pressure vessel and cover plate shall be radiographed in accordance with the ASME Codes. Films shall be submitted to the Purchaser. All faults disclosed by this survey shall be repaired by the contractor at his expense. No shipment shall be made until the radiographs have been approved by the Purchaser.
Notification of Progress	Purchaser shall be notified of progress so inspection can be made at various times. Special notification shall be made as to time of strength welding of vessel, cladding, insulation application, cleaning and testing.
Testing	
Hydrostatic test	No leakage at 600 psig for 2 hr in a simulated operating position (suspended from flange).
Helium Leak Test	Vessel only, exclusive of cover plate seal, at 300 psig for 48 hr with a maximum leakage allowable of 1.5 cc/day, to be collected in an impervious bag and measured by a mass spectrometer.
Cleaning	
General	The pressure vessel and piping shall be cleaned internally to remove dirt, oil, grease, mill scale, and welding beads.

Sandblasting

Sandblasting should be used as a preliminary operation only for the removal of heavy scale which would otherwise require excessive pickling. Only aluminum oxide should be used.

Passivation

The interior of the vessel shall be swabbed with a solution for passivating, followed by thorough scrubbing and rinsing with clean hot water and a final rinse with demineralized (iron-free) water.

Shipping

When the pressure vessel has been released for shipment, all openings, other than the flange, shall be tightly closed by adequate covers to prevent the entry of dirt, water, or other foreign material. All finished surfaces shall be adequately protected against marring and other damage. A 10-lb bag of Silica Gel shall be placed into the vessel prior to shipment.

The flange shall have a 3/16-inch steel lid and flat gasket bolted in place to protect the machined surface and also to guard against internal contamination.

All internal components shall be blocked and braced rigidly to insure against injury under normal transit conditions. Extra fasteners shall be furnished, as required, to prepare the vessel for shipment.

Shop drawings

Shop drawings, detail sketches, etc., shall be submitted to the Purchaser for approval, before the work is placed in the shop for fabrication.

B. Equipment

Thickness of shell plate

3/4-inch ASTM, A-212, Grade B Firebox, backing with 3/16-inch nominal cladding Type 304 stainless steel inside (Lukens Steel Co.)

Thickness of dished head plate

Same as above.

Thickness of flange

5 ⁷/₈-in. at bolting diameter.

Thickness of cover plate

8-inch ASTM, A-212, Grade B Firebox, clad with 3/16-inch Type 304 stainless steel.

Type of gaskets

For cover plate

Spiral-wound plated C.R.S. teflon or asbestos-filled (optional).

Dimensions and identification

53 ¹/₄-in. x 54 ³/₄ in. x 0.175 in.
Style R special

55 ³/₄-in. x 57 ¹/₄ in. x 0.175 in.
Style R special

Gasket manufacturer

Flexitallic Gasket Company

Type gasket for nozzle flanges

Spiral-wound stainless steel with asbestos filler

Dimensions and identification

5 in. - R4 - 6N
4 in. - R4 - 6L
3 in. - R4 - 6J

Gasket manufacturer

Flexitallic Gasket Company

Cover plate bolting

Number of bolts	48
Bolt diameter	1 $\frac{3}{4}$ in.
Bolt material, ASTM Specification or other designation	ASTM A-193-B14
Material of nuts, ASTM Specification or other designation	ASTM A-194-Class 2H
How does the Manufacturer propose to provide for differential expansion in the bolting area?	None required.
How does the Manufacturer propose to align the cover plate with the pressure vessel flange during assembly without damage to the studs?	Four guide pins non-symmetrical about the bolting diameter.
Method of attaching insulation to the vessel.	Wiring individual blocks together and banding around the vessel.
The Manufacturer shall submit estimated weights of the following:	
The pressure vessel, empty, including flange, insulation, insulation cover and miscellaneous accessories.	17,000 lb
Top cover plate	8,300 lb
Bolts, nuts, and washers	600 lb

III. RECOMMENDED SPARE PARTS

- (2) Complete sets Pressure Vessel cover gaskets
- (4) Complete sets Pressure Vessel nozzle gaskets
- (4) Studs with nuts and washers
- (2) Guide pins
- (2) Guide pin bars
- (6) Stud gauge bars

IV. REFERENCES

Drawing 3995 Pressure Vessel Details
3996 Pressure Vessel Details
3997 Pressure Vessel Details
3998 Pressure Vessel Details
3999 8-inch Blind Head with Opening and Access
4001 Transport Skids
4004 General Arrangement
Pressure Vessel Welding Procedure
Pressure Vessel Head Installation
RE-1-20235 Thermal Shield Drill Jig (ANL)

V. VENDOR

Lasker Boiler and Engineering Inc.
3201 South Wolcott Avenue
Chicago 8, Illinois

VI. PURCHASE ORDER

Argonne National Laboratory, AL-221892

SECTION 7

PRESSURE VESSEL SUPPORT CYLINDER AND COOLER

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I. GENERAL

These specifications are intended to cover the furnishing of all materials for and the shop fabrication of a carbon steel support vessel, together with certain cooling coils and thermal shields of lead, steel and Boral. That portion of the steel in this vessel which serves as a structural support for a heavy pressure vessel to be suspended from the upper flange face, is referred to as "support steel." Steel used as a lead enclosure is referred to as "lead jacket steel."

Installation of this equipment will be at the National Reactor Testing Station, Scoville, Idaho, and will be performed by others under separate contract.

All quotations shall be f.o.b., motor freight, ALPR Site, National Reactor Testing Station, Scoville, Idaho.

II. MATERIALS AND WORKMANSHIP

Materials and workmanship shall be first class in all respects, conforming with the technical data in this specification, and in accordance with the latest shop practice.

III. METHOD OF CONSTRUCTION

The copper cooling coils are to be bent into the desired configuration with dry sand inside, in order to obtain a smooth curvature and to prevent distortion. The sand will be removed completely, and the coils thoroughly cleaned. Each coil will be continuous in length (no joints). If damaged during fabrication, the coil will be replaced and not repaired. The entire surface of the cooling coils will be tinned to insure good lead bonding. The coils will be clipped to the steel support shell with 12-inch spacing. All flux will be removed after tinning.

The support shell will be tinned on all surfaces in contact with the lead and cooling coils. All flux will be removed after tinning.

The lead will be layed in between the cooling coils in form of $1\frac{1}{4}$ in. thick sheets, allowing enough clearance between the sheet and the coil for burning in lead. There will be a good bond between the lead and the cooling coils and support shell, except in the area of the shell where the lead sheet was placed. This area will be minimized by burning back from the edge enough to give a solid lead structure. The burned-in area of the lead will be scraped to conform with the curvature of the outer diameter of the lead shield. The lead burned in will be kept below 850°F at all times to prevent amalgamation with the copper cooling coils.

The lead projection will be built up manually by burning in and will conform with the configuration.

The $1\frac{1}{2}$ inch steel belt will be tinned on the concave side and receive a layer of lead conforming to the curvature of the lead shield. This belt will then be clamped to the lead shield with the lead interface compressing together. While the belt is still in a stressed position, it will be welded to the support shell flanges.

The steel jacket over the lead shield will be placed tightly over the lead shield, compression being at the steel and lead interface. The jacket will then be welded in place and all seal welds made.

When welding in the proximity of lead, sheet metal will be used to separate the weld area from the lead to prevent vaporization of lead and dilution of the weld.

The support shield strength welds (inner vertical cylinder) will be radiographed. All other welds will receive a dye-penetrant test.

IV. SUPERVISION AND INSPECTION

The Purchaser, or authorized representatives, shall have free access for inspection to all phases of the work performed by the Contractor, during construction and testing.

V. CLEANLINESS AND SHIPPING

The copper tubing shall be thoroughly cleaned of dirt and grease before shipping, and tube ends plugged against entry of dirt.

The two halves of the vessel shall be carefully packed and protected against damage in transit.

VI. TECHNICAL DATA

Number of support cylinders required	1
Number of sections	2
Method of connection	Flanged and bolted

Position	Vertical
Structural steel design	
Configuration	Hollow Column
Estimated loads	
Pressure vessel	100,000 lb
Skin friction from fill of gravel at 130 lb/cu. ft.	25,000 lb
Support cylinder	30,000 lb
Total	155,000 lb
Support steel material	ASTM A-212-54aT, Grade B, Firebox Quality
Bolting material	ASTM A-193-55T, Grade B7
Nuts	ASTM-194-55T, Grade 4
Fabrication, Support Steel	
Dimensions	As shown on Dwgs. No. 4002 and 4004
Out-of roundness	Limited to $\pm 1/4$ in.
Angular tolerance, flange face	± 0 deg 3 min 26 sec
(Linear tolerance, flange face)	($1/32$ in.)
Flange facing	The top face of the steel plate, and of the reinforcing angle, shall be faced for support of a pressure vessel.
Bottom head and base plate	Welded in half-cylinders

Welding

Welding shall be done by operators who have been qualified by tests as prescribed in Section 9 of the ASME Boiler Code.

Copies of the proposed welding procedure and a description of the electrodes shall be submitted to the Purchaser prior to beginning work. Written approval by the Purchaser shall be obtained before fabrication is started.

Stress Relief

After strength welds have been made and tested (including attachment of reinforcement around nozzle openings), but before placement of the copper coils or lead, the two halves of the vessel shall be bolted together and the assembly stress-relief of strength welds shall be mutually agreed upon by Contractor and Purchaser and approved prior to beginning work.

Lead Jacket Steel

ASTM A-212-54aT, Grade B Firebox quality.

Fabrication, Lead Jacket Steel

Dimensions

As shown on Dwgs. No. 4002 and 4004

Attachment of
Boral plates

Drill and tap for 1/4-inch cap screws on approximately 2-foot centers, each half. Method of attachment to outside of shell must comply with "closure section"

Closure

Continuous seal welds shall close all seams in steel around the lead; no cracks, gaps, or holes exposing lead shall remain after fabrication is complete. Closure shall be such that no leakage could occur if lead were accidentally melted during operation.

Testing, closure around lead	A pneumatic test of 5 psig will be made with all seams soaped. This will be done in the presence of a representative designated by the Purchaser.
Copper cooling coil material	ASTM B-75-55 seamless copper tubing Type DHP, soft annealed, 5/8 in. O.D. by 0.049 in. wall, tinned on outside, coiled at mill.
Fabrication, Copper Coils	
Position in vessel	As shown on Dwgs. No. 4002, 4003, and 4004.
Method of bending	So as not to collapse tube or cause restriction in internal flow.
Connections	No joints of any kind will be permitted in any individual coil.
Attachment of coils to support steel plate	The copper coils shall be firmly attached to the support steel by suitable clips welded to the steel, spaced at approximately 1-foot intervals along the tubing.
Marking	Both ends of a continuous coil shall be marked for identification during installation.
Testing and cleaning, copper coils	After bending to shape, but before imbedding in lead, coils shall be subjected to hydrostatic test at 500 psig, and a flow test of 4 gpm per coil at a supply pressure of 30 psig.
Lead Material	ASTM-B-29-55, chemical grade lead with a melting point of approximately 618°F.

Fabrication, Lead	As shown on Dwgs. No. 4002 and 4004
Bonding to copper coils	Lead shall completely cover and be firmly bonded to outer surface of copper coils.
Bonding to steel plates	Lead shall completely cover and maintain contact with the steel surface.
Voids and porosity	The lead shall be free of voids, cavities, and porosity, and shall completely fill the region in which it is placed.
Temperature during placement	Lead not to exceed 850°F so that copper tubing is not attacked.
Boral plate material (Brooks & Perkins, Inc.)	1/4-inch plate, 0.75 lb/sq ft of B ₄ C, as 35% B ₄ C in cast aluminum clad on both sides with 0.041 in. aluminum.
Fabrication, boral plate	As shown on Dwgs. No. 4002 and 4004
Attachment to steel	Drilled but not countersunk for 1/4-in. capscrews.
Painting	After completion, vessel shall be given shop coat aluminum paint inside and outside.
Shop drawings	Shop drawings, detail sketches, etc. shall be submitted to the Purchaser. Written approval by the Purchaser shall be obtained before the work is placed in the shop for fabrication.
Inspection and Tests	
Material	The Purchaser shall be furnished copies of all mill test reports, showing compliance with specifications.

Shop Inspection of
Fabrication

Shall be at discretion of the
Purchaser or his authorized
representative.

Inspection of Welds

All welding on the structural
7/8-inch steel support cylinder
shall be checked by a radiograph
method rather than by a die
penetrant method. Films shall
be submitted to the Purchaser.
All faults disclosed by this sur-
vey shall be repaired by the Con-
tractor, at his expense.

Inspection of Lead

The lead shield, when completed,
will receive a spot check for
voids at no more than four places.
Any additional checks authorized
by the Purchaser shall be billed
by vendor as an additional cost to
this order. All checks shall be
by a radiation source method in
locations specified by the
Purchaser.

VII. REFERENCE DRAWINGS

Vendor's Drawings Nos. 4001, 4002, 4003 and 4004.

VIII. VENDOR

Lasker Boiler and Engineering Corporation
3201 South Wolcott Avenue
Chicago 8, Illinois

IX. PURCHASE ORDER

Argonne National Laboratory AL-221899

SECTION 8

PROCESS CONTROLS AND ASSOCIATED INSTRUMENTATION

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I. SCOPE OF WORK

Manufacturer shall provide components for a complete metering and control system, including instrument panel and accessories, all separable sockets or thermometer wells, temperature-sensing elements, conductivity cells, and other meter and control accessories required for the complete installation of instruments, meters and controls, as listed in this specification. The work includes provision of the following:

- (1) A complete system of three-element feed-water control consisting of reactor level, steam flow, and feed-water flow instruments, complete with feed-water control valve.
- (2) A complete system of bypass steam pressure control consisting of upstream pressure instrument and bypass control valve.
- (3) A complete system of condenser air circulation control consisting of associated temperature instruments, damper operators, and fan speed control.
- (4) A complete set of recording and/or indicating instruments and all accessories for mounting in the Process Control Panel.
- (5) A complete annunciator system.
- (6) A Process Control Panel.

The work does not include:

- (1) All interconnecting wiring, valves, and piping unless otherwise specified. (To be furnished and installed by others.)
- (2) Installation of shop-wired panel and primary elements.

II. GENERAL

One year's supply of charts and ink shall be furnished with each recorder.

All data transmission between components of the system shall be accomplished electrically.

All temperature-measuring instruments shall incorporate automatic cold junction compensation. All instruments incorporating standard cells shall include automatic current standardization with provision for manual standardization.

Unless otherwise specified, all electrical interlocking and alarm contacts shall be closed under normal operating conditions, and open under the applicable abnormal conditions. Thus, contacts specified as "high" should open with an increase in the measured variable.

Wherever possible, vacuum tubes shall be of the "long-life" or "premium" type.

All electrically-operated instruments and accessories shall be rated for operation from an electrical supply of 120 volt, 60-cycle, unless otherwise specified. Supply voltage regulation shall be assumed to be within $\pm 5\%$.

Name plates made of black phenolic with white engraved letters shall be furnished for all instruments, meters, control devices, and transmitters. The engraving to be used will be specified by the Purchaser.

No single unit when crated for shipment shall exceed the dimensions of $7\frac{1}{2}$ ft by 9 ft by 20 ft and a weight of 20,000 lb.

The equipment is to be installed at the ALPR Site, National Reactor Testing Station, Scoville, Idaho, at an elevation of 5100 ft above sea level.

III. INSTRUMENT DATA AND DETAILS

A. Three-Element Feed-Water Control

Vendor to furnish an all-electric, three-element feed-water control system that will control the water level in the reactor vessel. Such a system will consist of the below listed instrumentation and control components, or equivalent, to control from (1) reactor water level; (2) feed-water flow; and (3) steam flow. The sensitivity of the control system to variations in each control parameter shall be independently adjustable. Should a single element control be desired (valve action controlled by reactor level), the additional elements may be cut out by means of selector switches.

<u>Item</u>	<u>Quantity</u>	<u>Description</u>
14	1	<p>L & N Speedomax H. Model R (Round Chart) Reactor Water Level Recorder.</p> <p>Measuring Circuit: Automatically balanced d-c potentiometer.</p> <p>Control Element: One control slidewire.</p> <p>Scale: -6 ft-6 in., to 0, to +5 ft-6 in. level, linear, circular, 23-in. calibrated length.</p> <p>Control Point Setter: Manually positioned on circular scale.</p> <p>Balancing Speed: 5 sec, full scale.</p> <p>Proportional Band: Adjustable from 0 to at least 2 ft.</p> <p>Chart Speed: 1 revolution per 24 hr.</p> <p>Alarm Contacts: Two pairs of high contacts and two pairs of low contacts, all independently adjustable over full-scale range.</p> <p>"Fail-safe Feature": Recorder shall drive up-scale in the event of open-circuited primary element or internal component failure.</p>
108	1	<p>Fisher-Hays Reactor Vessel Water Level Transmitter of the top-mounted displacer-torque tube type as follows:</p> <p>Normal Fluid Pressure: 300 psig</p> <p>Normal Fluid Temperature: 420°F</p> <p>Max. Fluid Pressure: 400 psig</p> <p>Max. Fluid Temperature: 450°F</p> <p>Active Displacer Length: 144 in.</p> <p>Materials (parts in contact with reactor water or steam): stainless steel</p> <p>Transducer: Movable core differential transformer</p> <p>Max. Ambient Temperature at Transducer: 400°F</p> <p>Mounting: 4-inch, 400 lb flange</p>

<u>Item</u>	<u>Quantity</u>	<u>Description</u>
	1	<p>Hays Model DEF1 Indicating Receiver and Retransmitter unit including associated amplifier.</p> <p>Range: -6 ft -6 in., to 0, to +5 ft, -6 in.</p> <p>Retransmitting Slidewire: (1) 100%</p> <p>Alarm Contacts: (2) SPDT adjustable over full-scale range</p>
13	1	<p>L & N Speedomax H. Model R (Round Chart) Main Steam Flow Recorder (Specs. same as Item 14 above except:)</p> <p>Control Element: (1) 100% control slidewire</p> <p>Scale: Circular: 23-inch calibrated.</p> <p>Range: 0-10,000 lb/hr steam flow, linear.</p> <p>Control Point Setter: None</p> <p>Chart Speed: 1 revolution per 24 hr</p>
107	1	<p>M,M,& M-Type 154-W-XSQ Barton-Microsen Differential Pressure Main Steam Flow Transmitter with integral square root extractor.</p> <p>Material (DP Cell Housing and Wetted Parts): Stainless Steel</p> <p>Range: Coordinated with Item 13 above and flow nozzle assembly below.</p>
	1	<p>Complete Flow Nozzle Assembly that includes:</p> <p>(1) Type 304 stainless steel weld-in type Flow Nozzle in a section of a 2½-inch Schedule 40, Type 304 stainless steel pipe and two stainless steel adapter bosses. Pipe and bosses shall have socket weld ends.</p> <p>(1) Set of Meter Manifold Piping using Schedule 40, Type 304 stainless steel pipe. Complete with all appurtenances and for socket weld ends.</p>

<u>Item</u>	<u>Quantity</u>	<u>Description</u>
		Range: 0-10,000 lb/hr This equipment to operate under the following conditions: Operating Pressure: 280-315 psig Operating Temperature: 411-420° F Max. Flow: 10,000 lb/hr Max. Pressure: 400 psig Max. Temperature: 450° F
6	1	L & N Speedomax H, Model R (Round Chart) Feed-water Flow Recorder. Specs. same as Item 13 except: Scale: Circular 23-inch calibrated. Range: 0-10,000 lb/hr feed-water flow, linear.
104	1	M, M, & M Type 154-W-XSQ Barton-Microsen Differential Pressure Feed-water Flow Transmitter with Integral square root extractor. Specs. same as Item 107 except for use with Item 6 above and Flow Nozzle Assembly below.
	1	Flow Nozzle Assembly for 1½-inch Schedule 40, Type 304 stainless steel pipe. Range: 0-10,000 lb/hr Operating Conditions: Maximum Flow: 10,000 lb/hr Operating Pressure: 295-330 psig Operating Temperature: 135-212° F Max. Pressure: 400 psig Max. Temperature: 275° F
	1	L & N Cat. No. 10874-K-S Series 60, Feed-water Control Servo Amplifier.
	1	Control Bridge Network Unit for Three-Element Feed-water Control.

<u>Item</u>	<u>Quantity</u>	<u>Description</u>
25	1	G. E. Co. DB-18 Position Indicator with scale 0-100% for indicating position of Feed-water Valve, complete with calibrating resistor.
	1	L & N Cat. No. 10268-60-W1, Valve Drive Mechanism for Feed-water Valve.
		Full Range Operating Time for full Valve Stroke: Approximately 20 sec.
	1	L & N Cat. No. 11261-Spec. Linkage for Feed-water Valve with spring adjustable for tension or compression.
	1	1 $\frac{1}{2}$ -inch Fisher Type 608-A, Lever-Operated Valve constructed of Type 304 stainless steel, or approved equal, with butt-weld ends. Flow to be a linear function of error signal to Servo unit.
26	1	Set Feed-water Valve Transfer (auto-manual) and Control (open-close) Pushbuttons for manually positioning the Feed-water Valve, with "Auto" position. Complete with two G. E. Co ET-6 lamps to indicate when system is on "Auto" or "Manual."

B. By-Pass Steam Pressure Control

This system is designed to perform two distinct functions:

- (1) To operate by-pass steam valve from main steam pressure; and
- (2) To provide a signal for operating a control rod drive.

The system will consist of the following instruments and controls (or equivalent):

<u>Item</u>	<u>Quantity</u>	<u>Description</u>
122	1	M, M, & M-Type 145-S-2-Spec Microsen Pressure Transducer with Vapor-proof Case and special Range Suppression.
		Range for Full Output: 117 psi, from 233 psig to 350 psig
		Sensitivity: 0.1% of 117-psi range

<u>Item</u>	<u>Quantity</u>	<u>Description</u>
	1	L & N Speedomax, Type H, Model R Pressure Deviation Indicator ($P-P_0$)
		Scale: -20 to 0 to +20 psi
		Contacts: (1) SPDT high contact, and (1) SPDT low contact independently adjustable over full scale.
		Retransmitting
		Slidewires: (2) 100%
		Balancing Speed: 5 sec, full scale.
	1	Input Network for Pressure Deviation Indicator, complete with panel-mounted set point setter to permit setting zero point of Pressure Deviation Indicator at any pressure between 270 psig and 310 psig.
	2	L & N Cat. No. 10104-60 Equalizing Relays with bias and travel ratio adjustments for Bypass Valve Drive Unit actuation. (<u>Note</u> : One of these units is now inoperative, because the control slidewire in the Pressure Deviation Indicator, formerly used in conjunction with the larger Steam Bypass Valve, has been replaced with a slidewire controlling the automatic rod drive circuits.)
	2	L & N Cat. No. 10267-M-W1-60 Valve Drive Mechanisms for Steam Bypass Valves
		Full-Range Operating Time for Full-Valve Stroke: 10 sec or less.
		Drive Unit Starting Time Constant: 0.15 sec
		Drive Unit Stopping Travel: 30 min of arc
		Retransmitting Slidewire: (1) 50 ohm
	2	L & N Cat. No. 11261-Spec. Linkage for Steam Bypass Valve with spring adjustable for tension or compression.

<u>Item</u>	<u>Quantity</u>	<u>Description</u>
	1	1-inch Fisher Type 608-A, Lever-Operated Valve constructed of Type 304 stainless steel or approved equal with socket- or butt-weld ends. Valve shall have a throttle plug-type of inner valve. Flow to be a linear function of error signal to Servo unit. Range: 0-3,000 lb/hr (nominal)
	1	1½-inch Fisher Type 608-A Lever-Operated Valve (same as preceding, except for size). Range: 0-10,000 lb/hr (nominal)
8	1	L & N Speedomax. Type H, Model R (Round Chart) Bypass Steam Flow Recorder. Scale: 23-inch circular; calibrated 0-3000 lb/hr steam flow, linear. Contacts: (2) SPDT high contacts and (1) SPDT low contact, each independently adjustable over full-scale range. Balancing 5 sec, full scale.
105	1	M, M & M-Type 154-W-XSQ Barton-Microsen Differential Pressure Bypass Steam Flow Transmitter with integral square root extractor. Specs, same as Item 107, except for use with Item 8 above and Flow Nozzle Assembly below:
	1	Flow Nozzle Assembly for 2½-inch Schedule 40, Type 304 stainless steel pipe. Range: 0-3000 lb/hr. This equipment to operate under the following conditions: Operating Pressure: 280-315 psig Operating Temperature: 411-420°F Max. Pressure: 400 psig Max. Temperature: 450°F Max. Steam Flow: 10,000 lb/hr

<u>Item</u>	<u>Quantity</u>	<u>Description</u>
21	2	G.E. Co. DB-18, Position Indicators with scale 0-100% for indicating position of Bypass Regulating Valve, complete with calibrating resistors.
22	2	Sets, Bypass Valve Transfer (auto-manual) and Control (open-close) Pushbuttons for manually positioning the Bypass Valves, with "Auto" position. Complete with four G.E. ET-6 lamps to indicate when systems are on "Auto" or "Manual."

C. Condenser Air Temperature Control

Equipment included in this section is to perform the following functions:

1. Mixer and Damper Control. An all-electric system to record and control inlet air temperature to face of air-cooled condenser from the average of 12 measurements at selected points in front of the condenser inlet face. Twelve primary detectors to be provided with equipment necessary to average their readings for single input to the recorder-controller. Temperature to be controlled by positioning mixer-box damper and, in parallel, a fan exhaust duct damper. Equipment provided to position exhaust damper is to be adjustable as to travel ratio and bias of exhaust damper to mixer damper. Manual-automatic selectors and remote-manual control stations complete with position indicators to be included for each damper.

2. Fan Speed Control. An all-electric system to record and control exit air temperature from outlet of air-cooled condenser from the average of 12 measurements at the condenser outlet face. Twelve primary detectors to be provided with equipment necessary to average their readings for a single input to the recorder controller. Temperature to be controlled by varying speed of the fan by positioning the hydraulic coupling scoop tube lever.

- Notes:
- (1) Ambient outside air temperature is to be assumed normally in the range -60°F to +60°F.
 - (2) Normal control point for condenser inlet air temperature will be 40°F but is to be adjustable.
 - (3) Normal control point for condenser outlet air temperature will be 120°F but is to be adjustable.

<u>Item</u>	<u>Quantity</u>	<u>Description</u>
<u>Mixer and Damper Control</u>		
9	1	L&N Speedomax H, Model R (Round Chart) Temperature Indicating Recorder Controller.
		Measuring Circuit: Automatically balanced d-c potentiometer.
		Control element: One control slidewire
		Range: 0-300°F Iron-Constantan
		Limit of Error: 0-5% of range
		Scale: Circular 23-inch calibrated.
		Control Point Setter: Manually positioned on circular scale.
		Alarm Contacts: (1) independently adjustable SPDT low-alarm contact for annunciator.
		Chart Speed: 1 revolution per hr
	1	G.E. Co. DB-18 Position Indicator with scale 0-100% for Mixer Damper, complete with calibrating resistor.
	1	L&N Cat. 10874-K, Series 60 Mixer Damper Control Servo Amplifier.
	1	L & N No. 10104-60 Equalizing Relay for Exhaust Damper.
		Adjustment of ratio of follower to master movement (0.5 to 4.5 ratio).
		Adjustment of bias or offset of follower position to master position (50% lag to zero 50% lead).
34	2	Sets, Damper drive transfer (auto-manual) and Control (open-close) Pushbuttons for manually positioning the dampers, with "Auto" position. Complete with G.E. ET-6 lamps to indicate when damper drive units are on "Auto" or "Manual."
10	1	G.E. Co. DB-18 Position Indicator with scale of 0-100% to be used to show position of exhaust damper.
	1	L & N No. 10268-60-W2 Mixer Damper Drive Unit (master).

<u>Item</u>	<u>Quantity</u>	<u>Description</u>
		Crank Arm Rotation Approx. 85° between limits.
		Output Torque (min.) 75 lb-ft
		Time for Full Travel: Approx. 20 sec.
		Retransmitting
		Slidewires: (1) 50 ohm; (1) 1000 ohm.
1		L & N No. 10268-60-M-W1 Exhaust Damper Drive (follower).
		Crank Arm Rotation: Approx. 20 sec.
		Retransmitting
		Slidewire: (1) 50 ohm
2		L & N No. 3298-3 Crank Arms and Linkages
12		L & N No. 8793-G-264 Iron-Constantan Thermocouples.

Fan Speed Control Assembly

11	1	L & N Speedomax H Model R (Round Chart) Temperature Indicating Recorder Controller.
		Measuring Circuit: Automatically balanced d-c potentiometer.
		Control Element: (1) control slidewire.
		Range: 0-300°F Iron-Constantan.
		Limit of Error: 0.5% of range
		Scale: Circular 23-inch calibrated.
		Control Point Setter: Manually positioned on circular scale.
		Chart Speed: 1 revolution per 24 hr
		Alarm Contacts: (1) independently adjustable SPDT high alarm for annunciator.
	1	L & N No. 10874-K Series 60 Fan Speed Control Servo Amplifier.
	1	L & N No. 10268-60 Scoop Tube Drive.
		Crank Arm Rotation: Approx. 85° between limits
		Output Torque (min.) 75 lb-ft
		Time for Full Travel: Approx. 20 sec.

<u>Item</u>	<u>Quantity</u>	<u>Description</u>
	1	L & N No. 3298-3 Crank Arm and Linkage
	12	L & N No. 8793-G-264 Iron-Constantan Thermocouples.

Miscellaneous Equipment

1	Thermocouple Junction Box with Swamping Resistors to be Used with the above equipment.
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D. Recording and/or Indicating Instruments and Accessories

<u>Item</u>	<u>Quantity</u>	<u>Description</u>
19	1	<p>Industrial Instruments, Inc. Type RI-3, single-point resistivity indicator with a range of 0.1 to 50 meg-ohms, and to indicate the following measurements:</p> <p>A. Demineralizer influent. B. Demineralizer effluent.</p> <p>These measurements to have automatic temperature compensation.</p> <p>Normal operating Conditions: 295-375 psig & 160-180°F Maximum Design Conditions: 400 psig & 450°F</p> <p>The resistivity indicator to be complete with the following items:</p>
	2	<p>Industrial Instruments, Inc. Cel. II-(SS)X1 stainless steel insertion cells with $1\frac{1}{4}$-inch fittings for service up to 500 psig. Cell constant to be determined by instrument manufacturer.</p> <p>Each cell to be furnished with a $1\frac{1}{4}$-inch (screwed) by $6\frac{1}{8}$-inch reducing 304 stainless steel, 300 lb RF flange. The cell and flange are to be seal welded after assembly.</p> <p>Gaskets or washers used in the cell to be a metal type such as lead alloy, suitable for maximum temperature.</p>

<u>Item</u>	<u>Quantity</u>	<u>Description</u>
20	1	G.E. Co. 2-way, 4-pole, SB-1 Switch to be used for Item 19 for selecting points A or B.
3	1	M, M&M, $8\frac{3}{4}$ -inch, Electric Remote Milliammeter Indicator Type 146R, for main steam pressure, with white dial, black markings. Range: 0-400 psig.
102	1	M, M&M Microsen Pressure transmitter Type 145-S-2 for Main Steam Pressure.
1	1	M, M&M $8\frac{3}{4}$ -inch diameter, Electric Remote Milliammeter Indicator, Type 146R for Feed-water Pressure, with white dial, black markings. Range: 0-400 psig.
38	1	M, M&M American-Microsen Precision Relay Series 135R-RO for adjustable low-alarm contact for feed-water pressure.
101	1	M, M&M Microsen Pressure Transmitter, Type 145-S-2 for Feed-water Pressure.
15	1	M, M&M $8\frac{3}{4}$ -inch diameter Electric Remote Milliammeter Indicator, Type 146R for Hot Well Level with white dial, black markings. Range: 0-42in. (inverse scale).
39	1	M, M&M American-Microsen Precision Relay Series 135R-RO for adjustable high-alarm contact for Hot Well Level.
40	1	M, M&M American-Microsen Precision Relay Series 135R for adjustable low-alarm contact for Hot Well Level.
109	1	M, M&M Barton-Microsen Type 154-W3G, Electronic Differential Pressure Transmitter for Hot Well Water Level. All parts in contact with water to be of stainless steel, and subject to the following operating conditions:

<u>Item</u>	<u>Quantity</u>	<u>Description</u>
		Normal Pressure: 5 in. Hg abs Min. Pressure: 1 in. Hg abs Max. Pressure: 30 psig Min. Temperature: 40°F Normal Temperature: 135°F Max. Temperature: 275°F
110	1	Mason-Neilan Model 12003-40 Reactor Water Level Alarm Transmitter of the displacer-torque tube type. Normal Fluid Pressure: 300 psig Normal Fluid Temperature: 420°F Max. Fluid Pressure: 400 psig Max. Fluid Temperature: 450°F Active Displacer Length: 97 $\frac{1}{4}$ in. Distance from Mounting Flange to Bottom of Displacer: Approx. 131 in. Materials (part in contact with reactor water or steam) Stainless Steel or Inconel. Alarm Switches: (2) SPDT adjustable to operate at levels within 12 in. of each other. Max. Ambient Temperature at Switch Housing: 400°F Mounting: 3-inch, 600-lb flange.
4	1	L & N Speedomax H Model R (Round Chart) Recorder, for Condenser Vacuum. Contacts: (1) SPDT Alarm Contact, adjustable over full scale. Scale: 23-inch circular calibrated 30 psig to 0 to 30 in. Hg. vacuum.
103	1	M, M&M Microsen Type 145-SC-2 Compound Pressure Vacuum Pressure Transducer. Range: 30 psig to 0 to 30 in. Hg. vacuum.

<u>Item</u>	<u>Quantity</u>	<u>Description</u>
7	1	L & N Speedomax H Model R (Round Chart) Temperature Recorder for Feed-water Temperature.
		Range: 0-400°F for Iron-Constantan Thermocouples.
		Chart Speed: 1 revolution per 24 hr
	1	L & N Cat. No. 8751-K-3051-3 $\frac{1}{2}$, Iron-Constantan Thermocouple Assembly with Drilled Well and 8 $\frac{1}{2}$ -inch Lagging Nipple, and 1-inch Socket Weld Connection. Complete with Thermocouple Head.
12	1	L & N Speedomax Type H, Model R (Round Chart) Recorder for Reactor Steam Pressure.
		Scale: 23-inch circular calibrated 0-500 psig, linear.
		Contacts: (2) SPDT High alarm contacts; (1) SPDT Low alarm contact. Each contact to be independently adjustable over full scale range.
106	1	M, M & M American-Microsen Type 145-S-2 Pressure Transmitter for Reactor Steam Pressure.
16	1	L & N Speedomax Type H, Model R Indicator for use with 48-point pushbutton unit (Item 17, below).
		Range: 0-500°F for Iron-constantan Thermocouples.
		To indicate temperature as follows:
	A	Water Purification
	B	Air Precooler Vapor Outlet
	C	Water from Thermal Shield Cooling Coil
	D	Reactor Water
	E	Air Ejector After Cooler Vapor Outlet
	F	Operating Floor
	G	Operating Floor
	H	Reactor Shield, Circuit No. 1

<u>Item</u>	<u>Quantity</u>	<u>Description</u>
		I,J,K,W Gravel
		L, M Sub-reactor Shield
		N,X Concrete Shield
		O Reactor Shield, Circuit No. 2
		P,X,Z,AA Instrument Wells
		Q,R,S,T,U,V Fuel Storage Wells
		BB through JJ Control Rod Drives
		KK Outside Air
		LL,MM,NN Air Space Above Reactor
17	2	L & N Cat. No. 32-12-0-1, 24-point mechanically inter-locked Pushbutton Station Selectors.
	4	L & N No. 8751-K-3051-3 $\frac{1}{2}$ Spec Iron-constantan Thermocouple Assemblies complete with screwed-type thermocouple connection head, extension nipple and Type 304 stainless steel protecting well with 1-inch socket weld connection and 3 $\frac{1}{2}$ -inch immersion length. For measurements A,B,D, and E.
	1	L & N No. 8751-K-3051-3 $\frac{1}{2}$ Iron-constantan Thermocouple Assembly as above except substitute <u>1-inch NPT for 1-inch socket weld connections</u> and use for measurement C.
	2	L & N No. 8759-K-1-24 Iron-Constantan Thermocouple Assemblies with connecting heads for measurements F & G.
	3	L & N No. 8793 Iron-Constantan Thermocouple Assemblies with 20-foot protecting tube for measurement H,I and J.
	3	L & N No. 8793, Iron-Constantan Thermocouple Assemblies with 17-foot protecting tube for measurement K,O and W.
	2	L & N No. 8793 Iron-Constantan Assemblies with 22-foot protecting tube and Universal Connection Head, for measurements L,M.
	2	L & N No. 8793 Iron-Constantan Thermocouple Assembly with 4-foot protecting tube for measurements N,X.

<u>Item</u>	<u>Quantity</u>	<u>Description</u>
	3	L &N No. 8795 Iron-Constantan Thermocouple Assemblies with 15-foot 6-inch stainless steel protecting tube for measurements Q,S and U.
	3	L &N No. 8795 Iron-Constantan Thermocouple Assemblies with 6-foot stainless steel protecting tube for measurements R,T and V.
	8	Minneapolis-Honeywell Part No. 362737 Plug Assemblies for Iron-Constantan Thermocouples, complete with Part No. 362740-3 tube adapters.
	14	Minneapolis-Honeywell Part No. 362738 Jack Assemblies for Iron-Constantan Thermocouples, complete with Part No. 362741 cable clamps.
	6	Minneapolis-Honeywell Part No. 362737 Plug Assemblies for Iron-Constantan Thermocouples complete with Part No. 362740-2 tube adapters.

E. Annunciator

<u>Item</u>	<u>Quantity</u>	<u>Description</u>
2	1	<p>Panalarm 36-point Annunciator (6 high x 6 wide), consisting of Series 31 Remote Light Cabinet and Series 54 Annunciator Adapter Cabinet. System shall be arranged for operation on 125-volt d-c from normally closed actuator contacts. System shall incorporate ring-back feature, with bell signal, lamp test pushbutton, acknowledgment pushbutton, and operating sequence AR. Nameplate legends shall be as follows:</p> <p> Condenser Vacuum - Low Bypass Steam Flow - High Bypass Valve Discharge Pressure - High Reactor Pressure - Low Condenser Outlet Air Temperature - High Condenser Inlet Air Temperature - Low Feed Pump Discharge Pressure - Low Purification Water Temperature - High Reactor Water Level - Low (Primary) Air Ejector After Condenser Temperature - High Shield Cooler Outlet Temperature - High Hot Well Water Level - High or Low </p>

<u>Item</u>	<u>Quantity</u>	<u>Description</u>
		Reactor Water Level - High (Primary)
		Feed Pump - Automatic Switchover
		Main Steam Pressure Relief Valve - Flow
		Reactor Pressure - High
		High Pressure Condenser Tank Level - High
		Low Pressure Condenser Tank Level - High
		Turbine Oil Inlet Temperature - High
		Main Steam Safety Valve - Flow
		Shield Cooler Pump Discharge Pressure - Low
		Diesel Generator Trouble
		Shield Cooler Bypass Valve - Open
		Turbine Oil Pressure - Low
		Emergency Power Trouble
		Remote Area Monitor Level - High
		Reactor Water Level - Low (Secondary)
		Reactor Water Level - High (Secondary)

F. Electrical Accessories

<u>Item</u>	<u>Quantity</u>	<u>Description</u>
23	1	G.E. Co. SB1 Switch, Start-Stop, for Feed-water Pump No. 1.
	1	G.E. Co. ET-6 Lamp, Green, 125-volt d-c.
	1	G.E. Co. ET-6 Lamp, Red, 208-volt a-c.
24	1	G.E. Co. SB1 Switch, Start-Stop, for Feed-water Pump No. 2.
	1	G.E. Co. ET-6 Lamp, Green, 125-volt d-c.
	1	G.E. Co. ET-6 Lamp, Red, 208-volt a-c.
31	1	G.E. Co. SB1 Switch, Start-Stop, for Condenser Air Circulating Fan.
	1	G.E. Co. ET-6 Lamp, Green, 125-volt d-c.
	1	G.E. Co. ET-6 Lamp, Red, 208-volt a-c.

<u>Item</u>	<u>Quantity</u>	<u>Description</u>
32	1	G.E. Co. AB-18 Ammeter, 0-5 amp movement, 0-200 amp scale, for Condenser Air Circulating Fan.
27	1	G.E. Co. ET-6 Lamp, Green, 125-volt d-c.
28,39 30,35	4	G.E. Co. ET-6 Lamp, Red, 208-volt a-c.
33	1	G.E. Co. SB1 Switch, emergency stop, for water purification pump.
	2	G.E. Co. Oil-Tight Momentary Contact Pushbutton Units, Type CR-2940.
	1	G.E. Co. ET-6 Lamp, Red, 208-volt a-c.

IV. REFERENCE DRAWINGS

X-2267-10-1	Base Angle and Plan View, Process Control Cubicle.
X-2267-10-1-A	Front and Internal View of Front Panel, Process Control Cubicle.
X-2267-10-1-B	Rear View and Terminal Board Construction, Process Control Cubicle.
X-CID-486-SF1	Wiring Diagram - Process Control Cubicle - Front
X-CID-486-SF2	Wiring Diagram - Process Control Cubicle - Front
X-CID-486-ST1	Wiring Diagram - Process Control Cubicle - Rear - L.H. Section and Terminal Board Arrangement
X-CID-486-ST2	Wiring Diagram - Process Control Cubicle - Rear - R.H. End Section and Terminal Board Arrangement

V. VENDOR

Leeds and Northrup Company
Philadelphia, Pennsylvania

VI. PURCHASE ORDER

Argonne National Laboratory AL-223347
Leeds and Northrup Company No. 12800

SECTION 9

REACTOR WATER PURIFICATION SYSTEM

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I. GENERAL

The following specifications are intended to cover the detailed design of, the furnishing of materials and components for, and the shop fabrication of a process system called the "Reactor Water Purification System."

The process stream flowing through the System is called "purification water."

The supplier of the System, designated hereinafter as the "Fabricator," shall complete in his shop the fabrication, assembly, and testing of the System. The System shall be broken down into minimum number of "packages" for shipping, after initial shop assembly and testing.

The System will be installed at the ALPR Site, National Reactor Testing Station, Scoville, Idaho. All quotations shall be f.o.b., motor freight, National Reactor Testing Station, Scoville, Idaho.

Field erection of the System will be accomplished by the "Erector."

The Fabricator shall accept full responsibility for the design, construction or purchase, and any required testing and modification of equipment included in the System.

The Fabricator shall select all valves, fittings, pumps, etc., and shall design, provide, and fabricate all piping in the System. The practice of bending pipe into the desired configuration is preferred. The design shall incorporate a minimum of piping joints and welding consistent with a workable and reliable system.

The Fabricator shall submit with his proposal a schematic flow diagram, and descriptive material as required, covering any changes in the System suggested by the Fabricator.

The Fabricator shall submit detailed drawings and engineering information on all components of the System to the Purchaser prior to construction or purchase of the equipment. The Purchaser will promptly examine the design of the equipment for apparent suitability, and approve or suggest changes in the design.

The Fabricator shall not obtain or commence construction of any equipment without prior written approval by the Purchaser. Such approval shall not relieve the Fabricator of any obligation imposed by these specifications.

II. MATERIALS TO BE SUPPLIED BY PURCHASER

Two conductivity cells, with associated indicators and accessories.

Motor starters, including circuit breakers, and wiring for all pump motors.

One thermocouple with well, wiring, and bridge.

One locally-mounted thermometer with mercury bulb, and contact points for remote alarm.

Equipment supports, foundations, caulking, and structural bolting.

Insulation for piping, as required.

Removable lids for waste storage sump tanks and equipment vault.

III. MATERIALS AND FACILITIES TO BE SUPPLIED BY ERECTOR

Erection labor.

Qualified and certified welders.

Welding equipment.

Tools, slings, scaffolds, and appliances necessary for erection.

Welding rod for all field welds.

IV. MATERIALS AND EQUIPMENT TO BE FURNISHED BY FABRICATOR

A. Equipment

One shell-and-tube heat exchanger for cooling 5 gpm of process water from 417°F to 170°F.

One sealed canned-motor high-pressure pump capable of delivering 5 gpm.

One filter of a removable-cartridge type, for efficient filtration of 5 gpm of water, with two extra cartridges.

One cation exchanger column of $1\frac{1}{2}$ cu ft resin capacity.

One mixed-bed demineralizer of $1\frac{1}{2}$ cu ft resin capacity.

Cation exchange and mixed-bed resins capable of continuous operation at 170°F.

One filter of a removable-cartridge type capable of efficient filtration of 25 gpm of water, with two extra sets of cartridges.

One low-pressure water-storage tank of 900 gal capacity, with associated header and pipe connections.

One low-pressure, low-head self-priming pump for transfer of water to and from the storage tank, and for priming the canned-motor pump.

Six resin disposal containers of $1\frac{1}{2}$ cu ft capacity.

One vertical cylindrical equipment vault, to contain, isolate, and support the heat exchanger and ion-exchange vessels.

Two vertical, cylindrical storage sump tanks, to contain, isolate, and support radioactive waste containers and storage.

Eight cu ft of mixed-bed resin (hydrogen and hydroxyl form), 8 cu ft of cation resin (hydrogen form), and 8 cu ft of anion resin (hydroxyl form). This includes the initial loading.

One self-operated pressure relief valve.

One self-operated temperature control valve, with sensing element and pilot.

Six standard 55-gallon removable-lid steel drums, for storage of used resins and filters.

Tool for removal of cartridge from filter.

B. Piping Equipment

All manually-operated valves, check valves, strainers, and sight-flow indicators.

All pipe and fittings, necessary bolts, studs, nuts, and gaskets.

Piping supports and hangers.

Framework as required to support pipe hangers.

Hose connections and four 30-foot lengths of rubber hose.

All necessary welding equipment and welding rods for shop welds.

Radiographic equipment for shop welds, as required.

Mill test reports, certification of chemical analyses and physical tests, etc., as required.

C. Instrumentation and Controls

Three direct-reading variable-area type flowmeters.

Three pump-motor control switches.

One water level indicator of the air-bubbler type.

Two direct-reading dial thermometers, with mercury bulbs.

Two pressure gauges.

Control panel for display of instruments and valve handles.

One direct-reading dial thermometer, with gas bulb.

V. SUPERVISION

The Purchaser, or authorized representatives, shall have free access for inspection of all phases of the Fabricator's work during construction and testing.

VI. MATERIALS AND WORKMANSHIP

Materials and workmanship shall be first-class in all respects and shall be satisfactory to the Purchaser. All materials furnished and all procedures followed in fabrication shall conform, unless otherwise specified, with the latest issues of the adopted and tentative specifications of the American Society for Testing Materials; the American Standard Code for Pressure Piping; the American Society of Mechanical Engineers' Boiler Code; and all applicable State and local requirements.

Vessels subject to internal or external pressure shall be designed, fabricated, and tested according to the requirements of the ASME Unfired Pressure Vessel Code. Each vessel shall be inspected by a qualified inspector, and marked with a Code U-symbol.

Vessels subject to pressure which by reason of their service requirements, application, or size are specifically exempted from the jurisdiction of the ASME-UPV Code, are so designated in the Technical Data section of these specifications, and alternate requirements given.

Those vessels which are to be buried in gravel during use shall be of adequate strength to resist damage during installation, assuming reasonable care is exercised in placement of the gravel.

VII. PROCESS FLOW SCHEME

The Reactor Water Purification System shall be designed in general accordance with Drawings RE-24947-D and B-78327.

The Fabricator shall make and incorporate into his system such changes in the process flow scheme or in the components of the System as he may deem necessary to insure efficient, safe, and reliable operation.

All changes made by the Fabricator from the referenced drawings and specifications shall be subject to written approval by the Purchaser. Any changes introduced by the Fabricator must satisfy the following general requirements:

(1) Lines between the high-pressure radioactive water system and the area of the operating floor should be normally closed by at least two valves, plugs, caps, or other isolating devices, in series.

(2) Wherever closed vessels designed for low pressure are connected to the high-pressure system, pressure-relief protection for the low-pressure unit must be provided.

(3) All safety valves, relief valves, drains, and vents must discharge into the Retention Water Storage Tank.

(4) All valves through which resin particles may pass, either through normal operation, leakage, or errors in operation, should be of a type which can subsequently close tightly, or else should be protected by suitable strainers or filters.

(5) The System shall be operative as an independent unit regardless of the operating status of the reactor.

The System shall include provisions for pH or resistivity monitoring.

VIII. EQUIPMENT LOCATION AND SUPPORT

The locations of certain major components of the System within the plant are given in Drawing AA-78320.

The Fabricator shall adapt his design of equipment to conform with the structural support, subfloor, and floor details shown in Drawings AA-78321, AA-77398, and AA-77903.

The exact location of smaller equipment not requiring individual supporting structures may be selected by the Fabricator.

All equipment shall be located to afford reasonable ease of inspection and maintenance.

Considerable piping, supports, structures, components, and systems of the plant are located in the area of the Reactor Water Purification System, as shown on the Drawings AA-78347, AA-77402, AA-78350, and AA-78258. The Fabricator shall exercise caution so as not to interfere with existing systems, and shall submit piping drawings to the Purchaser for checking of clearances.

The "package" concept of grouping equipment shall be applied where possible to minimize field fabrication.

IX. PIPING

The arrangement of piping shall be as generally shown on Drawings F-639.3D and F-639.4D.

The piping of the Reactor Water Purification System shall terminate at connections located as shown on the piping drawings.

The Fabricator shall design and fabricate all piping in accordance with the American Standard Code for Pressure Piping.

Materials shall be in accordance with the Technical data sheets.

All pipe fittings and equipment shall have socket weld ends; special equipment may have bolted flanges subject to approval by the Purchaser.

The Fabricator shall make and incorporate into his design such changes in the piping arrangement as he may deem necessary. All changes by the Fabricator from the referenced drawings and specifications shall be subject to the written approval of the Purchaser. Any changes introduced by the Fabricator must satisfy the following general requirements:

- (1) Wherever possible, piping shall be arranged along and supported from a structure located at the Control Panel shown on Drawing B-78450.

- (2) The stems of all manually-operated valves should extend through to the operating face of the Control Panel, except for sample taps, drains, etc., not in normal usage. The sample taps should be placed at the front of the panel.

(3) Any piping which conceivably could be subjected to pressure, either through normal operation, leakage, equipment failure, or operator error, shall be designed for the most adverse conditions.

(4) All equipment must be readily accessible for maintenance or replacement.

(5) Drainage of all piping and equipment must be possible.

(6) Insulation (1 in. thick) will be applied by the Erector to hot lines above floor level. The Fabricator shall arrange the piping to permit application of insulation during erection.

(7) All valves and equipment shall be welded into the system. Exceptions shall be subject to approval by the Purchaser.

(8) Hose connections should be located near bottom of panel.

X. CONTROL AND INSTRUMENTATION

The system will be operated from the opposite face of the Control Panel from which equipment and piping are placed. A pictorial flow diagram shall be placed on the operating face of the Control Panel to identify the location and function of each valve on the Panel. The face of the Control Panel shall be removable (following the removal of valve handles) to permit maintenance of valves.

XI. FACTORY TESTING

The Fabricator shall assemble the completed System in his shop, and perform a hydrostatic test for 48 hours, as follows: High-pressure part - 750 psig; Low-pressure part - 60 psig; Atmospheric part - 30 psig. No visible leakage of the test fluid is permissible.

The Fabricator shall submit complete details of a factory hydraulic and mechanical test procedure intended to demonstrate satisfactory system operation. Upon approval of the procedure by the Purchaser, the test will be performed, and four copies of the test data submitted to the Purchaser.

The Purification Vault and Storage Sump Tanks should be water tight. No hydrostatic pressure test is required; a standing water head test for 24 hr is sufficient.

XII. CLEANLINESS AND SHIPPING

Exceptional cleanliness shall be maintained at all times.

The System components and piping shall be thoroughly cleaned of dirt and grease before shipping, and all openings subsequently plugged or capped to prevent further contamination. Method and sequence of cleaning shall be submitted by the Purchaser.

The "packages" shall be carefully boxed or suitably protected against damage in transit, and identified with indestructible tags or markings. No "package" shall exceed dimensions of $7\frac{1}{2}$ ft by 9 ft by 20 ft, or a weight of 20,000 lb.

XIII. SYSTEM OPERATION

A continuous flow of water is normally withdrawn from the reactor vessel, cooled, circulated through filters and demineralizers, and returned, in order to maintain desired water quality in the reactor vessel. Water flow through the Purification System is fixed at 5 gpm maximum, for a coolant flow of 19 gpm.

Purification water is cooled before treatment by transfer of heat to the main feed-water stream, prior to the introduction of feed-water into the reactor vessel. Under conditions of low feed-water flow, the flow of purification water must be similarly restricted in order that its temperature not exceed limitations imposed by the ion exchange resins. A self-operated temperature control valve inserted immediately downstream of the Purification Water Cooler, controls the flow of purification water to maintain constant temperature. Minimum continuous feed-water flow is $7\frac{1}{2}$ gpm, for design. Feed-water temperature is approximately constant at 135°F.

Cooled purification water is pumped through the Purification System by a centrifugal pump of the "canned-motor" type. No leakage of pumped fluid will be tolerated at this unit. An eductor is placed near the reactor pressure vessel to improve "lift" and ensure continuous pumping of water when the temperature control valve is closed, and thus to avoid overheating of the pump.

Water from the pump discharge passes to a filter of the disposable-cartridge type, having a filter element of wound or woven cotton fiber. The filter is expected to accumulate radioactive matter, and must be shielded with lead (2 in. thick) on sides and top. The bottom is not shielded since the unit is mounted close to the floor. The filter unit must be of flanged and bolted removable-head construction, with all pipe connections on the removable head. The removable head is placed at the bottom of the unit, and supported on the floor. The filter cartridge must be attached to the filter body by a spring clip, so that the two may be removed together. The heavy shielded filter body and cartridge is transferred by a jib crane to a disposal sump to be described later.

Filtered water is piped to both cation and mixed-bed columns of $1\frac{1}{2}$ cu ft bed volume, arranged for both series and parallel flow. Ion exchange resins are of a type not damaged by exposure to 200°F. The anion exchange resin may be of weakly basic chemistry, and need not remove oxygen, carbon dioxide, or silica from the water.

Valving is provided to isolate the Purification System from the high-pressure portion of the plant. After isolation, resin is removed by opening a connection to the bottom and top of the demineralizer resin chamber, and also pumping water from the Retention Water Storage Tank into the bottom and top through a separate line. Resin is thus forced out of the vessel and into a pipeline for disposal as described later. Fresh resin is added in dry form through another top connection. Provisions must be made to ensure that mixed-bed resin does not separate during addition by classification, since no compressed air is available for subsequent mixing of the resins.

The Purification Water Cooler, cation exchange column, and mixed-bed demineralizer are located in a common vault below the surface of a gravel fill. The vault is constructed as a vertical cylindrical tank with top head removable. In order that the vault be as small as practicable, the three vessels contained therein are to be designed of similar size and shape, and arranged to fit closely within it. No valves or instrumentation are placed within the equipment vault, but are installed on the operating floor above. The vault is drained to the waste Storage Sump and vented to the operating floor area.

Water treatment equipment is placed below the surface of the gravel fill to protect operating personnel against radioactive contaminants accumulated in these units. The upper head of the equipment tank is removable in order that components may be taken out of the tank for repair or replacement. The removable head incorporates shielding for radiation protection, and provides access for piping to and from equipment in the tank. It is not required that a piece of equipment be removed from the tank singly, if piping and support considerations require connections between vessels within the tank. However, no controls or instrumentation, or any other components requiring routine inspection or maintenance are to be installed within the vault.

Water leaving the Purification System enters the feed-water line for return to the reactor vessel. The mixed stream is filtered before entering the reactor. No large amount of radioactivity will be collected in this filter, so that shielding is not required. Direct manual changing of filter cartridges is permissible.

Exhausted resin pumped from the demineralizers, and used filter cartridges, must be stored temporarily in a shielded area to allow their radioactivity to decay to a tolerable value. Waste storage sumps below the surface of the gravel fill are provided for this purpose. Storage is accomplished in the following manner:

- (1) A 55-gallon steel drum with removable lid is filled with gravel to a depth of about 8 in.

(2) A Resin Disposal Tank of $1\frac{1}{2}$ cu ft volume, provided with a screen for separating resin beads from water, is placed within the drum.

(3) Connections of copper tubing are brought from the resin disposal tank through the top drum opening.

(4) Gravel is placed around and above the disposal tank to approximately 4 in. from the top of the drum.

(5) Hoses are attached to inlet and outlet connections to the disposal tank, and to appropriate piping at the Water Purification System.

(6) The drum, with hoses attached, is lowered into the waste storage sump.

(7) Radioactive resin is pumped from the demineralizer into the resin disposal tank, with water going to the Retention Water Storage Tank.

(8) Hoses are detached at the Purification System connections, and the free ends blanked off.

(9) Hose ends are dropped into the Waste Storage Sump.

(10) The procedure is repeated for disposal of resin from the second demineralizer, with the second drum placed in the sump on top of the first drum.

(11) A third drum is partially filled with gravel and lowered into the sump.

(12) The shielded filter body is unbolted from its head, and transferred with a crane to a position immediately above the open drum.

(13) By means of a long-handled tool, the spring clip which holds the filter cartridge in the filter body is retracted, allowing the cartridge to drop into the open drum.

(14) Additional gravel is poured into the drum from above, to cover the filter element.

(15) The sump lid is replaced, and the stored wastes permitted to decay.

(16) After storage, the top drum is taken out of the sump, and a lid attached and clamped.

(17) The drums containing resin are removed and the hoses detached.

(18) The copper tubes which protrude from the drum opening are crimped closed, pushed back into the drum, and the opening closed and clamped.

(19) The drums are painted and stored in a convenient location awaiting ultimate disposal.

A self-priming turbine-type pump is needed for transfer of water to and from the Retention Water Storage Tank. The pump is mounted on the operating floor, above the buried equipment. The Retention Tank Water Pump must have high-lift characteristics, and be able to operate for extended periods with an open suction line. The piping is such that this pump can be used to prime the Purification Water Pump.

Retention Tank water may be removed from storage for reuse or disposal. In either case, any contained radioactivity must first be removed from the water. In order to decontaminate the water, it is recirculated through a Resin Disposal Tank which has been filled with fresh resin, thus serving as a demineralizer. Sample taps are provided to permit analysis of the water before it is discharged from storage.

XIV. TECHNICAL DATA

A. Process Equipment

1. Purification Water Cooler

Type	Shell-and-tube heat exchanger
Number	1
Heat transferred	625,000 Btu/hr (maximum)
Position	Vertical
Materials of construction	Type 304 stainless steel
Heads	Welded to shell
Hand holes	None required
Tube-to-tube sheet joints	Rolled only
Accessories	Thermowell for bulb of temperature control valve (Item 13)
Construction	As shown on Graham Mfg. Co. Dwg. A-7889
Code requirements	ASME-UPV Code: U-symbol stamp

1. Purification Water Cooler (Cont'd.)a. Tube Side (Feedwater)

Fluid handled	Water
Temperature in	135°F
Temperature out	175°F
Design maximum temperature	450°F
Nominal pressure	300 psig
Design maximum pressure	400 psig
Flow rate	
Normal	8600 lb/hr
Maximum	10,500 lb/hr
Tube side scale coefficient	1000 Btu/(hr)(sq ft)(°F)
Pressure drop (maximum)	15 psig
Tube length (nominal)	6 ft
External fittings	Socket weld, 1½ in., 2000 lb

b. Shell Side (Purification System Water)

Fluid handled	Water
Temperature in	420°F
Temperature out	170°F
Design maximum temperature	450°F
Working pressure	300 psig
Design maximum pressure	400 psig
Flow rate	2500 lb/hr
Shell side scale coefficient	800 Btu/(hr)(sq ft)(°F)
Shell diameter (nominal)	8 in.
External fittings	Socket weld, ¾ in., 2000 lb

1. Purification Water Cooler (Cont'd)

Surface area	59 sq ft
Weight of unit	400 lb
Tube sheet type (fixed or floating)	Fixed
Tube material	Type 304 Stainless Steel
Tube length	6 ft
Tube diameter	5/8 in.
Tube wall thickness	18 BWG (0.049 in.)
Number of tubes	60
Pressure drop at 8600 lb/hr, psi	Negligible
Pressure drop at 10,500 lb/hr, psi	Negligible
Velocity in tubes	0.424 ft/sec
Arrangement of tubes	Triangular
Pitch	15/16 in.
Shell material	Type 304 Stainless Steel
Shell length	7 ft
Shell inside diameter, thickness	8-inch, Schedule 40
Pressure drop	Negligible
Baffle position and type	40%
Baffle material	Type 304 Stainless Steel

2. Purification Water Pump

Type	Canned motor
Manufacturer	Chempump
Model	CFH-1-1/2-3/4 S
Number required	1
Fluid handled	Water
Flow rate (maximum required)	5 gpm
Maximum temperature (operating)	170°F

2. Purification Water Pump (Cont'd)

Design maximum temperature	450°F
Working pressure	300 psig
Design maximum pressure	600 psig
Net positive section head (NPSH)	
Nominal	600 ft
Minimum	10 ft
Suction lift	20 ft
Materials	
Casing and impeller	Stainless Steel Type 316, or approved equal
Motor can	Stainless Steel
Casing connections	Welded
Electrical supply	60-cycle, 3-phase, 120/208 volt
Protective devices	Thermal cut-out switch
Connections (size and type)	Welded
Inlet	1 in.
Outlet	3/4 in.
Developed head at zero flow	119 ft
Position (horizontal of vertical)	Horizontal
Motor rating	1 $\frac{1}{2}$ hp
Speed	3450 rpm
Motor voltage and number of phases	208 volt, 3 phase
Weight	125 lb

3. Water Purification Filter

Number required	1
Fluid handled	Water
Nominal temperature	170°F
Design temperature (maximum)	450°F
Flow rate (maximum)	5 gpm

3. Water Purification Filter (Cont'd.)

Permissible pressure drop at 5 gpm	5 psi
Working pressure	300 psig
Design pressure (maximum)	400 psig
Fittings	Socket weld; in removable head only
Attachments	Closed system drain and vent lines
Removable head connection	Flanged and bolted
Position, removable head	Head down
Filter element	Cotton, wound or woven
Number of filter elements required	One for 5-micron and two for 10-micron particles
Radiation shielding	2 in. lead on sides and top
Method of attaching lead shielding	Poured; jacketed
Code requirements	ASME-UPV Code, U-symbol stamp, or if less than 6 in. internal diameter, a hydrostatic test to establish allowable working pressure as described in Code, par. UG-101(p).
Name of Manufacturer	Commercial Filters Corporation
Model number	LLSS-2863 (Disposable Cartridge)
Nominal length	18 in.
Nominal diameter	4 in.
Body material	Type 316 Stainless Steel
Head material	Type 316 Stainless Steel
Bolt material	Type 304 Stainless Steel
Gasket type and material	Compressed metal and asbestos
Diameter of gasket circle	4 in. (nominal)

3. Water Purification Filter (Cont'd.)

Shell thickness	10 ga (0.141 in.)
Head thickness	5/8 in.
Flange thickness	1 $\frac{3}{4}$ in.
Weight with lead shielding	270 lb

4. Cation Exchanger

Number	1
Fluid handled	Water
Maximum flow rate	5 gpm
Minimum operating flow rate	2 gpm
Temperature (nominal)	170°F
Design temperature (maximum)	450°F
Working pressure	300 psig
Design maximum pressure	400 psig
Bed volume	1 $\frac{1}{2}$ cu ft
Piping connections	Socket weld, 2000 lb
Materials	Stainless Steel Type 304
Flow direction	Down
Resin type	Amberlite IR-120, or NR-1; hydrogen form
Resin quantity required	8 cu ft
Position	Vertical
Construction	As shown on Stover Tank Co. Dwg. BA-080-329
Code requirements	ASME-UPV Code; U-symbol stamp
Over-all length	9 ft
Shell inside diameter	6.065 in.
Shell thickness	0.280 in.
Shell Material	SA-312 Type 304 Stainless Steel
Screen mesh	50 mesh

4. Cation Exchanger (Cont'd.)

Screen material	Type 316 Stainless Steel
Water Piping connection	3/4 in.
Resin piping connection	
Inlet	2 in.
Outlet	1 in.
Resin (manufacturer and type)	Illinois Water Treatment Company Type NR-1
Depth of bed	98 in.
Weight empty	170 lb

5. Mixed-Bed Demineralizer

Number required	1
Fluid handled	Water
Maximum flow rate	5 gpm
Minimum operating flow rate	2 gpm
Working temperature (nominal)	170° F
Design temperature (maximum)	450° F
Working pressure	300 psig
Design pressure (maximum)	400 psig
Bed volume	1 $\frac{1}{2}$ cu ft
Position	Vertical
Piping connections	Socket weld, 2000 lb
Materials	Type 304 Stainless Steel
Flow direction	Down
Resin type	Equal mixture Amberlite IR-45 and Amberlite IR-120, or NR-11 in hydrogen and hydroxyl forms.
Resin quantity required	8 cu ft mixed-bed resin, and additional 8 cu ft anion resin and 8 cu ft cation resin.

5. Mixed-Bed Demineralizer (Cont'd.)

Construction	As shown on Stover Tank Co. Dwg. BA-080-329
Code requirements	ASME-UPV; U-symbol stamp
Over-all length	9 ft
Shell inside diameter	6.065 in.
Shell thickness	0.280 in.
Shell material	SA-312 Type 304 Stainless Steel
Screen mesh	50 mesh
Screen material	Type 316 Stainless Steel
Water piping connection	3/4 in.
Resin piping connection	
Inlet	2 in.
Outlet	1 in.
Resin (manufacturer and type)	Illinois Water Treatment Company Type NR 11
Depth of bed	98 in.
Weight empty	170 lb

6. Feed-water Filter

Number required	1
Type (Fulflo 2807-6SS-600)	Disposable cartridge
Fluid handled	Water
Flow rate (maximum)	25 gpm
Permissible pressure drop at 25 gpm	5 psi
Working pressure	300 psig
Design pressure (maximum)	400 psig
Working temperature	200°F
Design temperature (maximum)	450°F
Piping connections	In shell only

6. Feed-water Filter (Cont'd.)

Attachments	Closed system vent and drain lines
Removable head connection	Flanged and bolted
Position of removable head	Head at top
Filter element	Cotton wound
Number of filter elements required	(1) set for 5-micron and (2) sets for 10-micron
Radiation shielding	None required
Code requirements	ASME-UPV Code; U-symbol stamp
Name of manufacturer	Commercial Filter Corp.
Model number	2807-6SS-600
Length (nominal)	3 ft
Diameter (nominal)	9 in.
Body material	Type 304 Stainless Steel
Head material	Type 304 Stainless Steel
Bolt material	ASTM A-193, Grade B7
Gasket type and material	Type 304 Stainless Steel corrugated jacketed asbestos filler (Goetze No. 926)
Shell thickness	5/16 in.
Head thickness	5/16 in.
Flange thickness	1-15/16 in.
Diameter of gasket circle (nominal)	9 in.
Weight empty	190 lb

7. Retention Tank and Header

Number required	1
Volume	900 gal
Dimensions	66 in. dia. x 63 in. high
Position	Vertical cylinder, flat heads

7. Retention Tank and Header (Cont'd.)

Materials	Stainless steel, Type 304, SA-167
Internal pressure	Atmospheric
External pressure	Earth load from burial in gravel of density 130 lb/cu ft, with gravel surfaces 17 ft above bottom head of tank
Corrosion allowance	None
Header	10-inch, Schedule 10 pipe, Stainless steel Type 304, SA-312
Header Connections	Screwed fittings
Construction	As shown on Stover Tank Co. Dwg. BA-990-161.
Code requirements	ASME-UPV Code construc- tion; hydrostatic test at 60 psig; no radiography
Internal diameter	66 in.
Shell wall thickness	3/8 in.
Length, internal, head-to-head	63 in.
Bottom head thickness	3/8 in.
Top head thickness	3/8 in.
Weight empty, without header	2400 lb

8. Retention Tank Pump

Number	1
Fluid handled	Water
Flow rate at 120 ft total head and NPSH of 10 ft	10 gpm
Discharge pressure (nominal)	40 psig
Shaft seal, type	Packing, with lantern rings
Materials of construction	All bronze
Tank material	Type 304, Stainless steel
Electrical supply	60-cycle 3-phase 120/208 volts

8. Retention Tank Pump (Cont'd.)

Control	Manual on-off
Motor construction	Drip-proof
Manufacturer	Aurora Pump Co.
Model number	F 4T-3/4 (Self-priming, high-lift turbine-type)
Operating flow	10 gpm
Operating discharge pressure	52 psig
Discharge pressure (maximum)	230 psig (shutoff)
Operating temperature (maximum)	250°F
Motor rating	1 hp
Speed	1750 rpm
Voltage	220/440 volt, 3 phase

9. Resin Disposal Tank

Number	6
Length (nominal)	2 ft
Inside diameter (nominal)	14 in. (Standard weight pipe)
Materials	Carbon steel body
Protective coating	Shop coat; red lead outside
Fittings	Screwed couplings with tubing connectors
Construction	As shown on Illinois Water Treatment Co. DW. F-639, 1A
Design pressure	25 psig
Test pressure	50 psig
Head thickness	3/8 in.
Material	Carbon steel Bitumastic lined
Screen mesh and weave	20 mesh x 120 mesh, twill weave
Inside diameter	14 in.

9. Resin Disposal Tank (Cont'd.)

Body length	18 in.
Total length	$23\frac{1}{2}$ in.
Volume	$1\frac{1}{2}$ cu ft

10. Purification Vault

Number required	1
Outside diameter	29 in.
Length	$152\frac{1}{4}$ in.
Position	Vertical
Material	Carbon Steel, A-212 Grade A, Firebox Quality
Corrosion allowance (internal and external)	$1/16$ in. (each)
Protective coatings	One shop coat; red lead
Construction	As shown on Stover Tank Co. Dwg. BA-990-158
Internal Pressure	Atmospheric
External Pressure	Earth load from burial of lower 9 ft of vault in gravel of density 130 lb/cu ft
Cover	To be provided by others
Connections	$1\frac{1}{4}$ in. socket weld drain connection
Support legs	Three 6-in., 10.5-lb. steel ship channels
Code requirements	Fabricated in accordance with ASTM. Specification A-155 Class II; no hydro- static test; standing water head test for 24 hr
Shell wall thickness	$3/8$ in.
Bottom head thickness	$1/2$ in.
Material	SA-212, Grade A
Weight empty	1000 lb

11. Hose

Number	4
Size	3/4 in.
Length, each	30 ft
Design pressure (maximum)	100 psig
Design temperature (maximum)	150°F
Materials	Natural rubber, two-ply cotton duck
Fittings	Screwed, 3/4-inch male hose thread with cap on one end; 3/4-inch female swivel hose coupling on other end; brass

12. Waste Storage Sump Tank

Number	2
Material	Carbon steel, SA-212 Grade A, Firebox quality
Outside diameter	3 ft
Length	15 ft - 11 1/4 in.
Position	Vertical
Cover	To be provided by others
Support	From below
Pipe connections	None
Construction	As shown on Stover Tank Co. Dwg. BA 990-159
Internal Pressure	Atmospheric
External Pressure	Earth load from burial in gravel of density 130 lb/cu ft.
Corrosion allowance (internal and external)	1/16 in. (each)
Protective coating	shop coat; red lead

12. Waste Storage Sump Tank (Cont'd.)

Code requirements	Fabricated in accordance with ASTM. Specification A 155 Class II. No hydrostatic test; standing water head test for 24 hr
Shell wall thickness	3/8 in.
Bottom head thickness	1/2 in.
Material	SA-212, Grade A
Weight	2550 lb

13. Temperature Control Valve

Type	Direct-acting self-operated pilot controlled temperature regulator
Fluid handled	Water
Working pressure	300 psig
Design pressure (maximum)	400 psig
Control temperature (nominal)	170°F
Control temperature range	150-190°F
Design temperature (maximum)	450°F
Fittings	
Control valve	300-lb flanged, 3/4 in.
Pilot	Screwed
Temperature bulb	Screwed into well that is welded into system
Valve construction	Single-seat with dashpot, spring loaded
Flow rate(maximum)	2500 lb/hr
Pilot type	Internal or external, with adjustable control temperature
Manufacturer	Spence Engr. Co.
Model number	ET 14 w/style 700 temperature bulb, w/style 728 well

13. Temperature Control Valve (Cont'd.)

Pressure - temperature rating 300 psig, 500°F

Materials

Body	Steel
Seats	Stellite
Disc	Stellite
Bulb	Bronze
Well	Stainless steel
Motor type	Diaphragm

14. Pressure Relief Valve

Type (Powell Fig. 2333, 150 lb)	Spring-loaded pressure relief, enclosed spring
Set pressure	40 psig
Fittings	Socket weld
Materials	Type 304 Stainless Steel throughout
Size (nominal)	3/4 in.
Drain connections	Body and cap

B. Piping Equipment1. Piping and Valves Technical Data

Specifications for piping, valves, and fittings are given in Sections 4, 5, 6, and 7.

Valve stems shall be packed with graphited asbestos.

Valves mounted on the control panel shall be of the rising-stem, rising-wheel globe type, with back seats.

All valves shall have bolted bonnets, bolted glands, and socket weld ends.

Valve bodies and stems shall be of stainless steel. Valves used in throttling service shall have trim of Stellite, or approved equal.

Valves shall be tight, with a maximum allowable leakage not exceeding 2 cc/hr as determined by actual measurement at test pressure, with normal hand torque applied to the wheel.

Visible leakage through the stem packing is not permissible.

Exceptional cleanliness shall be maintained at all times; assemblies shall be protected against entry of foreign matter.

2. Stainless Steel Piping Procedure

Sizes and wall thicknesses shall be as designated on piping drawings.

Material for all pipe, tubing and fittings shall be Type 304 or 316 Stainless Steel unless otherwise noted on piping drawings.

All pipe, tubing and fittings shall be properly cleaned and aligned prior to welding.

Welding shall be done by the metallic-arc method, using direct-current, reverse polarity.

Electrode Size	3/32 in. preferred 1/8 in. permissible
Preheat	None
Stress Relief	None
<u>Material to be welded</u>	<u>Electrode Material</u>
Type 304 SST	AWS No. E-308-15 or E-347-15, G.E. Co. No. W-1308, W-1347 or equal.
Type 316 SST	AWS No. E-316-15, G.E. Co. No. W-1316, or equal
Type 304 to 316 SST	AWS No. E-316-15, G.E. Co. No. W-1316, or equal

3. Pipe Supports

All piping shall have supports, guides and sway braces conforming in all respects with Section 6, ASA Code for Pressure Piping B 31.1, 1955, or latest issue. The design and installation of all supports shall be subject to approval of Purchaser.

Accurate weight balances shall be made to determine the supporting force for each hanger. These calculations shall be based on the total weight of the pipe, valves, flanges, fittings, and other attachments to the pipe, the weight of the medium transported, and the weight of the insulation. Spring hangers shall be used where piping is subject to vertical movements caused by thermal expansion. Hangers of an approved constant load design shall be used for all piping where the vertical movement is 1 in. or more.

Variable spring hangers with a minimum usable spring deflection of $5\frac{1}{4}$ in. shall be used where vertical pipe movements are in excess of $1\frac{1}{2}$ in. but less than 1 in.

Variable spring hangers with a minimum usable spring deflection of $2\frac{5}{8}$ in. shall be used where vertical pipe movement is $1\frac{1}{2}$ in. or less.

Pipe supports featuring spring hangers in general and constant load hangers in particular, shall be installed so that the horizontal movements of the supported piping will cause the hanger rod to swing less than $3\frac{1}{2}$ degrees from the vertical.

Piping systems not subject to vertical movement shall be supported by rigid hangers.

The span between pipe supports shall be such that the sum of the longitudinal stresses in the pipe, due to weight and pressure, does not exceed three-fourths the allowable working stress for the pipe material at the operating temperature.

No holes shall be drilled or punched in steel members of the building. This restriction does not apply to steel members provided as a part of a pipe support. Beam clamps shall not be used, unless specifically approved by the Purchaser. Pipe supports shall not be cantilevered from the side of any beam in the building steel, unless specifically approved by the Purchaser. Building steel is shown on the Dwgs. AA-77400 and AA-77398.

Hanger attachments to the pipe shall be made by means of double-bolt pipe clamps of a material suitable for the operating temperature of the pipe. Where space does not permit the use of double-bolt clamp, single-bolt clamps of a material suitable for the operating temperature of the pipe may be used. Adjustable clevis-type attachments are not acceptable. Where plate lugs or other attachments are welded to the pipe, such attachments shall be suitable for the operating temperature of the pipe, and the materials and welding shall have a chemical composition similar to the piping materials. Forged-steel clevises, or suitable riser clamps, may be used with welded attachments where necessary to provide a trapeze beam by means of a suitable U-bolt.

Support calculations, selection of hanger components, and determination of support locations shall be made by the support manufacturer's engineers or by other competent support design organizations, as approved by the Purchaser.

4. Main Piping

Design pressure	400 psig
Design temperature	450°F
Inspection	Hartford
Radiography	None
Backing Rings	None

Piping

<u>Size, in.</u>	<u>ASTM Spec</u>	<u>Schedule</u>	<u>Remarks</u>
1/2	A-312, TP 304	80	Seamless
3/4		40	Seamless
1		40	Seamless

Fittings

Type	Socket weld
ASTM Spec.	A-182, Gr. F-304
Pressure Class	2000 lb.

Flanges

Size	1/2 in.
Type	Socket weld
ASTM Spec.	A-182, Gr. F-304
Facing	Raised face
Gasket	Corrugated stainless steel

Bolting

	<u>ASTM Spec.</u>
Bolts and bolt studs	A-193, Gr. B7
Nuts	A-194, Cl. 2H

Valves

<u>Size, in.</u>	<u>ASTM Spec.</u>	<u>Remarks</u>
1 1/2	A-296, Gr. CF-8	Globe; 300-lb socket weld ends; Powell No. 2446
3/4		
1		
1/2	A-296, Gr. CF-8	Self-cleaning strainer; 600-lb; socket weld ends; 20 x 120 screen; Leslie

4. Main Piping (Cont'd.)Valves

<u>Size, in.</u>	<u>ASTM Spec.</u>	<u>Remarks</u>
1/2 } 3/4 }	A-296, Gr. CF-8	Swing check; 300-lb; socket weld ends; Powell No. 2345

5. Feed-Water Piping

Design Pressure	400 psig
Design Temperature	450°F
Inspection	Hartford
Radiography	None
Backing Rings	None

Piping

<u>Size, in.</u>	<u>ASTM Spec.</u>	<u>Schedule</u>	<u>Remarks</u>
1 1/2	A-312, TP 304	40	Seamless

Fittings

Type	Socket Weld
ASTM Spec.	A-182, Gr. F-304
Pressure Class	2000 lb

Flanges

Size	2 in.
Type	600-lb; socket weld
ASTM Spec.	A-182, Gr. F-304
Facing	Raised face
Gasket	Corrugated Stainless Steel

Bolting

	<u>ASTM Spec.</u>
Bolts and Bolt Studs	A-193, Gr. B7
Nuts	A-194, C1.2H

5. Feed-Water Piping (Cont'd.)Valves

<u>Size, in.</u>	<u>ASTM Spec.</u>	<u>Remarks</u>
1 $\frac{1}{2}$	A-296, Gr. CF-8	Globe; 300-lb; socket weld ends; Powell No. 2446.
1 $\frac{1}{2}$	A-296, Gr. CF-8	Swing check; 300-lb; socket weld ends; Powell No. 2345

6. Retention Tank Piping

Design Pressure	100 psig
Design Temperature	220°F
Inspection	None
Radiography	None
Backing rings	None

Piping

<u>Size, in.</u>	<u>ASTM Spec.</u>	<u>Schedule</u>	<u>Remarks</u>
1/2	A-312, TP 304	80	Seamless
3/4	A-312, TP 304	40	Seamless

Fittings

Type	Socket Weld
ASTM Spec.	A-182, Gr. F-304
Pressure class	2000 lb

Valves

<u>Size, in.</u>	<u>ASTM Spec</u>	<u>Remarks</u>
1/2	A-296, CF-8	Globe; 150-lb; socket weld ends; Powell No. 2474.
3/4		
1		
3/4	A-296, CF-8	Check valve; 150-lb; socket weld ends; Powell No. 2341
1		

6. Retention Tank Piping (Cont'd.)Valves

<u>Size, in.</u>	<u>ASTM Spec.</u>	<u>Remarks</u>
3/4	A-296, CF-8	Self-cleaning strainers; 150-lb; socket weld ends; 20 x 20 screen; Leslie

7. Vent and Drain Piping

Design pressure	100 psig
Design temperature	220°F
Inspection	None
Radiography	None
Backing rings	None

Piping

<u>Size, in.</u>	<u>ASTM Spec.</u>	<u>Schedule</u>	<u>Remarks</u>
1/2	A-312, TP-304	80	Seamless

Fittings

Type	Socket weld; screwed
ASTM Spec.	A-182, Gr. F-304
Pressure class	2000 lb

Valves

<u>Size, in.</u>	<u>ASTM Spec.</u>	<u>Remarks</u>
1/2	A-296, CF-8	Globe; 150-lb; socket weld ends; Powell No. 2474
1/2		Double-window drip-lip sight-flow indicators; screwed ends; bronze body; Fischer & Porter Fig. 209

C. Control and Instrumentation1. Purification Water Pressure Gage

Type (Ashcroft 1379S)	Bourdon
Number required	1
Pressure range	0-400 psig

1. Purification Water Pressure Gage (Cont'd.)

Dial size and type	6-in., flush, bottom connection, threaded metal ring; black markings on white face
Material, dial	"Alumalife"
Materials, tube, socket, and tip	Type 316 Stainless Steel
Length of connecting tubing	5 ft (approx.)

2. Retention Tank Pump Gage

Type (Ashcroft 1379S)	Bourdon
Number required	1
Pressure range	0-100 psig
Dial size and type	6-in., flush, bottom connection, threaded metal ring; black markings on white face
Material, dial	"Alumalife"
Material, tube, socket, and tip	Type 316 Stainless Steel
Length of connecting tubing	5 ft (approx.)

3. Retention Tank Thermometer

Type (American 6-6440 DG)	Gas-actuated Bourdon
Number required	1
Temperature range	0-300°F
Bulb (American No. 40 plain)	12 in.
Dial size and type	6-in., flush; black markings on white face.
Length of capillary	30 ft
Capillary armor	Type 347 Stainless Steel seamless tubing
Material, dial	"Alumalife"
Material, bulk	Type 347 Stainless Steel

4. Retention Tank Level Gage

Type (Liquidometer Corp. "Midget Levelometer")	Air-bubbler displacement pressure type, with hand pump
Number required	1
Dial notation	Marked "Empty" and "Full"; graduated in quarters
Range of levels	4 ft
Fluid	Water at approximately 75°F
Length of connecting tubing	30 ft
Materials	Manufacturer's Standard

5. Purification Water Flowmeter

Type (Fischer & Porter Fig. 51)	Variable-area metal tube and float with external magnet follower
Number required	1
Working temperature	170°F
Design temperature (maximum)	450°F
Working pressure	300 psig
Design pressure (maximum)	400 psig
Flow rate	0-5 gpm
Materials, tube, float, and body	Type 316 Stainless Steel
Connections	Welded

6. Retention Tank Pump Flowmeter

Type (Fischer & Porter "Ratosight")	Variable-area glass tube with metal float
Number required	1
Fluid	Water
Flow rate	0-10 gpm
Direction of flow	Upward

6. Retention Tank Pump Flowmeter (Cont'd.)

Connections	Screwed
Materials	Bronze and brass
Pressure rating	125 psig

7. Shield Cooler Pump Control Switch

Type (G. E. Co. CR2940-AB103R)	Pushbutton with indicator light
Number required	1
Buttons	(2), marked "Start" and "Stop"
Light	(1), red
Voltage	208 volt
Contacts	Maintained-contact type
Mounting	Flush

8. Retention Tank Pump and Purification Water Pump Control Switches

Type (G. E. Co. CR 2940-AB103F)	Pushbutton with indicator light
Number required	2
Buttons (each)	(2), marked "Start" and "Stop"
Lights (each)	(1), red
Voltage	208 volt
Contacts	Momentary-contact type
Mounting	Flush

9. Valve Control Panels

Type	Sheet steel; hinged
Number required	3
Material	1/8-in. carbon steel
Dimensions and construction	As shown on Dwg. B-78450

9. Valve Control Panels (Cont'd.)

Additional bracing	As required for rigidity; to be located and supplied by the Fabricator, and bolted to backs of panels.
Cutouts	To suit piping arrangement as determined by Fabricator
Hinges and jambs	Heavy-duty, full-length
Framing	To be supplied by others, as shown on Dwg. AA-78473
Mounting in framing	Location and sizes of bolts and bolt holes in hinges to be determined by Fabricator
Painting	Finish coat ASA-61A light-gray paint
Flow diagram	Complete system flow diagram shall be drawn on linen paper, framed under glass, and placed on a panel to easily identify the location and purpose of each valve.

10. Instrument Panel

Type	Sheet steel
Number required	1
Dimensions and construction	As shown on Dwg. B-78450
Material	1/8-in. steel
Additional bracing	As required for rigidity; to be located and supplied by Fabricator, and bolted to back of panel
Mounting of instruments	To be performed by Erector
Instrument nameplates	Laminated Bakelite, 1 in. by 3½ in., white engraving on black background

10. Instrument Panel (Cont'd.)

Framing	To be provided by others, as shown on Dwg. AA-78473
Mounting in framing	Bolted; location and sizes of bolt holes to be determined by Fabricator
Painting	Finish coat ASA-61A light-gray paint

XV. RECOMMENDED SPARE PARTS

1. Aurora Pump F4T

<u>Part</u>	<u>Part No.</u>	<u>No. Required</u>	<u>Material</u>
Impeller	9	1	Bronze
Shaft	13	1	Bronze
Ball bearing	14	1	Bronze
Gasket	20	1	Bronze
Packing	23	1	Bronze
Spacer bushing	30	1	Bronze
Channel Ring (left)	179	1	Bronze
Channel Ring (right)	180	1	Bronze
Spacer (right)	204	1	Bronze
Spacer (left)	205	1	Bronze

2. Chempump Model CFH 1-1/2-3/4S (Serial No. 7219)

Front Shaft Sleeve	2-7	1	SST 316
Rear Shaft Sleeve	2-8	1	SST 316
Front Bearing Housing Assembly	3	1	SST 316
Rear Bearing Housing Assembly	4	1	SST 316
Front Bearings Assembly	5	2	U.S. Graphitar
Rear Bearings Assembly	6	2	No. 14 Graphitar

2. Chempump Model CFH 1-1/2-3/4S (Serial No. 7219) (Cont'd.)

<u>Part</u>	<u>Part No.</u>	<u>No. Required</u>	<u>Material</u>
Impeller	9	1	SST 316
Gaskets	14 and 15	2	Teflon
Circulating tube	10	1	SST 316

3. Midget Model Leveltrol and 30 ft tubing

4. Rotometer (Serial No. 5708A4108 x 2-3)

<u>Part</u>	<u>Part No.</u>	<u>No. Required</u>
Tube A-N (5 gpm, max)	M4-35-5	2
Gaskets (O-ring)	2-101S715	4
Gaskets (flat)	1-333C23402	2

5. Filter

<u>Part</u>	<u>Part No.</u>	<u>No. Required</u>
Cartridges	27 RO 1SV	18

6. Gaskets

Spiral Wound (SST 304)	3 in.	2
Spiral Wound (SST 304)	1-1/4 in.	2
Spiral Wound (SST 304)	3/4 in.	2
Flat	CR-06-020	1
Flat	CR-06-007	1

7. Gauges

Ashcroft (0.400 lb)	1379S (1/4 in. conn.)	1
Ashcroft (0-100 lb)	1379S (1/4 in. conn.)	1
Thermometer (0-300°F)	6-6440 DG-E-XLA (30 ft tubing and SST bulb S-12)	1

8. Resin

Mixed bed	NR-11	1.5 cu ft
Cation	NR-1	1.5 cu ft

XVI. REFERENCE DRAWINGSLegend

(ANL)	Argonne National Laboratory
(PS&E)	Pioneer Service & Engineering Company
(Graham)	Graham Manufacturing Company
(IWT)	Illinois Water Treatment Company
(Lasker)	Lasker Boiling & Engineering Corporation
(Stover)	Stover Tank & Manufacturing Company

Process Flow Scheme

(ANL)	RE-6-24947-D	Purification System Flow Diagram
(PS &E)	B-78327	Safety Valve Discharge and Vents Flow Diagram

General Arrangement

(PS&E)	AA-78320	ALPR Reactor Power Plant - Plan
(PS &E)	AA-78321	ALPR Reactor Power Plant - Elevation

Equipment

(Graham)	A-7889	Purification Water Cooler
(Stover)	BA-080-329	Demineralizer Vessel
(IWT)	F-639.1A	Resin Disposal Tank
(Stover)	BA-990-161	Contaminated Water Storage Tank
(Stover)	BA-990-158	Detail of Purification Vault
(Stover)	BA-990-159	Waste Storage Sump Tank

Piping

(IWT)	F-639.3D	Purification System
(IWT)	F-639.4D	Purification System
(PS &E)	AA-78350	Safety Valve Discharge and Vent Piping
(PS&E)	AA-78347	Shield Cooler and Turbine Oil Cooler Piping
(PS &E)	AA-78344	Reactor Piping in Trough

Piping (Cont'd.)

(PS & E)	AA-83976	Boron Injection System
(Lasker)	4004	Pressure Vessel Assembly

Structural

(PS & E)	AA-77398	Plan and Details of Operating Floor
(PS & E)	AA-77903	Operating Floor Sections
(PS & E)	AA-78358	Pipe Trough Details
(PS & E)	AA-77400	Plan and Details of Fan Floor
(PS & E)	AA-78473	Operating Floor Details
(PS & E)	A-77402	Layout of Crane and Hoist

Control and Instrumentation

(PS & E)	B-78450	Water Purification Control Panels
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XVII. VENDOR

Illinois Water Treatment Company
840 Cedar Street
Rockford, Illinois

XVIII. PURCHASE ORDER

Argonne National Laboratory AL-224800

Illinois Water Treatment Company Shop Order No. 12873
Reference No. C-1-364

SECTION 10

TURBINE-GENERATOR AND ACCESSORY EQUIPMENT

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I. INTENT

The intent of this specification is to state the requirements and conditions for the furnishing, delivery and supervision of installation of one 300-kw, geared-type steam turbine, synchronous generator unit with direct connected exciter, and accessories.

II. DESIGN

The unit shall be of the horizontal shaft-type and of a modern design and construction that has proved its durability, reliability and efficiency. It shall be of rugged construction and shall have high sustained economy.

The unit shall be designed to operate with either steady or varying load and without undue vibration or noise.

The design of the unit shall be consistent with the "package" concept, i.e., integral mountings for accessories shall be provided where practical.

The design and construction of the unit shall conform to the latest standards of ASA, AIEE, and NEMA.

III. MATERIALS AND WORKMANSHIP

All materials used shall be of first-class quality and which have proved successful in similar service. The workmanship shall be of high quality in every detail.

IV. PAINTING AND SHIPPING

All exposed and unfinished castings of the turbine-generator unit shall be filled in and rubbed down smooth. All exposed surfaces of the unit shall be painted with one coat of paint before shipment. All components of the unit shall be protected during shipment and storage from rust and entry of dirt and water. All flanges shall be closed tightly by adequate covers bolted in place. The type and method of application of rust preventive or inhibitor employed to protect interior surfaces shall be subject to prior approval by the Purchaser. All finished surfaces shall be adequately protected against marring and other damage. Small parts shall be boxed and identified with indestructible tags.

V. FACTORY TESTS

The equipment shall be tested at the factory before shipment. The tests shall include:

- (1) Mechanical inspection and balance.
- (2) Adjustment of speed governor and control devices.
- (3) Check of overspeed governor and tripping devices.
- (4) Measurement of cold resistances.
- (5) No load saturation.
- (6) Iron loss.
- (7) Voltage balance.
- (8) Insulation.

The steam turbine, reduction gear, generator, and exciter shall be assembled as a unit and operated at the specified steam conditions.

VI. FEATURES AND ACCESSORIES

The turbine-generator unit shall be provided with the following features and accessories, all of which shall comply with the latest standards of ASA, AIEE, and NEMA.

A. Turbine

(1) Combined trip and throttle valve actuated by the overspeed governor, an electrical signal, and low oil pressure.

(2) Overspeed governor entirely independent of normal speed-regulating governor.

(3) Automatic governor-control valve. A single governor-controlled valve with the hand-operated nozzle valves blanked off to minimize steam leakage from the turbine.

(4) Speed governor, oil relay type.

(5) Motor-and hand-operated speed changers and hand-operated exciter field rheostat capable of voltage regulation within 5%. The exciter rheostat shall be suitable for no-load synchronizing with hand control of the exciter voltage and without the use of a main generator field rheostat.

(6) Local indicating-type tachometer on turbine, and electric remote indicating-type tachometer calibrated for generator speed.

(7) Lubricating system including:

- (a) Oil pump
- (b) Oil reservoir
- (c) Suitable connections to attach an air-cooled oil cooler.
- (d) Motor-driven auxiliary oil pump (to cut in on drop in pressure on main pump, and cut out on increase in pressure from main pump).
- (e) Steel oil piping to connect all integral parts of the oiling system for the turbine, reduction gear, generator, all necessary transfer valves, except for connections to and from oil coolers.
- (f) Operating oil pressure gauges.

(8) Low oil pressure emergency trip.

(9) Operating steam gauges mounted on a gauge board which, in turn, is mounted on the turbine base-plate, with gauge piping, as follows:

- (a) Initial pressure
- (b) First-stage pressure
- (c) Exhaust pressure
- (d) Steam seal pressure

(10) Heat-insulating material, removable where necessary for maintenance of the unit, and protected by a sheet steel jacket on the turbine casing.

(11) A single structural steel baseplate under the entire unit, including turbine, reduction gear and generator.

(12) Steam inlet on right side, facing turbine.

(13) Steam exhaust outlet on right side facing turbine.

(14) Wrenches for special bolts and nuts, including any special rigs, etc., for assembly and dismantling of turbine-generator.

(15) Automatic control gland steam system and leakage-collecting system with all necessary valves. Waste steam is to be collected in a common header from which it will be removed by an ejector pulling sufficient vacuum to assure no leakage out of the glands. (Air will not be available for control.)

(16) All necessary foundation bolts, washers, and anchor plates.

(17) One set of dial-type thermometers to measure temperature of oil cooler oil inlet, turbine bearings, gear reducer oil sump, generator bearings, and turbine oil reservoir.

(18) All necessary flexible couplings between turbine and reduction gear, and generator with guards.

B. Gears

Helical herringbone reduction gear complete with spray-type lubrication system.

C. Generator

- (1) Field discharge resistor
- (2) Damper windings

D. Exciter

Hand-operated field rheostat.

VII. INSTALLATION SERVICES AND ACCESSORIES

The following will be furnished by others:

- (1) Foundation design and foundations, shims, material and labor
- (2) Free use of station facilities including crane of 10-ton capacity.
- (3) All steam, water, oil and drain piping, valves and traps which are external to the unit.
- (4) All electric wiring and cable.
- (5) Painting after installation.
- (6) Steam, water, oil, supplies and operating force for preliminary runs and for operation of the unit.
- (7) Openings into the building to permit passage of the largest piece of the unit as shipped.
- (8) Exhaust outlet pressure relief valves.
- (9) All common labor necessary for complete installation of equipment specified herein.

The Manufacturer shall provide the services of a competent field engineer to supervise installation; inspect the Purchaser's completed installation of the equipment; place the unit in operation; and instruct operating personnel in proper operation and maintenance of the unit. Per diem charges and travel expenses for the field engineer shall be specified by the Manufacturer.

VIII. RATING AND DESIGN CONDITIONS

A. Rated Capacity

The generator shall have a continuous rated capacity of 300 kw at 80% power factor at rated voltage and frequency measured at the terminals of the generator, based upon a temperature rise not to exceed 40°C measured by a thermometer on the armature, and 50°C by resistance on the field. The generator shall be capable of a 2-hour peak of 340 kw. The rating of the unit shall be in accordance with the latest standards of ASA, AIEE, and NEMA.

B. Rated Steam Conditions

The turbine shall be designed for operation with the following rated steam conditions:

Pressure at turbine throttle inlet flange	275 psig
Temperature at turbine throttle inlet flange	0° Superheat
Pressure at turbine exhaust flange	
Nominal	5 in. Hg abs
Peak Load	8 in. Hg abs
Oxygen concentration in steam (approx.)	30 ppm

C. Generator Characteristics

The generator shall be of the open, salient pole revolving field-type, having the following characteristics for service at altitudes of 5100 ft above sea level:

Kilowatts (nominal)	300
Kilovolt amperes (nominal)	375
Power factor	80%
Number of phases	3
Frequency cycles	60
Volts	120/208
Rated excitation voltage	125
Speed	1200 rpm

D. Speed Governor

The speed governor shall comply with NEMA, Class D specifications, except that:

(1) The maximum speed variation at any given load shall be $\pm 0.16\%$ (± 0.1 cps).

(2) Transient speed deviations from steady-state values shall not exceed $\pm 0.8\%$ (± 0.5 cps) upon sudden electrical load changes of as much as 60 kw. Steady-state speed shall be re-established within 5 sec.

E. Speed Changer Motor

Voltage 120-volt, single phase .

F. Direct-Connected Exciter

The exciter shall be open, shunt wound for 125-volt operation, and shall be suitable for use with a voltage regulator.

The exciter shall have the capacity to supply excitation current of not less than 10% in excess of the actual amperes excitation required by the generator at rated load, power factor, frequency, and voltage.

G. Application Data

The unit is to be on continuous duty service. It is desirable that the interval between inspection and/or maintenance shutdowns be as long as practicable. The design objective for the plant is the attainment of continuous operation for periods of up to three (3) years with a 0.70 plant factor.

Steam consumption shall be held at a minimum consistent with good performance and very high reliability and shall not exceed 7500 lb/hr under rated conditions.

IX. DETAIL SPECIFICATIONS

A. Steam Turbine

1. Trip and Throttle Valve

A corrosion-resistant, combined trip and throttle valve, actuated by the emergency overspeed governor shall be supplied. Additional provisions shall be incorporated for actuation by an electrical signal and by turbine oil pressure. The valve shall automatically stop the flow of steam into the turbine at predetermined settings of the above three functions. Suitable means shall be provided for (1) manual control of the steam flow into the turbine during startup operations; and (2) manual tripping of the valve.

2. Governor-Controlled Valve

The flow of steam into the turbine shall be controlled by the speed governor and its relay-controlled hydraulic mechanism through the governor-controlled valve, the design of which shall minimize the throttling losses.

The valve stem seal leak-off shall be piped to the gland seal exhaust system. The valve stem and valve seat shall be made of corrosion- and erosion-resistant materials especially suited for the specified service conditions.

3. Turbine Casing

The turbine casing shall be constructed of materials which have proved suitable for successful operation under the specified steam conditions.

The casing shall be designed to facilitate removal of necessary parts for inspection and repairs. The design of the casing and method of support shall be such that, in normal operation, injurious distortions will not occur with changes in load on the unit.

The turbine unit shall be given a hydrostatic test in the manufacturer's factory for one-half hour with no visual pressure loss as follows:

Steam chest:	600 psig
Exhaust end:	120 psig

4. Turbine Rotor

The turbine rotor shall be of high-quality steel and shall be designed and constructed so that injurious distortions will not occur with changes in load on the unit. The completed rotor shall be in dynamic balance so that it will run smoothly and without undue vibration.

5. Steam Nozzles

The nozzles shall be designed to produce efficient expansion of the steam. The materials used shall be selected for their strength and for their corrosion- and erosion-resisting qualities.

6. Blading

The blades shall be made of materials selected for their strength and corrosion- and erosion-resisting qualities. They shall have the form and the dimensions which are essential to efficiency and strength. All blading shall be securely anchored in place.

7. Emergency Overspeed Governor

An emergency overspeed governor, entirely independent of the speed governor, shall be provided.

8. Speed Governor

A powerful and sensitive governor shall be provided for controlling the turbine speed by varying the admission of steam into the turbine. Means shall be provided for adjustment of the speed or the power output of the unit while it is in operation. The speed changer shall be arranged for both manual and remote adjustment.

9. Main Bearings

The turbine and gear-bearing shells shall be horizontally split and lined with high-grade babbitt. They shall be arranged for pressure lubrication and shall operate without injurious temperature rise or undue wear. The bearing shells shall be readily removable without removing the rotors. Generator shall be supplied with two main bearings. Means shall be provided to prevent leakage of oil or oil vapors from the bearing housings.

10. Thrust Bearing

The turbine shall be provided with a thrust bearing to maintain the correct axial relations between the rotating and stationary parts. The bearing shall be arranged for pressure lubrication. Means shall be provided to adjust the axial position of the turbine rotor when the unit is at rest.

11. Shaft Seals

Efficient, durable, and readily renewable shaft seals shall be provided where the turbine shaft passes through the casing and between stages. Seals should be designed to limit leakage of air into the gland seal recovery system to not more than 50 lb/hr of air at standard conditions.

12. Lubrication

Oil shall be delivered to the bearings of the unit by means of an oil pump driven from the governor shaft. This pump shall deliver oil from the reservoir supplied with the unit at sufficient pressure for all necessary lubrication.

The supply and return oil piping shall be made of seamless steel tubing and shall have a minimum number of flanged joints. All flanges and fittings shall be welded to the piping.

The unit shall be supplied with suitable connections to attach an air-cooled oil cooler.

An auxiliary motor driven oil pump, with motor controlled with automatic pressure control shall be supplied.

13. Lagging

The turbine parts containing high-temperature steam shall be covered with heat-insulating material. The turbine casing insulation shall be protected by a sheet metal jacket.

14. Couplings

Suitable couplings, arranged to be readily disconnected, shall be provided for connecting together the shafts of the unit. Coupling guards shall be provided.

15. Reduction Gear

The reduction gear shall be of the helical type, designed for continuous high-speed service. It shall be totally enclosed. The lubricating system shall be of the pressure-type for the bearings, and a spray-type for the gears.

B. Generator

1. Type

The generator shall be of the open, self-ventilated, salient pole, revolving field type.

2. Stator

The stator frame, together with easily removable end enclosures, and associated ventilating system shall enclose the generator. The frame shall be of sufficient strength to support the armature laminations and coils.

3. Armature Core

The armature laminations shall be made of high-grade steel secured to the stator frame. Spacers shall be provided at intervals along the length of the core to form radial ventilating ducts. The laminations and spacers shall be securely clamped together to prevent undue vibration and noise.

4. Armature Coils

The coils shall be form wound and interchangeable. They shall be assembled in open-type slots in the armature core and shall be held securely by insulating wedges.

Each conductor shall consist of a number of strands insulated from each other. The conductors shall be individually insulated. The coils shall be insulated from each other and from the stator laminations. All insulation used shall be of high-grade materials and shall conform to the latest standards of ASA, AIEE, and NEMA for the specified voltages and kva rating.

End windings and connections shall be braced adequately to prevent any appreciable movement of or damage to, the windings during momentary short circuits at the terminals.

Both ends of each phase winding shall be brought out at the right side of the stator frame (when facing the turbine end).

5. Rotor

The rotor shall be made of laminated steel pole pieces fastened securely to a steel spider keyed to, or made integral with, the shaft.

6. Rotor Coils

The field winding shall be wound on the poles from copper wire suitably insulated. The coils shall be adequately braced.

7. Collector Rings

Collector rings shall be made from high-quality steel. They shall be insulated from the rotor and from each other by materials especially suitable for the purpose. Connections to the field coils shall be by metallic bond. Carbon brushes and adjustable box-type brush holders shall be used.

8. Insulation

The insulation shall be Class A and shall be in accordance with the latest standards of ASA and NEMA.

9. Temperature Rises

Temperature rises shall be in accordance with the latest standards of ASA and NEMA for the class of insulation specified and with due regard for the altitude of the proposed installation.

C. Direct-Connected Exciter

1. Type

The direct-connected exciter shall be of the open, self-ventilated, self-excited type.

2. Stator

The stator frame shall be liberally proportioned and substantially constructed so that the exciter will operate without injurious vibration.

3. Armature

The armature core shall be built up of high-grade laminations which shall be suitably mounted upon the armature shaft.

4. Commutator

The commutator shall be built up of copper bars, insulated from each other and from the supporting parts by high-quality mica insulation. The commutator bars shall be assembled to permit expansion and contraction under varying load conditions without injurious distortion of the parts.

5. Brushes and Brush Holders

High-grade carbon brushes shall be mounted in adjustable-type brush holders. The brushes shall be connected to the brush holders by flexible copper connections.

6. Insulation

Exciter insulation shall be Class A and shall be in accordance with latest standards of ASA, AIEE, and NEMA.

7. Temperature Rises

Temperature rises shall be in accordance with the latest standards of ASA, AIEE, and NEMA for the class of insulation specified and with due regard for the altitude of the proposed installation.

8. Commutation

The exciter shall successfully commute as defined by ASA standards, throughout its range of rated capacity without adjustment of the brushes and in such a manner that neither brushes nor commutator are injured.

9. Speed of Response

The exciter shall have a nominal speed of response ratio of 0.5, as defined by ASA standards, when used either with or without a pilot exciter.

X. TRANSPORTATION AND DELIVERY

The equipment is to be installed at the ALPR site in the National Reactor Testing Station located near Scoville, Idaho at an elevation of 5100 feet above sea level.

Complete equipment shall be shipped f.o.b. , Motor Freight, ALPR Site, National Reactor Testing Station.

XI. PERFORMANCE GUARANTEE

<u>Percent Load</u>	<u>Kilowatt Load</u>	<u>Power Factor</u>	<u>Steam Consumption lb/steam/kw/hr</u>
25	75	.80	30.8
50	150	.80	24.6
75	225	.80	22.1
100	300	.80	20.65
125	375	1.00	19.8

XII. TEMPERATURE RISE GUARANTEE

The following are based on an ambient temperature of 40°C.

Generator Armature	40°C
Generator Collector	65°C
Generator Field	50°C
Exciter Commutator	55°C
Exciter Winding	40°C

XIII. TECHNICAL DATA

A. Design

Continuous Load on Generator	280 kw
Peak Load on Generator	340 kw
Duration of Peak Load	2 hr
Generator Characteristics	
Kilowatts (nominal)	300
Kilovolt-amperes	375
Power Factor	80%
Number of Phases	3
Frequency	60 cycle
Volts	120/208
Rated Excitation Voltage	125 volts
Speed	1200 rpm
Rated Steam Conditions for Turbine	
Pressure at Throttle Inlet Flange	275 psig
Temperature at Throttle Inlet Flange	0° Superheat
Pressure at Turbine Exhaust Flange	
Nominal	5 in. Hg. abs
Peak Load	8 in. Hg. abs
Speed Governor Characteristics	
Make and Model	Woodward UG-8
	Direct Acting
NEMA Classification (with following exceptions)	Class D
Maximum speed variation	±0.16% (±0.1 cps)
Transient speed deviations	Not to exceed ±0.8% (±0.5 cps) upon sudden electrical load changes of as much as 60 kw. Steady-state speed shall be re-established within 5 sec.
Speed Changer Motor Voltage	120-volt, single phase
Maximum Steam Consumption at Rated Load and Rated Steam Conditions	7500 lb/hr

Gland Seal System Leakage

Minimum leakage
practicable and in
no case to exceed
50 lb/hr of free air
at standard conditions

Space Limitations

	<u>For Installation</u>	<u>For Shipping (crated)</u>
Length	18 ft	20 ft
Width	6 ft	9 ft
Height	7½ ft	7½ ft

B. Equipment

Weights and Dimensions

Net Weights

Complete unit	21,000 lb
Heaviest piece during erection	21,000 lb
Heaviest piece after erection	1,700 lb
Heaviest part to be handled after erection	Turbine Cover
Shipping Weight (crated)	21,500 lb

Over-all Dimensions

Length of complete turbine- generator unit	17 ft 8 in.
Width at widest point	7 ft 10 in.
Width at base plate	4 ft 5½ in.
Height	5 ft 1¾ in.
Diameter of exhaust connection opening	12 in. (with adapter) 16
Diameter of steam inlet connection	4 in.
Highest point of hook required for erection and overhaul	6 ft

Turbine Data

Speed	4514 rpm
Number of stages	9
Length of longest blade	2 in.
Material of blades	Stainless steel
Number of rows of blades	10
Type of blade protection against moisture erosion	None

Turbine Data (Cont'd.)

Number of stages protected against moisture erosion	None
Tip diameter of largest wheel	23.5 in.
Peripheral velocity of largest wheel (maximum)	462 ft/sec
Area of exhaust annulus	0.926 sq ft.

Loads and moments imposed on turbine exhaust connection

Minimum load	0 lb
Vertical load (maximum)	3600 lb
Moment at axis of rotation	1000 ft-lb
Moment at axis normal to exhaust flange face	90 ft-lb
Moment at axis normal to horizontal plane	9000 ft-lb
Critical speed	2480 rpm
Does machine pass through critical speed of any part in coming up to speed? (If so, what part and what rpm?)	
Turbine (1st critical)	2480 rpm
Overspeed governor trip speed	5000 rpm
Material for turbine casing	
Steam end	Steel
Exhaust end	Cast iron
Material for rotor forgings	Low alloy steel
Material for diaphragms	Cast iron
Material for valves	Stainless steel
Material for valve seats	Stainless steel
Diameter and length of turbine bearing	2 $\frac{5}{8}$ in. x 4 in. (each)
Bearing materials	Bronze and Babbitt
Method of preventing circulating currents in bearings	One bearing completely insulated
Material for nozzle elements	Stainless steel
Material for wheels	Steel plate

Time required for starting and stopping of equipment

To speed from cold and apply 1/4 rated load	30 min.
To speed from cold and apply full rated load	60 min.

Lubrication System

Oil capacity, total	50 gal
Oil tank capacity	50 gal
Bearing oil pressure	8 psig
Relay oil pressure	None required

Oil pumps

Main oil pump capacity and discharge pressure	22 gpm at 8 psig
Main oil pump drive	Turbine governor shaft
Auxiliary oil pump capacity	17 gpm
Oil flow to oil cooler	22 gpm
Oil temperature	
From turbine	
Normal	129°F
Maximum	134°F
To turbine	
Normal	120°F
Maximum	125°F

Gland Seal System

Type of seal	Carbon rings
Condition and quantity of gland seal steam required	50 lb/hr, 20 lb G min, D&S
Quantities of steam, water and air that must be removed from the system	400 scfh of air 50 lb/hr of steam

Generator Data

Synchronous reactance	110% (rated kva base)
Transient reactance	23% (rated kva base)
Sub-transient reactance	13% (rated kva base)
Negative sequence reactance	13% (rated kva base)
Zero sequence reactance	8% (rated kva base)
Field resistance at 25°C	3.2 ohm
Minimum excitation voltage with no load on a-c generator	14.0 volt
Maximum excitation voltage under maximum load and worst condition of speed and power factor	120 volts
Field current at rated load	28 amp
Short circuit ratio	1.0
Method of bringing out phase windings	Strap copper

Exciter Data

Rating	5 kw
Rated voltage	125 volts
Shunt or compound wound	Shunt
Field current at 1/2 rated voltage (no load)	.68 amp
Field current at rated voltage (no load)	1.63 amp
Field current at rated voltage (full load)	1.80 amp
Maximum field current (no load, field rheostat all out)	7.35 amp at 25°C
Maximum armature voltage (no load, field rheostat all out)	.209 volts at 25°C
Shunt field resistance (at 25°C)	28.4 ohm

Unit Rating and General Performance Data at Design Conditions

Turbine	300 kw
Generator (at 0.80 PF)	300 kw

Allowable Variations from Rated Initial Pressure and Temperature

Initial Pressure

The initial pressure at rated load and steam flow shall average not more than rated pressure over any 12-month operating period.

The turbine will be capable of operating without injury at less than rated steam flow to the turbine with an average initial pressure of 105% of rated pressure. (This permissible variation recognizes the increase in pressure with decrease in steam flow encountered in operation.)

The initial pressure shall not exceed 110% of rated pressure in maintaining these averages, except during abnormal conditions. During abnormal conditions, the initial pressure may swing momentarily to 120% of rated value, but the aggregate duration of such swings shall not exceed 12 hr per 12-month operating period.

Initial Temperature

The initial steam temperature shall average not more than rated temperature over any 12-month operating period. In maintaining this average, the temperature shall not exceed rated temperature plus 15° F, except for abnormal conditions.

During abnormal conditions, the temperature shall not exceed: (1) rated temperature plus 25° F for operating periods not more than 400 hr per 12-month operating period; nor (2) rated temperature plus 50° F for swings of 15 min duration or less. The aggregate shall not exceed 80 hr per 12-month operating period.

Turbine Capability

With rated initial steam conditions and 5 in. Hg abs exhaust pressure	375 kw
With rated initial steam conditions and 8 in. Hg abs exhaust pressure	375 kw
With rated initial steam and atmospheric exhaust pressure	200 kw
With maximum allowable steam pressure at throttle	375 kw
Maximum steam quantity turbine will pass at rated inlet pressure, and at exhaust pressures of 5 in., and 8 in. Hg abs	7500 lb/hr

Normal Steam Conditions entering last stage

Quality	90.1%
Pressure	4.4 psia
Enthalpy	1030 Btu/lb

Maximum Allowable Exhaust Temperature 250° F

Unit Motoring at Exhaust Pressures
of 5 in., and 8 in. Hg abs Indefinite time (with
sufficient coolant
steam)

Unit Operation at Zero Load Indefinite time (with
sufficient coolant
steam)

Gauges, Alarms, Switches, etc., to be furnished with unit

Motor and hand-operated synchronizer
Vibration and electric tachometers
Generator Bearing Thermometers
Auxiliary oil pump pressure gauge and switch

Gauges, etc. (Cont'd.)

Panel-mounted gauges

Steam inlet pressure
First-stage pressure
Exhaust pressure
Steam-end bearing thermometer
Bearing oil pressure
Exhaust-end bearing thermometer
Gear drain thermometer
Oil tank thermometer
Oil cooler thermometer
Steam-end gland pressure
Exhaust-end gland pressure

Standard flexible gear coupling to be used between turbine, reducer, and generator.

XIV. REFERENCE DRAWINGS

LL-77640	Outline - Turbine Generator
LC-78576	Gland Seal and Leakoff Piping Diagram
LD-78525	Diagrammatic Sketch of Oil Piping
C-78600	Dynamic Loading

XV. VENDOR

Worthington Corporation
400 West Madison Street
Chicago 6, Illinois

XVI. PURCHASE ORDER

Argonne National Laboratory AL-216583
Worthington Corporation Sales W-3534
Works U-11900