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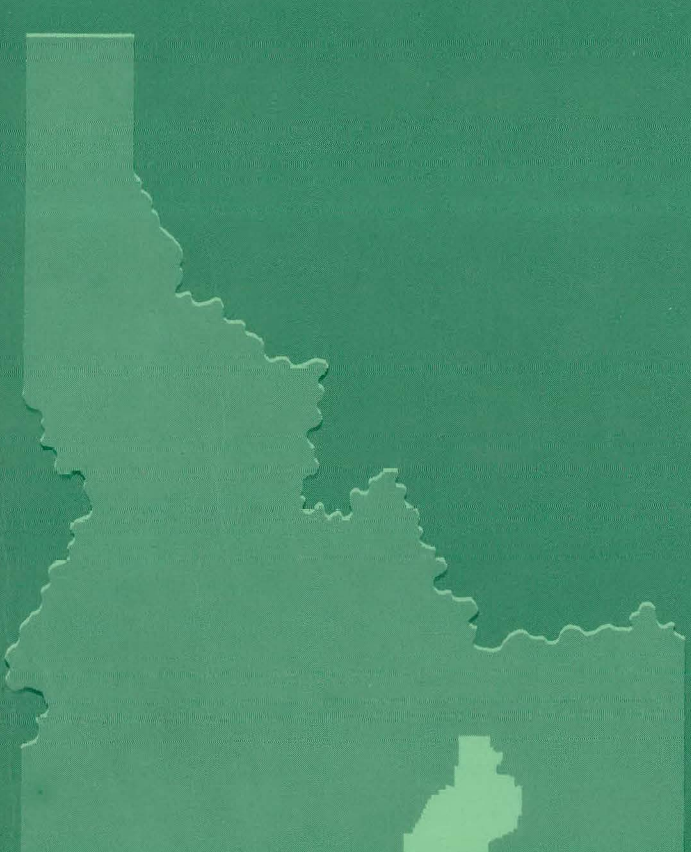
WCAP-4
HIGH-PRESSURE, HIGH-TEMPERATURE WATER LOOP OPERATING MANUAL

J. D. Stearns
K. S. Dawson

April 25, 1961



PHILLIPS PETROLEUM COMPANY

ATOMIC ENERGY DIVISION

NATIONAL REACTOR TESTING STATION

US ATOMIC ENERGY COMMISSION

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PHILLIPS PETROLEUM COMPANY
Atomic Energy Division

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ABSTRACT

The intent of this report is to describe the mechanical and electrical systems, design features and the general operating instructions of the WCAP-4 in-pile test loop. Details of loop system stability are covered in a report titled "WCAP In-pile Test Loop Analog Computer Study of the Loop Temperature Control System" WCAP-3222.

ACKNOWLEDGMENT

The authors wish to thank Westinghouse Atomic Power Department for much of the data and many of the drawings and charts included in this report.

WCAP-4 IN-PILE TEST LOOP OPERATIONS MANUAL

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I. INTRODUCTION

Information Desired and General History of Experiment

The WCAP-4 pressurized test loop was designed to determine the ability of the proposed materials of construction for the Yankee Atomic Electric Company Nuclear Reactor to withstand the nuclear, chemical, thermal and hydraulic conditions which will exist inside the reactor core. In order to determine the effects of radiation, temperature, pressure and flow on the core materials of construction, the expected conditions will be simulated by circulating pressurized water of specified composition through samples located inside an in-pile pressure tube. The in-pile pressure tube which is part of a 3/4 inch loop system will be located in the B-1 reflector position of the Materials Testing Reactor. All out-of-pile components will be located on the second level of the Materials Testing Reactor, south side.

II. PRIMARY SYSTEM

A. General Description

The WCAP-4 in-pile test loop is designed to operate at the following maximum or minimum conditions: (For further details see list of Mechanical Equipment and Flowsheet MTR-E-4802)

	Outlet leg of In-pile Tube	Inlet leg of In-pile Tube
Neutron -		
Thermal (max.) $n/cm^2 \times sec$	4.4×10^{13}	2.9×10^{13}
Fast (max.) $n/cm^2 \times sec$	1×10^{12}	0.8×10^{12}
Flow -		
Thru heat exchanger tubes (min.)	3 gpm	
Thru heat exchanger bypass (max.)	7 gpm	
Total (at 2000 psi and 537°F) (max.)	10 gpm	
Velocity past in-pile fuel samples (max.)	11.0 ft/sec.	
Heat Output -		
Maximum total from all sources	110 KW	
Temperature -		
Maximum sample outlet temperature	600°F	
Pressure -		
Operating	2000 psi	
Relief	2500 psi	

Water Chemistry -

pH = 9.5-10.5
H_2 = 25-35 ml(STP)/liter of water (min.)
O_2 = 0.07 cc/liter of water (max.)
Cl^-= 0.1 ppm (max.)

B. Description of Loop Packages

The test loop primary system consists of the following main section:

1. In-pile Pressure Tube

The in-pile pressure tube is that portion of test loop which will be located on or inside the MTR reactor vessel. It will house the samples to be tested.

For design specifications, materials of construction and details, reference should be made to the list of mechanical components, section III-B-6 and Appendix B. Component locations are as listed in this section.

2. Primary Component Cubicle

The primary component cubicle contains the primary system components, the primary detector cubicle and the lead shielding. The primary system inside the cubicle consists of piping, valves, and fittings, primary detectors for instrumentation, circulating pumps, a pressurizer, a heat exchanger, and a drainage system. Also included is a duct for ventilating the primary cubicle. The MTR Project Engineering will designate the location for the duct connection. The primary system cubicle houses the entire primary system. It is provided with an enclosure having removable walls consisting of 1" of steel and 3" of lead. All 3/4" primary system valve stems protrude through the north half of the west cubicle wall. Special removable valve handles have been provided so that this wall can readily be lifted off and the valve glands packed. The bottom of the cubicle is provided with a drip pan to collect any loop fluid leakage.

The primary detector cubicle contains all primary instrumentation elements of the primary system. This includes differential pressure cells, float type area meters, rupture discs, bleed valves and thermocouple terminals. This cubicle has a removable door so that the components are accessible for maintenance and adjustment.

C. Description and Function of Mechanical Components

1. In-pile Pressure Tube - (Appendix B)

The in-pile pressure tube which will be located in the B-1 reflector position of the Materials Testing Reactor is a U-tube pipe bend entering the reactor vessel through A-tank extension nozzles No. 16 and 17. The samples to be tested will be permanently welded into the 1-1/4" outside diameter sample section. In order to remove samples, it will be necessary to cut the stainless steel piping at appropriate locations. The in-pile pressure tube is considered to be an expendable item.

The in-pile pressure tube is surrounded by a thermal insulating jacket, which will be surrounded by MTR reactor water. The thermal insulating jacket is of stainless steel tubing at elevations above the core and is in the form of a drilled aluminum block over the distance of the core. To provide better thermal insulating and inert surroundings, a vacuum will be maintained in the annular gap between pressure tube and insulating jacket.

Differences in thermal expansion between in-pile tube materials have been accommodated in three ways. To accommodate overall pressure tube expansion in heating from 500°F to 600°F, sufficient clearance has been left to allow the pressure piping to expand into the bottom of the drilled aluminum block. (See Appendix B). To absorb differential expansion between the 500°F inlet pressure pipe and the 600°F outlet pressure pipe, the jacket between the first bend and the reactor vessel nozzles has been designed oversize. This allows 1/8" minimum additional clearance on the radius. In addition, the hot leg pressure piping is designed to be eccentric to the jacket piping through the first bend. This provides additional clearance. Any remaining thrusts or reactions are absorbed by the expansion bellows which connect from the jackets to the pressure tubes. The bellows assemblies are located external to the reactor vessel following the nozzle flanges. (See Appendix B). In this manner the bellows are readily accessible for repair.

A 1/8" aluminum purge line has been provided to remove any water that may have collected in the in-pile annulus section as a result of a leak in the system. The 1/8" aluminum purge line connection is located at the bottom of the aluminum sample block and changes to 1/4" stainless steel tubing inside the reactor tank about 2 ft. from the nozzle flange.

There are two other features related to the nozzle flange design which will assure a leak-proof seal at all times at the packing glands and at the neoprene O-rings. One is the renewable packing gland which is accessible external to the reactor vessel and the other feature is the two spare O-rings which are built into the flange. The spare O-rings allow replacing the sealing Oprings without have to cut the piping, and makes it possible for the entire primary piping to be of welded construction.

2. Pressurizer

The purpose of the pressurizer is to maintain the system pressure and to absorb fluid volume changes due to temperature variations. It is of sufficient capacity so as not to require blowdown during heatup of the system. To maintain pressure and to make up for pressurizer heat losses, there are 32 tubular immersion heaters with a total rating of 8 KW. The heaters are located in 1/2" diameter wells and are easily replaceable from the top of the pressurizer.

The degas line entering the pressurizer serves two functions. During startup, it receives loop fluid at the pump discharge and delivers it to the vapor space in the pressurizer. There the dissolved gases are removed from the loop fluid by the scrubbing action of the hot steam. The second function is to help maintain loop temperature during reactor shutdown by circulating through the degas line at the top of the pressurizer and back into the primary piping, thereby utilizing heat from the pressurizer heaters.

The heat input to the pressurizer is regulated by controlling the voltage exciting the heaters. This control is accomplished by the use of saturable core reactors which are the output device of the PRC-1 instrumentation channel. This channel senses and controls the system pressure.

3. Three-Way Main Control Valve - (VA-1)

This valve is a Kieley and Mueller Co. pneumatically operated diaphragm valve, which serves to control the flow to the heat exchanger tubes. It receives the total primary loop flow and proportions this flow between the heat exchanger tubes and the heat exchanger bypass. The distribution of flow is governed by the mixed fluid temperature following the heat exchanger. The valve is designed "fail safe" in the event of air supply failure.

4. Over-ride Control Valves (VA-2 and VA-3)

These valves are Automatic Switch Company solenoid operated valves which serve as backups to the main control valves. VA-2 is normally closed and VA-3 is normally open. In the event that the main control valve VA-1 fails to provide the necessary temperature control, VA-2 open fully and VA-3 closes fully, initiating rapid cooldown of the loop fluid. These valves are also designed "fail safe".

5. Primary Pumps

Three Westinghouse hermetically sealed A-11 B-2 pumps installed in series, provide the necessary flow. Under normal operation, two pumps will be operating in series to deliver 10 gpm at a total head of 100 ft. Upon failure of either pump or reduction in loop flow rate below a safe limit, an alarm is sounded, and the standby pump becomes motivated automatically to provide the necessary flow.

To protect the pumps, a strainer (Dwg. No. 414C510) is provided upstream of the pumps to catch any large particles which might otherwise be carried through the system. The strainer is designed so that the particles can be removed from it by slipping a container under the stagnant resevoir and then cutting the pipe containing the particles.

6. Out-of-pile Sample Holders

The purpose of the out-of-pile sample holders is to contain samples identical to those located inside the in-pile pressure tube for comparison purposes. Environmental conditions in the out-of-pile sample holders will duplicate in-pile holder conditions with the exception of neutron flux and fuel heat generation. One of the out-of-pile holders is located in the inlet piping and the other in the exit piping from the in-pile tube.

III. AUXILIARY SYSTEMS

For design specifications, materials of construction and details, reference should be made to the list of mechanical equipment. (See III B-6)

A. General Description

Includes all auxiliary systems with associated instrumentation, primary detectors, piping and valves. The auxiliary systems are the purification, sampling and reagent addition, water makeup, process water cooling, and the vacuum system.

The instrumentation racks will contain all the necessary recorders, controllers, indicators, and relays for the entire loop system.

The data logger will print out in digital form at regular intervals the most important loop operating conditions of flow, temperature, and pressure. In this manner, continuous and readily available records may be kept of the entire loop operating history.

1. Purification System

Flow (max.)	0.8 lb/min.
Cooler outlet temp.	140°F (max.)
Deionizer - mixed bed resin	

2. Makeup Water System

Pump capacity - 4 gal/hr. (min.) water at 100°F against 2100 psi
Water - Deionized and deaerated.

3. Vacuum System - Vacuum Pump #8 and #8A

Pressure (max.) 10 mm of Hg. absolute

4. Process Water - MTR (primary loop water)

Total flow required (min.) 30 gpm
Temperature (max.) 125°F

5. Potable Water - (Treated MTR drinking water)

Total flow (min.) 8 gpm
Temperature (max.) 90°F

6. Degas System - (Pump discharge to pressurizer)

Flow (max.) 3 gpm

7. Piping, Tubing, Fittings, and Valves

To assure a minimum amount of leakage, the entire primary portion of the loop system is of welded construction. The purification and emergency sampling system is constructed with back welding to the first connection from the primary and high pressure fittings thereafter. All primary system manual valves are Hancock globe boiler valves with bolted packing glands. All purification system and instrument valves are barstock body Autoclave Engineering "Speedline" valves with copper foil and graphite packing rings.

B. Auxiliary Systems Components

1. Purification Interchanger and Purification Cooler

Both of these units are of identical design and consist of 3/8 by 1/4" tubing units inside 3/8" Schedule 40 piping. The interchanger serves to conserve loop heat, a particularly vital function during reactor shutdown periods, during which the 10 KW loop heaters must maintain the system at 500°F. The cooler cools the purification stream prior to entering the radiation monitor.

2. Radiation Monitor

The radiation monitor consists of a section of coiled 3/9 by 1/4" tubing inside a section of piping. The larger section of piping is provided with a well for insertion of a BF_3 tube which is sensitive to delayed fission neutrons. The auxiliary system will automatically be shut off by valve "VA-4" if the activity reaches a pre-set value. Increased delayed neutron activity in the loop fluid due to a fuel sample cladding failure will result in an increased count rate. The monitor should perform best with fluid having a delay time of 40-60 seconds from the in-pile sample zone. The fluid delay time can be decreased by increasing purification flow; it can be increased by bypassing fluid around the radiation monitor.

3. Ion Exchanger

The ion exchanger is a high pressure autoclave type vessel which is completely shielded with a minimum of 3 inches of lead. It has a removable cover to allow changing of resin bed cartridges. It is designed for use with mixed bed anion, cation resin. The deionizer is removable during loop operation.

4. Sampling and Reagent Addition Vessel

This pressure vessel is a section of 1" Schedule 40 piping, which permits taking of samples and addition of reagents while the loop is operating.

5. Deaerating and Storage Tanks

The deaerating tank is provided for deaerating loop makeup water. It may also be used for mixing water treatment reagents and for boiling of demineralized water for makeup. The storage tank stores demineralized, deaerated water.

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WCAP-4 LOOP

6. LIST OF MECHANICAL EQUIPMENT, CUBICLE AND SHIELDING
(Does not include instrumentation or process primary detectors)

Quantity	Item	Flowsheet MTR-E-4802 Item No.	Description or Assembly Dwg. No.	Material of Construction	Design Pressure Psia	Conditions Temp. °F	Specification No.	Function
1. Primary System Components								
2	In-pile pressure tubes (Incl. flange assemblies)	(1)	Dwg. No. 646J489	See Dwg.	2500	650	WCAP-3173	To contain fuel element samples to be tested.
1	Heater Section	(7)	Clam-Shell heaters, 12 one foot halves, clamped on 3/4" Sch. 40 piping. Total capacity 12 KW. Supplier: Heatube Corp, Michigan	Chrome steel sheath cast in Aluminum-Bronze	-	1200 max. sheath	-	To maintain loop temperature during reactor shut-down.
1	Out-of-pile sample holders	(2)	Dwg. No. 414C503	See Dwg.	2500	650	E567324	To contain comparison fuel element sample.
1	Pressurizer	(3)	Dwg. No. 548D47	See Dwg.	2500	650	E-567324	To pressurizer loop system.
1	Primary Heat Exchanger	(4)	Graham Model 8-4C-3C12 450,000 Btu/hr rating; 4.40 ft^2 area	347 ss tubes 304 ss shell	2500 450	650 391	-	To remove heat generated by samples.
3	Canned Pumps	(5)	Westinghouse Model A11-B-2 10 gpm at 55' head each	300 type ss	2500	600	E-567316	To circ. loop water thru pri. and purif. sys.

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Quantity	Item	Flowsheet MTR-E-4802 Item No.	Description or Assembly Dwg. No.	Material of Construction	Design Pressure Psia	Conditions Temp. °F	Specification No.	Function
1	Pump Strainer	(6)	Dwg. No. 414C510	See Dwg.	2500	600	E567324	To filter cut large particles.
1	Sample Section	(22)		300 type ss	2500	600	-	Emergency sample section.
2. Vacuum System Components								
1	Vacuum Pump	(8A)	Welch Duo-seal Model 1400B (.0001 mm Hg.) 21 liters/min. free air at 450 rpm or equal	-	0-14.7	125	-	To evacuate loop and sample section.
1	Vacuum Pump	(8)	Duo-seal Burrell Cat. #1402	-	0-14.7	125	-	To evacuate inpile tube annulus.
3. Makeup Water System								
1	Makeup Pump	(9)	Milton Roy Model MD2-33 Std. duplex with 1/3 H.P. Motor	300 type ss (cylinders)	2500	150	E567328	To add water to loop.
1	Deaerating Tank	(10)	1-1/2 ft. dia. x 2 ft. high S.S. tank, capacity 25 gal. equipped with 3 KW side entering immersion heater Westinghouse Model 1213-455) provided with vent in cover and necessary inlets and outlets Dwg. No. 414C569	300 type ss	15	212	-	To deaerate demineralized make-up water.
1	Deaerated water storage tank	(11)	1-1/2 ft. dia. x 2 ft. high capacity 25 gal. totally closed provided with necessary inlets and outlets. Dwg. No. 414C569	300 type ss	50	212	-	To store deaerated make-up water.

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Quantity	Item	Flowsheet MTR-E-4802 Item No.	Description or Assembly Dwg. No.	Material of Construction	Design Pressure Psia	Conditions Temp. °F	Speci-fication No.	Function
4. Purification and Sampling System								
1	Purification Inter-changer	(12)	Dwg. No. 414C549	See Dwg.	tube 2500 shell 2500	600 600	E567324	To exchange heat be-tween inlet and out-let purification stream.
1	Purification Cooler	(13)	Dwg. No. 414C549	See Dwg.	tube 2500 shell 450	300 150	E567324	To cool purification stream.
1	Radiation Monitor	(14)	Dwg. No. 548D945	See Dwg.	tube 2500 shell 450	150 150	E567324	To measure loop water activity.
1	Process Water Cooler	(15)	Graham Heliflow Model 8S6C-12 Std. rating 45,000 Btu/hr Area 4.4 ft^2	tubes 304 S.S. shell-carbon steel	tube 450 shell 100	125 100	-	To cool process water used for cooling pri. pumps & purif. system.
2	Deionizer Assemblies	(16)	Dwg. No. 548D788	See Dwg.	2500	125	E567324	To filter & deionize loop water cooling pri. pumps & purif. system.
2	Sampling & Reagent Addition Vessels	(17)	Dwg. No. 296B021	See Dwg.	2500	125	E567324	To sample loop water & to add chemical reagent to loop water.
1	Emergency Sample Section	(23)		300 type ss	2500	600		Sample loop water >1R/Hr.
1	Hot Sample Section	(21)		300 type ss	2500	600		To sample thermally hot loop water.
2	Cold Sample Section	(22)		300 type ss	2500	140		To sample cold loop water.

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Quantity	Item	Flowsheet MTR-E-4802 Item No.	Description or Assembly Dwg. No.	Material of Construction	Design Pressure Psia	Conditions Temp. °F	Speci-fication No.	Function
5. Valves & Ruptures Discs								
1	Check Valve	(VC-1)	Republic A488-6SS or equal	300 type ss	2500	500	-	To prevent backflow into makeup pump.
2	Rupture Disc Assemblies (with discs)	(DR-1) (DR-2)	Black, Sivalls, & Bryson 1/2" Safety heads, Model 77-11-6U, 3000 lbs. 1/2" screwed union with welding ends, provided with 347 ss 1/2" disc; Model 77-28-1 or equal	347 type ss	2300	656	-	To relieve system pressure: (DR-1) In-pile tube outlet (DR-2) pressurizer.
1	Safety Relief Valves	(VR-3)	Farris Engrg. Model 2740 3/4 x 1" size; .049 in^2 orifice	300 type ss	2500	300	-	Make-up pump pressure relief.
2	Safety Relief Valves	(VR-1)	Farris Engrg. Model 2745 class 3 size 1/2" with orifice No. 8 for pressurized water service. Min. relief rate 1000 lbs/hr satd.				(VR-1)	In-pile tube outlet pressure relief.
		(VR-2)	stream at 2500 psia and 668°F	300 type ss	2500	668	(VR-2)	Pressurizer pressure relief.
2	Safety Relief Valves	(VR-4)	Farris Engrg. Model 1400 size 1/2" Min. relief rate 500 lb/hr steam at 150 psia and 358°F	Bronze	450	358	-	Primary heat exchanger pressure relief.
		(VR-5)	Same as VR-4 except min. relief rate of 100 lb/hr at 150 psia & 358°F	Bronze	450	358		Purification cooler pressure relief.
1	Automatic Valve 3-Way control (air operated)	(VA-1)	Kieley & Mueller Dwg. E-SK-816 or equal	347 S.S.	2500	650	E-567323	Control of flow rate thru pri. heat exchanger tubes.

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Quantity	Item	Flowsheet MTR-E-4802 Item No.	Description or Assembly Dwg. No.	Material of Construction	Design Pressure Psia	Conditions Temp. °F	Specification No.	Function
2	Automatic Valves (Solenoid operated)	(VA-2)	Automatic Switch Co. On-off type control valve having inlets for 3/4" socket welding max. pressure drop across seat of valve: 3 psi with 10 gpm water at 2000 psia and 537°F flowing. Valve is to be closed when energized. (normally closed operation).	300 type ss	2500	600	-	To provide override control of primary three way valve, in case of emergency.
		(VA-3)	Same as VA-2; except valve is to be open when energized. (normally open operation) suggested suppliers Kieley & Mueller, Schuette & Koerting, Automatic Switch Co.	300 type ss	2500	600	-	
1	Automatic Valve (solenoid operated)	(VA-4)	Atkomatic 1/2" HP ss (Cat. No. 8204 (modified for socket welding) or equal (normally open operation)	300 type ss	2500	300	-	To turn purification flow off.
1	Automatic Valve (solenoid)	(VA-5)	On the air line to AV-1. Closed when deenergized. (normally open operation).	-	-	30	-	To bleed off air from the AV-1 air supply when an automatic cool down is required.
6	Valves, Manual, Glove thru	(V-1) (V-6)	Hancock 1500# for 3/4" Sch 40 socket (type 7150 W)	347 ss	2500	650	-	Stops valves in primary sys. & emergency cooling system.
4	Valves, Manual, Globe	(V-7) (V-8)	Hancock 1500# 1/2" Socket welding (type 7150W)	347 ss	2500	668	-	Stop valves in pressurizer relief line.
		(V-9) (V-10)	Hancock 1500# for 1/2" socket welding (type 7150W)	347 ss	2500	650	-	Stop valves in loop drain line.
2	Valves, Manual, Globe	(V-11) (V-12)	Hancock 1500# for 1/4" socket welding (type 7150W)	347 ss	2500	650	-	Stop valves in degas line.

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Quantity	Item	Flowsheet MTR-E-4802 Item No.	Description or Assembly Dwg. No.	Material of Construction	Design Pressure Psia	Conditions Temp. °F	Specification No.	Function
18	Valves, Manual, Barstock	(V-13) thru (V-25) (V-28) & (V-29) (V-31) thru (V-33)	Autoclave Engineers "Speedvalves" Cat. No. 10V6001 or 10V6002, modified for socket welding of tubing (3/8 x 1/4) where periodic disassembly of component is not required (Copper Foil and graphite packing ring)	300 type ss	2500	300 (V-13, V-14) (V-32, V-33) 600	-	Stop valves in purif. system.
4	Valves, Manual, Barstock	(V-34) thru (V-36) (V-64)	Autoclave Engineer "Speedvalves" No. 10V6001 or 10V6002, modified for socket welding of tubing where periodic disassembly of component is not required (Copper Foil and graphite packing ring)	300 type ss	2500	125	-	Stop valves in make-up system.
9	Valves, Manual, Barstock	(V-26) (V-27) (V-30) (V-37) thru (V-42)	Autoclave Engineers 10V4001 or 10V4002 for socket welding 1/4 x 1/8 tubing (with Teflon packing ring)	300 type ss	2500	650	-	Stop and bleed valves in purification system.
4	Valves, Manual, Gate	(V-45) thru (V-47) (V-62)	Union bonnet, screw gland for butt or socket welding to 1" Sch. 40 pipe. Recommended suppliers: Hancock 950W	300 type ss	450	212	-	Stop valves for process water supply line.
2	Valves, Manual, Globe	(V-48) (V-63)	Union bonnet, screw gland for butt or socket welding to 3/8" Sch. 40 pipe. Recommended suppliers: Hancock 5520	300 type ss	450	125	-	Stop valves for radia. monitoring & purif. cooler lines.
3	Valves, Manual, Globe	(IV-39) (IV-40) (IV-20)	Autoclave Engineers Cat. No. 10V6001 or 10V6002 for 3/8" x 1/4" tubing (with teflon packing ring)	300 type ss	450	125	-	To control cooling water to primary pumps.
4	Valves, Manual, Globe	(V-52) thru (V-54) (V-60)	Union bonnet, screw gland for butt or socket welding to 1/2" Sech. 40 pipe. Recommended suppliers: Hancock 5520	300 type ss	125	125	-	Stop valves for make-up water treatment system line.

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Quantity	Item	Flowsheet MTR-E-4802 Item No.	Description or Assembly Dwg. No.	Material of Construction	Design Pressure Psia	Conditions temp. °F	Specification No.	Function
1	Valves, Manual, Globe	(V-55)	Union bonnet, screw gland for butt or socket welding to 1/2" Sch. 40 pipe. Hancock 5520	300 type ss	450	125	-	Stop valve process water to process water cooler.
1	Valves, Manual, Gate	(V-61)	Crane No. 410-100# screwed for 1/2" Sch. 40 pipe.	Bronze	100	125	-	Stop valve for potable water supply.
2	Valves, Manual, Needle type	(V-56) (V-57)	For vacuum or pressure service (Hoke Cat. #R334) with 1/8" NPT female connections	300 type ss	0-100	125-650	-	Stop & control valves for vacuum system.
2	Valves, Manual, Needle type	(V-58) (V-59)	For vacuum or pressure service (Hoke Cat. #R334) with 1/8" NPT female connections	300 type ss	50	212	-	Bleed & purge valves for deaerated water storage tank.

66 Total Valves

NOTE: 300 type ss denotes one of the following: 302, 303, 304, 316, 321, 347

6. Piping and Tubing Required (includes piping required for field installation at MTR) Piping to be Fabricated According to E567327

Approx. Length ft.	Size	Material	Design Pressure Psia	Conditions Temp. °F	Function
100	3/4" - Sch. 40	347 ss	2500	650	Primary Loop & heat exch. bypass.
20	3/4" - Sch. 40	304 ss	450	350	Loop emergency cooling.
100	1" - Sch. 40	304 ss	450	350	Process water Supply & Drain Line.
20	1/4" - Sch. 40	347 ss	2500	600	Degas Line.
10	1/8" - Sch. 40	304 ss	50	212	Nitrogen line to deaerated Water Storage Tank.
50	3/4" - Sch. 40	Carbon Steel	100	125	Potable Water Supply.

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Approx. Length, ft.	Size	Material	Design Pressure Psia	Conditions Temp. °F	Function
40	1/2" - Sch. 40	304 ss	450	200	Cooled Process Water
20	3/8" - Sch. 40	304 ss	225	200	Cooled Proc. Water to Purification.
10	1/2" - Sch. 40	304 ss	2500 2500	600 600	Pressure tube relief line. Pressurizer relief line.
20	1/2" - Sch. 40	304 ss	100	212	Make-up water supply.
10	1/2" - Sch. 40	304 ss	450	200	Primary pump cooling water return.
20	3/8" - Sch. 40	304 ss	450	350	Purif. cooler relief line.
20	1/4 x 1/8 tubing	304 ss	450	200	Primary pump cooling water sypply.
40	3/8" - Sch. 40 pipe	304 ss	0-100	125	Vacuum System.
20	3/8 x 1/4 tubing	304 ss	2500	150	Makeup water system.
100	3/8 x 1/4 tubing	304 ss	2500	350	Purification system.
20	1/4 x 1/8 tubing	304 ss	2500	125	Purification system.
40	5" diameter stove	Galvanized Steel	15	200	Ventilation of pri. cubicle.

7. Pipe Insulation - Johns Manville Thermobestos or Equivalent

Approx. Length, ft.	Pipe Size to be Covered	Insulation Thickness (in.)	Item used on
100	3/4"	1-1/2	Primary piping.
20	1/2"	1-1/2	Drain line, Pressurizer & in-pile tube relief line.
10	1/4"	1	Degas line.

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Approx. Length, ft.	Pipe Size to be Covered	Insulation Tickness (in.)	Item used on
40	3/8 O.D. tubing	1	Purif. system up to and from purif. cooler.
6	10"	3	Pressurizer vessel.
20 ft^2	Sheet insulation	1	Deaerating and deaerated water storage tanks.

8. Pipe Fittings & Accessories

1. For 2000 lb/in^2 piping use socket or butt welding fittings as required.
2. For 225 lb/in^2 piping use butt welding fittings as required.
3. For 2000 lb/in^2 tubing use socket welding fittings where possible; or Autoclave Engineer "Speedline" fittings where it is necessary to connect and disconnect tubing periodically.
4. For 150# tubing and vacuum service use NPT or flared standard thread fittings.
5. Thermocouple wells as required for system.
6. Pipe hangers, pipe expansion rolls as required for system.

9. Spare Parts

Quantity	Item	Flowsheet MTR-E-4802 Item No.	Spare Function
2 sets	Bearings and all materials required for complete bearing change.	5	Westinghouse Canned motor pump Model A11-B2
1	Impeller, Item 5 Westinghouse Atomic Equip. Dept. Dwg. 509D209	5	Westinghouse Canned motor pump Model A11-B2
1 set	Seals and Lantern ring	9	Milton Roy pump Model MD 2-33
10	Heating Elements	3	Pressurizer
1	Strip heater section	7	Heater Section

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Quantity	Item	Flowsheet MTR-E-4802 Item No.	Spare Function
1 set	Valve ports and solenoid operating elements	VA-2 or VA-3	Override control valves on Heat Exchanger bypass and 3-way primary valve bypass.
1 set	Valve ports	VA-1	Kieley and Mueller 3-way-air operated primary control valve.
1	Valve, manual, globe Hancock 1500#, type 7150 for 3/4" socket welding 347 ss	-	Primary loop or emergency process cooling water lines.
1	Valve, manual, globe Hancock 1500#, type 7150, for 1/2" socket welding	-	Pressurizer bleed or Primary System drain lines.
4	Valves, manual, barstock Autoclave Engineers modified for socket welding Cat. No. 10V6001 or 10V6002-300 type ss (with copper foil and graphite packing ring)	-	Purification or make-up system.
2	Valves, Manual, barstock Autoclave Engineers Cat. No. 10V4001 or 10V4002 with teflon packing ring	-	Purification or Reagent Addition and sampling system.
12	Discs, rupture, for 1/2" Black, Sivalls, and Bryson safety head, model 77-11-1 347 ss disc unit 77-28-1	DR-1 or DR-2	Replacement discs for in-pile pressure tube and pressurizer.
1 box	Packing, graphite impregnated asbestos	-	All Hancock type 7150 1500# valves.
1 box	Packing, graphite impregnated asbestos Dwg. No. 548D902	1	In-pile pressure tube flange assembly.
2	Expansion joint bellows; solar Aircraft Co. dwg. No. 548D902	1	In-pile pressure tube.
2	Deionizer Resin cans Dwg. 548D786	16	To hold resin in deionizer assembly.

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10. Chemicals and Chemical Equipment

Quantity	Item	Flowsheet MTR-E-4802 Item No.	Description of Item	Function
1 cylinder	Hydrogen gas	18	Commercial cylinder of hydrogen with necessary reducing valves and rubber tubing.	To intoduce Hydrogen into reagent addition and sampling vessel.
1 cylinder	Nitrogen gas	20	Commercial cylinder of nitrogen with necessary reducing valves and rubber tubing.	To maintain inert atmosphere over deaerated water. Also for general loop use.
10 lbs.	Boric acid	-	Reagent grade Boric Acid	To perform borinated water loop exposure.
10 lbs.	Lithium Hydroxide Monohydrate	-	Reagent grade Li-Hydroxide Monohydrate	To maintain high pH water conditions.
30 gals.	Hydrazine Solution	-	35% solution of Hydrazine in water	To remove oxygen from initial loop water and for periodic water treatment.
20 lbs.	*Ion Exchanger Resin	for 16	Lithinated mixed resin Westinghouse PD.S 12285-3	To remove soluble ions from loop water. (must be charged into resin can of deionizer prior to assembly of unit)

NOTES: All items under section 10 will be purchased by Westinghouse when required.

*Ion exchange resin shall be purchased by fabricator and put into Deionizer.

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IV. ELECTRICAL SYSTEM

A. General

With the exception of the 120 VAC single phase commercial power, all circuits enter the experiment through the Control Center. Circuit protection for the Diesel, Battery, and Commercial supplies is located there. It is not anticipated that operator attention will be required at this location, and circuit breakers will be used principally for service work.

Switches for operating the major electrical components are located on the CONTROL PANEL. Additional controls, such as the make-up system heater switch, are mounted on the Auxiliary Cubicle INSTRUMENT PANEL.

In order to increase the reliability of the control circuits, static switching devices have been used where practical. Magamp driven saturable reactors control the pressurizer heaters, and Cypak units are used in the annunciator system. Except for errors in installation, no maintenance should be necessary for these units.

Due to the limited space available, it was necessary to select components for size. Also, components were packaged in a manner that would permit ready servicing and still be economical of space.

B. Components (See Appendix A)

As applicable, units are rated according to standard NEMA classes.

C. Power Sources (See Appendix A)

A single line diagram showing the power sources and connected electrical equipment is included. It may be noted that the critical components are separately connected to the line through individual transformers and circuit protection devices.

D. Metering

Provision has been made for metering the current in all three phases of the circulating pumps, pressurizer heaters, and loop heaters. As the pressurizer heaters have automatic control, the ammeters in this circuit will assist in monitoring the operation of this system. The ammeters in the circuits are intended for use in determining pump performance, and in predicting pump malfunction.

A common voltmeter has been provided for the measurement of voltage on the various supply circuits. A combination of potential transformers and selector switches has made it possible to use one instrument in this application. Appropriate multipliers as noted on the switch plate must be used depending on selector position.

V. INSTRUMENTATION

A. Instrument Description

1. General

A complete listing of instruments is shown in Appendix B. This drawing shows the function of the instrument as well as the range and setpoints.

An instrument bill of material is included in Appendix A. This is included for the purpose of identifying individual components associated with the loop instrumentation, and supplements the information contained in MTR drawing E-4966 of Appendix "B".

In general, instrumentation was selected so as to provide the most reliable equipment consistant with the space limitation. Where an option existed, systems were used that eliminated intermediate means of signal conversion.

The majority of the equipment is electridal in nature. However, the temperature control equipment is a pneumatic system as the regulating valve requires pneumatic actuation.

2. Flow

Two identical channels of flow instrumentation have been provided. Each channel consists of a Foxboro DP cell with pneumatic transmission output. A gentile type flow tube creates the differential pressure. DPE-4 actuates the red pen and DPE-5 actuates the green pen on the same Foxboro recorder.

The loop flow meters have been calibrated for 2000 psi and 570°F. The value of specific gravity of the coolant at these conditions is 0.73. Due to the placement of the flow tubes at the pile inlet and outlet, the actual specific gravity will vary from this calibrated value because of the change in temperature. A correction graph is supplied in Appendix B for the purpose of correcting the recorded flow meter readings.

3. Temperature

Temperature is recorded and indicated on miniature, self-balancing potentiometer type instruments. The group of instruments is continuously standardized from a common power supply. In order to provide the maximum utility with the minimum of equipment, two of these instruments have been provided with selector switches to permit measurements at other points. An ALARM DISABLE switch should be actuated when the selector is moved from position 1, the normal position, to prevent the false operation of the alarm system when this is done. A red lamp is illuminated to warn the operator that he is not protected by the alarm system.

4. Pressure

A strain gage type pressure transducer is used in a bridge circuit as a means of measuring system pressure (PRC-1). The bridge is self-balancing with no standardization being necessary.

B. Setpoint Procedure (See Appendix A for setpoint List)

1. General

The setpoints may be regularly checked during reactor shutdowns. This can be accomplished by artificially varying the input to the loop detectors or introducing simulated signals. The loop will normally be pressurized and flow continued during reactor shutdowns.

2. Flow

In order to prevent cool down of the loop during the checking of the flow setpoints, the automatic control of the bypass valves should be shorted out. This will not result in an unsafe condition as long as there is no in-pile heat generation.

The differential pressure input to DPE-4 and DPE-5 may be individually reduced by opening the bypass valves. This should be done slowly until the annunciator indicates that the low flow level has been attained. The value of flow should be noted. The flow reading should be further decreased until the scram condition is indicated. This reading should also be noted. These values will be correct for the calibration of the flowmeters (FR-4 and FR-5) at 570°F and may be compared to the actual loop operating temperatures. (See Appendix A).

Meletron pressure switches initiate the action. See setpoint list (Appendix A) for pressure switches.

PA6	Low	Scram
PA5	Low	Alarm
PA8	Low	Scram
PA7	Low	Alarm

3. Temperature

The temperature inputs to the recorders may be elevated to actuate the control circuits by either the use of external heat or by the use of a portable potentiometer. By slowly raising the temperature to TRC-1 and TRC-2, the warning and scram annunciators may be operated. The temperatures at which this occurs should be noted.

Normally, there should be no change necessary in these settings as the switches are mechanically secured. However, due to the possibility of accidental disturbances, these might need adjustment. Only one of the switches is of the "front set" type. This is the one that positions the pointer on the face of the recorder. The other switch must be adjusted by removing the unit from its case.

The temperature of TRC-3 is set at a low enough value to protect the deionizer resin bed against high temperature damage. It accomplishes this by closing the solenoid valve in the deionizer loop. The same valve is closed by the high limit contact on the neutron detecting instrument. This prevents the radioactive contamination of the auxiliary cubicle in case of a fission break. The setpoint may be checked and adjusted in the same manner as TRC-1 and TRC-2.

4. Pressure

The pressure setpoints on the pressure recorder are mechanical limit switches and may be adjusted by opening the instrument. As with the temperature setpoints, these should remain fixed and require only infrequent attention. Since the pressure recorder is also used to control the loop pressure, the pressurizer heaters should be de-energized during the checking of pressure setpoints. This may be done by opening the circuit breaker in this line. Pressure may now be artificially varied by use of the make-up pumps.

The "Meletron" switches may be set by application of external pressure to the individual switches. This pressure may be read on the gage provided in the primary detector cubicle.

5. Level

Level set points on the pressurizer: (1) energize the make-up pump on low level, (2) de-energize the make-up pump on high level, (3) de-energize the pressurizer heaters before the level drops to the top of the active part of the heaters.

The pressurizer level setpoints (using LRC-1 as the indicator) should be set as follows:

High level alarm - 15
Make-up pump on - 27.5
Pressurizer heaters off - 29.0

These setpoints should be initially checked on filling the loop by use of the pressurizer calibration of volume vs level. When the loop is filled, it is not possible to re-run this check due to disturbing the material balance.

Therefore, an artificial means of producing a signal input to the level recorder (LRC-1) must be used. This can be accomplished by removing the cover plate on the pressurizer DP cell and manually moving the transmitting element to give a slowly varying reading on the recorder. The make-up pump circuit breaker should be opened before doing this so that the loop volume will not he altered by its actuation on automatic control circuits.

As the level of the signal to the recorder is raised, the automatic control system should be monitored to see that the desired action occurs at the desired level. An additional Barton cell (LI-1) has been provided to supplement the level recorder. It is provided with limit switches that are mechanically linked to the indicator pointer, and may be set by referring to the pointer.

In the case of the level indicators (LRC-1 and LI-1), it is not possible to use the bypass valve because this will drain the level reservoir with an accompanying loss of the reference leg. More complete information on the operation of the magamp flow and level systems may be found in the Foxboro manuals.

6. Radiation and Vacuum

Both of these instruments use high limit contacts on a contact type meter. The operation may be checked by manually decreasing the setpoint pointer until the annunciator alarms. The correspondence between the meter reading and the setpoint pointer reading should be noted. Any deviation of greater than $\pm$ 5% is considered undesirable.

Both of these setpoints are determined by loop operation. The radiation level at which annunciation occurs is arbitrarily determined relative to the normal operating background, and set above it. See item III-B-3 (Temperature) for the deionizer loop shutdown function associated with this setpoint. The vacuum setpoint is set at a value below what is considered a reasonable operating vacuum. This can best be done after the system is originally evacuated. The annunciation will indicate a leak in the in-pile annulus section.

7. In-pile DP Cell

A DP cell is connected across the in-pile section and is used to actuate an alarm for either a higher than normal or lower than normal flow condition. A high level would be caused by an obstruction in the in-pile lines and a low level might be caused by a major leak.

A Barton DP cell in the primary detector cubicle has been provided for this use. Removing the face plate of the instrument exposes the two limit switches and they may readily be adjusted to the desired values.

C. Automatic Control

1. Pumps

Automatic control has been provided for energizing a stand-by circulating pump when either of the two normally operating pumps are switched off the line. Tests show that the transition from an operating pump to a stand-by is rapid enough to cause an increase of flow for a short interval of time.

It is advisable to operate the stand-by pump for a short period during reactor shutdowns to check that the pump is in proper operating condition. When a high current level caused by an electrical or mechanical defect in an operating pump occurs during loop operation, this pump will be automatically switched off the line to prevent permanent damage. The stand-by will then be automatically energized. A defective pump may be manually shut down, if desired.

2. Temperature

In order to reduce thermal stresses due to reduced temperature, loop heaters are automatically energized when the outlet temperature drops below a predetermined level. They will be de-energized at a higher level when the heat input is sufficient to attain this level.

This control is accomplished by a combination of TRC-1 and TRC-2 low limit switches. The TRC-2 switch closes at 525°F and permits the heaters to be actuated. When the temperature drops to 500°F, the TRC-1 contacts pull in a relay which in turn energized the heater contactor. Even though the temperature rises above 500°F, the relay will be "locked in" by the TRC-2 switch until 525°F is reached. The heaters will then be de-energized.

During normal operating, the loop temperature is controlled by a three-mode, cascade control (TRC-4). (See Appendix B) This controller regulates a pneumatic bypass valve which proportions the flow through the heat exchanger. On air failure to the valve, it will be positioned so that the full flow is directed through the heat exchanger and thus cool the loop down to a safe operating condition.

Loop mixed flow temperature, TE-2, is regulated by the controller, TRC-4. The setpoint of the controller is positioned pneumatically by a tel-o-set integrator which in turn is actuated by the pneumatic signal from the TE-1, pneumatic converter. As TE-1 senses the loop outlet temperature, the setpoint of TRC-4 is continually being readjusted according to the integrated value of this variable. The setpoint of the tel-o-set unit is pneumatically applied by a manual loading station and may be readjusted by changing this value.

The rate, reset, and proportional band for this unit have been factory set and no adjustment is anticipated. However, if the controller does not rapidly respond to a step input change of setpoint with a slight overshot, refer to the manufacturer's literature (Minneapolis-Honeywell). The controller should provide stable temperature regulation and a "hunting" condition indicates a malfunction.

3. Pressure

Automatic pressure control is accomplished by regulation of the heat input to the pressurizer heaters. This is done by biasing the saturable reactors in the heater circuit under control of a magamp. This constitutes a static system, and no servicing should be required.

The pressure in the system is detected by PRC-1 as described in Section V item A-4. This instrument is provided with a potentiometer which feeds the Electro-Volt controller located immediately below it. This electronic chassis contains the means for adjusting the rate, reset, and proportional band of the pressure controller. These values are factory set and need not be changed unless "hunting" or poor response is noted. Refer to Minneapolis-Honeywell service information before making adjustments.

A high and low range of pressurizer heat has been provided by the use of two heater banks. High range makes use of all the heaters (2) banks) giving lower individual heater temperatures. Low range uses one bank of heaters.

The pressure control contains upper and lower setpoints which will actuate the pressurizer heater starter circuits. This acts as an emergency "backstop" in case of failure of the normal operating control.

VI. GENERAL OPERATING INSTRUCTIONS

A. Initial Gold Leak Test Procedure

Initial valve positions. All valves are open except:

Valve V-64 which isolates the Make-up Water System.

Valves V-3, V-4, V-5, V-6, IV-59, and IV-60 which isolate the Emergency Process Water Supply.

Valves V-96 and V-104, V-515, and V-152 which isolate the Nitrogen Gas Supply.

Valves V-74, V-75, V-76, V-78, V-97, V-112, V-139, V-154, and V-124 which isolate the Vacuum System.

Valve V-155 which isolates the Portable Demineralizer.

Close all vent and drain valves except valve V-105 which vents the Pressurizer, valve V-43 which vents the Primary Line Heater Section, valve V-133 which drains the Hot-Warm Drain Manifold to the warm drain, and valve V-132 which drains Potable Water. See list of vent and drain valves as follows:

System	Valve No.	Location
Pressurizer	7,8	By-pass around RD-2 and RV-2
	105	Before RD-2 and RV-2
	103	On Datum Head
Primary Loop	131	Hot-Warm Drain Manifold
	51	Below Primary Heat Exchanger
	43	Top of Loop Heater Section
	99, 100, 101, 102	For Evacuation of Loop at Nozzle System
	128, 129, 130	Primary Circulating Pumps
	IV-74	Primary Det. Cubicle. (Between V-9 and V-10)

System	Valve No.	Location
Auxiliary System	39, 40, 41	Auxiliary Sampling and Addition System
	50	Hot Sample System
	140	Out of Radiation Monitor
	37	Into Demineralizer
	38	Out of Demineralizer
	87	Below Aux. Sampling & Addition System
	85	Above Aux. Sampling & Addition System
	86	Above Aux. Sampling & Addition System
	42	Downstream from Aux. Sam. & Add. System
Make-Up System	92	On Loop Fill Line
	95	Deacrator Tank
	58, 59, 60	Storage Tank
	93, 94	Nitrogen Line
Vacuum System	138	Pump (8) Vent
	142	Pump (8A) Vent
Emergency Sample System	107, 123	Spray Trap
	118, 119, 120	Reagent Addition Bomb
	114, 115	Reagent Addition Point

Fill the loop with demineralized water through valves V-36, V-35, V-64, and V-34.

Close vlaves V-105 and V-43 when water overflows through these vents.

Close valves V-36 and V-35.

Open valves V-52, V-53, and V-54 in that order to fill the storage tank with demineralized water. Permit the storage tank level to rise so that it is just visible at the top of the sight glass.

Close valve V-52 to stop supply of demineralized water to the storage tank.

Turn on the make-up pump and pressurize the system to approximately 2000 psig, venting as required.

Open all vent and drain valves briefly until air is vented and water flows from the vents. After each vent and drain is vented, close the valves. Vent the Primary Circulating Pumps by opening valves V-128, V-129, and V-130 briefly. NOTE: Provide cooling water for the Circulating Pumps. (0.7 on Fl-2, Fl-3, and Fl-4). Then turn on these pumps and operate briefly. Repeat venting procedure until air is no longer vented from the pumps.

Adjust system pressure 2000 psig with the make-up pump and then turn off the make-up pump. Isolate the pump by closing valve V-64.

Observe the rate of pressure drop. It is required that the rate of pressure drop be no greater than 50 psi per hour.

If this maximum leakage rate is not achieved, locate and repair leaks until this rate is achieved.

When a leak rate of less than 50 psi per hour has been achieved, drain the system by opening drail valves V-9, V-10, and V-131. Vent through V-105 and V-43.

Open all valves.

B. Loop Startup

1. Charge Water Preparation

Valve positions at start: All valves in the make-up water system are closed. Open valves V-53, V-59, V-60, and V-150 to permit contents of the deaerator tank and storage tank from previous operations to drain out. Flush out deaerator tank and storage tank with demineralized water. Permit to drain. Close valves V-53, V-59, V-60, and V-150.

Open valves V-36 and V-155. Fill deaerator tank through the Barnstead demineralizer hooked to 41 centimeter level on sight glass with demineralized water. This corresponds to 20 gallons or 75.60 liters. The demineralized water shall contain less than 0.1 ppm chloride. Its resistivity shall be greater than 1 megohm-cm.

Turn on the deaerator tank heater and heat the water to boiling. This will require about $3\frac{1}{2}$ hours. Boil the water for one hour. Maintain the deaerator tank level at 41 centimeters by addition of demineralized water as required.

During the period of boiling the water in the dearator tank, the deaerated water storage tank is purged with nitrogen as follows:

> Open the nitrogen cylinder stop vlave. Set the reduced nitrogen pressure at 5 psig with V-96 open, then close V-96. Open valve V-59 (storage tank vent).
>
> Close valve V-104 (nitrogen supply to pressurizer) after two minutes. Open valve V-96.

When the water boiling period is completed, turn off the deaerator tank heater. Drain the contenets of the deaerator tank into the storage tank by opening valve V-53. Do not drain the deaerator tank below the visible portion of the sight glass (0 cm. on the sight glass). When the draining operation is completed, close valves V-53 and V-59 in that order. Valve VR-6 is set to relieve pressure at 7 psig. Maintain 5 psig nitrogen pressure in the storage tank during the entire filling procedure.

2. Filling Instructions

Initial status (loop at 0 psig): The make-up system is in use for preparation of charge water as described in charge water preparation (section B, item 1). This system is isolated from the remainder of the loop by valve V-64. All valves in the remainder of the system are open except:

Valves V-3, V-4, V-5, V-6, IV-59, and IV-60 which isolate the process water supply.

Valves V-96, V-104, V-151, and V-152 which isolate the nitrogen gas supply.

Valves V-74, V-67, V-78, V-97, V-121, V-122, and V-124 which isolate the vacuum system.

NOTE: Valve V-97 leads from the vacuum system to the nozzle section. The nozzle section will be installed for in-pile operation.

Blow residual water out of the system with nitrogen, as follows: (This operation may be performed concurrently with the charge water preparation).

Close V-96, nitrogen to deaerator storage tank and adjust nitrogen cylinder reduced pressure to a suitable value (about 25 psig may be sufficient).

Close vent valve V-105 and open valve V-104 to admit nitrogen to the pressurizer.

Close remaining vent and drain valves (see cold leak test procedure section VI-A for listing of vent and drain valves). It is preferred that the valves be closed in order of decreasing elevation; the highest vent valves being closed first and valves V-9 and V-10 at the lowest point in the system being closed last.

If the nozzle section has been installed, it is necessary to continue as follows to blow out water from the in-pile section:

Continue to admit nitrogen to the system as above.

Close valve 1. Valves V-99 and V-101 are already closed. Close valves V-13, V-33, V-113, and V-148.

Open valves V-92, V-34, and V-64. This drains through V-92.

Open valve 1 and close valve V-92. Open valves V-13, V-33, V-113, and V-148.

Shut the stop valve on the nitrogen cylinder and permit the nitrogen pressure to bleed down to at atmospheric pressure by opening valve V-105. Then close valves V-104 and V-105.

Evacuate the system using 8A vacuum pump as follows: NOTE: (This operation follows the blowing-out procedure described above and is performed concurrently with the charge water preparation procedure).

Open valves V-76, V-121, V-122, V-106, V-108, V-124, and V-143. If the nozzle section is installed, open valves V-97, V-99, V-100, V-101, V-139, and 102 also.

Empty the water traps on the vacuum pumps.

Close vacuum pump vent valve V-142 (on pump 8A).

Turn vacuum pump on (8A). Evacuate the system until the charge water preparation has been completed or until a minimum of one-half hour of evacuation has been performed. NOTE: Since the system is wet, the vacuum obtained will not be better than the vapor pressure of water at ambient temperature.

When the charge water preparation has been completed, close V-106 and V-108 and open V-149 and V-64 to permit charge water to be drawn into the system through valve 34. Continue to evacuate the system as charge water is pulled into the system.

When the system is full up to the level of the pressurizer vent, water will overflow into the 8A vacuum pump water trap. Close valve V-124 when the water trap is half full. If the nozzel section has not been installed, close valve V-76, shut off the vacuum pump and briefly open vent valve V-142 to vent the vacuum pump to atmospheric pressure. If the nozzle section has been installed, continue evacuation until a steady stream of water runs into the water trap of vacuum pump 8A. When the water trap is half full, shut valves V-99, V-101, and V-97 in that order and shut off vacuum pump 8A. Empty the water trap and return to the system. If the nozzle system has been installed, valves V-56 and V-98 are in the open position. Start vacuum pump 8 for continuous evacuation of the annulus through valves V-56 and V-98.

The system is now full of charge water. Isolate the emergency sampling system by closing valves V-113 and V-148. This system will be utilized only in the event of a fission break. Isolate and by-pass the demineralizer by closing valves V-18, V-19, V-20, and V-21 leaving V-23 open. Close valves V-22, V-29, V-30, and V-31. The demineralizer will be placed in service upon sponsor request through project engineering.

Check that all low pressure portions of the system are isolated.

Turn on the make-up pump. Pressurize the loop with deaerated water to 500 psig.

Vent at all vents (see cold leak test procedure for listing) while maintaining pressure. Vent until a solid stream of water emerges from each vent.

Close all DP by-pass valves. Set all instrument valves as shown in Appendix B-3.

Shut off make-up pump and close valve V-34. At a convenient time after startup, the following flush should be done. The line from the storage tank to valve V-34 is to be flushed by pumping demineralized water from the storage tank through the make-up pump and out through valve V-92. When this has been completed, the make-up pump is shut off, valve V-92 is closed, and valve V-34 is opened. Repeat the procedure described under charge water preparation except that addition of chemicals is omitted. This will result in the storage of deaerated, demineralized water in the storage tank for make-up purposes as required.

Vent the loop at valve V-87 upstream from the auxiliary sample station until the loop pressure is reduced to 50 psig.

Set nitrogen supply pressure at 75 psig and open valve V-104.

Drain water from the loop at valve V-87 until a reading of 24 inches is obtained on LCA-1. This will result in the proper cold operating level in the pressurizer.

Close valve V-104 and close the shut off valve on the nitrogen cylinder.

Start cooling water flow to the components requiring cooling as follows:

> Potable water to the P.W. cooler through valves V-61 and V-132.
>
> P.W. to the P. W. cooler, to the primary circulating pumps, to the primary heat exchanger, and to the purification cooler and radiation monitor through valves V-45, V-46, V-47, V-48, V-55, V-62, and V-63.

The following settings are to be made.

Component	Instrument	Adjustment	Range Above	Range Below	Annunciation Location
Primary Circulating Pumps					
No. 1	FI2	IV-39	1.25 gpm	.45 gpm	Annunciator
No. 2	FI3	IV-40	1.25 gpm	.45 gpm	Panel, Sec.
No. 3	FI4	IV-20	1.25 gpm	.45 gpm	Flow
Primary Heat Exchanger	FI6	V-46	98.5 in.	64 inches	Flow
Process Water Cooler	FI9	V-61	Approx. 7 gpm		None
Purification Cooler Radiation Monitor Cooler	FI8	V-48	Approx. 9 (gauge)		None

The system is now in the following status:

All vent and drain valves are closed.

A continuous flow path exists in the primary system.

A flow path exists from the suction side of the circulating pumps to the discharge side of these pumps, past the hot sampling system, through interchanger, the cooler, the radiation monitor, past the auxiliary sampling bomb, and through the interchanger.

The system is a positive pressure of approximately 75 psig.

Cooling water has been provided to all components requiring cooling.

Energize battery, diesel and commercial power supplies.

Set main pressurizer heater switches on "high" and put pressurizer heaters on automatic control. Set PRC-1 point controller at 2000 psig. Caregully watch pressure rise.

Start circulating pumps No's. 1 and 2 when the pressure reaches 300 psig. After FRC-4 and FRC-5 are at 10 gpm, put main loop emergency button on automatic so that the green light is out and the amber light is on.

When system pressure is 500 psig, start venting the pressurizer vapor phase slowly through valve 105 until the steam pressure and temperature are at saturation conditions.

Continue pressure rise to 2000 psig by pressurizer heaters, taking the following possibilities into consideration:

If the nozzle section is not installed, relocate temporarily thermocouples associated with TRC-1, TRC-2, and TE-1 on primary piping downstream of the loop heater section. Turn loop heater selector switch on automatic. Set TRC-4 at 560°F. Adjust TRC-4 setpoint so as to control TRC-1 and TRC-2 at 600°F. (Pile outlet temperature.)

If the nozzle section is installed, thermocouples are located in the permanent positions. Turn loop heater selector switch on automatic. Set TRC-4 at 450°F. After the reactor is at 50 MW, bring TRC-4 up slowly so as not to get a cooldown or scram from TRC-1 or TRC-2 over shooting 600°F. Each time the reactor goes down lower the TRC-4 setpoint to 450 and wait until reactor is at full power before raising.

Set flow in auxiliary system to about 3.5 scale reading using valve 14. Adjust this flow until the cooler outlet temperature is 100°F under normal operating conditions.

When the system has stabilized at 2000 psig and 600°F (TRC-1 and TRC-2) (Pile outlet temperature), hydrogen is to be added to the loop through the hot sampling system. The procedure for this addition is described below in the description of the hot sampling system.

Close valve V-11 and open the instrument valve IV-70 by-pass around valve V-11. Adjust flow in the degas line so that the pressurizer pressure is not distrubed.

The system is now in normal operation.

C. Sampling and Chemical Addition Procedures

1. Hot Sampling

Samples are to be taken Monday, Wednesday, and Friday. Based on the losses which are found to occur during the week, empirical additions of chemicals will be made as required to maintain the chemical composition within specified limits. On occasion, two samples may be requested by the CPP Analytical Laboratory for activity determination.

The sample bomb is clean and empty after return from the CPP (Chemical Processing Plant) Analytical Laboratory. A 10 ml bomb is normally used. A larger bomb (250 ml) is available if required.

Install the sample bomb between valves V-68 and V-71 which are in the closed position.

Open valves V-69 and V-70 (sample bomb valves) and valves V-73 and V-74 (which lead to the vacuum system).

Open valves V-75 and V-143 in the vacuum system. Valves V-76 and V-139 will be closed normally.

Empty the water trap for vacuum pump 8A, if necessary. Replace the water trap.

Start vacuum pump 8A. Evacuate for five minutes. Observe VI-2 to determine whether a good vacuum is being obtained. If a good vacuum is not being obtained, locate and repair leaks.

When evacuation is complete, close valves 74 and 75. Vent briefly through valve V-142. Close valve V-143. Shut off vacuum pump 8A.

Close valve V-127 and open valves V-66, V-67, V-68, V-71, and V-72. Valve V-14 is in the open position.

Continue circulation of fluid through the hot sampling bomb for $\frac{1}{2}$ hour.

At the end of $\frac{1}{2}$ hour of circulation, close bomb valves V-70 and V-69 in that order. Then close valves V-71, V-72, V-68, and V-67. Open valve V-127. This will restore normal circulation by-passing the hot sampling system.

Allow the sample bomb to cool and then remove it from the system.

Tag the bomb with the following information:

WCAP-4 Loop (To CPP Analytical Lab. - Care of;
V. G. Wheeler
Room 214)

Date:	
Time:	(Time of start & completion of circulation)
Operator:	
Sample No.:	Hot samples will have the code HS followed by chronological numbering. The first sample taken will be HS-1, etc.

Take the tagged sample bomb to the MTR Health Physics office for shipment to CPP Analytical Laboratory at 0800 hours. An analytical request form is to be supplied by the Project Engineer in duplicate, and taken with the sample to the Health Physics office.

The information on the bomb tag is also to be recorded in the log book together with all other pertinent information.

2. Cold Sampling

This operation is carried out in a similar manner to hot sampling and may be carried out concurrently. This sample will be taken daily only after the completion of the chemistry stability portion of the test (first three months) when the demineralizer is placed on stream. Prior to this time, the cold samples will be taken at Project Engineer's request via V-29, V-30, and V-39 into polyethylene bottles. During the training operation, cold samples will be taken twice weekly.

The sample bomb is empty and clean after return from the CPP Analytical Laboratory. A 10 ml bomb is normally used. A larger bomb (250 ml) is available, if required.

Install the sample bomb between valves V-27 and V-82 which are in the closed position.

Open valves V-80 and V-81 (smaple bomb valves) and valves V-78 and V-79 (which lead to the vacuum system).

Open valves V-141 and V-143 in the vacuum system. Valves V-76 and V-139 are normally closed.

Empty the water trap for vacuum pump 8A, if necessary. Replace the water trap.

Start vacuum pump 8A. Evacuate for five minutes. For concurrent operation with hot sampling, both sample bombs are evacuated at the same time. Observe VI-2 to determine whether a good vacuum is being obtained. If a good vacuum is not being obtained, locate and repair leaks.

When evacuation is complete, close valves V-78, V-79, and V-141. Vent briefly through valve V-142. Close valve V-143. Shut off vacuum pump 8A.

Close valve V-25 and V-31. Open valves V-28, V-29, V-84, V-83, V-82, V-27, and V-26 in that order.

Continue circulation of fluid through the cold sampling bomb for one hour.

At the end of one hour of circulation, close bomb valves V-80 and V-81 in the order. Then close valves V-26, V-27, V-82, and V-83. Open V-31. Close V-28, V-29, and V-84. This will restore normal circulation by-passing the cold sampling system.

Remove the cold sample bomb from the system.

Tag the bomb with the following information:

WCAP-4 Loop (To CPP Analytical Laboratory - Care of;
V. G. Wheeler
Room 214)

Date:
Time: (Time of start and completion of circulation.)
Technician:
Sample No.: Cold samples will have the code CS followed by chronological numbering. The first sample taken will be CS-1, etc.

The tagged sample bomb is to be ready for shipment to the CPP Analytical Laboratory at 7:00 a.m. An analytical request form will be supplied by the Project Engineer in duplicate and transmitted with the sample.

The information on the bomb tag is also to be recorded in the log book together with all other pertinent information.

3. Auxiliary Sampling (See Appendix B)

This procedure is designed to provide two samples simultaneously and will be performed as per notification from Project Engineer. One sample is taken for determination of chloride, specific resistivity and corrosion product analysis and the other for dissolved oxygen. The glass oxygen bulb, the polyethylene bottle, and the rubber tubing will be provided by the CPP Analytical Laboratory. These will have been carefully cleaned and prepared for sampling. All precautions shall be taken to aviod contamination of the equipment in handling.

The point from which the samples may be taken is to be V-39. With V-39 closed, V-30 is then opened.

One length of rubber tubing is attached between the stainless steel tubing extending from V-39 and the bottom stopcock of the glass oxygen bulb. NOTE: The rubber-covered reagent addition tip must be at the bottom of the bulb.

Another length of rubber tubing is attached to the other end of the glass oxygen bulb to transfer overflow from the bulb to the polyethylene bottle.

The stopcocks on the glass oxygen bulb are turned to the open position, (this is very important, as the glass oxygen bulb will withstand very little pressure) and valve V-39 is cracked slightly and water is permitted to raise slowly up into the oxygen bulb and to overflow into the polyethylene bottle. It is important to avoid entrapment of air bubbles in the bulb since the sample is being taken to analyze for oxygen in the water. The polyethylene bottle will have a mark to indicate the volume of the first batch of water which is to be discarded. This will be approximately 200 cc. An accurate calibration of the total volume of the bottle and the volume up to the mark should be made and the values should be inked on the bottle. This first batch of water will be discarded. The overflow will continue to be collected until the polyethylene bottle is full.

Close valves V-39 and V-30.

Immediately close the upper stopcock on the glass oxygen bulb followed quickly by closing the bottom stopcock.

Stopper the polyethylene bottle with the stopper provided.

Tag the oxygen bulb and also the polyethylene bottle with the following information:

WCAP-4 Loop (To be transmitted to Mr. G. V. Wheeler, Phillips Petroleum Co., CPP Analytical Laboratory, National Testing Station, Room 214.)

Date:
Time:
Technician:
Sample No.: Both the bulb and bottle will be designated by the code AS. Both samples are part of the same sample and will be so designated. Chronological numbering will be used. Thus, the first sample taken will be AS 1 bulb for the oxygen sample and AS 1 bottle for the chloride sample.

Attach a CPP Analytical Laboratory analytical request form in duplicate and submit with the samples.

Record all pertinent information in the log book. This will include the information on the tags as well as the volume of water discarded and the volume of water collected in the polyethylene bottle.

The samples are to be ready for shipment to the CPP Analytical Laboratory at 7:00 a.m.

It is important to avoid contamination of the glass bulb, the rubber tubing and the polyethylene bottle.

<u>NOTE</u>: Project Engineering and/or the sponsor should be present when the first auxiliary sample is taken. Since the sample is quite large, it will be important to observe closely the loop pressure during sampling. It may become necessary as a standard procedure to make the loop up to high surge tank level prior to sampling and/or to have the make-up pump operating during the slow sample withdrawal.

4. <u>Emergency Sampling</u>

In the event of a fission break, the normal sampling system in the auxiliary cubicle will be isolated. An emergency sampling system has been provided to permit sampling for control of the test fluid composition. These samples will be taken daily after a fission break and will be analyzed for dissolved hydrogen, lithium and pH only (In the event of a fission break during the chemical stability portion of the test, boron will also be included).

Install a clean and empty 10 ml sample bomb between valves V-109 and V-112.

Evacuate the emergency sampling system as follows:

Empty the water trap on vacuum pump No. 8A, if required and re-install this trap.

Close vacuum pump No. 8A vent valve 142 and open valve V-143. Valves V-75 and V-141 will be normally closed.

Open valves V-76, V-106, V-121, V-122, V-147, V-109, V-110, V-111, V-112, and V-146 in that order.

Start vacuum pump No. 8A. Evacuate until a good vacuum is obtained as determined by the reading on VI-2 (the equivalent of 0 mm of mercury - depending on the gauge units). Approximately five minutes of evacuation is recommended.

Close valve V-143 and observe VI-2. The vacuum should hold well unless a leak exists. If evidence of a leak is detected, locate and repair. If no leak exists, close valves V-121 and V-122 and proceed immediately to the next step.

Circulate loop fluid through the emergency sampling system, as follows:

Open slowly valves V-113, V-145, V-108, and V-148 in that order.

Permit circulation to proceed for one hour.

After initiation of circulation, deactivate the vacuum system by closing valves V-106, V-76, and V-143. Shut off vacuum pump No. 8A and vent the pump to atmospheric pressure by opening valve V-142 and then closing valve 142.

Take the sample as follows:

Close valves V-110, V-111, V-109, V-147, V-108, V-148, V-112, V-146, V-145, and V-113 in that order.

Remove the sample bomb from between valves V-109 and V-112.

Prepare for transfer of the sample bomb to the CPP Analytical Laboratory as follows:

Remove the bomb with Health Physics surveillance.

Tag the sample bomb ES, date and time of start and time sampling was completed.

Attach a CPP Analytical Laboratory analytical request form in duplicate and submit with the sample.

Record all pertinent information in the log book, including the information on the bomb tag.

The sample is to be ready for shipment to the CPP Analytical Laboratory at 7:00 a.m.

5. Normal Reagent Addition System

During normal loop operation (as opposed to operation in the event of a fission break), the hot sampling system will be used for the injection of reagents as required to maintain specified test fluid composition. A stock solution of each of the reagents (lithium hydroxide and boric acid) will be prepared by the CPP Analytical Laboratory. The existing hydrogen system at the Materials Testing Reactor, outside the southeast door of the reactor building will be used for hydrogen addition. It is likely that hydrogen addition will be required daily whereas addition of lithium hydroxide and boric acid may be required on a weekly basis depending on the leakage rate. The leakage rate will also determine the size of the bomb used for addition. Normally the 10 ml bomb used for sampling will be adequate. A 250 ml bomb is available, if necessary.

a. Lithium Hydroxide Addition

A clean empty 10 ml. sampling bomb is filled with the required solution to be added. The sampling bomb is fitted with a fitting and a short length of tubing at each end. The lower end is fitted with a length of clean rubber tubing, which is submerged in a bottle containing the solution to be added. The upper end is connected via a length of rubber tubing to the vent valve V-142 of vacuum pump No. 8A.

Valve V-143 is closed. Valve V-142 is cracked slightly and the vacuum pump is started.

The solution is drawn up into and through the sample bomb slowly, keeping the rubber tubing submerged. When it appears in the water trap, close the sample bomb valves.

Remove the rubber tubing from valve V-142. Shut off the vacuum pump and vent it to atmospheric pressure through valve V-142. Empty the water trap and reinstall it. Close valve V-142.

Remove the fittings from the sample bomb.

Fill the exposed fitting hold of valve V-68 with demineralized water.

Install the sample bomb between valves 68 and 71.

Evacuate the space between valves 70 and 71 by the following procedure:

> Open valves V-75 and V-143 in the vacuum system. Valves V-76 and V-139 will normally be closed.
>
> Empty the water trap for vacuum pump 8A, if necessary. Replace the water trap.
>
> Start vacuum pump 8A. Evacuate for 5 minutes. Observe VI-2 to determine whether a good vacuum is being obtained. If a good vacuum is not being obtained, locate and repair leaks.
>
> When evacuation is complete, close valves 74 and 75. Vent briefly through valve V-142. Close valve V-143. Shut off vacuum pump 8A.

Note that in this sampling procedure the bomb valves are left closed during evacuation.

Close valve V-73.

Close valve V-127 and open valves V-67, V-68, V-69, V-70, V-71, and V-72 in that order. Valve V-14 is in the open position.

<u>NOTE</u>: Valve V-66 is always left open.

Continue circulation of fluid through the hot sampling bomb for one hour.

At the end of one hour of circulation, close valves V-72, V-71, V-70, V-69, V-68, and V-67 in the order.

Open valve V-127 to restore normal circulation by-passing the hot sampling system.

Allow the sample bomb to thermally cool and then remove it from the system.

Enter the following information in the log book:

Date and time of addition: ______________

Indicate time of start and completion of circulation. ______________

Technician: ______________

Solution concentration: ______________

Supplied by the CPP Analytical Laboratory with the solution to be added.

b. Boric Acid Addition

This procedure is performed exactly the same as the lithium hydroxide addition procedure except that a boric acid solution will be added instead of the lithium hydroxide solution.

NOTE: At a later date, when sufficient experience has been accumulated, boric acid and lithium hydroxide may be added together in a single solution.

c. Hydrogen Addition

A clean, empty 10 ml sampling bomb is filled with hydrogen to the required pressure at the MTR hydrogen system outside the southeast door of the MTR reactor building.

NOTE: The bomb is to be purged sufficiently to be entirely free of air using the special adapter for connecting the bomb to the hydrogen cylinder. Adapter is stored in the cabinet on top of the auxiliary cubicle.

Proceed with the same procedure as outlined under Lithium Hydroxide Addition starting with the step to fill the exposed fitting hold of valve V-68 with demineralized water. Note that in the step covering the log book entry, enter the hydrogen pressure in the log book in place of the solution concentration.

At a later date, allow the sample bomb to thermally cool and then remove it from the system to porvide a sample for analysis instead of the sampling procedure previously described. Thus, the hydrogen addition procedure may become a combined sampling and hydrogen addition procedure.

6. Emergency Reagent Addition System

In the event of a fission break, the normal sampling and reagent addition system in the auxiliary cubicle will be isolated. Samples will be taken and reagent additions will be made in the emergency sampling system. Additions will be made as required to maintain specified test fluid composition. Normally a 10 ml sampling bomb will be sufficient for this purpose. If required, a 250 ml bomb is available.

a. Lithium Hydroxide Addition

The bomb is filled as described under normal addition.

Fill the exposed fitting hole of valve 112 with demineralized water.

Install the bomb between valve V-109 and V-112.

Evacuate the space between valves V-108 and V-109 using vacuum pump 8A, as described under the emergency sampling system procedure.

Circulate test fluid through the bomb as described under the Emergency Sampling Procedure (step 4). Note that in the case of Emergency Addition, the bomb valves (Nos. V-110 and V-111) are opened.

After one hour of circulation, stop circulation as described under the emergency sampling procedure (step 4).

Enter addition information in the log book as described under Normal Reagent Addition.

b. Boric Acid Addition

The Emergency Boric Acid Addition procedure is exactly the same as the Emergency Lithium Hydroxide Addition procedure except that a boric acid solution is used instead of a lithium hydroxide solution.

c. Hydrogen Addition

The bomb is filled as described under normal addition.

Proceed with the same procedure as described for Emergency Lithium Hydroxide Addition. In place of solution concentration, enter hydrogen pressure in the log book.

D. Feed and Bleed Dilution

At the conclusion of the chemistry stability portion of the in-pile test (and for training purposes during the checkout out-of-pile test), it will be necessary to remove boric acid from the test fluid without shutdown of the experiment. This will be accomplished by dilution of the loop contents with demineralized water with concurrent removal of diluted test fluid. This procedure is termed "Feed and Bleed Dilution."

At the conclusion of feed and bleed dilution, the test fluid composition will be adjusted to a pH value of 10 with a lithium hydroxide solution and the test will proceed.

The loop is at normal temperature and pressure. The test fluid contains approximately 200 ppm B (as boric acid) and approximately 3 ppm Li (as lithium hydroxide).

The storage tank is full of deaerated, demineralized water (capacity 20 gallons).

Additional demineralized water is being boiled in the deaerator tank as described in Charge Water Preparation under Loop Startup, page 49.

NOTE: Approximately 75 gallons of deaerated, demineralized water will be fed into the loop. No chemicals are added to the feed water, for feed and bleed dilution.

Valves V-54, V-64, and V-34 are normally open and makeup pump is on automatic control.

Operate makeup pump on manual control until the high level alarm is activated.

Close the IV-70 by-pass around valve V-11 and open valve 11 to perimit circulation of loop fluid through pressurizer at a rate of which will not disturb maintenance of system pressure.

At this time, crack valve V-87 (or valves V-85 and V-86 if more convenient) and drain water from the loop at a rate designed to maintain the pressurizer level slightly below the high level alarm set point (LRC-1 may be used to determine pressurizer level). Take an initial sample of drainage water in a 250 ml polyethylene bottle after adequate purging (depending on the drainage location).

Collect the water drained from the loop in a 5 gallon container. When the container is filled, take a sample (a 250 ml polyethylene bottle will be provided) from the drain directly for analysis by the CPP Analytical Laboratory. Empty the 5 gallon container into the auxiliary cubicle catch basin and continue to collect drainage from the loop. Repeat the sample taking process each time the 5 gallon container if filled with loop drainage. Samples are to be coded as F.B. and are to be numbered chronologically. The time required to fill each 5 gallon container - full of drainage is to be noted carefully. The data is to be entered in the log book as follows:

Time			
End of Filling	End of Filling	Sample No.	Drainage Container Filling No.

The initial sample taken before drainage is initiated will be F.B.-1. Then filling at the first drainage container full of bleed fluid will be initieated and the time of start of drainage will be noted. When the container is full, the time will again be noted. A sample will be taken directly from the drainage point and will be marked F.B.-1. The drainage container will be emptied and further drainage will be collected, etc. A temporary container will be used during the period when the large container is being emptied and the contents of the temporary container will be added to the large container when it is replaced. The sample bottles will be sent to the CPP Analytical Laboratory for analysis. Each bottle will be tagged with the following information:

Date:
Time taken:
Sample No.:
Operator:

An analytical request form will be prepared in duplicate for the CPP Analytical Laboratory.

Approximately 75 gallons of demineralized, deaerated water will be fed into the loop. As the stored supply of deaerated water in the storage tank is consumed, additional boiled, demineralized water will be fed into the storage tank through valve V-53 to maintain the storage tank water level just below the top of the sight glass. The nitrogen overpressure will be maintained in the storage tank as described under Charge Water Preparation.

When 75 gallons of water have been fed into the loop, the Feed and Bleed Dilution procedure will be temporarily halted by shutting off the makeup pump and closing the drainage point. The last sample taken will be submitted to the CPP Analytical Laboratory for a RUSH analysis for boron. If the boron concentration is greater than 5 ppm, continue feed and bleed dilution until boron concentration is below 5 ppm.

When the boron concentration has been reduced to below 5 ppm, the loop is restored to normal operation by:

Shutting off the makeup pump and returning it to automatic control.

Closing the drainage point (valve V-87 or valves V-85, and V-86).

Preparing and storing a supply of deareated water, if necessary.

Injection of lithium hydroxide by the procedure described under Normal Reagent Addition to obtain a pH value of 9.5 - 10.5.

Install a fresh mixed resin bed in the demineralizer by a procedure to be described below:

Place the demineralizer on-stream by closing valve 23 and opening valves V-18, V-19, V-20, V-21, and V-29.

E. Normal Operation

Sample loop fluid for chemical analysis as previously described in sampling procedures. Additions of chemicals will be made to maintain specified water chemistry. Samples will be taken to determine specified water chemistry. Samples will be taken to determine the radioactivity of the loop water before and after the interchanger to determine whether deposition of active material occurs in the interchanger. After the chemical stability portion of the test, the deionizer will be placed on stream and samples will be taken after this unit to determine when the resin bed is depleted.

Adjust purification flow manually with V-14 as required to maintain desired water conditions.

Compare pressurizer temperature with pressure to determine presence of non-condensable gases. (Temperature should be saturation for the pressure existing.) Open V-7 and V-8 to bleed pressurizer if required.

Deaerate and store demineralized water to supply makeup to loop as required.

Pack or replace valves in purification system as required by shutting off V-13, V-14, V-32, and V-33 to isolate from primary system. If required, open V-30 and V-39 to drain.

Periodically check all primary detector elements in primary detector cubicle. Adjust as required.

F. Emergency Operation

In the event of leakage from the primary system approaches makeup pump capacity, cool the loop to 400°F and then reduce the pressure to 350 psi. Attempt to operate loop until next scheduled shutdown.

If the leakage from primary system exceeds makeup pump capacity, let automatic controls actuate MTR scram or power reduction as required. When system pressure falls below 100 psi gradually open V-3, V-4, V-5, and V-6 and close V-1 and V-2. Circulate process water through loop.

On failure of one primary pump continue to operate until next scheduled MTR scheduled MTR shutdown. Attempt to locate cause of failure.

For all other failures, let automatic controls operate system.

Stop leakage from any auxiliary system by closing appropriate valves.

The auxiliary system will be automatically shut down in the event of radiation activity above allowable tolerance. In the event of radiation activity above working tolerance in the primary loop area, the reactor and loop should be shut down. The in-pile tube should then be discharged and the loop decontaminated.

G. Standby Operation

Loop running, reactor down:

Loop heater will turn on and maintain temperature of 450°F.

Loop down, reactor running:

Cool loop to 150°F and depressurize through valves V-7 and V-8.

Circulate process water through in-pile tube by opening V-3, V-4, V-5, and V-6.

Close V-1 and V-2 gradually.

Drain water from loop by opening V-9, V-10, V-30, and V-39 if required.

Loop down, reactor down:

Same as above except no process water flow is required through in-pile tube.

H. Preventive Maintenance

1. Primary Pumps (Westinghouse Model A-11-B2)

Within one week after loop installation with standby pumps on automatic setting, de-energize one of the primary pumps and witness operation of the standby pump. Operate for fifteen minutes.

If any significant change in primary flow (0.2 gpm) is noted, investigate cause.

Record pump cooling water flow and temperature.

Note variation of operating current with time. An increase of current is indicative of increased pump friction and may result in pump failure.

Caution must also be exercised to avoid system over-pressure that might damage valve packing, seals, etc.

Repeat the procedure outlined above during each shutdown period.

a. Pump Characteristics

Ambient Pressure	2000 psi
Inlet Temperature	600°F
Cooling Flow (minimum)	1 gpm
Cooling Inlet Water Temperature	90°F
NPSH required	50 psi

Reference should be made to the manufacturer's literature for installation, maintenance, and trouble-shooting.

2. Makeup Pump (Milton-Roy Model MD2-33)

Loop water samples will frequently be taken at least during the early stages of operation. Otherwise, the makeup pump would not be expected to operate excessibely.

In the event of frequent or continuous operation, all bearing surface lubrication fittings should be serviced daily.

Pump packing should be lubricated daily.

Motor driver gear case should be serviced every three months.

Reference should be made to the manufacturer's literature for recommended lubricant types, general maintenance, and trouble-shooting.

3. Vacuum Pump (Welch Duo-Seal Model 1400 B)

The pump is relatively free of maintenance requirements, however, reference should be made to the manufacturer's literature for installation, lubrication and trouble-shooting. Maintain the type and level of oil as specified by the manufacturer.

4. Relays and Circuit Breakers

Inspect contacts for signs of eterioration before placing the equipment in service and after each month of use. Replace faulty contacts where necessary. Where contacts are not removable, replace the entire relay.

5. Differential Pressure Cells

The differential pressure cells are capable of containing full system pressure in either bellow chamber. However, extreme pressures will result in loss of calibration of the cell.

In order to insure porper operation of the cells, care must be taken to completely fill the sensing lines to eliminate any entrapped air. About once per each month of operation, a small amount of liquid should be bled through these lines to remove any non-condensible gases.

Refer to manufacturer's literature for proper calibration procedures.

6. Pressure Transducer

The pressure transducer provides the input tothe PRC-1 pressure controller. It is relatively rugged, and will need only an initial check and an occasional calibration check thereafter. This may be done by careful comparison to the permanently attached bourden tube gauge which can be calibrated by use of the dead weight gauge tester.

7. Pyrometry Equipment

Thermocouples and the associated read-out equipment can be calibrated by the use of a portable potentiometer.

8. Recorders

All recorders are of the standard type and manufacturer's literature should be referred to for servicing of this equipment. Inkwells should be inspected to see that the remaining ink supply is adequate. Charts should be replaced at regular intervals.

9. Data Logger

The data log printer is a conventional electric typewriter and similar servicing procedures should apply. Under certain conditions of jamming, it is possible to apply continuous 48 V. to the typewriter solenoids resulting in failure. A circuit breaker is provided in this line to shut off this supply in case this trouble appears.

All information printed out by the data logger is also available from other instruments and hence loop operation may be continued during periods of data logger malfunction or during servicing. The data logger accomodates thirty inputs, and is manufactured by Hansen-Gorill-Brian.

I. Pre-operational Testing Procedure

1. General

The purpose of this test procedure is to check all individual loop components and to check loop systems under operational conditions. The results of the test should be recorded in a manner that will permit the future comparison of this data to operational conditions existing at the time. This is important to determine whether the loop is operating in a normal manner. The test procedure is arranged in chronological order. However, individual tests may be run in a different order if it is apparent that this will facilitate the general testing procedure.

All charts should be appropriately referenced so that one may determine what changes in settings have occurred. The charts should be retained as part of the permanent test record. Date, time ambient conditions, and setpoints should be included. At this point, hydrostatic testing and system filling should be completed.

The following is a list of pre-operational tests to be performed:

Electrical Systems Test

Initial Settings

Valves - normal operating position

Instrumentation - on

Regulate cooling water to pumps, record flow

Circuit Breakers

Actuate circuit breakers individually

Record change in lamps illuminated

Record voltages and currents

Annunciator Panel

Test annunciator panel and record which channels are operating

Meter Panel

Record initial values on elapsed time meters

Pressurization

Record change of lamps illuminated with operation of controls

Record readings on ammeter for pressurizer heaters

Record stability of control

Turn off pressurizer heaters and allow pressure to decrease to 1500 psi. Record variation of pressure with time and pressure at point where fast set back occurs.

Allow pressurizer to automatically attain 2000 psi

Record stability of pressure control

Note ammeter readings

Select most stable pressurizer heat control for remainder of tests

Circulating pump

Record loop temperature

Energize each pump individually

Record the individual flow and changes in loop temperature

Record the change in lamps illuminated

Energize the three combinations of two pumps and record the flow for each case.

Energize all three pumps and record the flow and loop temperatures.

Energize pumps No. 1 and 2 and set No. 3 for automatic

Turn off each of the operating pumps in turn and record what is the condition of No. 3

Operating with No. 1 and 2 restrict the flow until 3 is energized. Record the flow when this occurs and annunciator condition. Record the loop temperature after this occurs.

Turn No. 3 pump off. Reduce flow below scram condition. Record flow when scram annunciation occurs. (Scram relay should energize)

Loop heaters - system at 500°F

Operate pump No. 1 only.

Record initial loop temperature

Energize heaters manually and record change in lamps illuminated

Record the rise in loop temperature and the steady state value. Record flow.

Energize pump No. 2 and record flow and any change in temperature.

Turn on pump No. 3 and record flow and changes in temperature

De-energize pump No. 3 and loop heaters. Set loop heater to automatic

Supply cooling water to primary heat exchanger and record flow

Allow the loop to cool down.

Record the temperature at which the loop heaters are automatically energized

Mechanical Component Function Test

Heat exchanger and three-way valve

At operating temperature (500°F) record heat exchanger inlet and mixed temperatures.

Record heat exchanger cooling water temperatures

At operating temperature de-energize the loop heaters, cool loop to 400°F by closing VA-1 to bypass. Record time required to cool.

Alternate heat input of loop heater, record variation in heat exchanger mixed outlet temperature.

Cut off air to three-way valve, record mixed temperature, (Fail Safe Test).

Back-up valves (VA-2 and VA-3).

At temperature manually close VA-1 to the heat exchanger. Witness function of VA-2 to open and VA-3 to close by observing mixed temperature.

Cut off electrical power to VA-2 and VA-3. Observe mixed temperature.

Decrease cooling water to heat exchanger, with scram setting at 620°F allow loop to heat up and witness scram annunciator action. (Scram relay should energize).

Purification interchanger and cooler

At temperature and with cooling water supply, record purification and cooling water flow and temperature.

Decrease flow and check for annunciator alarm

Process water cooler

At loop temperature record coil water temperature and cooling water temperature.

Make-up system

With loop at operating pressure, drain system to low level setpoint, record make-up flow.

Check automatic high level shut off.

VII. ALARM SYSTEM

A. Primary Loop Parameters

High Pile Temperature. This alarm indicates that the safe operating temperature of the loop coolant is being exceeded. Boiling may result in the in-pile section if corrective action is not taken. Contacts have been provided on TRC-1 and TRC-2 to initiate this alarm, based on the temperature of the coolant leaving the in-pile section. As this temperature is regulated by the loop temperature controller, TRC-4, this instrument should be inspected to insure proper operation. Coincident with the alarm, an automatic cool down will occur if the emergency cool down valve selector switch is set to the automatic position. This action may also be initiated manually by use of the same switch. If the difficulty was due to improper operation of the temperature control, readjustment of the set point will permit return to normal operation. The automatic cooldown circuit should be reset as it contains a "lock-in" feature to prevent valve flutter.

Low Pressure. As is the case with High Pile Temperature, boiling may result from a reduction in pressure. The signal originates from a limit switch on the loop pressure controller, PRC-1. This signal will cause the pressurizer heaters to be automatically actuated by a circuit that bypasses all automatic control functions (the saturable reactors). The most likely cause of low pressure is improper control by the pressurizer heater regulator and PRC-1 should be checked. When the fault has been eliminated, an increase in pressure will automatically open the bypass circuit and normal operation will continue. The ammeters in the pressurizer heater circuit may be used as a guide in determining whether control action is properly occuring.

High Pressure. Although high pressure in itself will not be dangerous to loop components, it will eventually result in the rupture of the rupture disc and operation of the relief valve which will give a dangerous low pressure condition as noted in the foregoing section. As is the case with Low Pressure, the signal originated from PRC-1 and the same corrective procedures would apply. However, unlike Low Pressure, the pressurizer saturable reactor heater circuit will be de-energized to decrease system pressure. When the situation is cleared, the automatic pressurization will be continued.

A Barton DP cell DPI-1 measures the differential pressure across the in-pile piping and alarms both on High Pressure and Low Pressure. Several factors can contribute to an out-of-range condition. Variation in flow is a major one. Also, an obstruction in the primary piping line will raise the differential pressure. The differential pressure may drop due to several leaks. Due to the importance of monitoring the flow through the piping external to the loop cubicles, this instrument is used.

The flow instruments FR-4 and FR-5 should be checked first to determine that the cause of the alarm is not dependent on flow. Then depending on whether DPI-1 reads high or low a determination of leakage or obstruction can be made. Although the out-of-range condition is not directly dangerous, its effect on flow may eventually be harmful, and it is helpful in diagnosing a bad flow condition. If flow and temperature conditions are still normal, operation may be continued.

Low Flow. A low flow condition is very dangerous to loop operation and may rapidly cause a melting of the in-pile samples. In order to detect this effect, the pressure switches PA-5 and PA-7 associated with FR-4 and FR-5 actuate the electric circuit and where either one or both signals drop below the setpoints, an alarm will will be given. If the flow drops below the next set of setpoints, PA-6 and PA-8 will initiate a scram. FR-4 measures the flow into the in-pile section and FR-5 measures the flow out. In the same manner as with High Pile Temperature, automatic cool down will be initieated. Also, the spare pump will be automatically started to overcome the deficiency in flow, if its selector switch is in the automatic position. Operation of the loop may be safely continued if the spare pump valves will have to be reset by use of the selector switch to permit the temperature to rise. The electrical excitation to the pumps should be checked to insure proper current and voltage. If these values are marginal, manufacturer's literature should be consulted to determine whether continued operation will be detrimental to the pumps.

High Pressurizer Level. A possible cause of a high level alarm would be an inadequate expansion volume allowance in the pressurizer. The system may be bled to bring the water level in the pressurizer to a proper level. Too high a water level in the pressurizer will result in improper operation of the loop pressure control system. It will limit the volume of the vapor phase, and thus limit the buffering action resulting in an overly sensitive central system. The worst condition would be a water logged system. The level in the pressurizer is measured and alarmed by LRC-1, a Foxboro electronic recording system. LI-1, a Barton DP cell is an indicator showing a pressurizer level. (Can be checked against LRC-1; see Apendix B). The Foxboro system for level operates in the same manner as the ones for flow as mentioned in the Low Flow section. Simultaneous with the alarm, the circuit to the make-up pump is opened to prevent this possible cause of the fault.

Low Pressurizer Level. A separate level detector on LRC-1 will originate an alarm on a low pressurizer water level condition. This is the same instrument channel as is used for high level. The make-up pump will be started if its selector switch is in the automatic position and make-up water will cause the pressurizer level to return to a safe operating range. When this occurs, the alarm may be cleared. The level may drop due to a drop in loop operating temperature, or more seriously, due to a leak. If the latter situation exists, the operator should determine whether the make-up system has adequate compacity to compensate for the leak. If so, operation may be continued.

Pressurizer Gas. The alarm signal is the result of a computed value. This computation involves the comparison of a pressure signal which comes from PRC-1 and a temperature signal from TE-15 (TlC-1 switch position 1). When the temperature in the pressurizer falls 20^{o} below the temperature necessary to maintain saturated water vapor conditions, an alarm occurs. This indicates that non-condensible gases have been trapped in the pressurizer heater control. As the over-all effect on the control system is slight, and the computer included as a convenience, lack of operation will not jeopardize loop performance.

Loop Vaporization. As is the case with Pressurizer Gas, this alarm results from a similar computation. However, the comparison temperature is the loop temperature. As measured by TE-1, the computation in this case shows whether the boiling point of loop coolant outlet is being approached. As the loop has been designed for steady state conditions of pressure and temperature, and all operational deviations are in a safe direction, this alarm merely serves as a back-up and sees its greatest utility in protecting against boiling during unusual transient conditions. The alarm may be cleared when process variables depart from the boiling condition.

Fission Break. A fission break alarm originates from the high limit contact on the delayed neutron detecting chassis, RIA-1. This channel of instrumentation uses a BF_3 neutron detector input and measures the delayed neutrons in a special monitoring vessel. A fission break should cause a rise in the level of delayed neutrons. The alarm is used to warn the operator of the possibility of out-of-tolerance radiation levels in the vicinity of the loop. In order to prevent the contamination of the purification loop, the solenoid valve AV-4 is closed automatically when the alarm occurs. The operator should attempt to determine whether an appreciable increase of radiation level has occurred. The alarm may be cleared by raising the limit contact on the LCRM. Continued operation will be dependent on the radiation level due to the fission break.

Pump Failure. This alarm is caused by the control power failure of one of the normally operating pumps. Operation of the loop on one pump is marginal, and automatic change over circuitry is used in conjunction with the alarm. Thus, on the failure of an operating pump, the standby pump is automatically energized. The loop will then be in a safe operating condition and no immediate operator attention is necessary. However, subsequent action to examine the cause of pump failure should be taken. The alarm will be in a condition to be cleared as soon as the automatic transfer has been completed. Relays 21CR, 22CR, and 23CR are used in this circuit.

Vacuum Leak. An evacuated jacket provides thermal insulation for the in-pile piping. A continuous vacuum is maintained by vacuum pump No. 8 and this vacuum is measured by VIA-1. The output of this instrument is a meter with a high limit contact. Pressures higher than normal will initiate an alarm signal from this contact. Loss of vacuum may be due to a malfunction in the vacuum pumping system and this should be checked. Aside from the loss of insulation and the cooling down of the loop, a loss of vacuum may accompany a leak from either the process piping side or the reactor coolant side of the jacket. If the loss of vacuum is slight, operation may be continued and the alarm ceared by setting the instrument contact to a higher value. If the loss of vacuum is major, it may be necessary to examine the vacuum pump trap and discontinue pumping if they are full.

B. List of Relays and Contacts

Relays and Contacts	Energized By (MTR-E-4852 Station Title)	Function (MTR-E-4852 Station Title)
1CR-1 NO	High Pile Temp.	Main Loop Emergency By-pass Valves
-2 NC		Main Loop
2CR-1 NO	High Purification Temperature	Purification Loop Incoming Line Valve
-2 NC		Purification Loop Incoming Line Value
3CR-1 NC	Low Pressure	Pressurizer Heaters
4CR-1 NO	High Pressure	Pressurizer Heaters
7CR-1 NC	Low Flow	Circ. Pump #3
-2 NO		Main Loop Emergency By-pass Valves
-3 NC		Main Loop
9CR-1 NO	High Pressurizer Level	Make-up Pump
10CR-1 NO	Low Pressurizer Level	Pressurizer Heaters
12CR-1 NC	Loop Vaporization	Pressurizer Heaters (Disconnected)
-2 NO		Main Loop Emergency By-pass Valves
-3 NC		Main Loop (Disconnected) (Jumpered)
21CR-1 NO	Circ. Pump #1	Pump Fail
-2 NO		Pump Fail
-3 NC		Circ. Pump #3
22CR-1 NO	Circ. Pump #2	Pump Fail
-2 NO		Pump Fail
-3 NC		Circ. Pump #3
23CR-1 NO	Circ. Pump #3	Pump Fail
-2 NO		Pump Fail
24CR-1 NO	Loop Heaters	Loop Heaters
-2 NO		Loop Heaters
25CR-1 NO	Secondary Flow	Circ. Pump #1
-2 NO		Circ. Pump #2
-3 NO		Circ. Pump #3
26CR-1 NO	Fission Break	Fission Break
-2 NO		Purification Loop Incoming Line Valve
-3 NC		Purification Loop Incoming Line Valve

Relays and Contacts	Energized By (MTR-E-4852) Station Title)	Function (MTR-E-4852 Station Title)
CPI-1 NO	Circ. Pump #1	Circ. Pump #1 Power Supply (MTR-E-4853)
-2 NO		Circ. Pump #1 Power Supply (MTR-E-4853)
-3 NO		Circ. Pump #1 Power Supply (MTR-E-4853)
-4 NO		Circ. Pump #1
-5 NC		Circ. Pump #1 Off Light
CP2-1 NO	Circ. Pump #2	Circ. Pump #2 Power Supply (MTR-E-4853)
-2 NO		Circ. Pump #2 Power Supply (MTR-E-4853)
-3 NO		Circ. Pump #2 Power Supply (MTR-E-4853)
-4 NO		Circ. Pump #2
-5 NC		Circ. Pump #2 Off Light
CP3-1 NO	Circ. Pump #3	Circ. Pump #3 Power Supply (MTR-E-4853)
-2 NO		Circ. Pump #3 Power Supply (MTR-E-4853)
-3 NO		Circ. Pump #3 Power Supply (MTR-E-4853)
-4 NO		Circ. Pump #3
-5 NC		Circ. Pump #3 Off Light
H1-1 NO	Pressurizer Heaters	Press. Heaters Power Supply (MTR-E-4853)
-2 NO		Press. Heaters Power Supply (MTR-E-4853)
-3 NO		Press. Heaters Power Supply (MTR-E-4853)
H2-1 NO	Pressurizer Heaters	Press. Heaters Power Supply (MTR-E-4853)
-2 NO		Press. Heaters Power Supply (MTR-E-4853)
-3 NO		Press. Heaters Power Supply (MTR-E-4853)
H3-1 NO	Line Heaters	Line Heaters Power Supply (MTR-E-4853)
-2 NO		Line Heaters Power Supply (MTR-E-4853)
-3 NO		Line Heaters Power Supply (MTR-E-4853)
MP1-1 NO	Make-up Pump	Make-up Pump Power Supply (MTR-E-4853)
-2 NO		Make-up Pump Power Supply (MTR-E-4853)
-3 NO		Make-up Pump Power Supply (MTR-E-4853)
VC1-1 NO	Purification Loop Incoming Line Valve	Purification Loop Incoming Line Valve
-2 NC		Purification Loop Incoming Line Valve
VC2-1 NO	Main Loop	Main Loop
-2 NC		Main Loop Emergency By-pass Valves
-3 NC		Loop Heaters
VC2X-1 NO	Main Loop	Shuts Off Air to 3-way Valve
R1-1A	Scram	Main Loop Emergency By-pass Valves
1B		
2A		
2B		
3A NO		Main Loop
3B		
4A		Scram
4B		
-2 NO		Safety Circuit Diagram

Relays and Contacts	Energized By (MTR-E-4853 Station Title)	Function (MTR-E-4852 Station Title
RIA-1A	Scram B.U.	
1B		Main Loop Emergency By-pass Valves
2A		
2B		
3A NO		Main Loop
3B		
4A		Scram B.U.
4B		
-1 NO		Safety Circuit Diagram
R4	Setback	
-4A		Fast Setback
-2 NO		Safety Circuit Diagram
R4A	Setback B.U.	
-4A		Fast Setback
-1 NO		Safety Circuit Diagram
SRL-1 NC	Inst. Relay	Pressurizer Gas
SR2-1 NC	Inst. Relay	Loop Vaporization
R5	Loss Instr. Power	Scram
-1A NC		Safety Circuit Diagram
R5A	Loss Instr. Power B.U.	Scram B.U.
-1A NC		Safety Circuit Diagram

VIII. REACTOR POWER REDUCTION - (Refer to Hazards Analysis for Pump Coast-Down and Safe Operating Curves).

A. High Temperature, SCRAM

A full scram is initiated on high temperature by instruments TRCI-2 and TRC2-2. Also initiated is the emergency cool down. The loss of fission heat will prevent fuel melting, although boiling exists in the samples.

Corrective measures should include checking the heat exchanger and three way valve (K & M) operation and possible lowering the loop inlet temperature.

B. Low Flow, SCRAM

A full scram is initiated on low flow by pressure switches PA-6 and PA-8. Also initiated is the emergency cool down. The loss of fission heat will prevent fuel melting, although boiling exists in the samples due to resulting higher local temperatures.

Corrective measures should include reading the pump ammeters to check pump operation. The water level should be checked. Main loop valves V1 and V2 should be checked to insure that they are open. Finally, the pressure drop across the in-pile section DPI-1 may be an indication of excessive resistance in the in-pile section or the primary cubicle. If indications point to the primary cubicle, the strainer should be checked.

C. Loss of Instrument Control Power, SCRAM

A full scram is initiated on loss of instrument control power by R5 and R5A relays.

Corrective measures should start with the fuses or circuit breakers. (See drawings MTR-E-4852 and 4853).

D. Low Pressure, Fast Setback

A fast setback is initiated on low pressure by pressure switches PCA-1 and PRCI-2 to prevent excessive steam formation in the fuel samples. Excessive steam reduces the heat transfer and increases local temperatures, the reduction of fission heat preventing melting of the fuel elements.

Corrective measures should include checking the pressurizer for proper level and operation. The loop temperatures should be checked to determine if excessive cooling exists.

E. High Pressure, Slow Setback

A slow setback is initiated by Meletron pressure switches PCA-2 and PCA-3 to prevent the relief valve from reducing the system pressure to an excessive low pressure condition.

Corrective measures should include checking the pressurizer for proper level and operation. The temperature in the pressurizer should be checked to determine if an excessive saturation temperature is indicated.

IX. RADIATION MONITORING

Delayed fission neutrons are detected by a BF_3 chamber that is inserted in a radiation monitoring vessel. This vessel is located in the auxiliary cubicle and the piping is sized to provide a 32 - second transport delay for attenuation of background radiation.

A log count ratemeter chassis is used to determine the level of the measured radiation. This unit uses a meter relay with a high level contact as an output device, and the contact actuates an annunciator point. This contact is normally set at a point above normal background level so that it may be necessary to vary the setting if background conditions change. In the event of a fission break, the purification shutoff valve VA-4 will stop flow from the primary cubicle to the auxiliary cubicle to prevent contamination of the auxiliary system and to keep radiation levels down in the unshielded system.

X. IN-PILE TUBE INSERTION AND REMOVAL PROCEDURE

A. Insertion Procedure

Lower support bracket assembly (Reference drawing MTR-E-4888).

Remove lock wires, 8 cap screws, and 8 washers (item 6 and 7 of reference drawing)

Back off bolt (item 12) all the way.

Reassemble bracket around in-pile tube approximately 8' - 6" above the aluminum black in-pile section (see drawing 646 J 489).

Replace the strap and screws. Lock wire into position.

Tighten bolt (item 12) to secure bracket to the tube.

Tighten 2 bolts (item 9) against shaft in the position shown on reference drawing.

Leave other bolts slightly loose, so that the relative position of the tube with respect to the lower support bracket ring can be adjusted without binding the tube.

With the crane rigged to the in-pile tube, lower the assembly into the reactor tank and about half way into the B-1 refledtor position.

Now start the filler piece into position (Drawing 414 C 487).

Work both the in-pile tube and the filler piece into position, loosening item 12 of drawing MTR-D-4888 as required to locate tube and bracket in the unstressed vertical position.

Do not retighten bolt (item 12) until the flange assembly is complete.

Reference drawing 548 D 902 - Insert items 3 and 4 of referenced drawing through the tank nozzle from the outside, align with the in-pile section primary piping and make field welds as indicated on referenced drawing (note - the in-pile section is designed to permit adjustment vertically to align with piping extending through the nozzles).

Position "O" rings item 12 of referenced drawing, packing box item 5, flange item 10, and asbestos packing item 12 over jacket piping items 1 and 2.

Insert items 1 and 2 through the tank nozzle from the outside, align with the in-pile jacket piping and make field welds as indicated on referenced drawing.

Assemble the above items with stud, nut, and clamp items 8, 14, and 7 of referenced drawing, with particular notice that the packing box seats firmly on the face of the nozzle flange providing a good "O" ring seal.

Install the packing and packing gland with associated hardware. Maintain axial clearence between the packing gland and packing box to firmly seal the packing.

Position item 10 and weld to the jacket piping. Install retaining bolts as shown on referenced drawing.

Install bellows cover (item 11) and tack weld into position. Tack weld at one point only so that cover can be removed easily should it become necessary. Repeat procedure for remaining exit assembly. Tighten lower bracket bolt (item 12 drawing MTR-D-4888). Make trial fit of upper bracket.

Cut 1/8" aluminum purge line approximately 2' within reactor vessel, attach 1/4" SS tubing with reducer. Run the SS tubing through flange hole #15 and tie into existing copper line from V-56 (Reference drawing MTR-E-4802).

Tie in primary piping to in-pile tube section including thermocouple will "T" shown on Westinghouse drawing 548D902.

Attach four thermocouples located in thermocouple duct at reactor spool piece.

3 - to triplex thermocouple on outlet pipe (TRC-1, TRC-2, TE-1).

1 - Weld to bottom side of inlet pipe at nozzle 16 (TI-6).

Attach two copper vacuum tubes to in-pile assembly at reactor spool piece. Use 1/4" SS tubing from present termination points to:

1 - "T" into both jackets in position shown on drawing 548D902 and SK-4.

1 - into four value network as shown on drawing 548D902, SK-1, and SK-2.

Insulate and shield with preformed 8 inch high shielding as close as possible to the reactor spool piece. Complete shielding with leak brick.

Prefomed shielding must be cut to allow for the 4 inch cubicle exhaust duct.

1. Hydrostatic Test

Fill the loop and hydrostatic test at 3000 psig.

Following a successful pressure test (allowable rate 25 psi drop per hour), drain loop and remove the double-up rupture discs and replace with single, properly sized, discs supplied by Project Engineering.

Refill loop with chemically treated degassified water.

Check insulating jacket vacuum system for leak tightenss with 80 psig nitrogen. Close V-98 in auxiliary cubicle and open V-56 at nozzle.

Replace primary valve wall section and valve extension handles. Replace all the wall sections after all accessable vent and and drain valves have been securely tightened.

B. Removal Procedure

The loop must be in the following conditions:

Cooled down to 100°F.

Flow off.

Depressurized to zero, not drained. The pressurizer must have liquid in the bottom so as not to lose the gas dome.

When the pressure holds at zero, does not build up, isolation valves V-1 and V-2 will be closed. Loop must be at zero pressure during removal.

1. Preparations

Cut the "V" clamp off from around the in-pile tubes at the upper support bracket inside the reactor tank (Westinghouse drawing 646 J 489).

Close valves V-99, V-100, V-101, and V-102. Cut the 1/4" SS tubing on the side with the four valves between the in-pile tube connections and the cut. Leave three or four inches on the stub from the valve side. To this stub attach 1/4" I.D. plastic tubing and seal the other end of the plastic tubing in a VG hole with Operations Supervision's approval. (Ref. drawing MTR-E-4802).

With HP monitoring the plastic tubing, slightly open V-99 and V-100 on inlet tube through nozzle No. 16 and wait 5 to 10 minutes.

At this time thr first cut will be made inside the reactor tank.

2. <u>In-Pile Tube Cutting Inside Reactor Tank</u>

Cut at right angles to the inlet tube. Make the cut close to the jacket weld on the cross arm connection. Cut on the side toward the in-pile tube from the weld. See Westinghouse drawing 548 D 902.

When the first cut is completed, open V-101 and V-102 slowly and HP will monitor the plastic tubing as before. Make the second cut on the outlet tube at a corresponding position to the first cut.

Tape the four open ends using surgical gloves and tape. Close V-99, V-100, V-101, and V-102 and disconnect the two 1/4" lines from the inlet and outlet tubes where they connect to both tubes. Cut the 1/8" annulus purge line near the inside of the nozzle flange and crimp both ends. Also, disconnect the purge line from the tubing at the flange in the nozzle trough. Loosen the lower support bracket from the in-pile tube but not from the spider ring.

Rig the in-pile tube to the crane and raise the tube (B block will come with the in-pile tube as it is welded to it) to an elevation, if the radiation field permits, so as to expose the beaded weld on the outlet tube. The beading is about 9 feet below the curved section at the top of the tubes. (Reference drawing Westinghouse 584 D 883).

Secure the lower section by using a lifting tool hooked on the "B" block. Then tape the upper part of the lifting tool to the tubes for stability. When this has been done, cut both tubes at the beaded weld on the outlet tube.

After making these cuts, the top section of the in-pile tube should be discarded to the hot waste can. Remove the lower support bracket from the spider ring and also up and off the in-pile tubes.

The open ends of the lower section of the in-pile tubes should now be taped or sealed off.

Put the lower section in the discharge chute. The filler piece for the "B" block should also be stored in the canal for reuse.

Removal of flange assemblies and connecting tubes: (Reference drawing Westinghouse 548 D 902).

Remove the insulation around the inlet and outlet pressure pipes 4" below the right angle bend. (This is outside the MTR A tank extension).

Cut both pipes 4" below the bend.

Remove both inlet and outlet tubes and their flange assemblies from the reactor tank. Close holes No. 16 and No. 17 with blank flanges.

Bag the connection tubes and their flange assemblies in a plastic bag, HP tag, label them "WCAP" and store on hot storage rack - MTR basement.

Remove upper support bracket from reactor tank. Bag upper and lower support brackets in plastic, HP tag, label "WCAP" and store with the connection tube assemblies.

XI. WATER CHEMISTRY CONDITIONS

A. Introduction

It is the purpose of the WCAP-4 In-pile Loop Test at MTR to evaluate the following under irradiation:

Fuel element performance.

Stability of proposed Yankee startup water composition.

Corrosion and crud release of Yankee materials of contruction.

It is intended here to establish the conditions under which the last two items above are to be evaluated. Fuel element performance evaluation is described elsewhere in the Operations Manual.

The scope of WCAP-4 operations with respect to water chemistry at MTR is as follows:

MTR training period (3 - 4 weeks) where experience will be obtained in operation of the equipment.

Installation of actual specimens, hydrostatic testing and installation of the loop into the pile. Details concerning these operations will be supplied elsewhere.

Actual test period (continuous for 12 months). During the initial portion of the test, verification of the stability of the proposed Yankee startup water composition will be made. Subsequently, water composition will be maintained at conditions to determine corrosion behavior and crud release characteristics of porposed Yankee materials of contruction under pile conditions.

B. Water Composition

The experiment will be performed with two major types of fluid:

Yankee startup water chemistry:

Boron (as boric acid) = 200 ppm $\pm$ 20 ppm
Lithium (as lithium hydroxide) = 3 ppm $\pm$ 0.3 ppm

Yankee regular operation chemistry:

pH = 10 $\pm$ 0.5 (with lithium hydroxide)

The initial portion of the in-pile test (4 reactor cycles) will be performed with startup chemistry. Following this, the additive concentration will be reduced by feed and bleed dilution with demineralized, deaerated water to achieve essentially boron free water (less than 5 ppm boron). The pH value will be increased to 10 with lithium hydroxide and the remainder of the test will be carried out with the pH value maintained at 10 with lithium hydroxide addition as required. In all test operations, a dissolved hydrogen concentration of 25 - 35 ml (STP) per kilogram of solution is to be maintained as part of the specified water compostion.

In all test operations, the following requirements are to be observed in regard to water and reagent quality:

Oxygen and chloride concentrations are to be maintained at less than 0.1 ppm each.

Water is to be demineralized water of greater than one megohm-cm specific resistivity.

Boric acid and lighium hydroxide are to be of reagent grade quality.

C. Preliminary Operations

The following operations should be performed after transportation of the loop to the test site:

A leak test at 2000 psig after reconstruction of the loop.

Analysis of test fluid, after leak test, for chloride to insure that no contamination has occurred during transportation.

Re-setting of pressurizer level setpoints.

Calibration of sampling bombs and the reagent addition bomb.

Recalibration of Milton-Roy makeup pump at stroke setting to be used.

Completion of the hydrogen analytical system at the CPP Analytical Laboratory.

Miscellaneous operations required to supply facilities for makeup and injection of chemicals, etc.

D. Training Operation - (Out-of-Pile)

During the training operation, loop technicians are to become familiar with the loop and with the manipulations required to maintain or alter water chemistry as specified. Water composition during the training operation, sampling, and analytical schedules for control of water composition are shown in Table I. Analytical personnel of CPP will use this time to become familiar with the analytical techniques required to control water composition.

E. In-Pile Test Operation

The in-pile test is to be performed for a period of 12 months with actual test specimens installed. The pile cycle is as follows:

> Approximately 15 days under irradiation (1 day in the middle of this period for refueling with no experiment changes).
>
> An average of 6 days for refueling and experiment changes.
>
> Total time for one complete cycle is 21 days.

The schedule for test operation is based on the reactor cycle described above. The various water chemistry conditions to be maintained have been defined under Water Composition, and will be referred to as:

> Startup
>
> Concentration Decrease
>
> Regular

Start of the test is defined as the time at which water composition and temperature are as specified. For scheduling purposes at this time, the day of the start of the test is designated as Day 1. The schedule for water chemistry is shown in Table II. The sampling and analytical schedule is shown in Table III.

TABLE I

F. TRAINING OPERATION SCHEDULE AND SAMPLING SCHEDULE
(Out-of-pile)

Stage No.	Water Chemistry*	Time Interval days**	Analysis to be made	Frequency of Analysis***
1	Start-up (B=200 ppm) (Li=3 ppm)	1-6	pH	daily
			Hydrogen	daily
			Boron	daily
			Sp resistivity	Once start and once at end of stage
			Oxygen	
			Chloride	Once start and once at end of stage
			Corrosion Product	Once at end of stage
2	Concentration reduction	7	pH	hourly
			Lithium	hourly
			Boron	hourly
			Sp. resistivity	hourly
			Oxygen	Once at start and once at end of stage
			Chloride	Once at start and once at end of stage
			Corrosion Product	Once at end of stage
3	Regular operation (pH = 10 with LiOH)	8-end of training operation	pH	daily
			Hydrogen	daily
			Lithium	daily
			Boron	weekly
			Sp. resistivity	weekly
			Oxygen	weekly
			Chloride	weekly
			Corrosion Product	Once at end of stage

* - As described under Water Composition.
** - The day of start of training operation is Day 1.
*** - All samples, except samples taken during Stage 2, are to be taken before 8 A.M. and are to be ready for shipment to CPP at 8:15.

TABLE II

WATER CHEMISTRY SCHEDULE FOR IN-PILE TEST OPERATION

DAYS	PERIOD	WATER CHEMISTRY
1-15	1	Start-up with irradiation
16-21	2	Start-up without irradiation
22-36	3	Start-up with irradiation
37-42	4	Start-up without irradiation
43-57	5	Start-up with irradiation
58-63	6	Start-up without irradiation
64-78	7	Start-up with irradiation
79-83	8	Start-up without irradiation
84	9	Conc. decrease without irradiation
85-99	10	Regular with irradiation
100-105	11	Regular without irradiation
106-120	12	Regular with irradiation
121-126	13	Regular without irradiation
127-141	14	Regular with irradiation
142-147	15	Regular without irradiation
148-162	16	Regular with irradiation
163-168	17	Regular without irradiation
169-183	18	Regular with irradiation
184-189	19	Regular without irradiation
190-204	20	Regular with irradiation
205-210	21	Regular without irradiation
211-225	22	Regular with irradiation
226-231	23	Regular without irradiation
232-246	24	Regular with irradiation
247-252	25	Regular without irradiation
253-267	26	Regular with irradiation
268-273	27	Regular without irradiation
274-288	28	Regular with irradiation
289-294	29	Regular without irradiation
295-309	30	Regular with irradiation
310-315	31	Regular without irradiation
316-330	32	Regular with irradiation
331-336	33	Regular without irradiation
337-351	34	Regular with irradiation
352-357	35	Regular without irradiation
358-372	36	Regular with irradiation

TABLE III

SAMPLING AND ANALYTICAL SCHEDULE FOR IN-PILE TEST OPERATION

Analysis to be made	Period	Frequency***
pH	All except 9	Daily
	9	Hourly
Hydrogen	All except 9	Daily
	9	None
Lithium	All except 9	Daily
	9	Hourly
Boron	1-8	Daily
	9	Hourly
	10-36	None
Sp-resistivity	All except 9	Once at start of each period
	9	Hourly
Oxygen	All except 9	Once at start of each period
	9	None
Chloride	All except 9	Once at start of each period
	9	None
Corrosion Products	All except 9	Once at end of each period
	9	None
Gross Water Activity		
Before heat exchanger	All except 9	Daily**
	9	None
After heat exchanger	All except 9	Daily**
	9	None
After ion exchanger*	10-36	Daily**
Radiochemical analysis		
Before heat exchanger	All except 9	Once at end of each period**
	9	None
After heat exchanger	All except 9	Once at end of each period**
	9	None
Ion exchange resin analysis	10-36	When resin is depleted

* - The ion exchanger will not be placed on steam until after period 9.

** - The frequency will be adjusted after experience is obtained, and the need for analysis is determined.

*** - All samples, except Period 9 samples, are to be taken before 8 A.M. and are to be ready for shipment to CPP at 8:15.

APPENDIX A

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1. WCAP-4 Valve List (Numerical)
(IV's not included)

Valve No.	Location	Type	Description or Dwg. No.	Material	Design Pressure	Conditions Temp. °F	Function
V-1	Prim. cub. extended handle	Manual, globe	Hancock 1500 lb. for 3/4" Sch. 40 socket (type 7150W)	347 SS	2500	650	Stop valve in primary system in-pile inlet
V-2	"	"	"	"	"	"	Stop valve in primary system in-pile outlet
V-3	"	"	"	"	"	"	Stop valve in emergency cooling system in-pile inlet
V-4	"	"	"	"	"	"	"
V-5	"	"	"	"	"	"	Stop valve in emergency cooling in-pile outlet
V-6	"	"	"	"	"	"	"
V-7	"	"	Hancock 1500 lb. for 1/2" Sch. 40 socket type (7150W)	"	"	"	Stop valve in pressurizer relief line
V-8	"	"	"	"	"	"	"
V-9	"	"	"	"	"	"	Stop valve in primary loop drain line (low point in system)
v-10	"	"	"	"	"	"	"

Valve No.	Location	Type	Description or Dwg. No.	Material	Design Pressure	Conditions Temp. °F	Function
V-11	Prim. cub. extended handle	Manual, globe	Hancock 1500 lb. for 1/4" Sch. 40 socket type 7150	347 SS	2500	650	Stop valve in pressurizer degas line
V-12	"	"	"	"	"	"	"
V-13	Inside primary cubicle	Manual, barstock	Autoclave speed valve Cat. No. 10V6001 3/8 x 1/4	304 SS	"	525	Stop valve in purification system from pump discharge
V-14	Aux. cubicle	"	"	"	"	"	"
V-15	"	"	"	"	"	140	Purification flow from radiation monitor
V-16	"	"	"	"	"	"	"
V-17	"	"	"	"	"	"	Radiation monitor by-pass
V-18	"	"	"	"	"	"	Stop valve in purification system to demineralizer
V-19	"	"	"	"	"	"	"
V-20	"	"	"	"	"	"	Stop valve in purification system from deionizer
V-21	"	"	"	"	"	"	"

Valve No.	Location	Type	Description or Dwg. No.	Material	Design Pressure	Conditions Temp. °F	Function
V-22	Aux. cubicle	Manual, barstock	Autoclave Speed valve Cat. No. 10V6001 3/8 x 1/4	304 SS	2500	525	Cooler interchanger radiation monitor and deionizer by-pass
V-23	"	"	"	"	"	140	Deionizer by-pass
V-24	"	"	"	"	"	"	Stop valves in purification system from aux. sample
V-25	"	"	"	"	"	"	"
V-26	"	"	"	"	"	"	Stop valve out of cold sample section
V-27	"	"	"	"	"	"	"
V-28	"	"	"	"	"	"	Stop valve to aux. sample bomb
V-29	"	"	"	"	"	"	"
V-30	"	"	"	"	"	"	Stop valve in chemical addition system
V-31	"	"	"	"	"	"	Aux. sample bomb by-pass
V-32	"	"	"	"	"	300	Stop valve in purification system to pump suction
V-33	Primary cubicle	"	"	"	"	"	"
V-34	"	"	"	"	"	100	Stop valve in make-up system pump discharge

Valve No.	Location	Type	Description or Dwg. No.	Material	Design Pressure	Conditions Temp. °F	Function
V-35	Aux. cubicle	Manual, barstock	Autoclave speed valves Cat. No. 10V6001 3/8 x 1/4	304 SS	2500	100	Demineralized water to primary system by passing make-up system
V-36	"	"	"	"	"	"	"
V-37	"	"	Autoclave speed valve Cat. No. 10V4001 1/4 x 1/8	"	"	140	Purification drain valve to demineralizer
V-38	"	"	"	"	"	"	Purification drain line from demineralizer
V-39	"	"	"	"	"	"	Drain line from chemical addition system
V-40	"	"	"	"	"	"	"
V-41	"	"	"	"	"	"	Stop valve from chemical make-up
V-42	"	"	Autoclave speed valve Cat. No. 10V4001 1/4 x 1/8	"	"	140	Bleed valve cold sample section
V-43	Primary cub.	"	"	"	"	650	Primary system vent valve at loop heater
V-44	Aux. Cubicle	Globe value	Crane 1/2"	"	"	100	Drain valve on VR-3
V-45	Process water header	"	Crane 1"	"	300	150	Process water supply
V-46	Primary cub.	Glove	Hancock 1"	"	"	"	Process water supply to heat exchanger

Valve No.	Location	Type	Description or Dwg. No.	Material	Design Conditions Pressure	Temp. °F	Function
V-47	Process water header	Globe	Crane 1"	304 SS	300	150	Process water return
V-48	Auxiliary cubicle	"	Hancock 1/2"	"	"	"	Process water to radiation monitor
V-49	"	Manual, barstock	Autoclave speed line Cat. No. 10V6001 3/8 x 1/4	"	2500	650	Stop valve connecting line between hot and cold sample system
V-50	"	"	"	"	"	"	Drain valve hot sample section
V-51	Primary cub.	"	"	"	"	"	Vent on exit of primary heat exchanger in primary system
V-52	Auxiliary cubicle	Manual, Globe	Crane 1/2"	"	100	100	Demineralized water supply to deaerator tank
V-53	"	"	"	"	"	"	Stop valve between de-aerator and storage tanks
V-54	"	"	"	"	"	"	Treated water to make-up pump
V-55	"	"	"	"	300	"	Process water to water cooler
V-56	"	Manual, barstock	Autoclave speed valve Cat. No. 10V6001 3/8 x 1/4	"	2500	100	Annulus vacuum line shut off valve
V-57	"	"	"	"	"	"	Shut off valve at VAC pump 8
V-58	"	Manual	Hoke	"	100	"	Vent at Storage Tank

Valve No.	Location	Type	Description or Dwg. No.	Material	Design Pressure	Condition Temp. °F	Function
V-59	Auxiliary cubicle	Manual	Hoke	304 SS	100	100	Vent at Storage Tank
V-60	"	Manual, globe	Crane 1/2"	"	300	"	Drain valve at storage tank
V-61	"	Manual	Crane 3/4"	-	300	"	Stop valve potable water to process water cooler
V-62	Primary cubicle	Manual, globe	Hancock 1"	304 SS	"	150	Process water from primary heat exchanger
V-63	Auxiliary cubicle	"	Hancock 3/8"	"	"	"	Process water from purification cooler
V-64	"	Manual barstock	Autoclave speed valve Cat. No. 10V6001 3/8 x 1/4	"	2500	100	Stop valve in make-up system line to primary loop
V-66	Auxiliary cubicle	"	"	"	"	650	Stop valve to hot sample
V-67	"	"	"	"	"	"	"
V-68	"	"	"	"	"	"	"
V-69	"	"	"	"	"	"	Valve on hot sample bomb
V-70	"	"	"	"	"	"	"
V-71	"	"	"	"	"	"	Stop valve on hot sample bomb
V-72	"	"	"	"	"	"	"
V-73	"	"	"	"	"	"	"
V-74	"	"	"	"	"	"	"

Valve No.	Location	Type	Description or Dwg. No.	Material	Design Pressure	Condition Temp. °F	Function
V-75	Auxiliary cubicle	Manual	Hoke	304 SS	100	100	Shut-off to vacuum system
V-76	"	"	"	"	"	"	Vacuum line shut-off to pressurizer and emergency sample section
V-77	"	"	"	"	"	"	Stop valve to vacuum gage V-12
V-78	"	Manual, barstock	Autoclave 3/8 x 1/4	"	2500	"	Stop valve vacuum system to cold sample
V-79	"	"	"	"	"	"	"
V-80	"	"	Autoclave speed valve Cat. No. 10V6001 3/8 x 1/4	"	"	140	Stop valve on cold sample
V-81	"	"	"	"	"	"	"
V-82	"	"	"	"	"	"	Stop valve to cold sample bomb
V-83	"	"	"	"	"	"	"
V-84	"	"	"	"	"	"	Stop valve from auxiliary sample bomb
V-85	"	"	Autoclave speed valve 3/8 x 1/4	"	"	"	Vent valve at auxiliary sample bomb
V-86	"	"	"	"	"	"	"
V-87	"	"	"	"	"	"	Drain valve at auxiliary sample bomb

Valve No.	Location	Type	Description or Dwg. No.	Material	Design Pressure	Condition Temp. °F	Function
V-88	Auxiliary cubicle	Manual, barstock	Autoclave speed valve 3/8 x 1/4	304 SS	2500	500	Stop valve to P13 vacuum gage
V-89	"	"	"	"	"	100	Stop valve to P12
V-90	"	"	"	"	"	300	Vent valve for process water
V-91	"	"	"	"	"	"	Stop valve process water to P14 process water cooler
V-92	"	"	Autoclave speed valve Cat. No. 10V4001 1/4 x 1/8 (to be installed)	"	"	100	Vent valve in makeup system
V-93	"	"	"	"	"	"	Vent valves in nitrogen system
V-94	"	"	"	"	"	"	"
V-95	"	"	"	"	"	"	Deaerator tank drain line
V-96	"	"	"	"	"	"	Nitrogen supply line
V-97	"	"	Autoclave speed valve Cat. No. 10V6001 3/8 x 1/4	"	"	"	Nozzle section vacuum line shut-off valve
V-98	"	"	"	"	"	"	Annulus section vacuum line
V-99	"	"	"	"	"	"	Nozzle section vacuum line
V-100	"	"	"	"	"	"	"
V-101	"	"	"	"	"	"	"
V-102	"	"	"	"	"	"	"

Valve No.	Location	Type	Description or Dwg. No.	Material	Design Pressure	Condition Temp °F	Function
V-103	Primary cubicle	Manual, barstock	Autoclave speed valve Cat. No. 10V4001 1/4 x 1/8	304 SS	2500	650	Datum head drain line
V-104	"	"	"	"	"	"	Nitrogen supply line to pressurizer
V-105	"	"	"	"	"	"	Pressurizer drain
V-106	"	Manual	Hoke (to be installed)	"	100	100	Emergency sample house vacuum line
V-107	Emergency sample house	"	Autoclave 1/4 x 1/8	"	2500	"	Emergency sample house vent line
V-108	"	"	Autoclave speed valve Cat. No. 10V6001 3/8 x 1/4	"	"	650	Stop valve in emergency sample house from sample bomb
V-109	"	"	"	"	"	"	"
V-110	"	"	"	"	"	"	Shut-off valves on emergency sample bomb
V-111	"	"	"	"	"	"	"
V-112	"	"	"	"	"	"	Stop valve to emergency sample bomb
V-113	Primary cub. (extended handle)	"	"	"	"	"	Stop valve to emergency sample house
V-114	Emergency Sample house	"	"	"	"	"	Stop valve at reagent addition point
V-115	"	"	"	"	"	"	"
V-116	"	"	"	"	"	"	Stop valve emergency sample house addition bomb

Valve No.	Location	Type	Description or Dwg. No.	Material	Design Pressure	Condition Temp. °F	Function
V-117	Emergency Sample house	Manual	Autoclave speed valve Cat. No. 10V6001 3/8 x 1/4	304 SS	2500	100	Stop valve in emergency sample house vacuum line
V-118	"	Manual, barstock	Autoclave 3/8 x 1/4	"	"	"	Vent valve at reagent addition bomb
V-119	"	"	"	"	"	650	Drain valve at reagent addition bomb
V-120	"	"	"	"	"	"	"
V-121	"	"	"	"	"	"	Stop valve on spray valve
V-122	"	"	"	"	"	"	"
V-123	"	"	"	"	"	"	Drain valve on spray trap
V-124	Primary cubicle extended value	"	"	"	"	100	Stop valve in vacuum line
V-125	"	"	"	"	"	"	Emergency sample system drain line
V-126	Emergency Sample House	"	"	"	"	"	Stop valve on reagent addition bomb
V-127	Auxiliary cubicle	"	"	"	"	650	Stop valve to by-pass hot sample section
V-128	Primary cubicle	"	Autoclave speed valve Cat. No. 10V4001 1/4 x 1/8	"	"	"	Vent valve circulatory pump No. 1
V-129	"	"	"	"	"	"	Vent valve circulating pump No. 2
V-130	Emergency Sample House	"	"	"	"	"	Vent valve circulating pump No. 2

Valve No.	Location	Type	Description or Dwg. No.	Material	Design Pressure	Condition Temp. °F	Function
V-131	Hot warm drain manifold	Manual globe	Crane	304 SS	2500	650	Main loop and sample house drain
V-132	"	"	"	"	"	"	Potable water drain into manifold
V-133	"	"	"	"	"	"	From manifold to warm drain
V-134	"	"	"	"	"	"	From manifold to hot drain
V-135	"	"	"	"	"	"	From primary cubicle basin to manifold
V-136	"	"	"	"	"	"	From auxiliary cubicle basin to manifold
V-137	Auxiliary cubicle	Manual barstock	Autoclave	"	"	100	Stop valve to V11 at Pump 8
V-138	"	Manual	Hoke (to be installed)	"	100	"	Vent at vacuum system pump 8
V-139	"	"	"	"	"	"	Stop valve between vacuum pump 8 and 8A
V-140	"	Manual barstock	Autoclave speed valve Cat. No. 10V4001 1/4 x 1/8	"	2500	140	Purification system drain at radiation monitor
V-141	"	Manual	Hoke	"	100	100	Shut-off valve between vacuum pump 8A and cold sample
V-142	"	"	Autoclave	"	2500	100	Vent on vacuum pump 8A
V-143	"	"	"	"	"	"	Stop valve on vacuum pump 8A
V-145	Emergency Sample house	Manual	Autoclave	"	"	650	Stop valve to emergency sample section

Valve No.	Location	Type	Description or Dwg. No.	Material	Design Pressure	Condition Temp. °F	Function
V-146	Emergency Sample house	Manual	Autoclave	304 SS	2500	650	Stop valve for emergency sample bomb
V-147	"	"	"	"	"	"	Stop valve from emergency sample bomb
V-148	"	"	"	"	"	"	Stop valve in return from emergency sample house
V-149	Auxiliary cubicle	"	"	"	"	"	Make-up pump by-pass
V-150	Hot-warm drain manifold	Manual, globe	Crane	"	"	"	Deaerated water storage tank to manifold
V-151	Nitrogen Tank	Manual	Autoclave	"	"	"	Nitrogen Supply line
V-152	"	"	Hoke	"	"	"	Nitrogen Supply line bleed
V-153	Auxiliary cubicle	Manual	Autoclave	"	"	100	Vacuum pumps 8A and 8
V-154	"	"	"	"	"	100	Stop on vacuum pump 8A
V-155	Auxiliary cubicle	"	"	"	"	100	Demin. water to portable demineralizer

2. PRIMARY DETECTOR CUBICLE
Numerically ordered valve list

Valve No.	System	Function	Location
IV-2	DPE-2	Block	Upper Valve Panel
IV-3	PA-2	Bleed RD-1, RV-1	Upper Valve Panel
IV-4	DPE-1	Block	Upper Valve Panel
IV-5	DPE-1	Block	Upper Valve Panel
IV-6	PA-3	Bleed IV-56, PA-3	Upper Valve Panel
IV-7	Dead	Bleed NC	Upper Valve Panel
IV-8	PA-4	Bleed IV-57, PA-4	Upper Valve Panel
IV-9	DPI-1	Block	Upper Valve Panel
IV-10	DPI-1	Block	Upper Valve Panel
IV-11	PCA-1, 2, 3	Block	Upper Valve Panel
IV-12	FI-7	Block	Upper Valve Panel
IV-13	PCA-1, 2, 3	Bleed IV-11, 19	Upper Valve Panel
IV-14			Upper Valve Panel
IV-15			Upper Valve Panel
IV-16	PE-1	Block	Upper Valve Panel
IV-17	PI-1	Coupling	Upper Valve Panel
IV-18	PI-1	Coupling	Upper Valve Panel
IV-19	PCA-1, 2, 3	Block	Upper Valve Panel
IV-20	FI-4	Regulating	Upper Valve Panel
IV-21	DPE-2	Bleed	Upper Valve Panel
IV-22	DPE-2	Block	Upper Valve Panel
IV-23	DPE-2	Block	Upper Valve Panel
IV-24	DPE-1	Block	Upper Valve Panel
IV-25	DPE-1	Block	Upper Valve Panel
IV-26			
IV-27	Dead	Block NC	Upper Valve Panel
IV-28			Upper Valve Panel
IV-29	DPI-1	Block	Upper Valve Panel
IV-30	DPI-1	Block	Upper Valve Panel
IV-31	FI-7	Block	Upper Valve Panel
IV-32	FI-7	Block	Upper Valve Panel
IV-33	FI-7	Block	Upper Valve Panel
IV-34			Upper Valve Panel
IV-35			Upper Valve Panel
IV-36	PE-1	Block	Upper Valve Panel
IV-37	PI-1	Coupling	Upper Valve Panel
IV-38	PA-1	Bleed RD-2, RV-2	Upper Valve Panel
IV-39	FI-2	Regulating	Upper Valve Panel
IV-40	FI-3	Regulating	Upper Valve Panel
IV-41	DPE-2	Bleed IV-21, 22, 23 and IV-2	Upper Valve Panel
IV-42	DPE-2	Bleed	Upper Valve Panel
IV-43	DPE-1	Bleed IV-4, -24	Upper Valve Panel
IV-44	DPE-1	Bleed IV-5, -25	Upper Valve Panel
IV-45			Upper Valve Panel
IV-46	Dead	Block NC	Upper Valve Panel
IV-47	DPI-1	Bleed IV-9, -29	Upper Valve Panel

Valve No.	System	Function	Location
IV-48	DPI-1	Bleed IV-10, 30	Upper Valve Panel
IV-49	FI-7	Bleed IV-31, 33	Upper Valve Panel
IV-50	FI-7	Bleed IV-12, 32	Upper Valve Panel
IV-51			Upper Valve Panel
IV-52			Upper Valve Panel
IV-53	PE-1	Bleed IV-16, 36	Upper Valve Panel
IV-54		Drain	Upper Valve Panel
IV-55		Drain	Upper Valve Panel
IV-56	PA-3	Block	Upper Valve Panel
IV-57	PA-4	Block	Upper Valve Panel
IV-58		Drain	Upper Valve Panel
IV-59	Emergency Process Water Outlet	Bleed	Upper Valve Panel
IV-60	Emergency Process Water Inlet	Bleed	Upper Valve Panel
IV-61	DPE-2	By-pass	Locally Mounted
IV-62	DPE-1	By-pass	Locally Mounted
IV-63		Drain	Locally Mounted
IV-64	DPE-3 LCA-1	By-pass	Locally Mounted
IV-65			Locally Mounted
IV-66	DPI-1	By-pass	Locally Mounted
IV-67	FI-7	By-pass	Locally Mounted
IV-68	DPE-3, LCA-1	Block	Locally Mounted
IV-69	DPE-3, LCA-1	Block	Locally Mounted
IV-70	Pressurizer De-Gas	Regulating	Upper Valve Panel
IV-71	3-way valve	Adding to 3-way valve gasket	Locally Mounted
IV-72	3-way valve	Vent for IV-71	Locally Mounted
IV-73	Instrument Set Point	Introduce Pressure to instruments	Locally Mounted
IV-74	Loop Water	Bleed for V-9, V-10	Locally Mounted
IV-75	FI-6	By-pass FI-6	Locally Mounted
IV-76	DPE-4	Block	Locally Mounted
IV-77	DPE-4	Block	Locally Mounted
IV-78	DPE-4	Block	Locally Mounted
IV-79	DPE-4	Block	Locally Mounted
IV-80	DPE-4	By-pass	Locally Mounted
IV-81	DPE-5	Block	Locally Mounted
IV-82	DPE-5	Block	Locally Mounted
IV-83	DPE-5	Block	Locally Mounted
IV-84	DPE-5	Block	Locally Mounted
IV-85	DPE-5	By-pass	Locally Mounted

3. VALVE LIST, (BY SYSTEMS)

Primary System

Valve No.	Function	Location
1	Stop valve in primary system in-pile inlet	Primary cubicle (extended handle)
2	Stop valve in primary system in-pile outlet	Primary cubicle (extended handle)
3	Stop valve in emergency cooling system in-pile inlet	Primary cubicle (extended handle)
4	Stop valve in emergency cooling system in-pile inlet	Primary cubicle (extended handle)
5	Stop valve in emergency cooling system in-pile outlet	Primary cubicle (extended handle)
6	Stop valve in emergency cooling system in-pile outlet	Primary cubicle (extended handle)
7	Stop valve in pressurizer relief by-pass line	Primary cubicle (extended handle)
8	Stop valve in pressurizer relief by-pass line	Primary cubicle (extended handle)
9	Stop valve in primary loop drain line system low point	Primary cubicle (extended handle)
10	Stop valve in primary loop drain line system low point	Primary cubicle (extended handle)
11	Stop valve in pressurizer line	Primary cubicle (extended handle)
12	Stop valve in pressurizer line	Primary cubicle (extended handle)
43	Primary system vent valve at loop heater	Inside primary cubicle

Valve No.	Function	Location
46	Process water to HX	Primary cubicle (extended handle)
128	Vent valve on primary pump No. 1	At pump location
129	Vent valve on primary pump No. 2	At pump location
130	Vent valve on primary pump No. 3	At pump location
AV-1	Primary loop flow control valve	Inside primary cubicle
AV-2	Normally closed on-off valve diverts entire primary flow through heat	Inside primary cubicle
AV-3	Normally open on-off valve entire primary flow through heat exchanger at emergency conditions	Inside primary cubicle
RV-1	Relieves system at high pressure	Inside primary cubicle
RV-2	Relieves pressurizer at high pressure	Inside primary cubicle

Auxiliary System Main Flow Line

Valve No.	Function	Location
V-13	Stop valve in purification system at primary pump discharge	Inside primary cubicle
V-14	Stop valve in purification system from pump discharge	Auxiliary cubicle
V-15	Stop valve in purification system to radiation monitor	Auxiliary cubicle
V-16	Stop valve in purification system from radiation monitor	Auxiliary cubicle
V-18	Stop valve in purification system to de-ionizer	Auxiliary cubicle
V-19	Stop valve in purification system to de-ionizer	Auxiliary cubicle
V-20	Stop valve in purification system from de-ionizer	Auxiliary cubicle

Valve No.	Function	Location
V-24	Stop valve in purification system from auxiliary sample bomb	Auxiliary cubicle
V-25	Stop valve in purification system from auxiliary sample bomb	Auxiliary cubicle
V-28	Stop valve in purification system to auxiliary sample bomb	Auxiliary cubicle
V-29	Stop valve in purification system to auxiliary sample bomb	Auxiliary cubicle
V-32	Stop valve in purification system from interchanger	Auxiliary cubicle
V-33	Stop valve in purification system to pump suction	Primary cubicle
V-84	Stop valve in purification system from auxiliary sample bomb	Auxiliary cubicle
V-127	Stop valve in purification system at hot sample	Auxiliary cubicle
AV-4	Automatic shut-off valve, closes purification flow at high temperatures and at excessive radiation levels in system	Auxiliary cubicle
Purification System (Auxiliary Cubicle)		
15	Stop valve to radiation monitor	Auxiliary cubicle
16	Stop valve from radiation monitor	Auxiliary cubicle
17	By-pass around radiation monitor	Auxiliary cubicle
18-19	Stop valves to demineralizer	Auxiliary cubicle
20-21	Stop valves from demineralizer	Auxiliary cubicle
22	By-pass around interchanger, cooler, radiation monitor, and demineralizer	Auxiliary cubicle

Valve No.	Function	Location
37	Vent above demineralizer	Auxiliary cubicle
38	Drain below demineralizer	Auxiliary cubicle
140	Vent between radiation monitor and demineralizer	Auxiliary cubicle

Purification System Component By-pass Valves

Valve No.	Function	Location
V-17	Radiation monitor by-pass valve--normally closed. To by-pass monitor, close V-15 and V-16 and open V-17	Auxiliary cubicle
V-22	Cooler, radiadion monitor, and de-ionizer by-pass valve--normally closed. To by-pass components close V-15, V-16, and V-29, and open V-22	Auxiliary cubicle
V-23	De-ionizer by-pass. To by-pass component close V-18 and V-29 open V-23	Auxiliary cubicle
V-31	Auxiliary sample bomb by-pass To by-pass close V-24 and V-29 and open V-31	Auxiliary cubicle

Make-up System

Valve No.	Function	Location
V-34	Stop valve in make-up system at primary pump discharge	Primary cubicle
V-35	Stop valve in make-up system. Demineralized water supply by-passing make-up.	Auxiliary cubicle
V-36	Stop valve in make-up system. Demineralizer water supply by-passing make-up	Auxiliary cubicle
V-44	Drain line at relief valve RV-3	Auxiliary cubicle
[illegible]	[illegible]	Auxiliary cubicle

Valve No.	Function	Location
V-54	Treated water supply line to make-up pump	Auxiliary cubicle
V-58	Storage tank vent valve	Auxiliary cubicle
V-59	Storage tank vent valve	Auxiliary cubicle
V-60	Storage tank drain valve	Auxiliary cubicle
V-64	Stop valve in make-up system to primary pump discharge	Auxiliary cubicle
V-92	Make-up system vent valve	Auxiliary cubicle
V-93	Make-up system vent valve from storage tank	Auxiliary cubicle
V-94	Make-up system vent valve from storage tank	Auxiliary cubicle
V-95	Deaerator tank drain valve	Auxiliary cubicle
V-96	Shut-off valve in nitrogen supply line to storage tank	Auxiliary cubicle
V-149	Make-up pump by-pass	Auxiliary Cubicle
V-150	Deaerated water storage tank to hot-warm drain manifold	Hot-warm drain manifold
V-155	Demineralized water to portable demineralizer	Auxiliary cubicle
RV-3	Make-up system relief valve	Auxiliary cubicle
RV-6	Storage tank relief valve	Auxiliary cubicle
Vacuum System		
56	Stop valve in annulus vacuum line	--
57	Stop valve from vacuum pump (8)	Auxiliary cubicle
73	Stop valve to hot sample selection	Auxiliary cubicle
74	Stop valve to hot sample selection	Auxiliary cubicle

Valve No.	Function	Location
75	Stop valve to hot sample selection	Auxiliary cubicle
76	Stop valve to pressurizer and emergency sample section	Auxiliary cubicle
77	Stop valve to VI2	Auxiliary cubicle
78	Stop valve to cold sample section	Auxiliary cubicle
79	Stop valve to cold sample section	Auxiliary cubicle
97	Stop valve to nozzle section	Auxiliary cubicle
98	Stop valve to annulus	Auxiliary cubicle
99	Stop valve in vacuum line from nozzle section	Reactor top
100	Stop valve in vacuum line from nozzle section	Reactor top
101	Stop valve in vacuum line from nozzle section	Reactor top
102	Stop valve in vacuum line from nozzle section	Reactor top
137	Stop valve to VI-1	Auxiliary cubicle
138	Vent valve for pump (8)	Auxiliary cubicle
139	Shut-off valve in connecting line between pump (8) and (8A)	Auxiliary cubicle
141	Stop valve to cold sample section	Auxiliary cubicle
142	Vent valve for pump (8A)	Auxiliary cubicle
143	Stop valve from vacuum pump (8A)	Auxiliary cubicle
V-153	Dead	Auxiliary cubicle
V-154	By-pass V-139	Auxiliary cubicle

Pressurizer System

Valve No.	Function	Location
7	By-pass around VR-2	Primary cubicle
8	By-pass around BR-2	Primary cubicle
11-12	Degas line stop valves from primary loop to pressurizer vapor space	Primary cubicle
103	Datum head drain	Primary cubicle
104	Stop valve from nitrogen supply	Primary cubicle
105	Pressurize vent valve	Primary cubicle
106	Stop valve-vacuum line to emergency sampling system	Primary cubicle
124	Stop valve from vacuum system to pressurizer	Primary cubicle
144 Removed	Stop valve between datum head and pressurizer	Primary cubicle
RV-2	Pressurizer relief valve	Primary cubicle
IV-70	By-pass around V-11	Detector cubicle

Process Water Cooling System

V-3	Stop valve emergency cooling to in-pile inlet	Primary cubicle (extended handle)
V-4	Stop valve emergency cooling to in-pile inlet	Primary cubicle (extended handle)
V-5	Stop valve emergency cooling in-pile outlet	Primary cubicle (extended handle)
V-6	Stop valve emergency cooling in-pile outlet	Primary cubicle (extended handle)
V-45	Process water supply	Process water header inlet
V-46	Stop valve process water supply to primary heat exchanger	Primary cubicle
V-47	Stop valve process water returns from primary heat exchanger and primary pumps	Process water header outlet

Valve No.	Function	Location
V-48	Stop valve process water supply to radiation monitor and purification cooler	Auxiliary cubicle
V-62	Stop valve process water return from primary heat exchanger and circulating pumps	Primary cubicle
V-63	Stop valve process water return from radiation monitor and purification cooler	Auxiliary cubicle
V-90	Vent valve process water supply	Auxiliary cubicle
RV-5	Relieves process water cooling systems at high pressure	Auxiliary cubicle
RV-4	Relief valve on cooling side of primary heat exchanger	Primary cubicle

Potable Water System

V-61	Potable water supply	Auxiliary cubicle
V-91	Stop valve to PI-4	Auxiliary cubicle
V-132	Stop valve potable water drain	Near hot-warm drain manifold

Hot-Warm Drain Manifold

131	Drain valve from primary system and emergency sampling system	Manifold
132	Potable water drain valve	Near manifold
133	Stop valve to warm drain	Manifold
134	Stop valve to hot drain	Manifold
135	Drain valve in primary cubicle catch basin line	Manifold
136	Drain valve in auxiliary cubicle catch basin line	Manifold
150	Deaerated water storage tank drain	Manifold

Nitrogen System

Valve No.	Function	Location
V-93	Vent valve in nitrogen supply line	Auxiliary cubicle
V-94	Vent valve in nitrogen supply line	Auxiliary cubicle
V-96	Stop valve in nitrogen supply line to water storage tank	Auxiliary cubicle
V-104	Stop valve in nitrogen supply line to pressurizer	Primary cubicle
V-151	Stop valve in nitrogen supply line	Nitrogen bottle
V-152	Bleed valve in nitrogen supply line	Nitrogen bottle

Emergency Sampling and Addition System

104	Stop valve in nitrogen supply line to pressurizer	Primary cubicle (extended handle)
106	Stop valve in vacuum line to emergency sample house	Primary cubicle
107	Emergency sample house vent line	Emergency sample house
108	Stop valve in emergency sample system from sample bomb	Emergency sample house
109	Stop valve in emergency sample house from sample bomb	Emergency sample house
110	Shut-off valve on emergency sample bomb	Emergency sample house
111	Shut-off valve on emergency sample bomb	Emergency sample house
112	Stop valve in emergency sample house to emergency sample bomb	Emergency sample house
113	Stop valve from primary system to emergency sample house	Primary cubicle (extended handle)

Valve No.	Function	Location
114	Stop valve at reagent addition point in emergency sampling system	Emergency sample house
115	Stop valve at reagent addition point in emergency sampling system	Emergency sample house
116	Stop valve emergency sample house addition bomb	Emergency sample house
117	Stop valve in emergency sample house addition bomb vacuum line	Emergency sample house
118	Vent valve in emergency sample house addition bomb	Emergency sample house
119	Drain valve at reagent addition bomb in emergency sample house	Emergency sample house
120	Drain valve at reagent addition bomb in emergency sample house	Emergency sample house
121	Stop valve in emergency sample house from spray trap	Emergency sample house
122	Stop valve in emergency sample house from spray trap	Emergency sample house
123	Drain valve on spray trap	Emergency sample house
124	Stop valve in vacuum line to pressurizer	Primary cubicle (extended handle)
125	Emergency sampling system drain line	Primary cubicle (extended handle
126	Stop valve on reagent addition bomb	Emergency sample house
145	Stop valve from primary system to emergency sample system	Emergency sample house
146	Stop valve to emergency sample bomb	Emergency sample house

Valve No.	Function	Location
148	Stop valve in returns from emergency sample house	Primary cubicle (extended handle)

Hot Sampling System (Auxiliary Cubicle)

13	From discharge side of circulating pumps to purification system	Primary cubicle
14	Hot sampling system by-pass	Auxiliary cubicle
49	Interconnecting valve between hot and cold sampling systems to common drain	Auxiliary cubicle
50	Hot and cold sampling system drain	Auxiliary cubicle
66	Stop valve to cold sampling system	Auxiliary cubicle
67-68	Stop valves to hot sampling bomb	Auxiliary cubicle
69-70	Hot sample bomb valves	Auxiliary cubicle
71-72	Stop valves from hot sampling bomb	Auxiliary cubicle
73-74	Stop valves to vacuum system	Auxiliary cubicle
127	Hot sampling system by-pass	Auxiliary cubicle

Cold Sampling System (Auxiliary Cubicle)

24-25	By-pass around cold sampling system	Auxiliary cubicle
26-27	Stop valves from cold sampling bomb	Auxiliary cubicle
42	Vent in by-pass line around cold sampling system	Auxiliary cubicle
49	To hot sampling system drain	Auxiliary cubicle
78-79	Stop valves to vacuum	Auxiliary cubicle
80-81	Cold sampling bomb valves	Auxiliary cubicle

Valve No.	Function	Location
82-83	Stop valves to cold sampling bomb	Auxiliary cubicle
84	By-pass around cold sampling system	Auxiliary cubicle

4. SETPOINT LIST

	Parameter	Instrument	Normal Reading	Action	Set Point	Annunciator Panel Reading
1.	Loop Outlet Temp.	TRC-1 Bristol	600°F	Annunciate above fast setback	610°F 620°F	High Pile Temp. Scram
2.	Loop Outlet Temp.	TRC-2 Bristol	600°F	Annunciate above fast setback	610°F 620°F	High Pile Temp. Scram
3.	Purif. Loop Temp.	TRC-3 Bristol	100°F	Annunciate above and flow shut-off	140°F	High Purif. Temp.
4.	Loop Mixed Outlet	TRC-4 M-H	Approx. 560°F	Controls		
5.	Primary HX Coolant Out	TE-15 (TIC-1)	150°F			
6.	HT. Ex. Outlet	TE-17 (TIC-1)	285°F			
7.	Pump #1 Coolant Out.	TE-8 (TRC-3)	110°F			
8.	Pump #2 Coolant Out.	TE-9 (TRC-3)	110°F			
9.	Pump #3 Coolant Out.	TE-10 (TRC-3)	110°F			
10.	Pile Inlet Temp.	TE-4 (TIC-1)	Approx. 550°F			
11.	Proc. Water Cooler Out.	TE-11 (TRC-3)	100°F			
12.	Purif. Interchanger Outlet	TE-13 (TRC-3)	300°F			
13.	Cooler Inlet	TE-14 (TRC-3)	300°F			
14.	Process Water Inlet	TE-12 (TRC-3)	120°F			
15.	Loop Flow Inlet	FR-4 (Red Pen)	10 gpm			
16.	Loop Flow Outlet	FR-5 (Green Pen)	11 gpm			

Parameter	Instrument	Normal Reading	Action	Set Point	Annunciator Panel Reading
17. Loop Flow Inlet	PA-5 Meletron PA-6 Meletron	Blind Blind	Annun. below Scram below	7.5 gpm 5.2 gpm	Low Flow Scram
18. Loop Flow Outlet	PA-7 Meletron PA-8 Meletron	Blind Blind	Annun. below Scram below	8.0 gpm 5.6 gpm	Low Flow Scram
19. Dionizer Flow	FI-1 Foxboro, Integ. Orif. DP Cell	3 (.037 gpm)	Annun. above	6.9(.069 gpm)	Secondary Flow
20. Coolant #1 Pump	FI-2 Rotometer	0.75 gpm	Annun. below Annun. above	.45 gpm 1 1/4 gpm	Secondary Flow
21. Coolant #2 Pump	FI-3 Rotameter	0.75 gpm	Annun. below Annun. above	.45 gpm 1 1/4 gpm	Secondary Flow
22. Coolant #3 Pump	FI-4 Rotameter	0.75 gpm	Annun. below Annun. above	.45 gpm 1 1/4 gpm	Secondary Flow
23. Total Make-up	FI-5 Rockwell	Inoperative	None		
24. Primary Heat Exchanger Coolant	FI-6 Barton	85.5 (200 ppm)	Annun. below Annun. above	64.1 (150 ppm) 98.3 (230 ppm)	Secondary Flow
25. Press. Off-gas Flow	FI-7 Barton	7.9 (5 ppm)	None		
26. Rad. Monitor Coolant	FI-8 Barton		None		
27. Potable Water to Process Water Cooler	FI-9 Rotameter	58 ppm	None		
28. Loop Pressure	PRC-1-3M-H	2000 psig	Shuts off Htrs. and Annunc.	2050 psig	High Pressure
	-1		Turns on HTRS. and Annunc.	1900 psig	Low Pressure
	-2		Fast Setback	1800 psig	Set back

	Parameter	Instrument	Normal Reading	Action	Set Point	Annunciator Panel Reading
29.	Loop Pressure	PCA-1 Meletron	Blind	Fast Setback	1800 psig	Set back
30.	Loop Pressure	PCA-2 Meletron	Blind	Slow Setback	2200 psig	Set back
31.	Loop Pressure	PCA-3 Meletron	Blind	Slow Setback	2200 psig	Set back
32.	Press. Rupt. Disk	PA-1 Meletron	Blind	Annunciator above	400 psig	Seal Leak
33.	Loop Rupt. Disk	PA-2 Meletron	Blind	Annunciator above	400 psig	Seal Leak
34.	Loop Heat Ex. Coolant	PA-3 Meletron	Blind	Annunciator above	400 psig	Seal Leak
35.	Control Valve Leak	PA-4 Meletron	Blind	Annunciator above	400 psig	Seal Leak
36.	System Press.	PI-1 Ashcroft	2000 psig			
37.	Reag. Add. Press.	PI-2 Ashcroft	2000 psig			
38.	Purif. Loop Press.	PI-3 Duragage	2000 psig			
39.	Potable Water Press.	PI-4 Duragage	55 psig			
40.	Make-up Pump Press.	PI-5 Ashcroft	2000 psig			
41.	In-pile DP	DPI-1 Barton	19 psig	Annunc. below Annunc. above	8 psig 30 psig	In-pile Diff. Press.
42.	Radioactivity	RIA-1 Hanner	Background	Annunciator above & Purif. Loop shutoff	10% above background	Fission Break
43.	Vacuum	VIA-1 Vacuum	2 MM	Annunciator above	10 MM	Vacuum Leak
44.	Pressurizer Level	LRC-1-3 Foxboro (DPE-3)	27.5-15	Annun. above and make-up off	27.5	High Press. Level
				Annun. below and Press. Heaters off	15	Low Press. Level

5. INSTRUMENTS

a. WCAP-4 IN-PILE TEST LOOP INSTRUMENT BILL OF MATERIAL

Symbol*	Description	Manufacturer	Model	Location	Function
TRC-1	Recorder	Bristol	1P4G663-E60-GM-S12	F-B Panel	Pile Outlet Temp. Recorder and Scram control
TE-1	Thermocouple	Thermoelectric	Minit. Bayonet	Reactor Nozzel	Pile Outlet
	Remote Ref. Junct. Comp.	Bristol	9x6Z	F-B Panel	Parallel signal source to data logger
	(2) 16 pt. Rotary Select Switch	Bristol	LEC	F-B Panel	Thermocouple Selector Switches for TIC-1 and TRC-3
TRC-2	Recorder	Bristol	1P4G663-E60-GM-S12	F-B Panel	Pile Outlet Temp. Recorder & Scram Control
TE-2	Thermocouple	Thermoelectric	Minit. Bayonet	Reactor Nozzel	Pile Outlet
TRC-3	Recorder	Bristol	1P4H663-E60-S12	F-B Panel	Purification loop temp. control and hi-temperature cutoff
TE-7	Thermocouple (TRC-3 Sw. Pos. 1)	Thermoelectric	Minit. Bayonet	Purification Loop	Purification cooler outlet
TE-8	Thermocouple (TRC-3 Sw. Pos. 2)	Thermoelectric	Minit. Bayonet	Cir. Pump #1	Coolant Temperature
TE-9	Thermocouple (TRC-3 Sw. Pos. 3)	Thermoelectric	Minit. Bayonet	Circ. Pump #2	Coolant Temperature
TE-10	Thermocouple (TRC-3 Sw. Pos. 4)	Thermoelectric	Minit. Bayonet	Circ. Pump #3	Coolant Temperature
TE-11	Thermocouple (TRC-3 Sw. Pos. 5)	Thermoelectric	Minit. Bayonet	Process Water Cooler	Outlet Temperature

*MTR-E-4966, Appendix B.

Symbol*	Description	Manufacturer	Model	Location	Function
TE-12	Thermocouple (TRC-3 Sw. Pos. 6)	Thermoelectric	Minit. Bayonet	Primary Cubicle	Process Water Inlet to HX
TE-13	Thermocouple (TRC-3 Sw. Pos. 7)	Thermoelectric	Minit. Bayonet	Purif. Interchanger	Interchanger Outlet
TE-14	Thermocouple (TRC-3 Sw. Pos. 8)	Thermoelectric	Minit. Bayonet	Purif. Cooler	Cooler Inlet
TRC-4	Circ. Chart Controller	M-H	X152(14)P-193-(W72)	M-H Rack	Loop Temperature Control
	Tel-O-Set Controller	M-H	822A1B	M-H Rack	Reset and Setpoint Adjustment
	Manual Loading Station	M-H	352921	M-H Rack	Pneumatic Setpoint Adjustment
TE-3	Thermocouple	Thermoelectric	Minit. Bayonet	Reactor Nozzle	Pile Outlet
	Electronic Temp. Trans.	M-H	158N32P-(M)	M-H Rack	Loop Outlet Temp-Pneumatic Controls Setpoint of TRC-4
TE-6	Thermocouple (TRC-4)	Thermoelectric	Minit. Bayonet	Heat Exch.	Mixed Flow - HX Outlet
TIC-1	Indicator	Bristol	663	F-B Panel	Press. Gas & Misc. Temp. Indicator
TE-15	Thermocouple (TIC-1 Sw. Pos. 1)	Thermoelectric	Minit. Bayonet	Pressurizer	Pressurizer Gas
TE-16	Thermocouple (TIC-1 Sw. Pos. 2)	Thermoelectric	Minit. Bayonet.	Heat Exch.	Pri. Ht. Ex. Coolant Outlet
TE-17	Thermocouple (TIC-1 Sw. Pos. 3)	Thermoelectric	Minit. Bayonet	Heat Exch.	Pri. Ht. Ex. Outlet
TE-4	Thermocouple (TIC-1 Sw. Pos. 4)	Thermoelectric	Minit. Bayonet	Pile Inlet	In-pile Inlet

Symbol*	Description	Manufacturer	Model	Location	Function
TE-5	Spare Thermoccuple	Thermoelectric	Minit. Bayonet	Pile Inlet	In-pile Inlet
FI-1	Integral Orif. DP Cell	Foxboro	13a	Aux. Cub.	Flow Purification Loop
	FI-1 Pneumatic Switches (2)	M-H	Pressuretrol	Aux. Cub. Panel	Purif. Loop Flow Sws.
	FI-1 Press. Gage	Foxboro		Aux. Cub. Panel	FI-1 Signal Indicator
FI-2	Rotameter and Switch	Fisher & Porter	10A1735-0A	Pri. Det. Cub.	#1 Pump Flow Indic. & Alarm
FI-3	Rotameter and Switch	Fisher & Porter	10A1735-0A	Pri. Det. Cub.	#2 Pump Indic. & Alarm
FI-4	Rotameter and Switch	Fisher & Porter	10A1735-0A	Pri. Det. Cub.	#3 Pump Indic. & Alarm
FI-5	Pos. Disp. Flowmeter	Rockwell		Aux. Cub.	Total Make-up (Inoperative)
FI-6	DP Indicator	Barton	234 0-100 WC	Pri. Detect Cub.	Heat Ex. Coolant Flow
	Flow Tube	Foster Eng. Co.	1/2" x .589" Serial 2260	Pri. Cubicle	HX Coolant
FI-7	DP Indicator	Barton	234-857 0-100 WC	Pri. Detect. Cub.	Off Gas Flow
	Flow Tube	Foster Eng. Co.	1/2" x .125" Serial 2255	Pri. Cubicle	Off Gas Flow
FI-8	DP Indicator	Barton	Serial 200-12390	Aux. Cub. Panel	Rad. Monitor Coolant
	Flow Tube	Foster Eng. Co.	3/8" x .1097 Serial	Pri. Cubicle	Rad. Monitor Coolant
FI-9	Rotameter	Brooks Co.	Size R10M 25-3	Aux. Cub. Panel	Process Water Coolant
FRC-1	Recorder (Red Pen)	Foxboro	M/6420H EC1	F-B Panel	Flow Recorder
DPE-1	DP Cell and Transmitter	Foxboro	ECI-T37	Pri. Det. Cub.	Pile Inlet DP Transmission

Not Being Used

	Symbol*	Description	Manufacturer	Model	Location	Function
Not Being Used	TA-1	Magamp	Foxboro	Type 6	F-B Panel	Amplification of DPE-1 signal
	AR-1	Magamp Relay	Sigma	Series 8000	F-B Panel	Low Flow - Alarm
	AR-2	Megamp Relay	Sigma	Series 8000	F-B Panel	Low Flow - Scram
	VS-1	Voltage Stabilizer	Sola	30885	F-B Panel	Const. Voltage Supply
	T-1	Special Transformer			F-B Panel	Signal to SR-1
	FRC-2	Recorder (Blue Pen)	Foxboro	M/6420H EC1	F-B Panel	Flow Recorder
	DPE-2	DP Cell and Transmitter	Foxboro	ECI-T37	Pri. Det. Cub.	Pile Outlet DP Transmission
	TA-2	Magamp	Foxboro	Type 6	F-B Panel	Amplification of DPE-2 Signal
	AR-3	Magamp Relay	Sigma	Series 8000	F-B Panel	Low Flow - Alarm
	AR-4	Magamp Relay	Sigma	Series 8000	F-B Panel	Low Flow - Scram
	LRC-1	Recorder	Foxboro	M/6410H EC1	F-B Panel	Pressurizer Level Recorder Alarm and Cont.
	DPE-3	DP Cell and Transmitter	Foxboro	ECI-T37	Pri. Det. Cub.	Press. Level DP Trans.
	TA-3	Magamp	Foxboro	Type 6	F-B Panel	Amplification of DPE-3 Signal
	AR-5	Magamp Relay	Sigma	Series 8000	F-B Panel	Low Press. Level Alarm
	AR-6	Magamp Relay	Sigma	Series 8000	F-B Panel	Lower Press. Level Alarm
	AR-7	Magamp Relay	Sigma	Series 8000	F-B Panel	High Press. Level Alarm
	LI-1	DP Ind. and Sw.	Barton	234-858	Pri. Det. Cub.	Press. Level Ind.

Symbol*	Description	Manufacturer	Model	Location	Function
FR-1	Stroke Counter	Veeder Root		Aux. Cub. Pan.	Indic. Total Make-up
ET1-4	Clock Driven Pot	Pgh. Eng. Products	Special	Aux. Cub. Panel	Make-up Pump running time
PRC-1	Circ. Chart Controller	M-H	SC152R(14)-(12)-(147)-(W73)-10	M-H Rack	Pressure control-saturation computer transmission
PE-1	Strain gage press. cell	C. E. C.	4-313A	Pri. Det. Cub.	Press. Trans.
TA-4	Magnetic Amplifier	M-H	701225-1	M-H Rack	Amplification of press. signal
SR-1 (Disconnected at Contacts)	Electronic Relay	M-H	SC801C1	M-H Rack	Press. Gas. Ann. Relays
SR-2 (Disconnected at Contacts)	Electronic Relay	M-H	SC801C1	M-H Rack	Loop vaporization Ann Relays
PI-1	Pressure Gage	Ashcroft	0-5000 psig	Pri. Det. Cub.	System Pressure
PI-2	Pressure Gage	Ashcroft	0-5000 psig	Aux. Cubicle	Chem Add. Bottle
PI-3	Pressure Gage	Duragage	0-3000 psig	Aux. Cubicle	Purif. Loop Press.
PI-4	Pressure Gage	Duragage	0-100 psig	Aux. Cubicle	Potable Water Pressure
PI-5	Pressure Gage			Aux. Cubicle	Make-up Pump By-pass
PA-1	Pressure Switch	Meletron	312-9SS	Pri. Det. Cub.	Ann. Loop Rupture Disc Leak on Pressurizer
PA-2	Pressure Switch	Meletron	312-9SS	Pri. Det. Cub.	Ann. In-pile Rupture Disc Leak
PA-3	Pressure Switch	Meletron	312-9SS	Pri. Det. Cub.	Alarms on H.X. Leak
PA-4	Pressure Switch	Meletron	312-9SS	Pri. Det. Cub.	Alarms on cont. valve seal leak
DPI-1	DP Indicator and Sw.	Barton	234-857	Pri. Det. Cub.	In-pile DP Indic. & Alarm

Symbol*	Description	Manufacturer	Model	Location	Function
VIA-1	Thermocouple Type	Haystings-Raydist	CP-1RU-Serial 27	Aux. Cub. Panel	Vacuum Gage
VI-1	Vacuum Gage	Kunkle	0-30	Aux. Cubicle	Vacuum Pump 8
VI-2	Vacuum Gage	Kunkle	0-30	Aux. Cubicle	Vacuum Pump 8A
RIA-1	Prop. Counter and LCRM	Hammer Elec.	N-701	Aux. Cub. Panel	Neutron Detect.
	Delayed Neutron Counter		BF-3	Aux. Cub. Panel	Neutron Detector Input
ETI-1	Clock Driven Pot	Phg. Eng. Products	Special	F-B Panel	#1 Pump Running Time
ETI-2	Clock Driven Pot	Phg. Eng. Products	Special	F-B Panel	#2 Pump Running Time
ETI-3	Clock Driven Pot	Phg. Eng. Products	Special	F-B Panel	#3 Pump Running Time
FR-4	Recorder (Red Pen)	Foxbcro		Pri. Det. Cub.	Pile Inlet Flow Recorder
FR-5	Recorder (Green)	Foxboro		Pri. Det. Cub.	Outlet Flow Recorder
DPE-4		Foxboro	13-A	Pri. Det. Cub.	Inlet Flow
DPE-5		Foxboro	13-A	Pri. Det. Cub.	Outlet Flow
PA-5	Pressure Switch		Meletron	Pri. Det. Cub.	Inlet Ann. Flow
PA-6	Pressure Switch		Meletron	Pri. Det. Cub.	Inlet Scram Flow
PA-7	Pressure Switch		Meletron	Pri. Det. Cub.	Outlet Ann. Flow
PA-8	Pressure Switch		Meletron	Pri. Det. Cub.	Outlet Scram Flow
PCA-1	Pressure Switch		Meletron	Pri. Det. Cub.	Press. Low Pressure Backup for PRC-1
PCA-2	Pressure Switch		Meletron	Pri. Det. Cub.	Press. High Pressure Heater Cut Out

Symbol*	Description	Manufacturer	Model	Location	Function
PCA-3	Pressure Switch		Meletron	Pri. Det. Cub.	Press. High Pressure Heater Cut Out
AI-1	Ammeter			Control Panel	Pump #1 Indicating 3 ϕ Current
AI-2	Ammeter			Control Panel	Pump #2 Indicating 3 ϕ Current
AI-3	Ammeter			Control Panel	Pump #3 Indicating 3 ϕ Current
AI-5	Ammeter			Control Panel	Indication Pressurizer Heater Current

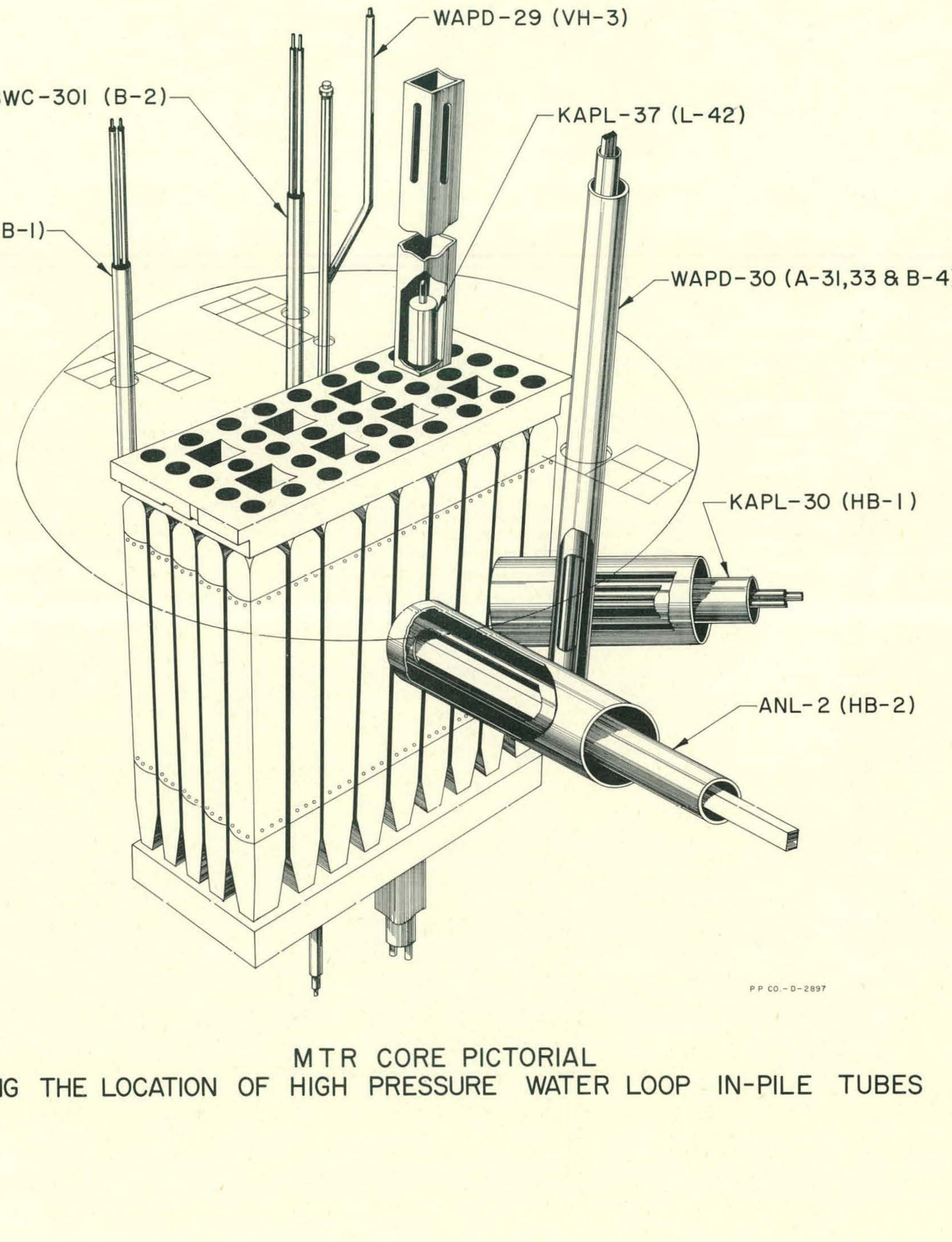
6. WCAP-4 IN-PILE TEST LOOP

ELECTRICAL COMPONENTS BILL OF MATERIAL

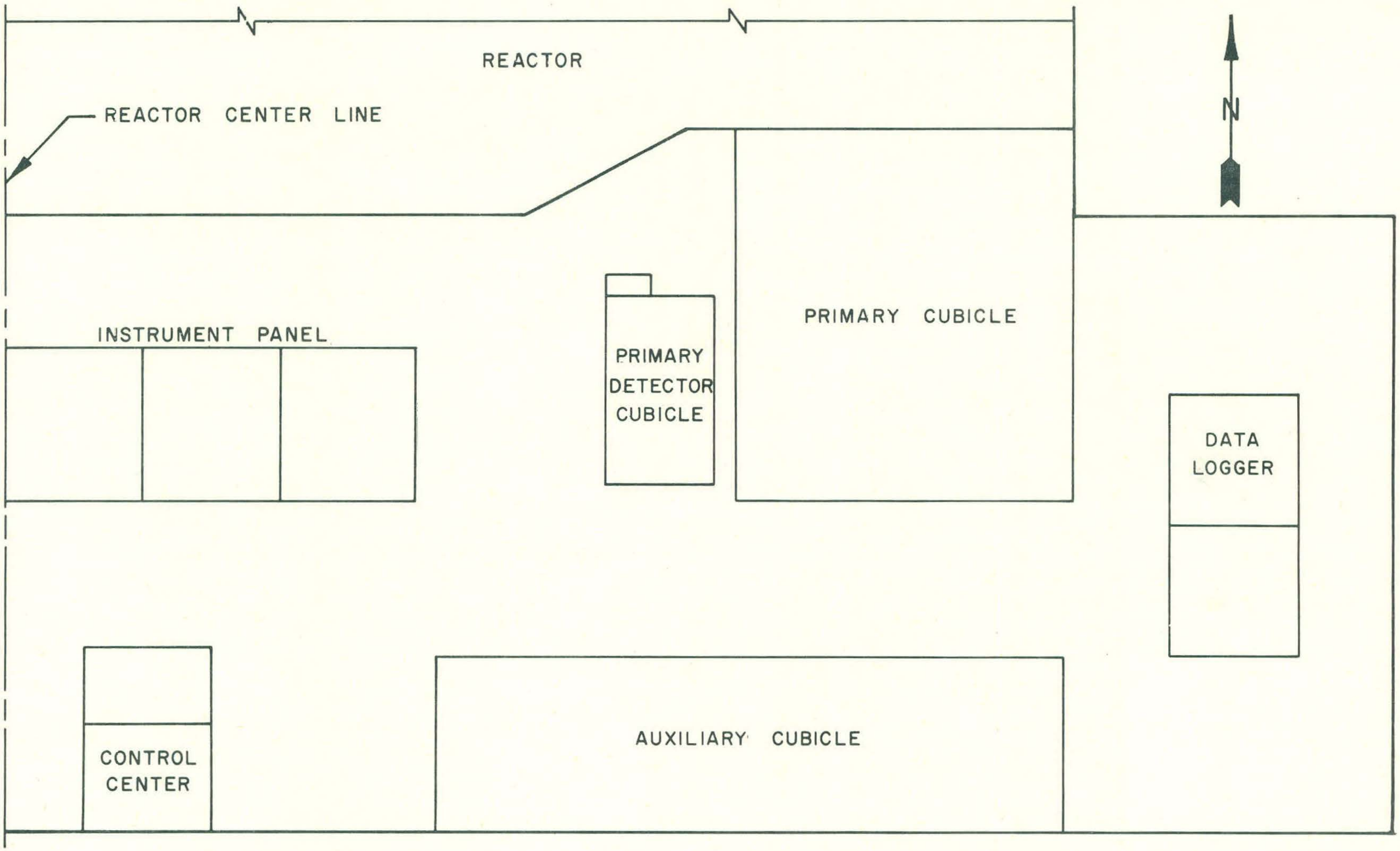
Symbol	Description	Manufacturer	Model	Location	Function
L	Plug in strip	National Electric	CF2G	M-H Rack	Utility and instrument outlet
M	Circuit breaker	Westinghouse	AB	M-H Rack	Overhead
N,P, & R	Saturable Reactors	Westinghouse	5KVA	M-H Rack	Pressurizer heater control
TA & TB	Terminal Block	General Electric	EB-5 (48 pt)	M-H Rack	Tie Points
	Wire #14		Type TA	M-H Rack	General Wiring
	Connector	Amphenal	AN-3106B-20-4S	M-H Rack	Connection to C.E.C. pressure transducer
H1	Comb Linestarter	Westinghouse	11-206 CL3	Control Center	Pressurizer heaters-Low
H2	Comb Linestarter	Westinghouse	11-206 CL3	Control Center	Pressurizer heaters-High
H3	Comb Linestarter	Westinghouse	11-206 CL3	Control Center	Line Heaters
MP1	Comb Linestarter	Westinghouse	11-206 CL1	Control Center	Make-up Pump
CP1	Comb Linestarter	Westinghouse	11-206 CL1	Control Center	Circulating Pump #1
CP2	Comb Linestarter	Westinghouse	11-206 CL1	Control Center	Circulating Pump #2
CP3	Comb Linestarter	Westinghouse	11-206 CL1	Control Center	Circulating Pump #3
2FE	Transformers	Westinghouse	3-KVA 440/220	Control Center	Pump Battery Supply
2FZ	Transformers	Westinghouse	1-3KVA 440/110	Control Center	Instrument Battery Supply
	Wire #14		Type TW	F-B Panel	

Symbol	Description	Manufacturer	Model	Location	Function
	Wire #16		Type TW	F-B Panel	
	Connector	Cannon	19 pin	F-B Panel	Interconnection of Foxboro panels
TRC1	Tel-O-Set Controller	M-H	822A1B	M-H	Reset and setpoint adjustment
J & K	Combination Filter Regulator	M-H	35849-1 with 74646	M-H	Filter and regulate pneumatic supply
S	Air Filter	M-H	353411	M-H Rack	
XA	Bulkhead Fittings	B.I.	30-PP-114 with 30-PP-39-1	M-H Rack	Pneumatic connectors
	Piping, 1/4: O.D. Poly	Imperial	Poly-Flow Fittings	M-H Rack	Pneumatic tube and connectors
	Time Transducer	Pgh. Eng. Prod.	5/3/58		Data logging make-up pump running time
	wire thermocouple	M-H	S-7008-P	M-H Rack	Extension Leadwire (T/c J)

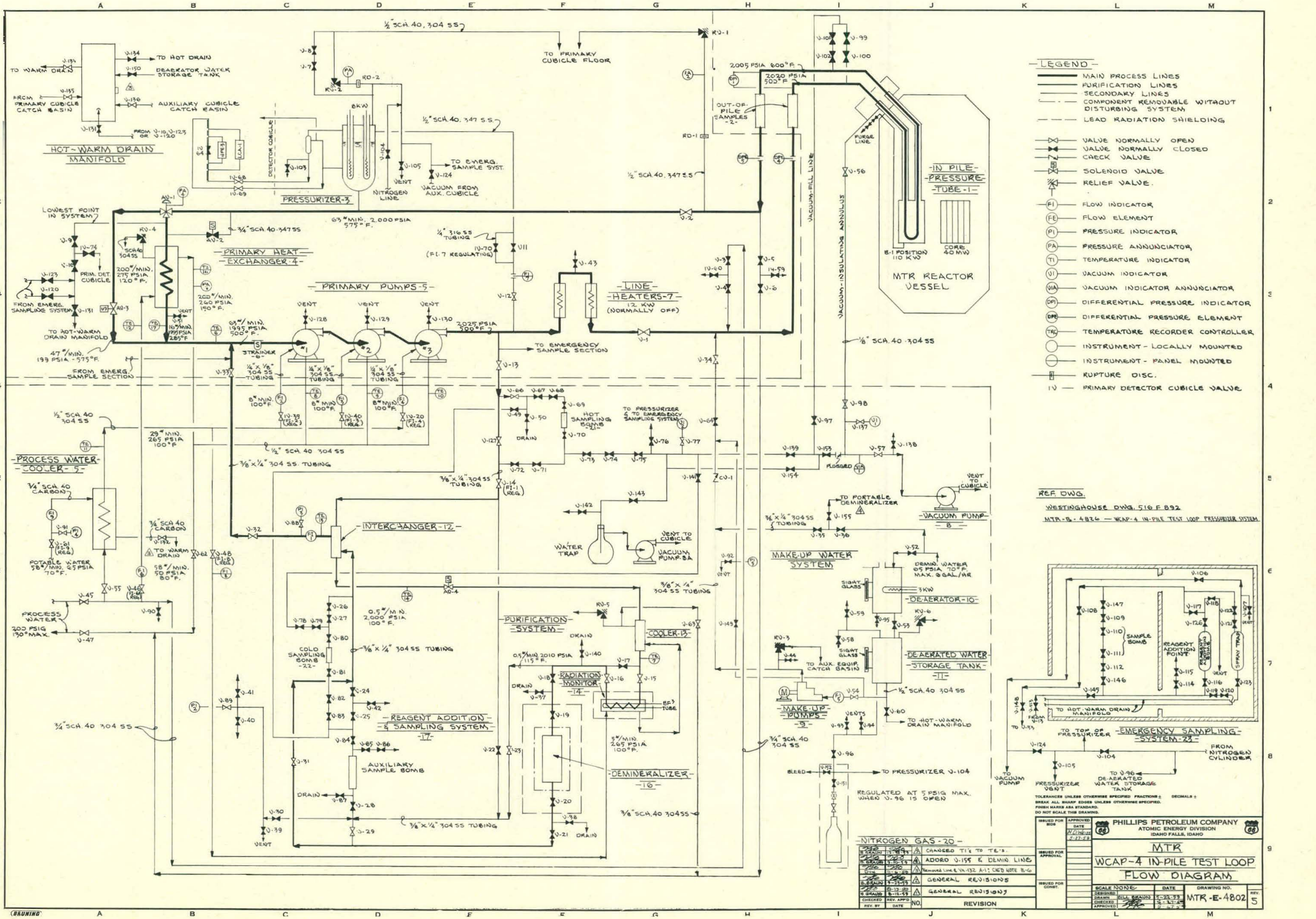
APPENDIX B

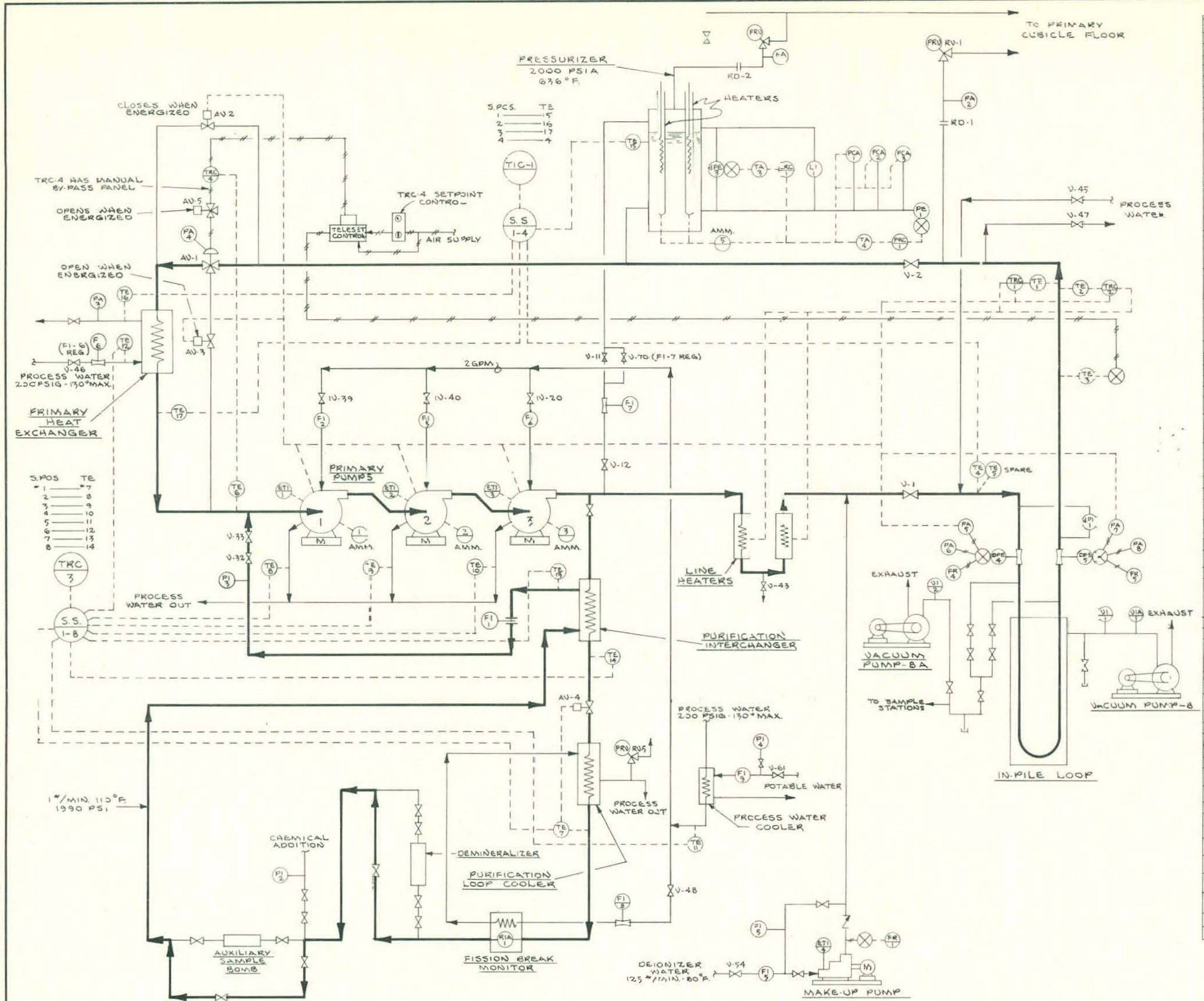


MTR CORE PICTORIAL
SHOWING THE LOCATION OF HIGH PRESSURE WATER LOOP IN-PILE TUBES



WCAP-4 IN PILE TEST LOOP CUBICLE LOCATION
(BALCONY 2nd LEVEL SOUTH)


HOT-WARM DRAIN MANIFOLD
PRESSURIZER-3
PRIMARY HEAT EXCHANGER-4
PRIMARY PUMPS-5
LINE HEATERS-7
12 KW
(NORMALLY OFF)
IN PILE PRESSURE TUBE-1
MTR REACTOR VESSEL
CORE 40 MW
B-1 POSITION 110 KW
OUT-OF-PILE SAMPLES -2-
VACUUM-FILL LINE
VACUUM-INSULATING ANNULUS
PROCESS WATER COOLER-5
INTERCHANGER-12
HOT SAMPLING BOMB -21-
VACUUM PUMP -8
VACUUM PUMP-8A
WATER TRAP
MAKE-UP WATER SYSTEM
DE-AERATOR-10
DE-AERATED WATER STORAGE TANK -11-
MAKE-UP PUMPS -9-
PURIFICATION SYSTEM
COOLER-13
RADIATION MONITOR -14-
DEMINERALIZER -16-
REAGENT ADDITION & SAMPLING SYSTEM -17-
COLD SAMPLING BOMB -22-
AUXILIARY SAMPLE BOMB
NITROGEN GAS -20-
EMERGENCY SAMPLING SYSTEM-23-
TO PRIMARY CUBICLE FLOOR
TO EMERGENCY SAMPLE SECTION
TO PORTABLE DEMINERALIZER
TO PRESSURIZER V-104
REGULATED AT 5 PSIG MAX. WHEN V-96 IS OPEN
LEGEND
MAIN PROCESS LINES
PURIFICATION LINES
SECONDARY LINES
COMPONENT REMOVABLE WITHOUT DISTURBING SYSTEM
LEAD RADIATION SHIELDING
VALVE NORMALLY OPEN
VALVE NORMALLY CLOSED
CHECK VALVE
SOLENOID VALVE
RELIEF VALVE
FLOW INDICATOR
FLOW ELEMENT
PRESSURE INDICATOR
PRESSURE ANNUNCIATOR
TEMPERATURE INDICATOR
VACUUM INDICATOR
VACUUM INDICATOR ANNUNCIATOR
DIFFERENTIAL PRESSURE INDICATOR
DIFFERENTIAL PRESSURE ELEMENT
TEMPERATURE RECORDER CONTROLLER
INSTRUMENT - LOCALLY MOUNTED
INSTRUMENT - PANEL MOUNTED
RUPTURE DISC.
IV — PRIMARY DETECTOR CUBICLE VALVE
REF. DWG.
WESTINGHOUSE DWG. 516 F 892
MTR-B-4826 — WCAP-4 IN-PILE TEST LOOP PRESSURIZER SYSTEM
REVISION
CHANGED TI'S TO TE'S.
ADDED V-155 & DEMIN. LINE
GENERAL REVISIONS
GENERAL REVISIONS
PHILLIPS PETROLEUM COMPANY
ATOMIC ENERGY DIVISION
IDAHO FALLS, IDAHO
MTR
WCAP-4 IN-PILE TEST LOOP
FLOW DIAGRAM
SCALE NONE
DRAWING NO.
MTR-E-4802
REV. 5



INSTRUMENTS

SYMBOL	LOCATION	FUNCTION	MODE	RANGE	SETTING	DESCRIPTION
— TEMPERATURE —						
TICI-2	HEAT EX.	IND. TEMP. OF COOLANT OUTLET	ELECTRIC	0-800°F.	~	THERMOCOUPLE
TICI-3	HEAT EX.	IND. TEMP. OF EX. OUTLET	ELECTRIC	0-800°F.	~	THERMOCOUPLE
TRC3-2	CIRC. PUMP #1	IND. TEMP. OF COOLANT OUTLET	ELECTRIC	0-150°F.	~	THERMOCOUPLE
TRC3-3	CIRC. PUMP #2	IND. TEMP. OF COOLANT OUTLET	ELECTRIC	0-150°F.	~	THERMOCOUPLE
TRC3-4	CIRC. PUMP #3	IND. TEMP. OF COOLANT OUTLET	ELECTRIC	0-150°F.	~	THERMOCOUPLE
TICI-4	IN-PILE LOOP	IND. TEMP. OF LOOP INLET	ELECTRIC	0-800°F.	~	THERMOCOUPLE
TRC3-5	PROCESS WATER COOLER OUTLET	IND. TEMP. OF PROCESS WATER	ELECTRIC	0-150°F.		THERMOCOUPLE
TRC-1	IN-PILE OUTLET	RECORDS LOOP OUTLET TEMP. - LOOP HEATERS ON BELOW 525°F. - CLOSES EMERG. BY-PASS VALVES & ANNUN. ON HIGH TEMP. - SCRAMS & ANNUN. ON HIGHER TEMP.	ELECTRIC	300-800°F.	610°F. 620°F. 525°F.	RECORDER WITH 2 UL SW., 1 LL SW.
TRC-2	IN-PILE OUTLET	SAME AS TRC1	ELECTRIC	300-800°F.	610°F. 620 & 500°F.	SAME AS TRC-1
TRC3-1	PURIFICATION LOOP	RECORDS PURIFICATION LOOP TEMP. - CLOSES PURIFICATION COOLER INCOMING LINE VALVE & ANNUN. ON HIGH TEMP.	ELECTRIC	0-150°F.	140°F.	MINIATURE RECORDER WITH UL SW. & THERMOCOUPLE SEL. SW.
TRC-4	HEAT EXCHANGER	RECORDS & CONTROLS MIXED FLOW OUTLET TEMP. PER SET POINT OF IN-PILE LOOP OUTLET TEMP.	PNEUMATIC	200-700°F.	DEPENDENT ON TRC-1 & TRC-2 READINGS	PNEUMATIC CONTROLLER WITH THERMOCOUPLE INPUT.
TICI-1	PRESSURIZER	IND. PRESSURIZER TEMPERATURE	ELECTRIC	0-800°F.		INDICATOR WITH RETRANSMITTING SLIDE WIRE & THERM. SEL. SW.
TRC3-6	HEAT EX. COOLANT INLET	RECORDS PROCESS WATER TEMP. INTO HEAT EX.	ELECTRIC	0-150°F.	~	THERMOCOUPLE
TE-3	IN-PILE OUTLET	CONTROLS SET POINT OF TRC 4	ELECTRIC PNEUMATIC	200-700°F.	~	THERMOCOUPLE WITH PNEUMATIC OUTPUT
TE-6	HEAT EX.	TRC4 SENSING ELEMENT	ELECTRIC	200-700°F.	~	THERMOCOUPLE
TRC3-7	PURIF. INTER.	IND. TEMP. OF RETURN FLOW	ELECTRIC	0-150°F.	~	THEMOCOUPLE
TRC3-8	PURIF. INTER.	IND. TEMP. OF INLET	ELECTRIC	0-150°F.	~	THEMOCOUPLE
— FLOW —						
FI-1	DEIONIZER	IND. DEIONIZER FLOW	DIRECT	0-2#/MIN.	6.9(.083GPM)	INTEGRAL ORIFICE D/P CELL
FI-2	CIRC. PUMP #1	IND. COOLANT FLOW	DIRECT	0-2 GPM	.45 GPM 1¼ GPM	ROTOMETER WITH UL & LL SW.
FI-3	CIRC. PUMP #2	IND. COOLANT FLOW	DIRECT	0-2GPM	.45 GPM 1¼ GPM	ROTOMETER WITH UL & LL SW.
FI-4	CIRC. PUMP #3	IND. COOLANT FLOW	DIRECT	0-2GPM	.45 GPM 1¼ GPM	ROTOMETER WITH UL & LL SW.
FI-5	MAKE-UP PUMP	IND MAKE-UP PUMP FLOW	DIRECT			(INOPERATIVE) POSITIVE DISPLACEMENT F.M.
FI-6	HEAT EX.	IND. COOLANT FLOW THRU HX.	DIRECT		0-20 GPM 0-30 GPM	GENTILE FLOW TUBE WITH UL & LL SW.
FI-7	PRESSURIZER	IND. PRESSURIZER OFF GAS FLOW	DIRECT			GENTILE FLOW TUBE
FI-8	LOOP COOLER	IND. COOLANT FLOW	DIRECT			GENTILE FLOW TUBE
FR-4 (RED PEN)	IN-PILE INLET	RECORDS FLOW	PNEUMATIC			RECORDER WITH MELETRON PRESS. SWITCHES PA5 & PA6
FR-5 (GREEN PEN)	IN-PILE OUTLET	SAME AS FR-4	PNEUMATIC			RECORDER WITH MELETRON PRESS. SWITCHES PA7 & PA8
FR-1	MAKE-UP PUMP	RECORDS MAKE-UP PUMP STROKES	ELECTRIC	6 DIGITS		ELECTRIC REVOLUTION COUNTER
FI-9	PROCESS WATER COOLER	IND. FLOW OF COOLANT	DIRECT			ROTOMETER
— LEVEL —						
LRC-1	PRESSURIZER	RECORDS LEVEL - ACTUATES MAKE-UP PUMP & ANNUN. ON LOW LEVEL - KEEPS HTRS OFF AT LOWER LEVEL. DEACTIVATES MAKE-UP PUMP & ANN. AT HI LEVEL	ELECTRIC	0-50 IN. H_2O	15 IN. H_2O 12 IN. H_2O 27.5 IN. H_2O	RECORDER - CONTROLLER WITH UL SW. & 2 LL SW.
LI-1	PRESSURIZER	LEVEL INDICATOR	DIRECT	0-50 IN. H_2O		D/P CELL
— PRESSURIZER —						
PRC-1	PRESSURIZER	RECORDS PRESSURE - SHUTS OFF HTRS. & ANN. ON HIGH PRESSURE - ACTUATES HTRS. ON LOW PRESSURE. FSB ON LOW LOW PRESSURE	ELECTRIC	0-2500 PSI	2050 1900 1800	RECORDER WITH UL SW., 2 LL SW. PCA-2 & 3, SSB @ 2200 PSIG - ON PRC-1
PCA-1	PRESSURIZER	LOW PRESS. BACKUP FOR PRC-1				
PI-1 THRU PI-5		IND. MISC. PRESSURES	DIRECT	MISC.		PRESSURE GAGES
PE-1	PRESSURIZER	RETRANSMITS PRESSURIZER PRESSURE	ELECTRIC	0-2500 PSI	~	PRESSURE CELL
PA-1	PRESSURIZER	ANN. LEAK IN BURST DIAPHRAM	DIRECT	0-3750 PSI	400 PSI	PRESSURE SW.
PA-2	IN-PILE LOOP	SAME AS PA-1	DIRECT	0-3750 PSI	400 PSI	PRESSURE SW.
PA-3	HEAT EX.	ANN. LEAK IN HEAT EX.	DIRECT	0-3750 PSI	400 PSI	PRESSURE SW.
PA-4	HEAT EX.	ANN. LEAK IN HEAT EX. VALVE	DIRECT	0-3750 PSI	400 PSI	PRESSURE SW.
— MISCELLANEOUS —						
DPI-1	IN-PILE LOOP	IND. IN-PILE LOOP D.P. ANN. OUT OF RANGE	DIRECT	0-30 IN. H_2O	8 PSIG 30 PSIG	DP INDICATOR WITH UL & LL SW.
DPE-4	IN-PILE INLET	RETRANSMITS FLOW DP	PNEUMATIC	0-50 IN. H_2O		GENTILE FLOW TUBE WITH DP CELL
DPE-5	IN-PILE OUTLET	SAME AS DPE-4	PNEUMATIC	0-50 IN. H_2O		SAME AS DPE-4
DPE-3	PRESSURIZER	RETRANSMITS LEVEL DP	ELECTRIC	0-50 IN. H_2O		DP CELL
VIA-1	IN-PILE LOOP	IND. VACUUM & ANN. LEAK	ELECTRIC	0.1-20 mm Hg.	10 mm. Hg.	THERMO VACUUM GAGE
RIA-1	DEIONIZER	ANN. FISSION BREAK & SHUTS OFF PURIFICATION LOOP FLOW	ELECTRIC		10% ABOVE BKGD.	BF-3 INSTR. INPUT LCRM MTR RY OUTPUT
AI-1 ETI-1	CIRC. PUMP #1	IND. 3 ø CURRENT IND. ELAPSED RUNNING TIME	ELECTRIC	0-5 AMPS		AMMETER ELAPSED TIME METER
AI-2 ETI-2	CIRC. PUMP #2	IND. 3 ø CURRENT IND. ELAPSED RUNNING TIME	ELECTRIC	0-5 AMPS		AMMETER ELAPSED TIME METER
AI-3 ETI-3	CIRC. PUMP #3	IND. 3 ø CURRENT IND. ELAPSED RUNNING TIME	ELECTRIC	0-5 AMPS		AMMETER ELAPSED TIME METER
ETI-4	MAKE-UP PUMP	IND. ELAPSED RUNNING TIME	ELECTRIC			ELAPSED TIME METER
AI-5	PRESSURIZER	IND. 3 ø CURRENT OF HEATERS	ELECTRIC	0-40 AMPS		AMMETER

NOTE

REDRAWN FROM WESTINGHOUSE DWG.-516F896

TOLERANCES UNLESS OTHERWISE SPECIFIED FRACTIONS ± DECIMALS ±
BREAK ALL SHARP EDGES UNLESS OTHERWISE SPECIFIED.
FINISH MARKS ASA STANDARD.
DO NOT SCALE THIS DRAWING.

PHILLIPS PETROLEUM COMPANY
ATOMIC ENERGY DIVISION
IDAHO FALLS, IDAHO

MTR
WCAP #4 INPILE TEST LOOP
INSTRUMENTATION DIAGRAM

B. BRAUN	3-21-60	1	GENERAL REVISIONS
CHECKED / REV. BY	REV. APP'D / DATE	NO.	REVISION

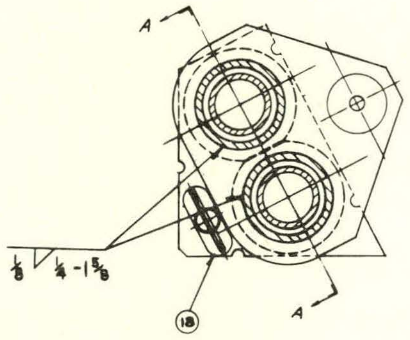
ISSUED FOR BIDS — APPROVED DATE 3-21-60
ISSUED FOR APPROVAL
ISSUED FOR CONST.

SCALE NONE — DRAWN BILL BRAUN 1-18-60 — CHECKED/APPROVED 3-22-60
DRAWING NO. MTR-E-4966 — REV. 1

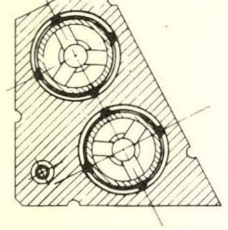
Item	Description & Material Dimensions in Inches	Patt. No. or Ref. Dwg.	Qty
1	TEST SAMPLE BLOCK	IT. 1 414C486	1
2	TOP PLATE	IT. 1 296B177	1
3	BOTTOM PLATE	IT. 1 296B176	1
4	INLET PRESSURE TUBE	GR. 1 414C496	1
5	INLET JACKET ASSY	GR. 1 548D882	1
6	OUTLET PRESSURE TUBE	GR. 1 414C495	1
7	OUTLET JACKET ASSY	GR. 1 548D883	1
8	SPRING	IT. 8 185A003	2
9	TUBE	IT. 1 296B195	2
A 10	TEST SAMPLE	GR. 2 414C480	1
11	ADAPTER	IT. 1 185A258	3
12	ADAPTER ASSY.	GR. 1 296B174	2
13	ELBOW ASSY.	GR. 1 296B175	1
A 14	TEST SAMPLE	GR. 1 414C480	1
A 15	TEST SAMPLE	GR. 1 548D046	1
16	GUIDE PLATE	GR. 1 296B347	1
17	LIFTING PIN	IT. 1 296B222	1
B 18	FLUX MONITOR	GR. 1 296B368	1

TITLE WCAP-4 TEST LOOP
TEST SAMPLE BLOCK ASSEMBLY
DWG. 646J521
SUB. 2345678

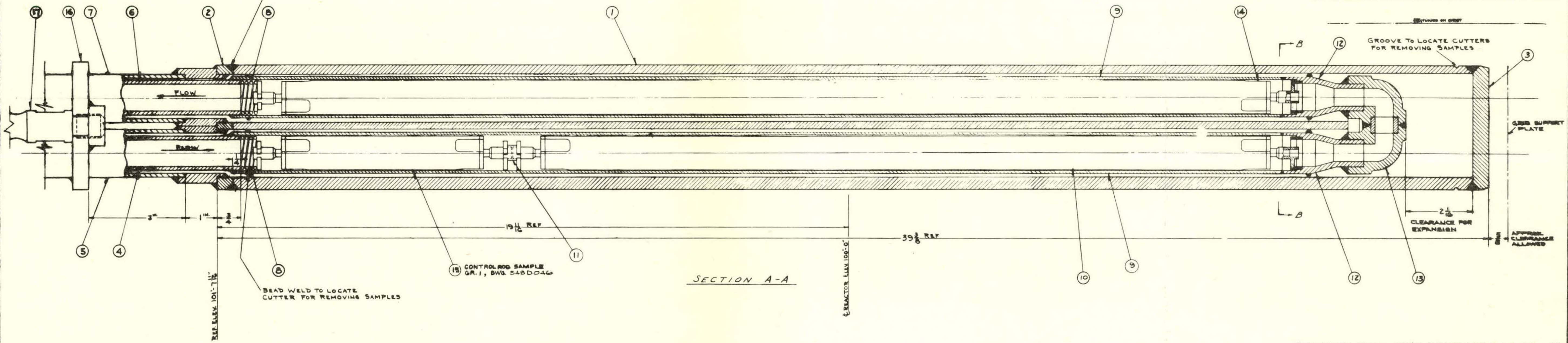
A. SUPPLIED BY WESTINGHOUSE
B. TO BE SUPPLIED BY WESTINGHOUSE FOR USE AT M.T.R.



TOP VIEW



SECTION B-B



SECTION A-A

RECOMMENDED ASSEMBLY PROCEEDURE

1. WELD ITEMS 12 AND 13 TOGETHER
2. WELD ITEM 9 TO 12 AND 13
3. INSERT ITEMS 10, 11, 14, & 15 INTO ITEM 9 EXERCISING CARE TO LOCATE ENDS OF ITEMS 10 AND 14 INTO SLOTS IN ITEM 12
4. INSERT ITEM 8 INTO ITEM 9
5. WELD ITEMS 4 AND 6 TO ITEM 9
6. INSERT ASSEMBLED PARTS INTO ITEM 1 FROM BOTTOM
7. WELD ITEM 7 TO ITEM 2 AND ITEM 5 TO ITEM 2
8. WELD ITEMS ASSEMBLED IN STEP 7 TO ITEM 1

PRESSURE TUBE ASS'Y. (ITEMS 4-6-8-9-10-11-12-13-14-15)
DESIGN PRESSURE - 2500 P.S.I.
DESIGN TEMP. - 650° F
HYDROSTATIC TEST ITS. 4, 6, 9, 12 & 13 TO 4500 P.S.I. BEFORE INSERTING ITS. 10, 14, 15

VESSEL TO BE MADE IN ACCORDANCE WITH THE A.S.M.E. CODE FOR UNFIRED PRESSURE VESSELS.

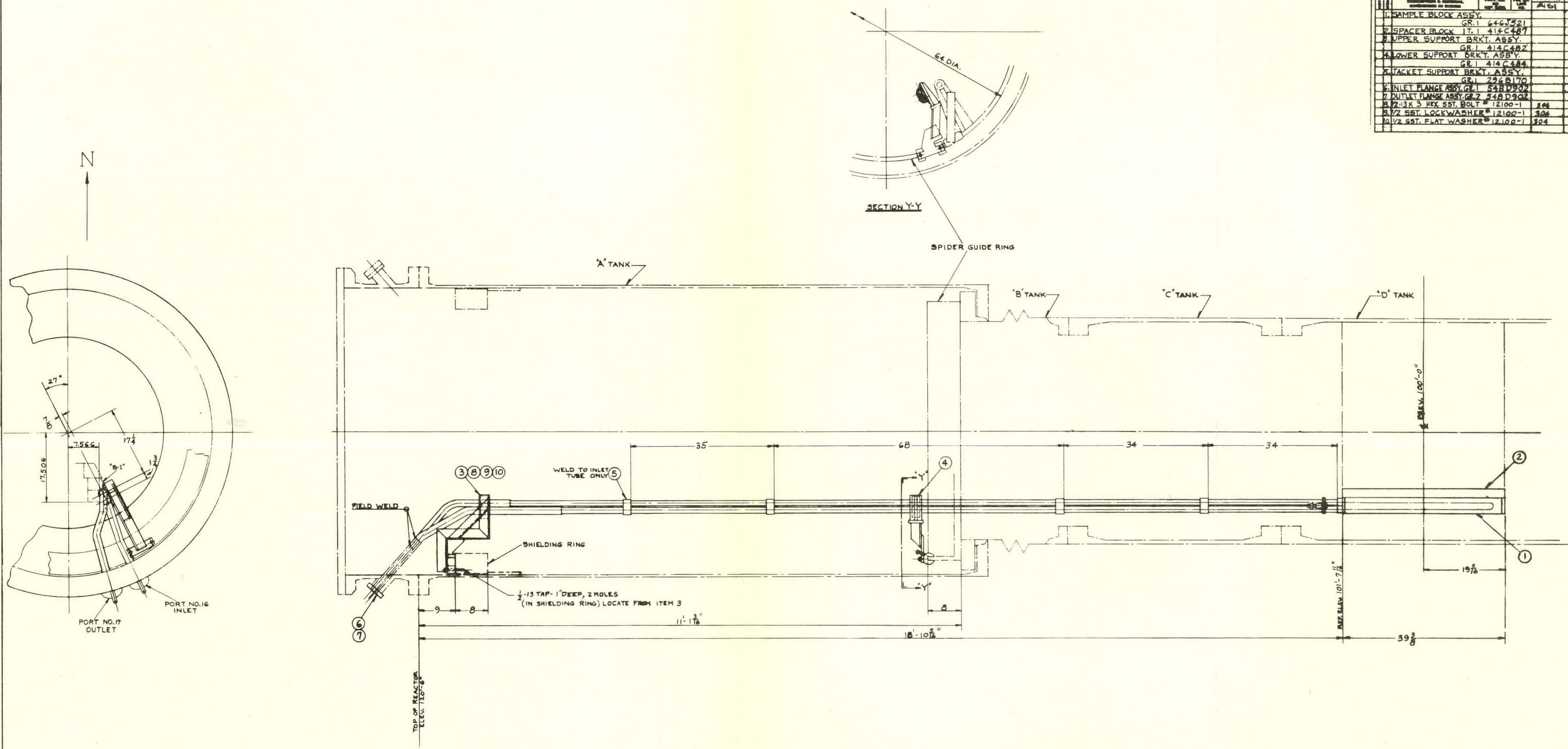
PENETRENT DYE TEST	PROC. SPEC. - AP 292187
HYDROSTATIC TEST	PROC. SPEC. - AP 291995-7
PARTIAL RADIOGRAPH	PROC. SPEC. AP 292253
CLEANING	PROC. SPEC. AP 291995-9
WELDING	PROC. SPEC. AP 292252

JACKET ASSEMBLY (ITEMS 1-2-3-5-7-16 & 17)
DESIGN PRESSURE - 100 P.S.I.
DESIGN TEMP. - 150° F
TEST PRESSURE - 150 P.S.I.

WESTINGHOUSE ELECTRIC CORPORATION
TITLE WCAP-4 TEST LOOP
TEST SAMPLE BLOCK ASSEMBLY
DIMENSIONS IN INCHES - SCALE N.T.S.
DIV. & PLANT LOCATION ATOMIC POWER DEPT. PITTSBURGH, PA. U.S.A.
646J521

WCAP-4 TEST LOOP		
INPILE TUBE ASSEMBLY		
646J489		CONV. NO.

Item	Description	Material	Qty
1.	SAMPLE BLOCK ASSY. GR. 1 646J521		1
2.	SPACER BLOCK IT. 1 414C487		1
3.	UPPER SUPPORT BRKT. ASSY. GR. 1 414C482		1
4.	LOWER SUPPORT BRKT. ASS'Y. GR. 1 414C484		1
5.	JACKET SUPPORT BRKT. ASSY. GR. 1 296B170		4
6.	INLET FLANGE ASSY. GR. 1 548D902		1
7.	OUTLET FLANGE ASSY. GR. 2 548D902		1
8.	1/2-13 X 3 HEX. SST. BOLT # 12100-1	304	2
9.	1/2 SST. LOCKWASHER # 12100-1	304	2
10.	1/2 SST. FLAT WASHER # 12100-1	304	2



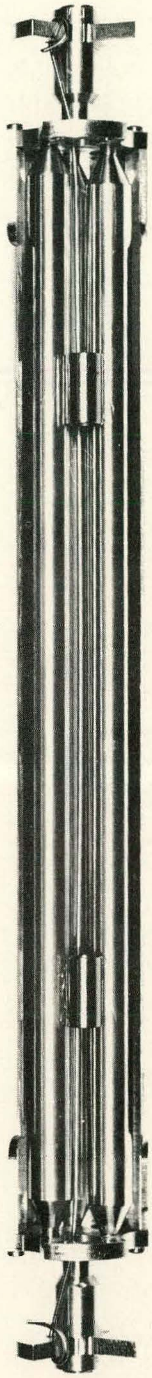
1	2-Y80-811-1 / 602429-3
IT.	CHANGE

WESTINGHOUSE ELECTRIC CORPORATION

TITLE WCAP-4 TEST LOOP
INPILE TUBE ASSEMBLY

DIMENSIONS IN INCHES-SCALE
DFTM. D. BUSH
APPD.
APPD.
CHKD.
APPD.
DIV. & PLANT LOCATION

646J489

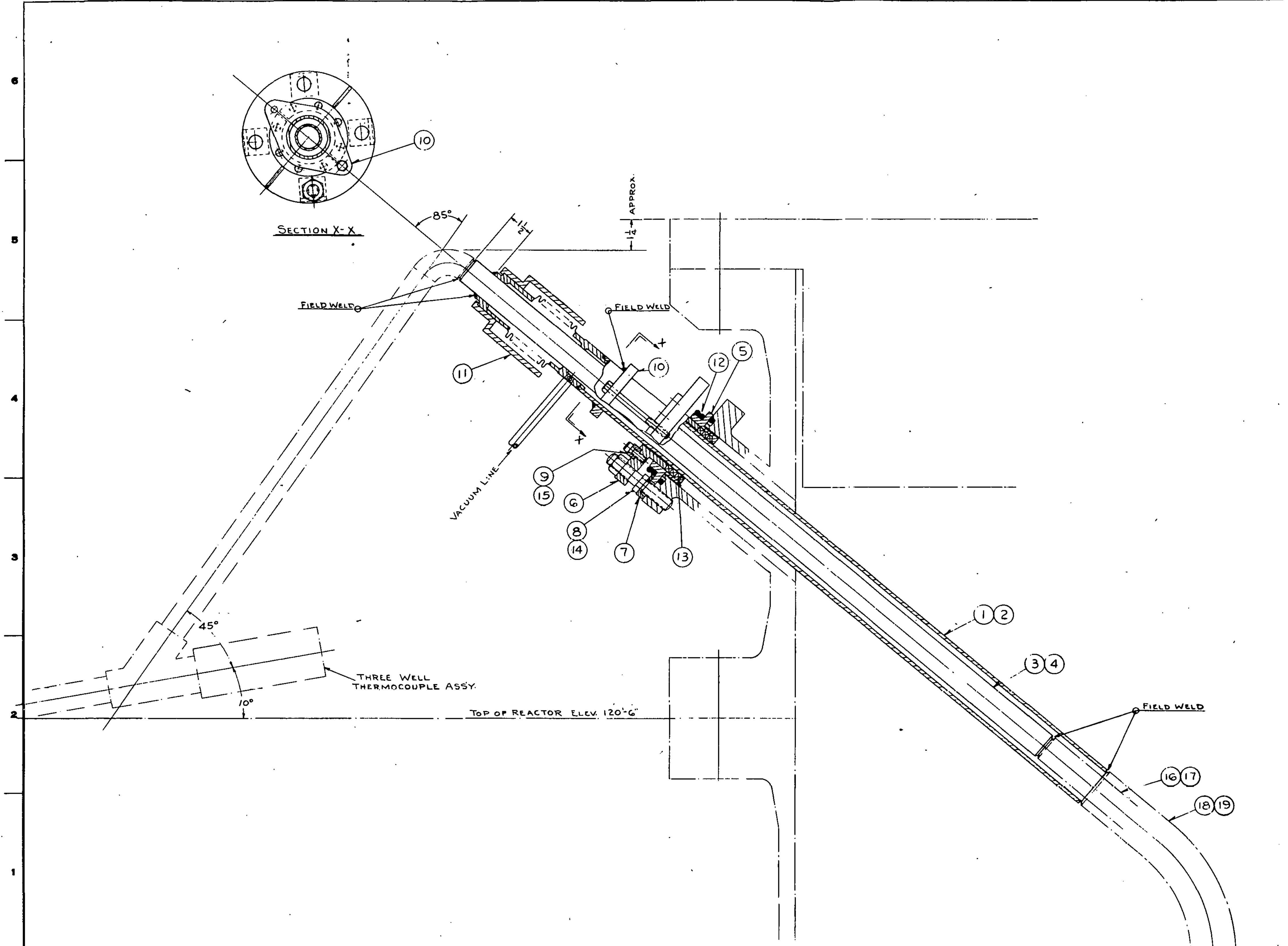


WCAP-4 Loop Fuel Element Test Sample

TITLE WCAP-4 TEST LOOP
INLET & OUTLET FLANGE ASSEMBLY

VDR	ITEM	DESCRIPTION & MATERIAL DIMENSIONS IN INCHES / PATT. NO. OR REF. DWG.	CONV. NO.	1	2	3	4	5	6
	1	INLET JACKET ASSY. GR. 1 414C527		1					
	2	OUTLET JACKET ASSY. GR. 2 414C527			1				
	3	INLET PIPE FR. 34" OF 3/4 SCHED. 40							
		SEAMLESS S.ST. PIPE #9941-1	347	1					
	4	OUTLET PIPE FR. 32" OF 3/4 SCHED 40							
		SEAMLESS S.ST. PIPE #9941-1	347		1				
	5	PACKING BOX IT. 1 296B201		1	1				
	6	PACKING GLAND IT. 1 296B200		1	1				
	7	CLAMP IT. 1 195 A 316		4	4				
	8	STUD IT. 1 296 B 218		4	4				
	9	LOCKING RING IT. 1 296 B 217		1	1				
	10	FLANGE IT. 1 296 B 219		1	1				
	11	BELLOWS COVER IT. 1 296 B 220		1	1				
A	12	"O" RING No. 1820-38 2 1/4 I.D. x 3 1/8 O.D.		3	3				
B	13	ASBESTOS PACKING - MOGUL #223							
		1 3/4 I.D. x 1/4 SQ.		3	3				
	14	1/2-13 HEX. S.ST NUT 12100-1		4	4				
	15	1/4-20 x 3/4 S.ST SCKT. HD. CAP SCR. 12100-1		8	8				
	16	INLET PRESSURE TUBE GR. 1 414C496		REF					
	17	OUTLET PRESSURE TUBE GR. 1 414C495			REF				
	18	INLET JACKET GR. 1 548D882		REF					
	19	OUTLET JACKET GR. 1 548D883			REF				

A. B.O. FROM LINEAR INC. PHILA. PENNA.
B. B.O. FROM JOHNS-MANVILLE CO.

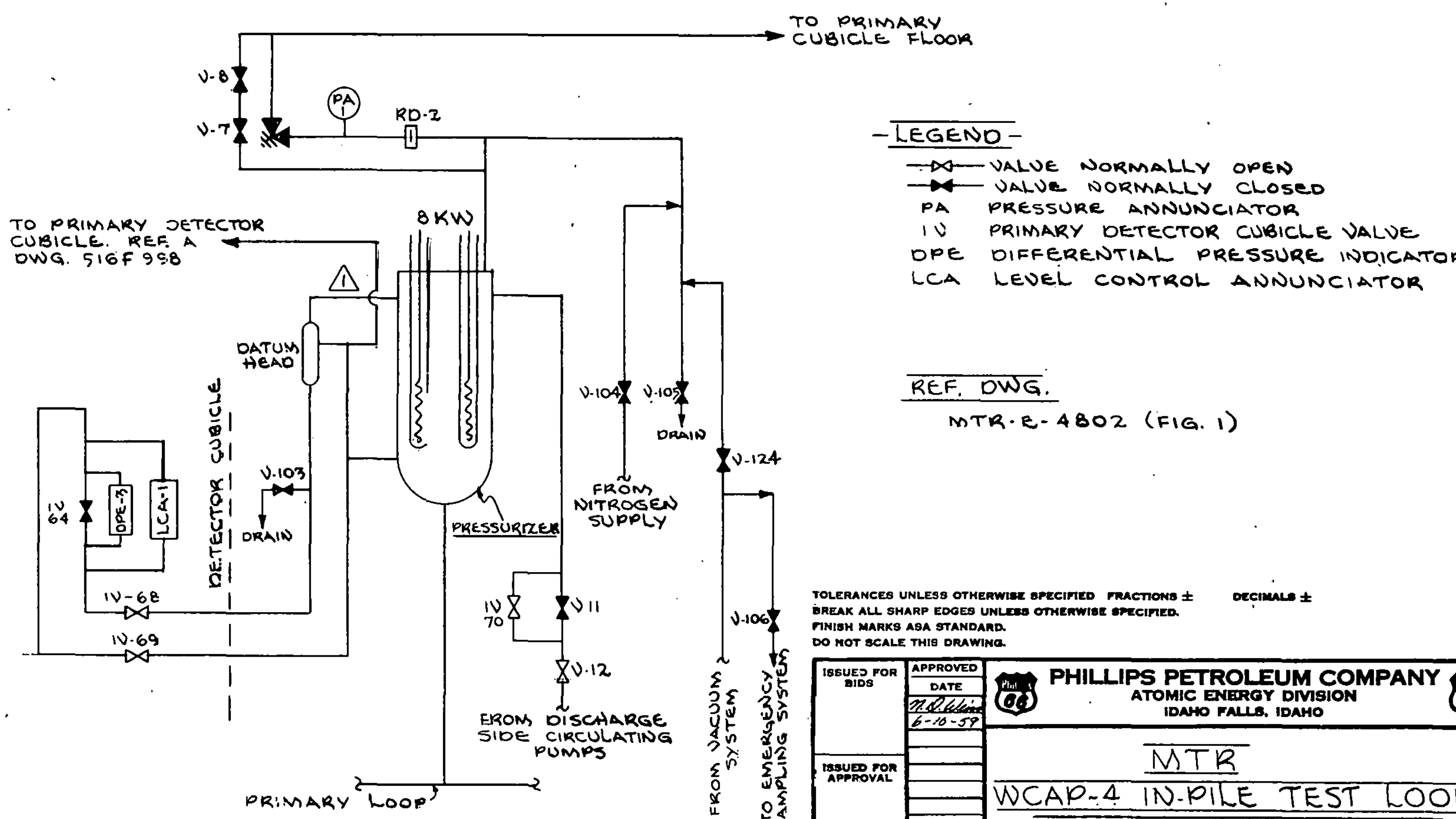


WESTINGHOUSE ELECTRIC CORPORATION

TITLE WCAP-4 TEST LOOP
INLET & OUTLET FLANGE ASSEMBLY
DIMENSIONS IN INCHES - SCALE NTS
DFTM V. SHORT
DIV. & PLANT LOCATION ATOMIC POWER DEPT.
PITTSBURGH, PA., U.S.A.

548D902

Fig. 8 - In-Pile Tube Inlet and Outlet Flange Assembly



TOLERANCES UNLESS OTHERWISE SPECIFIED FRACTIONS ± DECIMALS ±
BREAK ALL SHARP EDGES UNLESS OTHERWISE SPECIFIED.
FINISH MARKS ASA STANDARD.
DO NOT SCALE THIS DRAWING.

ISSUED FOR BIDS	APPROVED DATE 6-10-59
ISSUED FOR APPROVAL	
ISSUED FOR CONST.	

PHILLIPS PETROLEUM COMPANY
ATOMIC ENERGY DIVISION
IDAHO FALLS, IDAHO

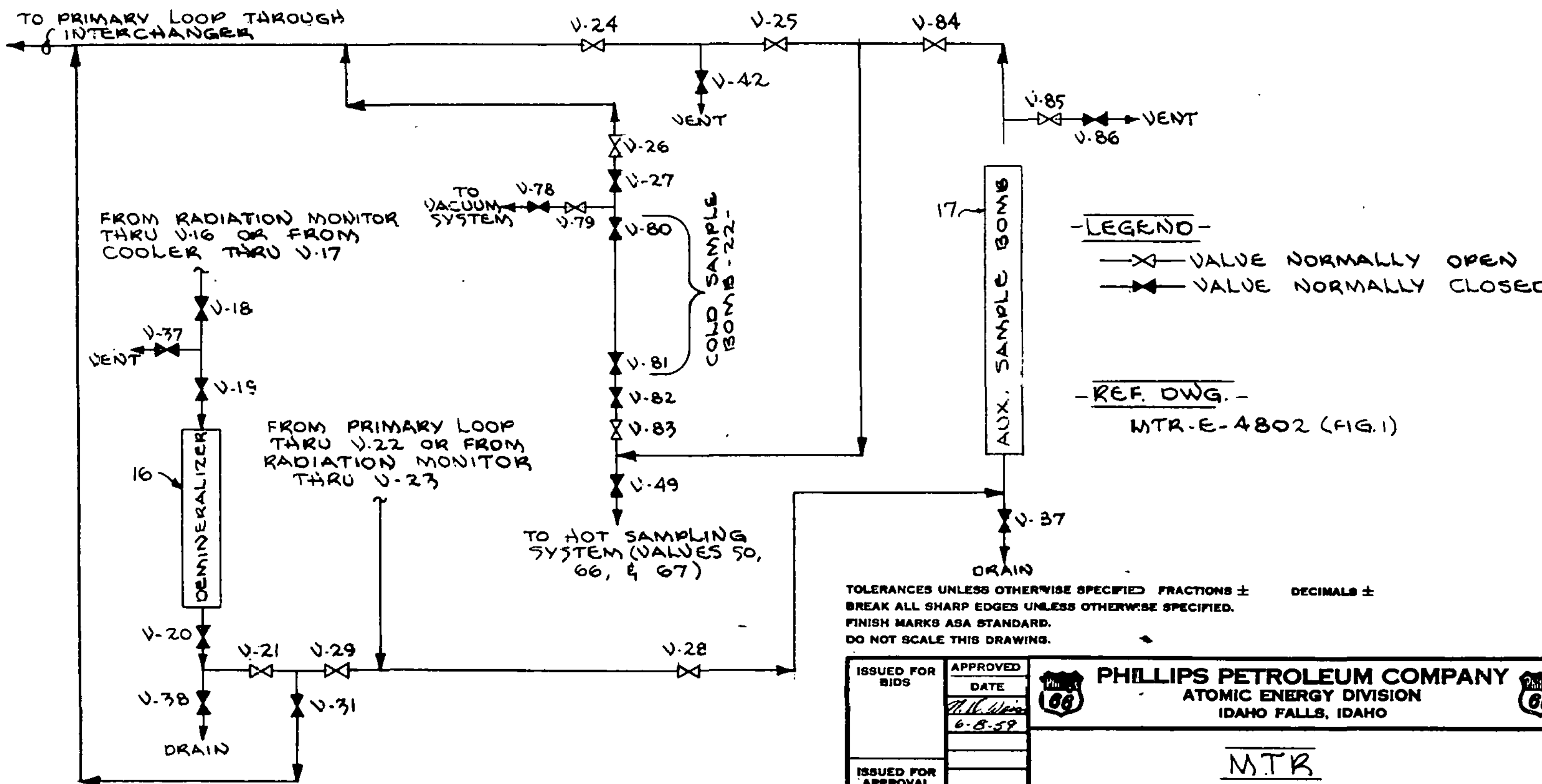
MTR
WCAP-4 IN-PILE TEST LOOP
PRESSURIZER SYSTEM

	DATE
SCALE NONE	
DESIGNED	
DRAWN BILL BRAUN	6-5-59
CHECKED	6-10-59
APPROVED	6-10-59

DRAWING NO. MTR-B-4826 REV. 1

REV. BY	DATE	NO.	REVISION
J. Roland	3-30-60	1	REMOVED VALVE V-144
CHECKED	REV. APP'D		

(BRUNING)



TOLERANCES UNLESS OTHERWISE SPECIFIED FRACTIONS ± DECIMALS ±
BREAK ALL SHARP EDGES UNLESS OTHERWISE SPECIFIED.
FINISH MARKS ASA STANDARD.
DO NOT SCALE THIS DRAWING.

ISSUED FOR	APPROVED / DATE
BIDS	M. K. Weis 6-8-59
APPROVAL	
CONST.	

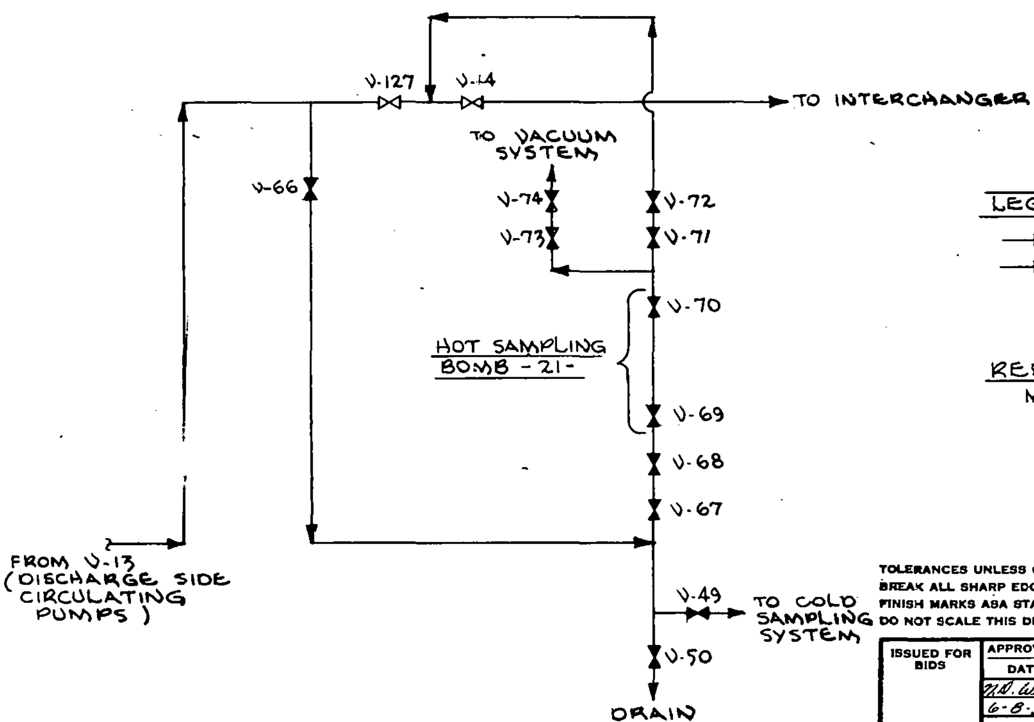
PHILLIPS PETROLEUM COMPANY
ATOMIC ENERGY DIVISION
IDAHO FALLS, IDAHO

MTR
WCAP-4 IN-PILE TEST LOOP
COLD SAMPLING SYSTEM

SCALE NONE		DATE	DRAWING NO.	REV.
DESIGNED			MTR-B-4827	
DRAWN	BIL BRAUN	6-5-59		
CHECKED		6-10-59		
APPROVED		6-10-59		

CHECKED	REV. APP'D	NO.	REVISION
REV. BY	DATE		

BRUNING



LEGEND
- NORMALLY OPEN VALVE
- NORMALLY CLOSED VALVE

REF. DWG.
MTR-E-4802 (FIG. 1)

TOLERANCES UNLESS OTHERWISE SPECIFIED FRACTIONS ± DECIMALS ±
BREAK ALL SHARP EDGES UNLESS OTHERWISE SPECIFIED.
FINISH MARKS ASA STANDARD.
DO NOT SCALE THIS DRAWING.

CHECKED / REV. BY	REV. APP'D / DATE	NO.	REVISION

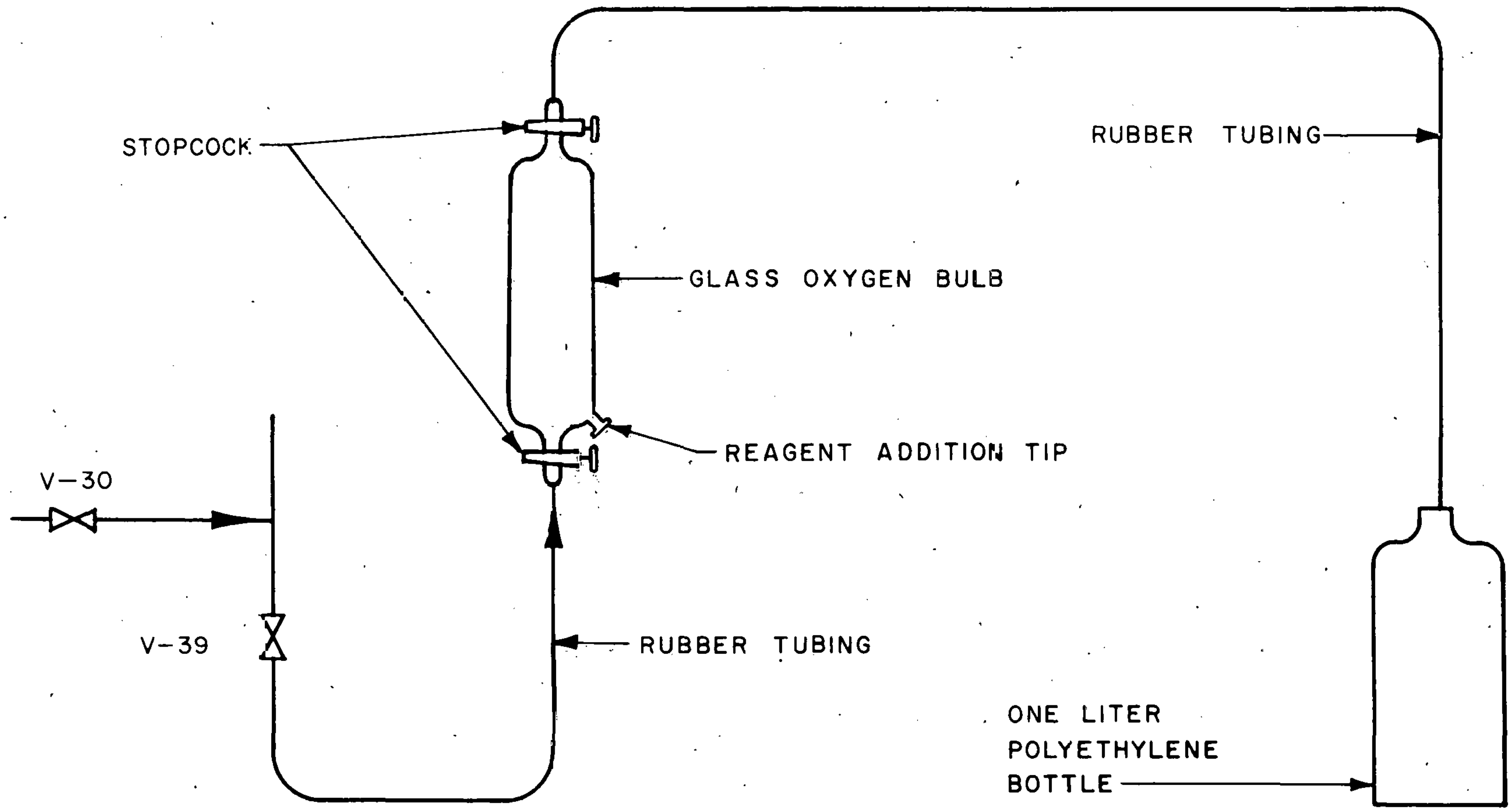
	APPROVED / DATE
ISSUED FOR BIDS	N.D. Wea... 6-8-59
ISSUED FOR APPROVAL	
ISSUED FOR CONST.	

PHILLIPS PETROLEUM COMPANY
ATOMIC ENERGY DIVISION
IDAHO FALLS, IDAHO

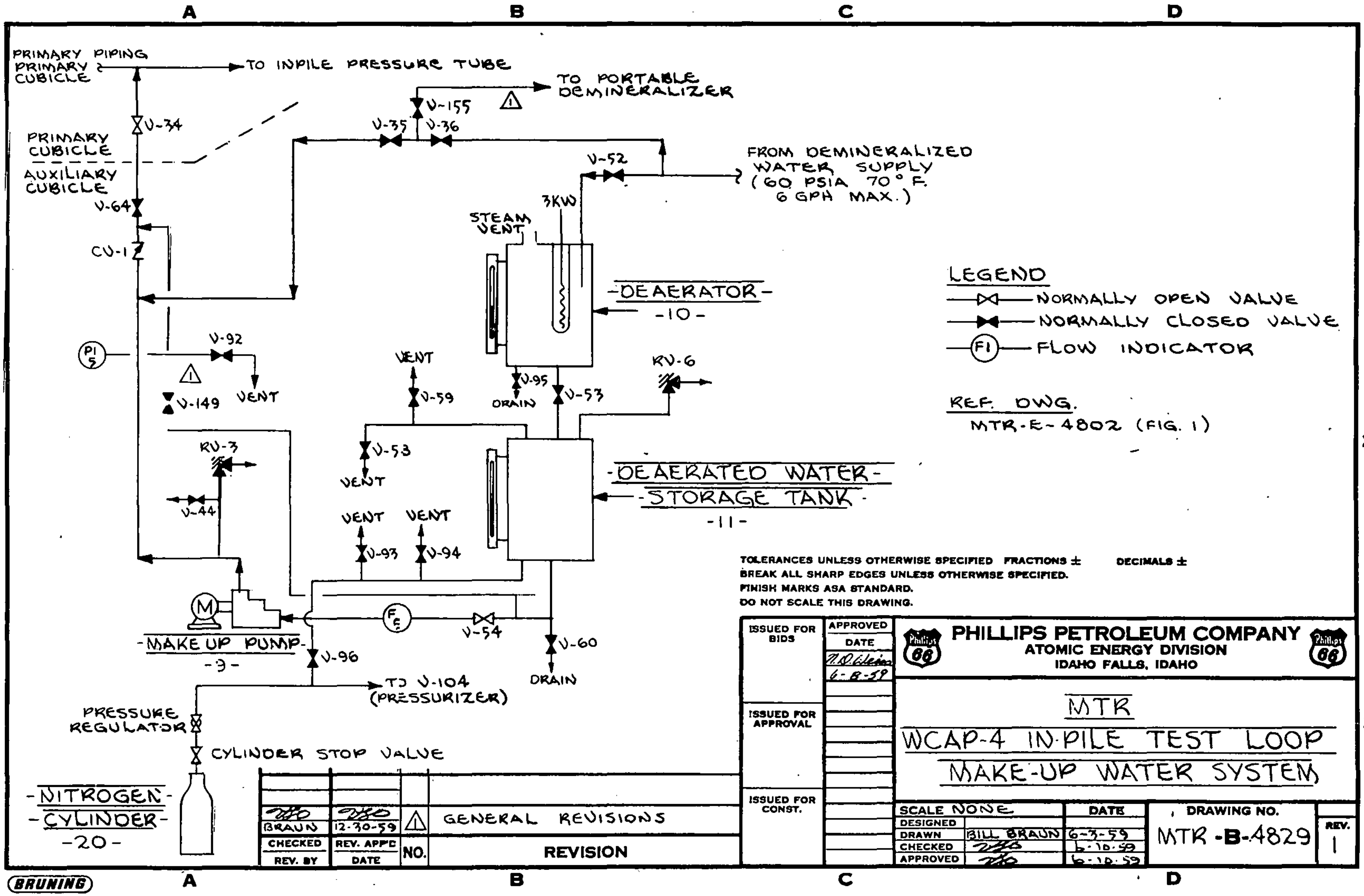
MTR
WCAP-4 IN-PILE TEST LOOP
HOT SAMPLING SYSTEM

SCALE NONE	DATE	DRAWING NO.	REV.
DESIGNED		MTR-B-4828	
DRAWN BILL BRAUN	6-4-59		
CHECKED [illegible]	6-10-59		
APPROVED [illegible]	6-10-59		

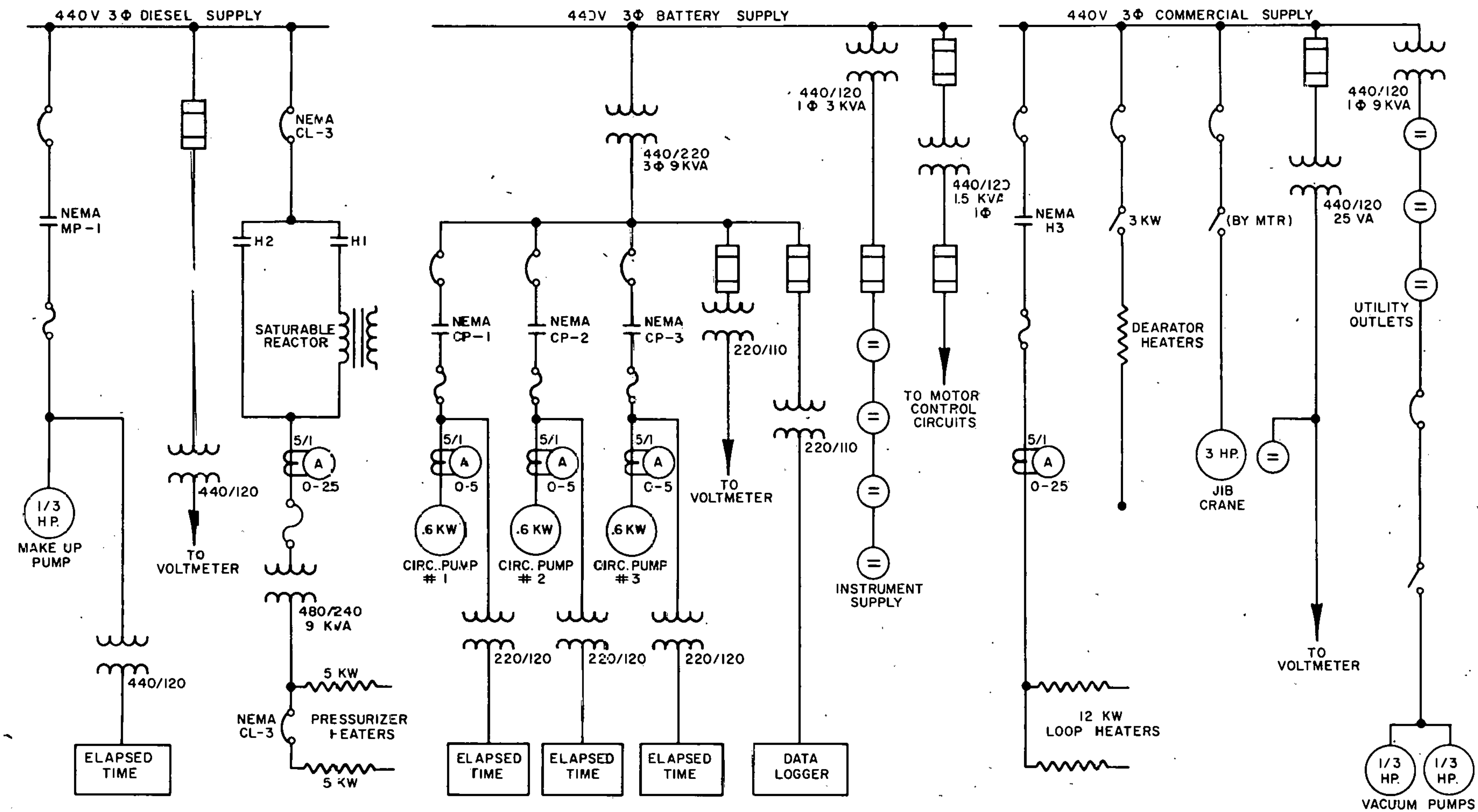
BRUNING



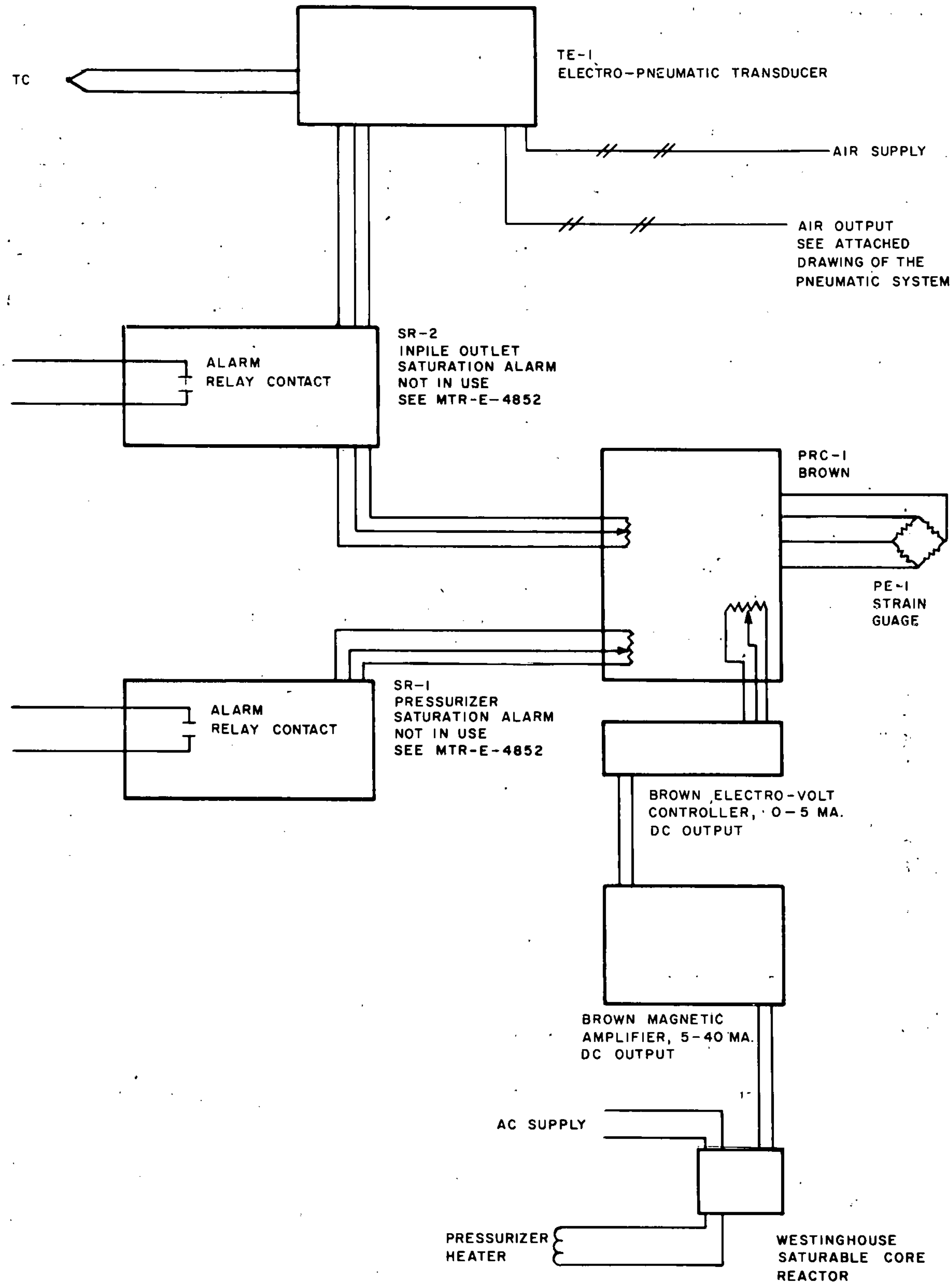
WCAP-4 AUXILIARY SAMPLING SYSTEM



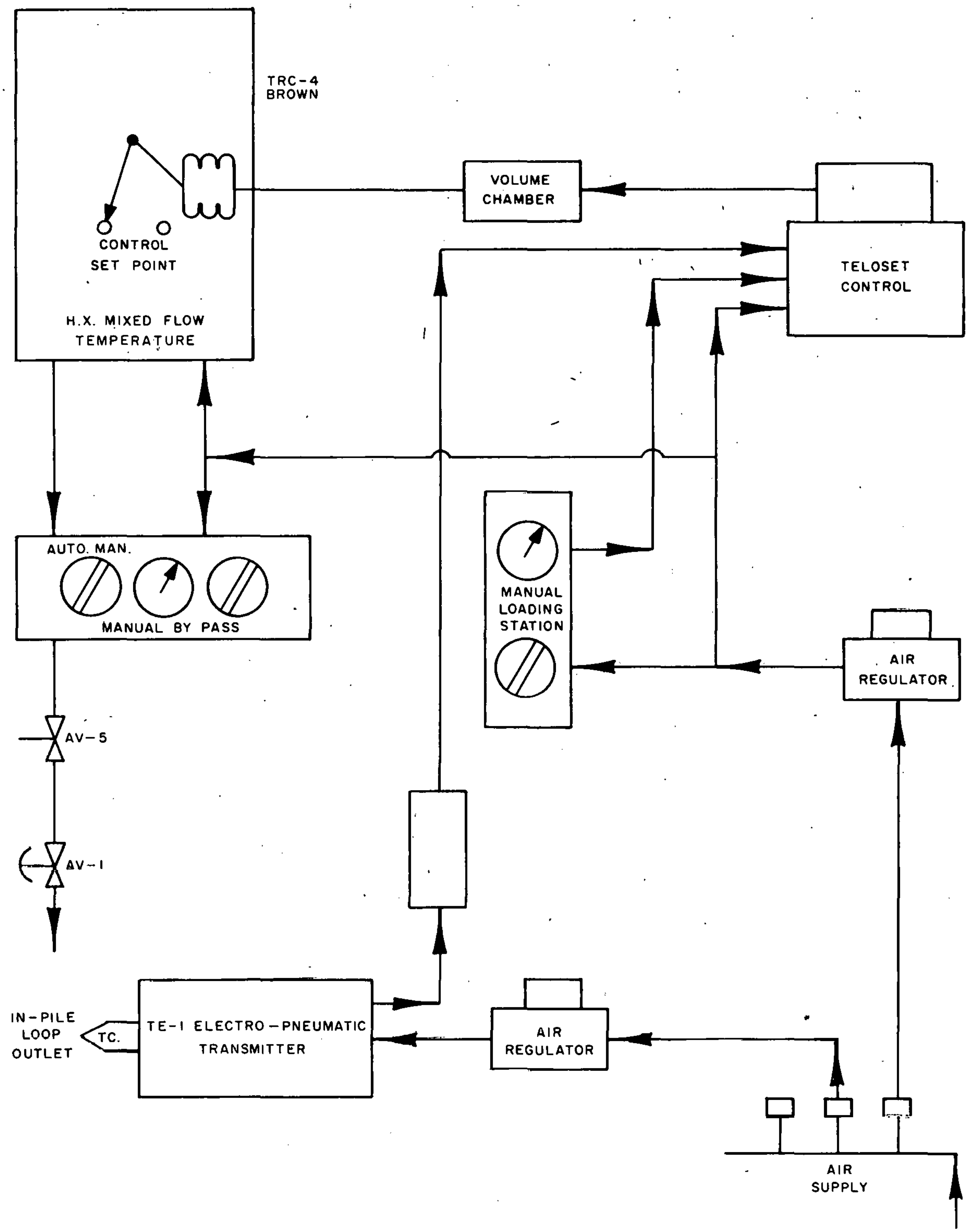
PRIMARY PIPING
PRIMARY CUBICLE
TO INPILE PRESSURE TUBE
TO PORTABLE DEMINERALIZER
V-155
V-35
V-36
V-34
PRIMARY CUBICLE
AUXILIARY CUBICLE
V-52
FROM DEMINERALIZED WATER SUPPLY (60 PSIA 70° F. 6 GPH MAX.)
V-64
3KW
STEAM VENT
CV-1
DEAERATOR -10-
LEGEND
NORMALLY OPEN VALVE
NORMALLY CLOSED VALVE
FLOW INDICATOR
PI 5
V-92
VENT
V-59
V-95
DRAIN
V-53
RV-6
V-149
VENT
REF. DWG. MTR-E-4802 (FIG. 1)
RV-3
V-58
VENT
DEAERATED WATER STORAGE TANK -11-
V-44
VENT
VENT
V-93
V-94
TOLERANCES UNLESS OTHERWISE SPECIFIED FRACTIONS ± DECIMALS ±
BREAK ALL SHARP EDGES UNLESS OTHERWISE SPECIFIED.
FINISH MARKS ASA STANDARD.
DO NOT SCALE THIS DRAWING.
M
FE
V-54
MAKE UP PUMP -9-
V-96
V-60
TO V-104 (PRESSURIZER)
DRAIN
PRESSURE REGULATOR
CYLINDER STOP VALVE
NITROGEN CYLINDER -20-
ISSUED FOR BIDS
APPROVED
DATE
6-8-59
ISSUED FOR APPROVAL
ISSUED FOR CONST.
PHILLIPS PETROLEUM COMPANY
ATOMIC ENERGY DIVISION
IDAHO FALLS, IDAHO
MTR
WCAP-4 IN-PILE TEST LOOP
MAKE-UP WATER SYSTEM
BRAUN
12-30-59
GENERAL REVISIONS
CHECKED
REV. APPD
NO.
REVISION
REV. BY
DATE
SCALE NONE
DATE
DRAWING NO.
DESIGNED
DRAWN BILL BRAUN 6-3-59
CHECKED 6-10-59
APPROVED 6-10-59
MTR-B-4829
REV. 1
BRUNING



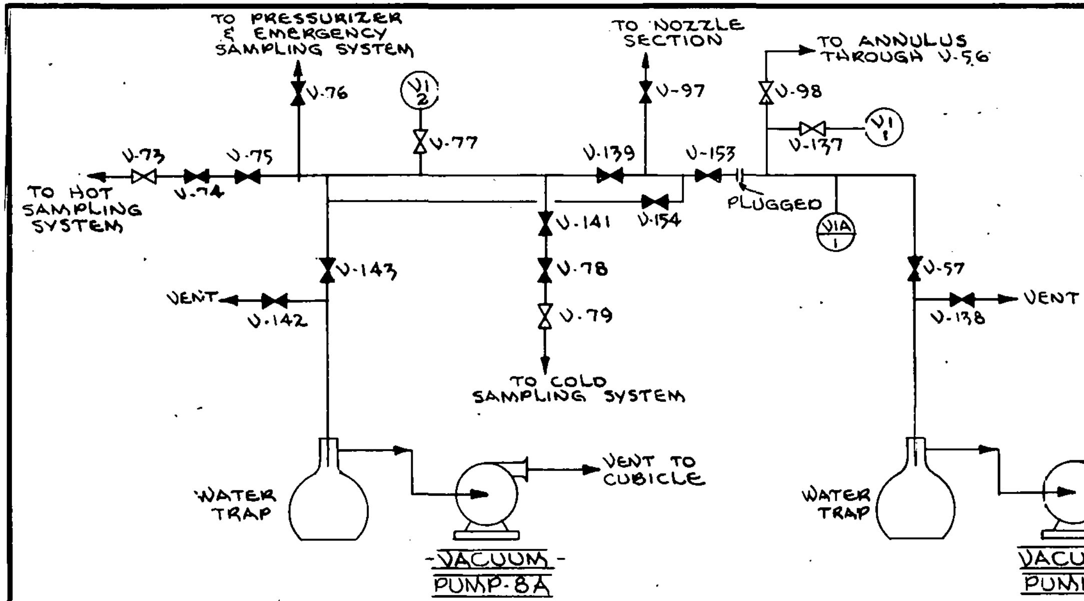
WCAP-4 IN PILE TEST LOOP ELECTRICAL DISTRIBUTION



PRC-1 BLOCK DIAGRAM OF BROWN PANEL
CONTROL SYSTEM ON WCAP-4



TRC-4 BLOCK DIAGRAM OF BROWN PANEL CONTROL SYSTEM ON WCAP-4



LEGEND

- VALVE NORMALLY OPEN
- VALVE NORMALLY CLOSED
- VI VACUUM INDICATOR
- VIA VACUUM INDICATOR ANNUNCIATOR

REF. DWG.
MTR-E-4802 (FIG. 1)

TOLERANCES UNLESS OTHERWISE SPECIFIED FRACTIONS ± DECIMALS ±
BREAK ALL SHARP EDGES UNLESS OTHERWISE SPECIFIED.
FINISH MARKS ASA STANDARD.
DO NOT SCALE THIS DRAWING.

REV. BY	DATE	NO.	REVISION
BRAUN	12-30-59	1	ADDED V-154 & LINE, V-153, & PLUGS
CHECKED	REV. APP'D		

	APPROVED	DATE
ISSUED FOR BIDS		6-8-59
ISSUED FOR APPROVAL		
ISSUED FOR CONST.		

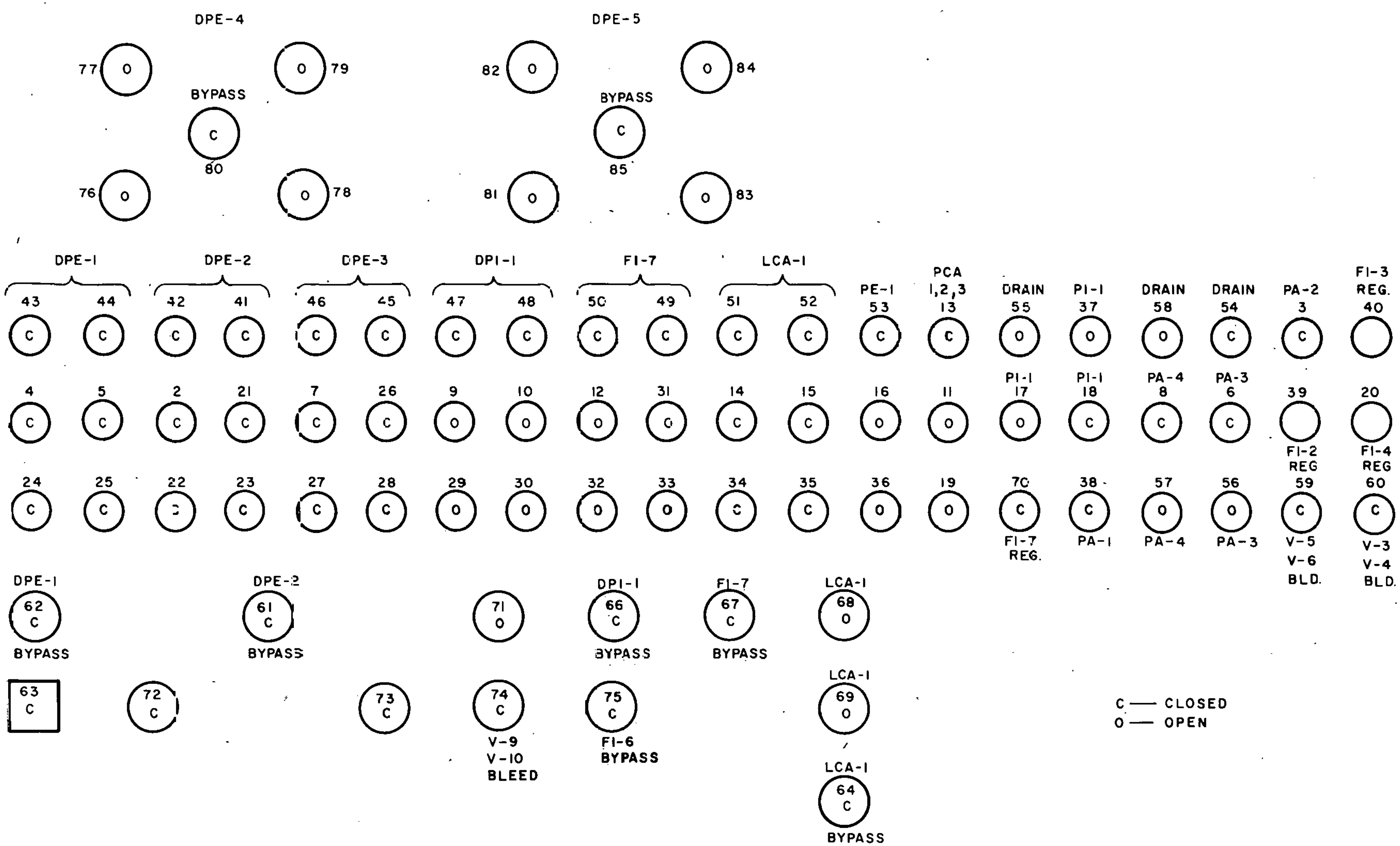
PHILLIPS PETROLEUM COMPANY
ATOMIC ENERGY DIVISION
IDAHO FALLS, IDAHO

MTR
WCAP-4 IN-PILE TEST LOOP
VACUUM SYSTEM

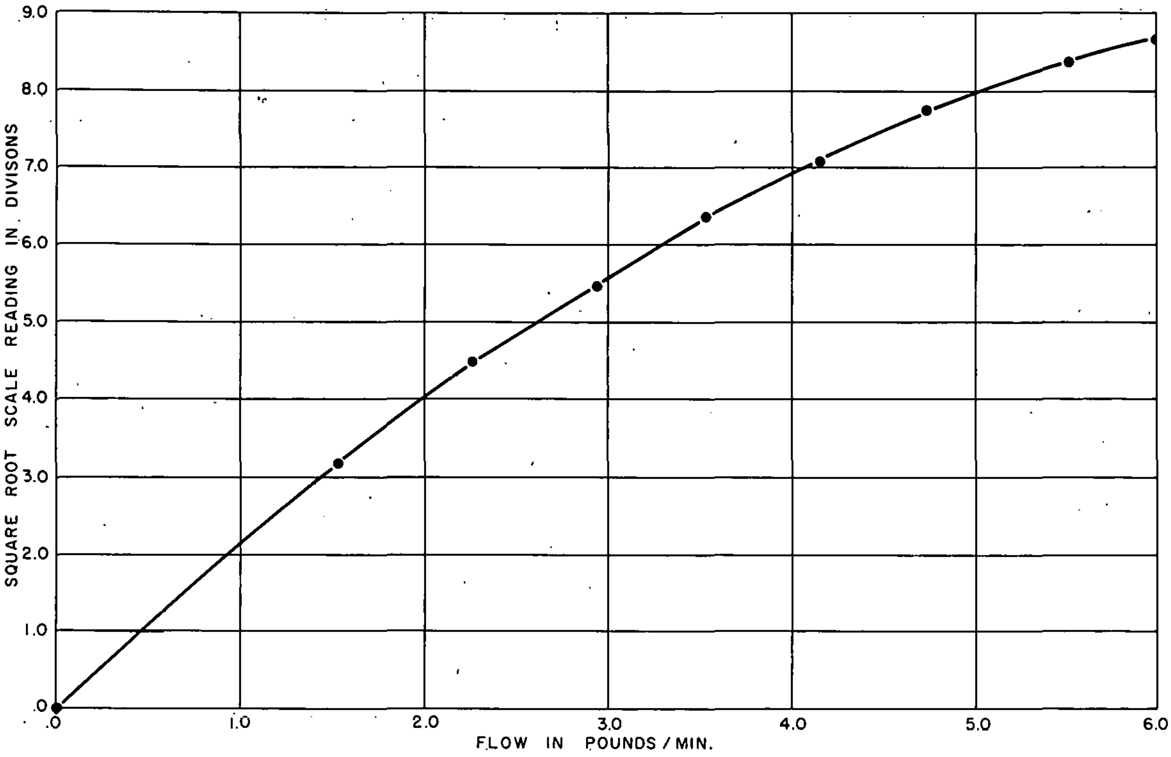
SCALE NONE		DATE
DESIGNED		
DRAWN	BILL BRAUN	6-3-59
CHECKED		6-10-59
APPROVED		6-10-59

DRAWING NO. MTR-B-4830 REV. 1

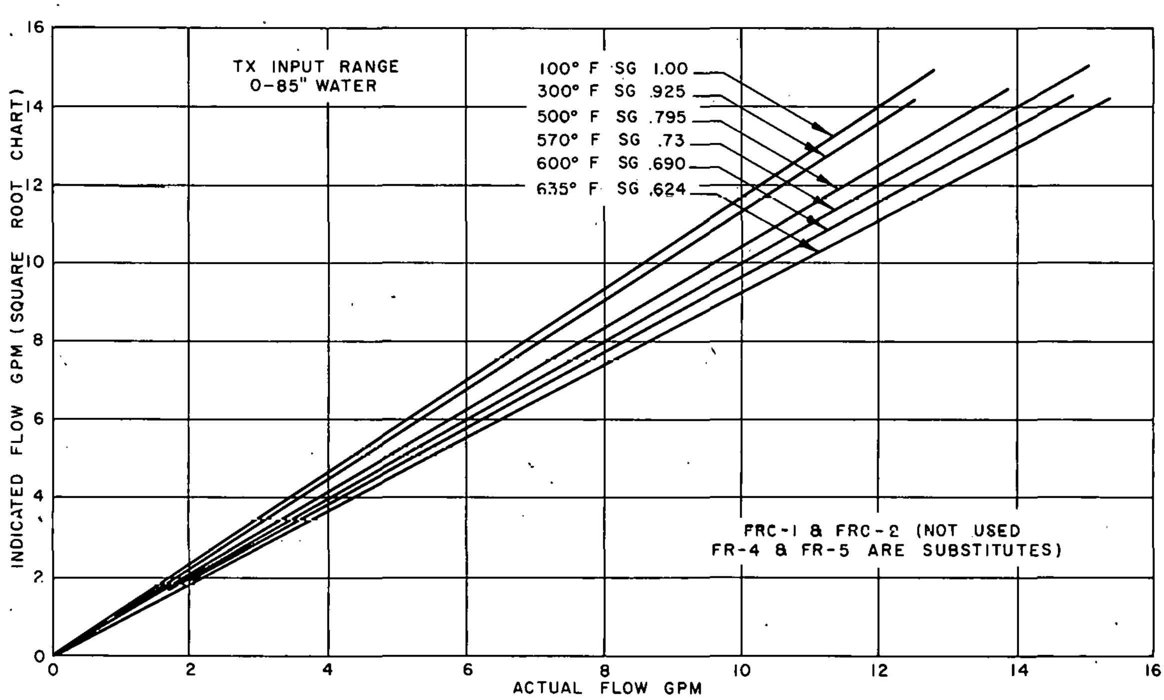
BRUNING



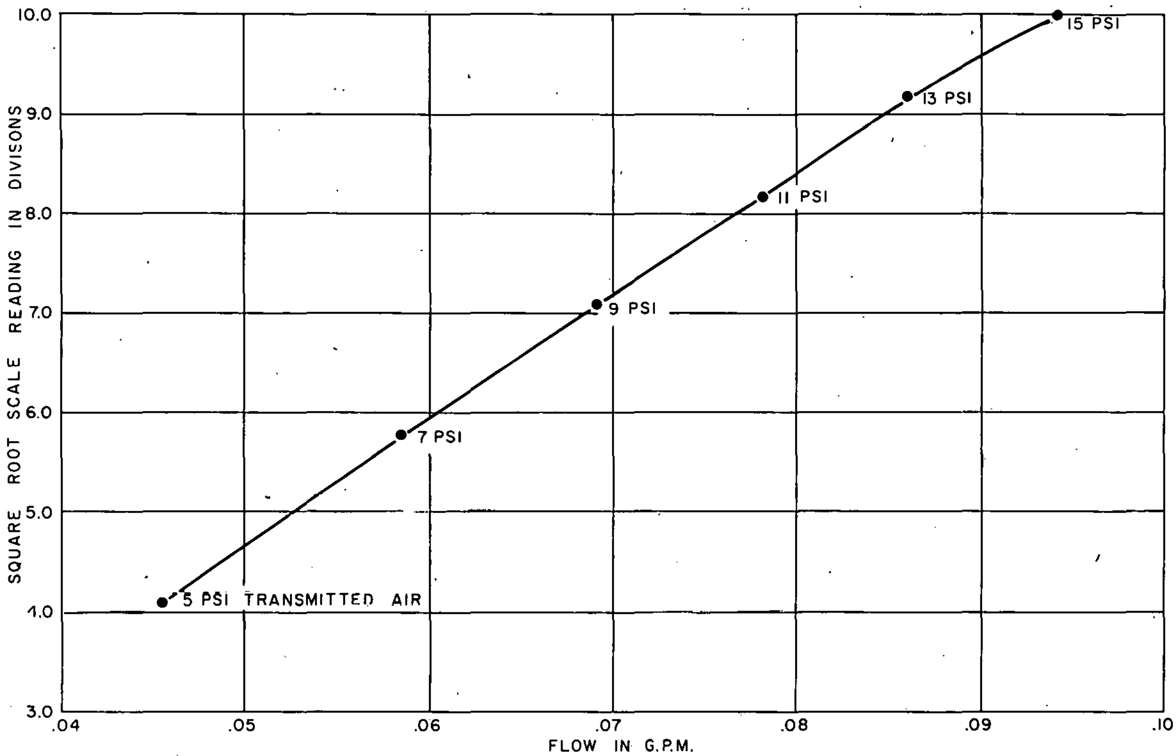
NORMAL OPERATING POSITIONS OF INSTRUMENT VALVES IN PRIMARY DETECTOR CUBICLE



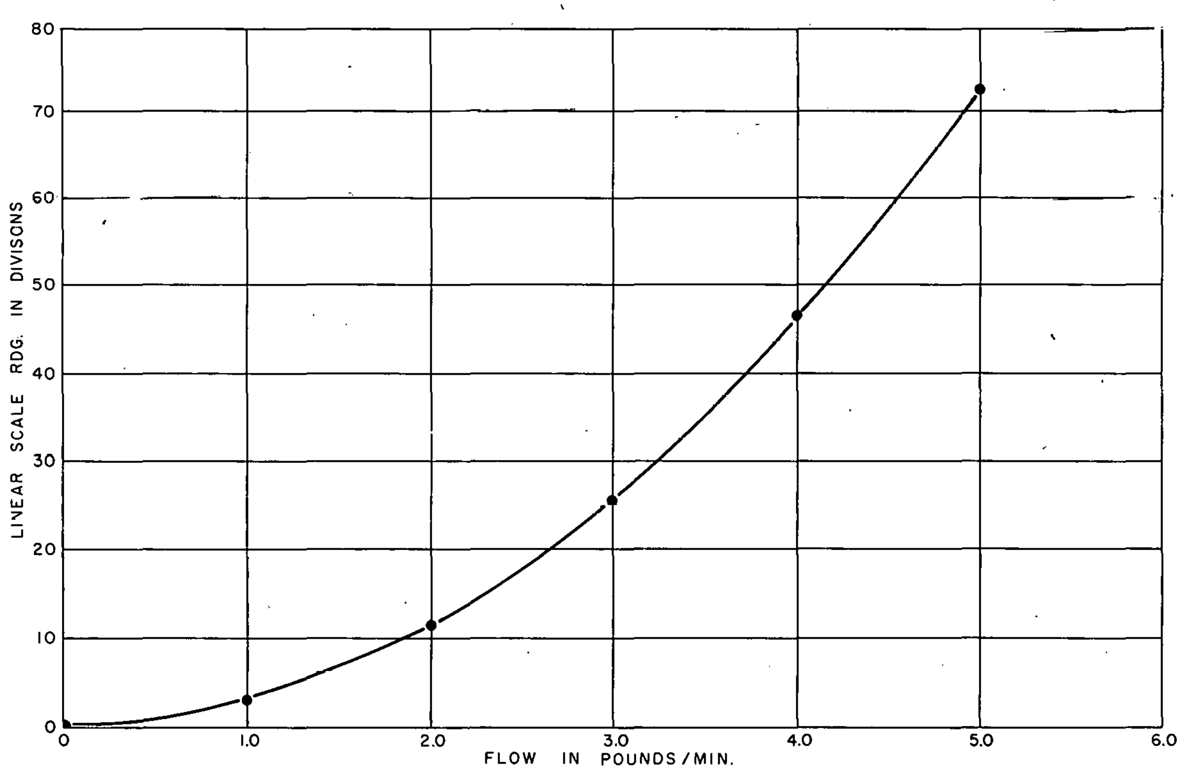
FI-8



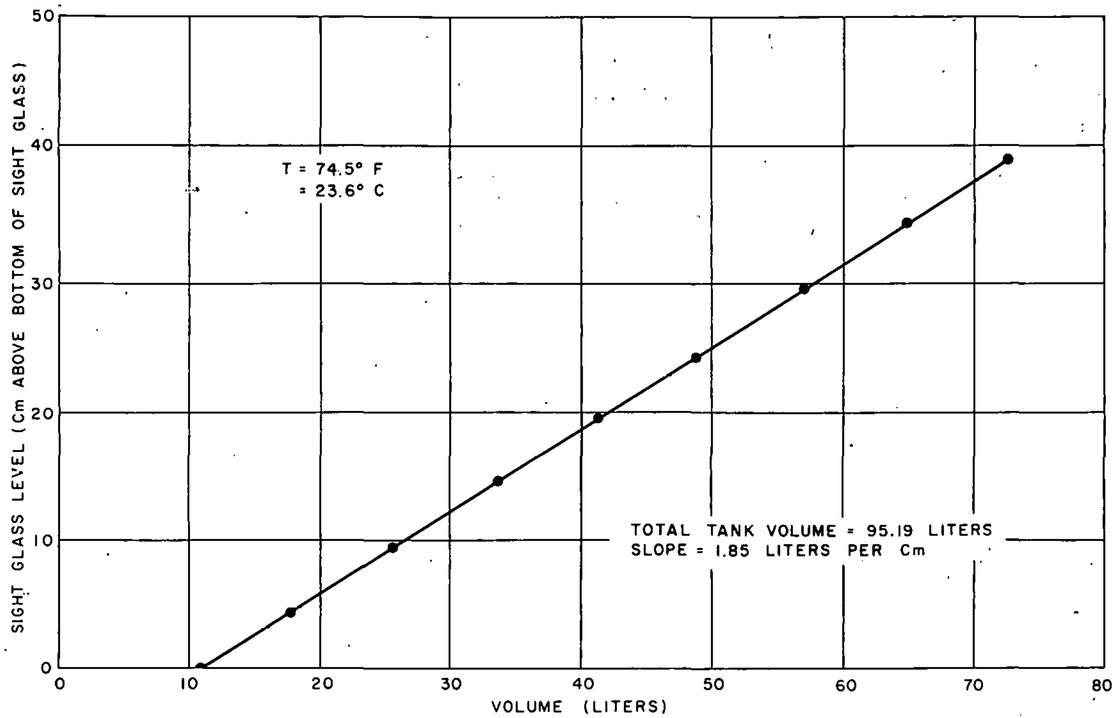
WCAP-4 FRC-1 & FRC-2 INDICATED vs ACTUAL FLOW


10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
SQUARE ROOT SCALE READING IN DIVISONS
15 PSI
13 PSI
11 PSI
9 PSI
7 PSI
5 PSI TRANSMITTED AIR
.04
.05
.06
.07
.08
.09
.10
FLOW IN G.P.M.

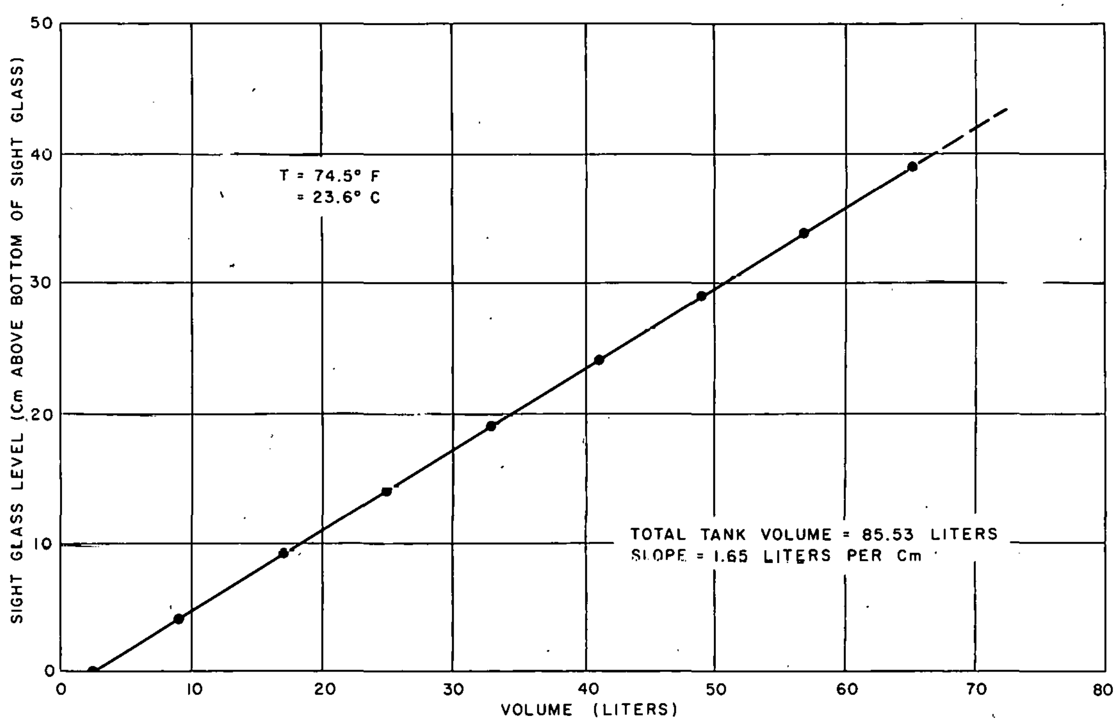
FI-1


80
70
60
50
40
30
20
10
0
LINEAR SCALE RDG. IN DIVISONS
0
1.0
2.0
3.0
4.0
5.0
6.0
FLOW IN POUNDS/MIN.

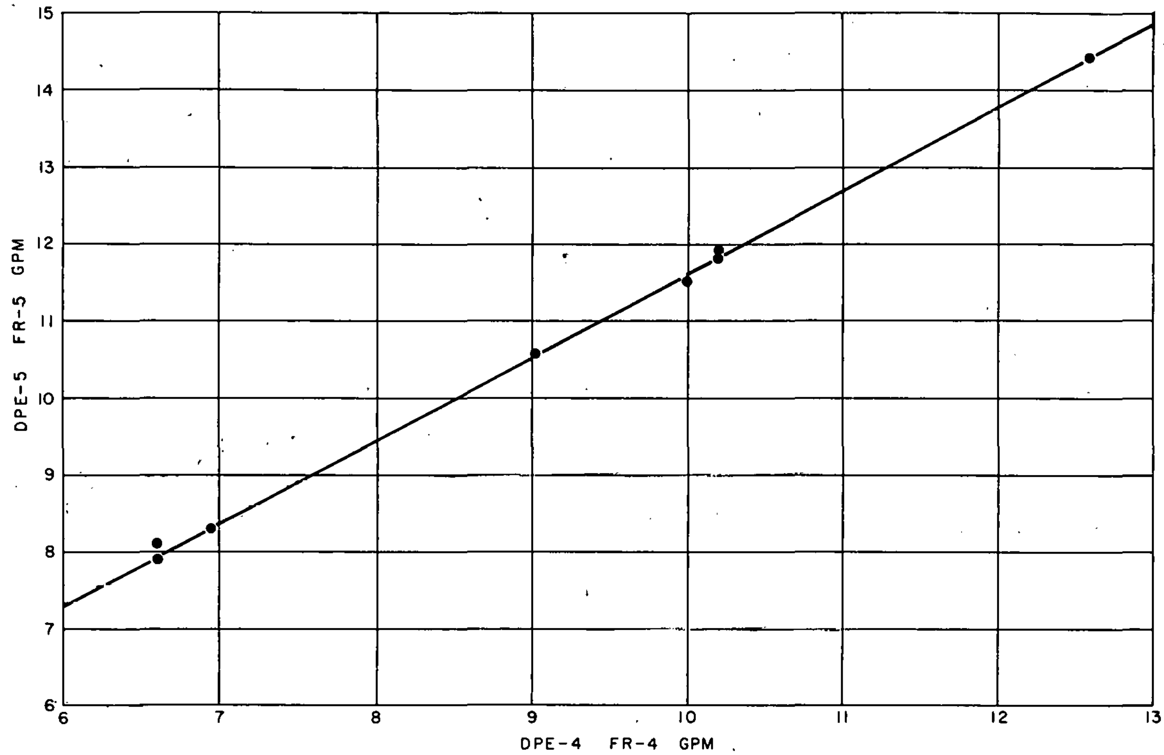
FI-7



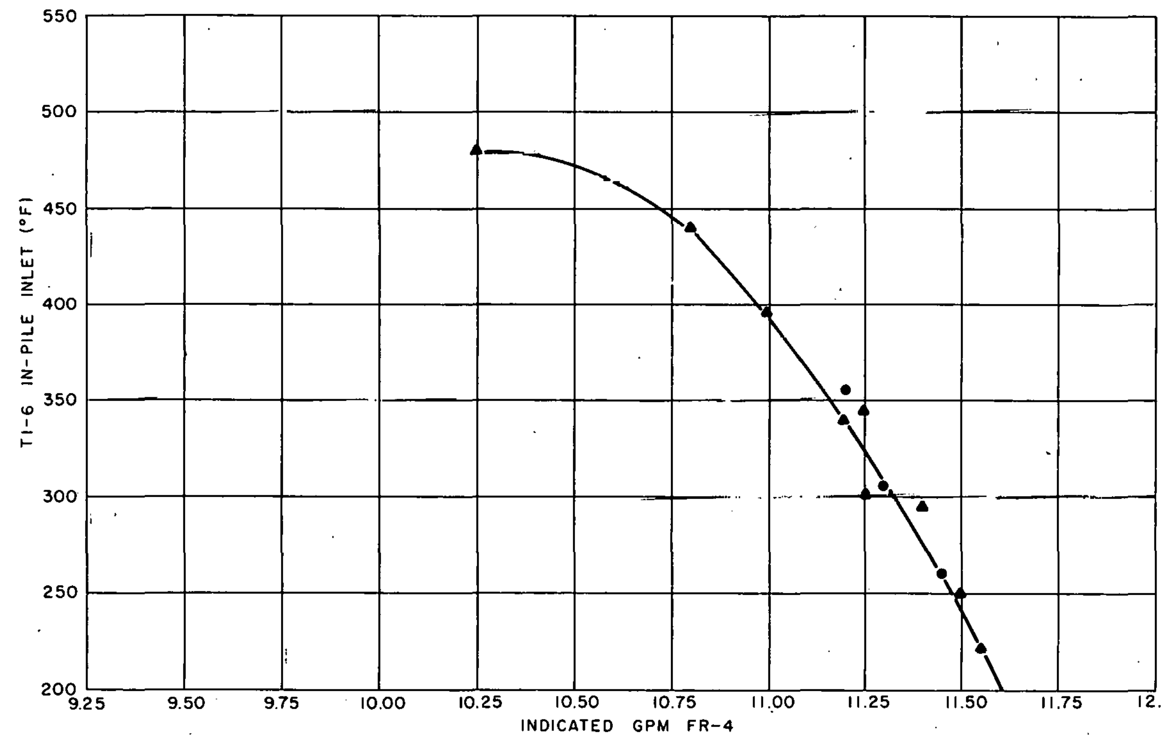
DEAERATOR TANK CALIBRATION



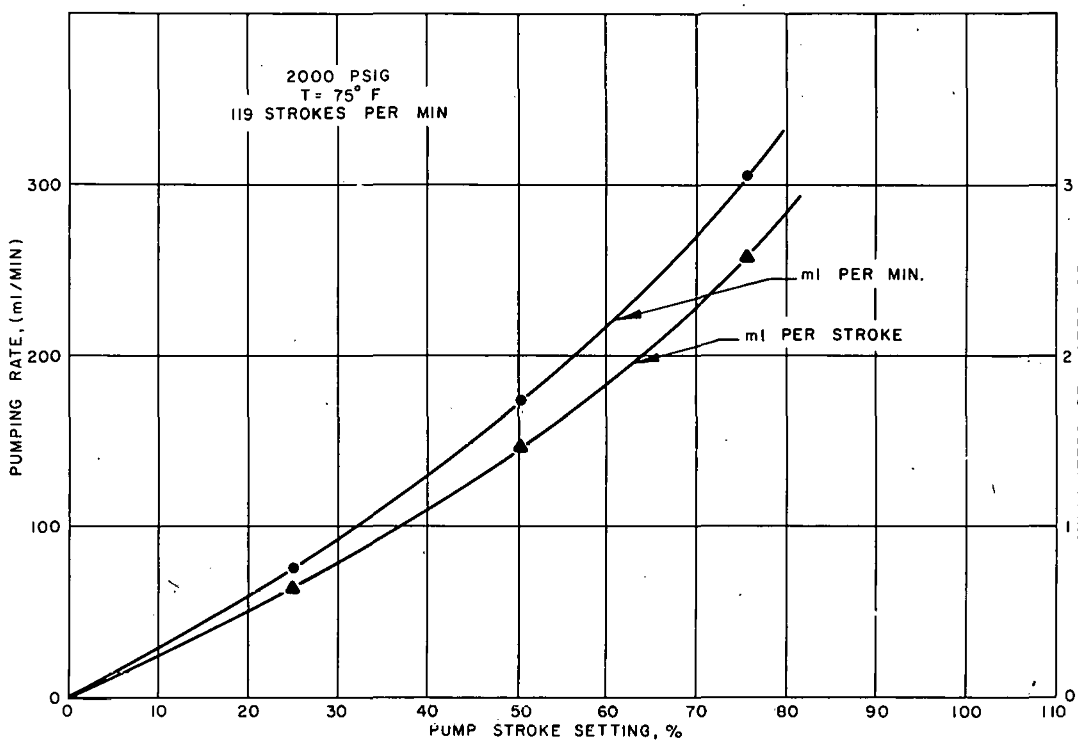
TREATED WATER STORAGE TANK



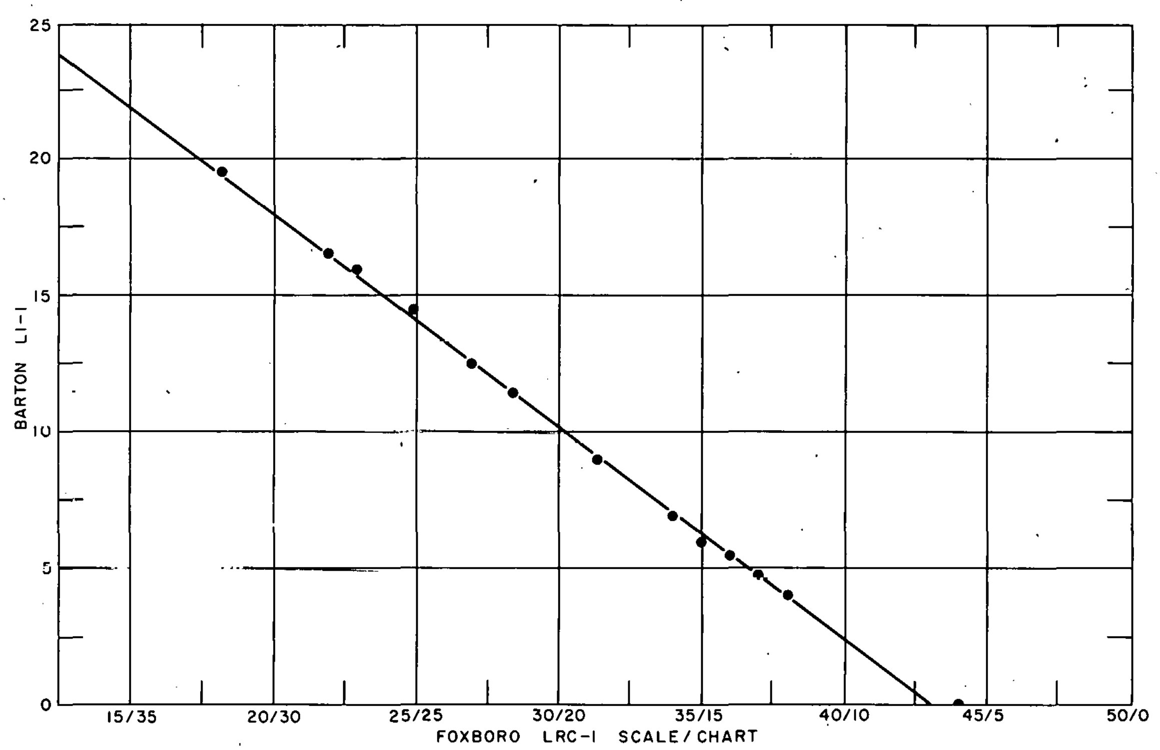
FR-4 vs FR-5



FR-4 FLOW vs INPILE INLET TEMPERATURE



MILTON-ROY MAKEUP PUMP CALIBRATION



LI-I vs LRC-I AT 2000 psig

PHILLIPS
PETROLEUM
COMPANY

ATOMIC ENERGY DIVISION