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MAINTENANCE OF ETR COOLANT

F. C. Haas

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AEC RESEARCH AND DEVELOPMENT REPORT

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By F. C. Haas

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SUMMARY

The ETR is a thermal reactor using ordinary demineralized water as coolant and moderator. Three resin beds are used for activity reduction and to improve the water quality. Design specifications were for water having a specific resistance of one million Ohms, but at 175 megawatts the resistance has only been 400,000 to 500,000 Ohms. Iron, aluminum, and beryllium are routinely determined and have been of the same order of magnitude as these in the MTR. No evidence of nitrogen fixation has been found at 80 megawatts. The gross beta-gamma activities are 10,000 at 80 megawatts and 40,000 counts per minute per milliliter at 175 megawatts. The cation exchanger is removing about 90 per cent of the gross activity; the anion is removing about 30 per cent, and the mixed bed about 97 per cent. Gross water activities are twenty times those found in the MTR before fission breaks occurred. Fission products have been found and identified in the primary water and the gases from the degassing tank. Gaseous activity has necessitated installing a temporary exhaust system on the heat exchanger building and a permanent ventilating system has been designed. The production of gaseous hydrogen and oxygen has presented no problems since the total gas has been 20 to 40 ml/1 of water. The primary water is continuously monitored by convection pH and conductivity meters and by a fission break monitor.

* Text of paper presented at the Los Angeles Meeting of the American Nuclear Society, June 2, 3, 4, and 5, 1958. Report issued as PTR 314 on June 1, 1958.

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I. Introduction:

The Engineering Test Reactor is a thermal reactor using ordinary demineralized water as both coolant and moderator. The primary system is a pressurized closed water loop using four 800 HP electric motor driven centrifugal pumps for circulation. The inlet pressure is maintained at 200 psig by means of two 50 HP electric motor driven pumps. The pressure drop through the reactor is about 55 psi at a flow of 60,000 gpm. The heat from the reactor is transferred to a secondary coolant system by means of four, three bank shell and tube heat exchangers. The reactor heat transferred to the secondary system is in turn dissipated in a conventional induced draft cooling tower. See the attached diagrams for schematic of the components of the system and the flow.

The water for filling the primary system is furnished by the MTR make-up demineralizer. This make-up water has a specific resistance of 250,000 to 500,000 Ohms and a pH of 5.5 to 6.5.

II. Resin Beds:

Three resin beds on a side stream from the main primary coolant are used for clean-up of the water in the system. The design specifications for ETR water were one million Ohms; however, at this time, the resistance is running 400,000 to 500,000 Ohms. As a comparison, the MTR process water quality is 250,000 to 500,000 Ohms and has operated with a minimum of corrosion for a number of years. Four resin beds were installed as original equipment, but as the system is presently operated, one bed is used exclusively for hot waste clean-up. The remaining three beds serve the primary system. The cation unit is filled with 30 ft^3 of Amberlite IR 120 in the hydrogen form; the anion unit is filled with 30 ft^3 of Amberlite IRA 400 in the hydroxyl form, and the third bed is filled with 15 ft^3 of each of the above resins. Normal flow for each bed is 100 gpm; however, the flows through the anion and cation beds are varied to maintain pH control. The cation and anion beds can only be operated in parallel. A better arrangement would have placed the anion downstream and in series with the cation, which would have resulted in more efficient activity removal. The mixed bed is downstream of the cation and anion units and receives a portion of the combined anion and cation effluents. A pH of 5.5 to 6.5 is maintained to minimize corrosion of the aluminum and beryllium in the reactor. The primary system is fabricated of 304 L stainless steel except pump cases and check valves which are cast steel, so corrosion of the primary system is of little concern. Any iron hydroxide floc from corrosion products in such a system becomes extremely hot due to absorption of the radioactive elements present in the water. This hydroxide floc also tends to plug the resin beds; however, this has not been observed at the ETR.

The resin beds are filled with resin by means of a water eductor located outside of the shielded resin bed cell. No regeneration facilities are provided for the units since it is planned to remove the resin when it is depleted. A two inch plug valve is located on each tank above the Anthrafilt subfill for pressuring out the resin into a shielded disposable tank. The ETR resin removal is patterned after and similar to that of MTR; the only major difference being that it is necessary to pump the resin from the MTR tank while the resin will be pressured out of the ETR tanks. The ETR removal system was tested before the critical runs when no activity was present, and functioned as designed. The direct radiation from these resin beds was measured after 6,000 megawatt days' operation, and after eleven days' decay time. The following radiation levels were found: cation bed 5R/hr., anion bed 1.25R/hr., and mixed bed 0.5R/hr. The low level found on the mixed resin bed reflects the fact that the primary water has already been cleaned-up by the cation and anion units before it reached the mixed bed unit. Radiation levels on these beds have not been measured during operation because of the air activity and expected high radiation levels. The resin bed cell walls are concrete, two and one-half feet thick, and have been adequate up to this time.

III. Chemical Aspects of Process Water:

The usual routine chemical analysis of process water consists of the determination of iron, aluminum, and beryllium. Presented below are the amounts of these materials found in the primary coolant.

TABLE NO.1

Date	Reactor Power MW	Fe, ppm	Al, ppm	Be, ppm
11-18-57	0	0.06	0.03	<0.01
12-21-57	0	0.03	<0.01	<0.01
2-28-58	80	0.04	0.01	<0.01
4-10-58	80	0.05	0.01	<0.01
4-22-58	175	0.02	0.01	<0.01
5-1-58	175	0.02	0.01	<0.01

Table No. 2 below lists the amounts of these elements found in the MTR process water at reactor powers of 30 megawatts.

TABLE NO. 2

Date	Fe, ppm	Al, ppm	Be, ppm
5-19-52	0.04	---	0.01
6-20-52	0.02	---	0.02
4-17-54	0.03	<0.01	0.03
6-23-54	0.02	<0.01	0.04
3-18-55	0.01	<0.01	0.01
7-10-55	<0.01	<0.01	<0.01

Examination of these two tables indicates that the concentration of these elements in the primary coolants of both reactors are of the same magnitude.

Normally, these three elements are the only ones determined routinely since any large increase in the amount in the primary coolant could indicate excessive corrosion at some point in the coolant system.

Table No. 3 below presents a spectrographic analysis of the ETR primary coolant and of the MTR process water.

TABLE NO. 3

Element	MTR Water (9-10-52)	ETR Water (3-17-58)
Ag	Trace	Trace
Al	Minor	Minor
Cu	Trace	Trace
Fe	Trace	Major
Mg	Minor	Minor
Mn	Trace	Trace
Ni	Trace	Trace
Pb	Trace	Minor
Si	Trace	Minor
Sn	-----	Trace
Cr	-----	None

NOTE: MTR water analysis made on ions collected on a resin column. ETR analysis made on solids after evaporation.

No evidence of nitrogen fixation has been found in powers up to 80 megawatts. During initial power operation, the by-pass demineralizer was isolated so that any nitric acid produced would not be removed by the anion resin. The pH and specific resistance of the primary coolant water were closely watched for signs of pH or resistance reduction. Water samples were taken at regular intervals and analyzed for nitrate concentration. These analyses showed no increase in nitrate concentration with time. Nitrate concentrations from 0.2 to 0.8 ppm were found but these are normal since nitric acid is added at the MTR make-up demineralizer to reduce the pH of this water to the normal operating limits of 5.5 to 6.5. Nitrate concentrations in the ETR coolant and make-up water during the initial power runs were 0.2 to 0.8 ppm as nitrate. The large variation in concentration is due to the amounts added to the make-up water at the MTR. Normally the concentration is 0.2 to 0.3 ppm which is sufficient to lower the pH of the make-up water from 8.0 - 9.0 to 5.5 - 6.5. The 0.8 ppm nitrate concentrations were due to insufficient mixing of the acid and the demineralized water in the storage tanks.

IV. Radioactivity of Process Water:

The gross activity of the water is determined once per shift. One milliliter samples are evaporated to dryness by means of a heat lamp and a gross beta-gamma count made on the residue, after a two hour decay. Normally at 80 megawatt operation this gross count was 9,000 to 11,000 counts per minute and 30,000 to 40,000 for 175 megawatt operation. The counter used has a geometry factor of 10. Any significantly higher activity is promptly investigated by Operation's supervision to determine the source of the activity. Table No. 4 presented below tabulates these activities for 80 and 175 megawatt operation as well as the gross activities on samples from the resin bed effluents.

TABLE NO. 4

80 Megawatt Operation

Date	Primary Water	Cation Effluent	Anion Effluent	Mixed Bed Effluent
2-21-58	9175	1724	6977	13
2-22-58	8880	929	7083	15
2-23-58	9991	1012	7631	4
2-24-58	9584	959	8509	6
2-25-58	9682	996	7798	6
2-26-58	9459	940	7220	4
2-27-58	9671	881	7514	20
2-28-58	10179	1131	7618	79
3-1-58	8428	976	7949	15
3-2-58	10505	966	7817	65
3-3-58	10704	1006	8704	7
3-4-58	10981	1015	8879	144
Average	9769	1045	7808	32
Per Cent Activity Removed		89	20	99 +
		175 Megawatt Operation		
4-19-58	17780	2374	11410	609
4-20-58	32188	4243	22693	867
4-21-58	24704	2362	15955	553
4-22-58	28702	4404	21624	1054
4-23-58	42600	4100	27100	852
Average	29194	3497	19756	787
Per Cent Activity Removed		88	32	97

As noted in the above table, 89 per cent of the gross activity of the primary water is removed by the cation bed while the anion bed only removed 20 to 30 per cent of this activity. The mixed bed effluent sample indicated almost 100 per cent removal. These results indicate that a cation exchanger is adequate for gross activity reduction; however, an anion unit is required for pH control since a cation unit operation alone will finally lower the pH of the water system below the operating limit. This has been demonstrated at the MTR where it was found that a single cation unit can not be operated continuously because of this pH reduction. About ninety per cent removal of gross activity from the water is a characteristic of cation units, where water contains no fission products. However, only about 60 per cent of the activity is removed in a cation bed where fission products are a major part of the total activity. At this time, about 50 per cent of the gross activity is due to Na^{24}. The mixed bed was installed to obtain one million Ohm resistance primary water. However, this has not been possible and resistance has been 400,000 to 500,000 Ohms at 175 megawatts at a flow rate through the resin beds of 100 gpm. Design flow rate is 100 gpm.

MTR gross gamma-beta activities during initial power operation were considerably less than those found in the ETR primary water at 80 and 175 megawatt operation. The higher activities for the ETR are probably due to several factors:

1. ETR power is almost six times initial MTR operating power.

2. The heat transfer area in the ETR is considerably greater.

3. The ETR primary system volume is about 60,000 gallons compared to 300,000 gallons for the MTR; complete cycle time is one minute for ETR compared to 15 minutes for MTR.

Listed in the table below are gross beta-gamma activities of the coolant for MTR at 30 megawatts and the ETR at 80 megawatts and 175 megawatts after a two hour decay.

TABLE NO. 5

MTR		ETR 80 MW		ETR 175 MW	
Date	- c/min/ml	Date	- c/min/ml	Date	- c/min/ml
4-10-53	2,149	2-20-58	10,546	4-19-58	17,780
4-22-53	1,923	2-25-58	9,786	4-20-58	32,188
4-29-53	1,912	3-12-58	12,220	4-21-58	24,704
5-6-53	2,042	3-16-58	10,240	4-22-58	28,702
5-16-53	1,974	3-19-58	8,824	4-23-58	42,600
6-5-53	2,498	3-22-58	11,968		
6-27-53	2,100	3-25-58	10,947		

These activities are typical of the two reactors before any fission breaks occurred. In 1954 when fission breaks in the MTR fuel elements were experienced, these activities increased by factors of 10 to 30 times normal operating levels.

In spite of the fact that no known fission break has occurred in the ETR, fission products are continuously found in the primary coolant as was the case with MTR.

V. Gaseous Activity:

Approximately one curie per day of gaseous and particulate activity was discharged to the stack from the degassing tank when the reactor operated at 80 megawatts initially. The amount of gaseous and particulate activity decreased appreciably when the reactor was operated with the 175 megawatt core loading; at 80 megawatts the activity discharged to the stack dropped to about 0.2 of a curie per day and at 175 megawatts the discharge activity was only about 0.5 a curie per day. The 175 megawatt core was loaded with pinned elements whereas the 80 megawatt core was loaded with brazed elements. The only explanation for the reduction in gaseous fission activity released appears to be the use of pinned rather than brazed elements, since the fabrication of both types is similar except for the final assembly. This activity has been identified as Cs^{138}, Rb^{88}, Rb^{89} (fission gas daughter products), again confirming the fact that fission products are present in the primary coolant.

Listed below in Table No. 6 are fission products identified in the primary water at a reactor power of 80 megawatts. Also included is neptunium.

TABLE NO. 6

Date	Fission Product	Concentration d/min/ml
2-18-58	Sr^{92}	3000
2-20-58	Sr^{92}	1040
3-3-58	Sr^{92}	3200
2-24-58	I^{132}	1240
3-10-58	I^{132}	1420
3-10-58	I^{133}	1720
2-24-58	Ba^{140}	263
3-3-58	Ba^{140}	250
2-18-58	Np^{239}	500
2-24-58	Np^{239}	381
3-3-58	Np^{239}	460

It is not definitely known by what means this occurs, but it is postulated that surface contamination of the cladding with U^{235} during fabrication or that the aluminum metal and the beryllium contains enough uranium to account for the presence of fission products in the coolant water.

At 80 megawatts and with no major fission breaks, the gaseous activity has created operating problems. The primary coolant system, though enclosed in adequate shielding, is not completely sealed from the operating area. In addition there was no forced or induced ventilation system which would move the air from operating areas into the primary system cubicles. This resulted in the air activities in the operating areas rising to 6 or 8 times MPC at certain times. As a temporary measure blowers were installed at the heat exchanger building so that air movement is from the compressor building, which is an operating area, into the pump cubicles, pipe tunnel, and heat exchange building. This contaminated air is discharged to atmosphere at ground level. This point of air discharge being outside of the buildings and in an area that is seldom used has proved satisfactory as a temporary measure.

A permanent ventilating system for the pipe tunnel, pump cubicles, and heat exchanger building has been designed. The contaminated air from these areas will be discharged to the existing ETR stack. Also incorporated into this design is an exhaust system for the reactor which is to be used during shutdown when the top dome is removed. The top dome exhaust is not needed at this time, but as the experimental load increases, fuel bearing capsules will rupture from time to time so that reactor tank work will be difficult without an exhaust system.

VI. Radiolytic Gas Production:

The production of gaseous hydrogen and oxygen by decomposition of water up to reactor powers of 175 megawatts has presented no problems. Total gas found in the primary coolant water has been 20 to 40 ml/l of water. The so-called degassing system in the ETR operates on a 300 gpm side stream off the main primary coolant loop. In this 300 gpm side stream the pressure on the water is reduced from system pressure at 200 psig to atmospheric pressure in a 1000 gallon tank. Air is continuously swept across the surface of the water in this tank to remove any gases released. No facilities for the measurement of the volume of this gas stream were provided so that the quantity of gas released is not known. In the MTR process water system where the entire process water stream is degassed each time the water leaves the reactor, the gas concentration is 3 to 5 cc per liter of water. The total volume of gas leaving the MTR degassing system was about 12 scfm at a reactor power level of 40 megawatts. Of course, in the MTR the gas never has a chance to achieve equilibrium.

Table No. 7 lists the gas concentrations determined at several powers.

TABLE NO. 7

Date	Power, Megawatts	Total Gas, ml/l
1-26-58	50	15
1-26-58	65	19
1-26-58	75	18
1-26-58	80	16
2-19-58	80	36
2-28-58	80	37
3-17-58	80	38
3-19-58	80	22
4-8-58	90	34
4-18-58	100	40
4-19-58	120	30
4-19-58	140	36
4-19-58	150	18
4-19-58	160	18
4-19-58	170	33
4-19-58	175	25
4-20-58	175	26
4-20-58	175	25
4-28-58	175	21

VII. Monitoring of Process Water:

The usual industrial pH and conductivity instrumentation continuously records these values in the primary coolant control room. These two recording instruments and the conventional laboratory type pH and conductivity meters are considered adequate to detect any changes in water quality.

A fission break monitor continuously analyzed a small primary coolant side stream for the presence of I^{135}. The initial development work on this instrument was done at the MTR by R. L. Heath of Phillips Petroleum Company. A complete and excellent description of theory and operation of such a fission monitor is given in the report "Fission Product Monitoring in Reactor Coolant Streams", IDO-16213, by R. L. Heath.

Fifty milliliters per minute of primary coolant flows through a cation resin column, where the major background activities are removed. From this column the water stream flows to an anion resin bed where the fission iodines are collected. A gamma scintallation detector looks at this anion resin column. A level discriminator rejects all pulses due to gammas below one mev, this will provide response to the high energy gammas emitted by 6.7 hr I^{135} with some contamination from gammas from I^{134} and I^{132}. The detector out-put is fed to suitable amplifiers, a count rate meter, and a recorder.

The stack gas activity monitor is an excellent back-up instrument for the fission break monitor since a break will release fission gases which will almost immediately cause an increase in the stack gas radiation monitor.

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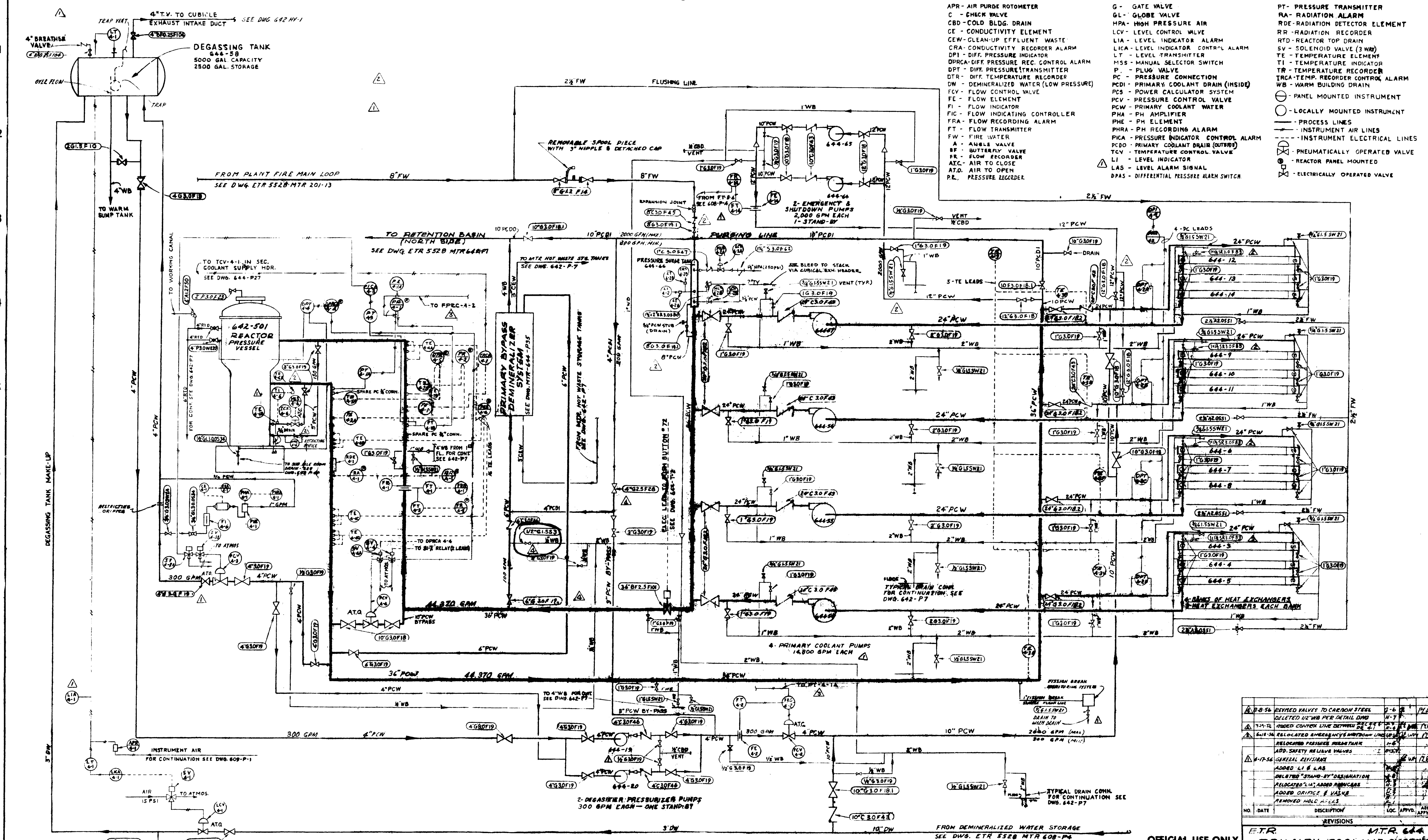

LEGEND

- APR - AIR PURGE ROTOMETER
- C - CHECK VALVE
- CBD - COLD BLDG. DRAIN
- CE - CONDUCTIVITY ELEMENT
- CEW - CLEAN-UP EFFLUENT WASTE
- CRA - CONDUCTIVITY RECORDER ALARM
- DPI - DIFF. PRESSURE INDICATOR
- DPRCA - DIFF. PRESSURE REC. CONTROL ALARM
- DPT - DIFF. PRESSURE TRANSMITTER
- DTR - DIFF. TEMPERATURE RECORDER
- DW - DEMINERALIZED WATER (LOW PRESSURE)
- FCV - FLOW CONTROL VALVE
- FE - FLOW ELEMENT
- FI - FLOW INDICATOR
- FIC - FLOW INDICATING CONTROLLER
- FRA - FLOW RECORDING ALARM
- FT - FLOW TRANSMITTER
- FW - FIRE WATER
- A - ANGLE VALVE
- BF - BUTTERFLY VALVE
- FR - FLOW RECORDER
- AT.C. - AIR TO CLOSE
- AT.O. - AIR TO OPEN
- P.R. PRESSURE RECORDER
- G - GATE VALVE
- GL - GLOBE VALVE
- HPA - HIGH PRESSURE AIR
- LCV - LEVEL CONTROL VALVE
- LIA - LEVEL INDICATOR ALARM
- LICA - LEVEL INDICATOR CONTROL ALARM
- LT - LEVEL TRANSMITTER
- MSS - MANUAL SELECTOR SWITCH
- P. - PLUG VALVE
- PC - PRESSURE CONNECTION
- PCDI - PRIMARY COOLANT DRAIN (INSIDE)
- PCS - POWER CALCULATOR SYSTEM
- PCV - PRESSURE CONTROL VALVE
- PCW - PRIMARY COOLANT WATER
- PHA - PH AMPLIFIER
- PHE - PH ELEMENT
- PHRA - PH RECORDING ALARM
- PICA - PRESSURE INDICATOR CONTROL ALARM
- PCDO - PRIMARY COOLANT DRAIN (OUTSIDE)
- TCV - TEMPERATURE CONTROL VALVE
- LI - LEVEL INDICATOR
- LAS - LEVEL ALARM SIGNAL
- DPAS - DIFFERENTIAL PRESSURE ALARM SWITCH
- PT - PRESSURE TRANSMITTER
- RA - RADIATION ALARM
- RDE - RADIATION DETECTOR ELEMENT
- RR - RADIATION RECORDER
- RTD - REACTOR TOP DRAIN
- SV - SOLENOID VALVE (3 WAY)
- TE - TEMPERATURE ELEMENT
- TI - TEMPERATURE INDICATOR
- TR - TEMPERATURE RECORDER
- TRCA - TEMP. RECORDER CONTROL ALARM
- WB - WARM BUILDING DRAIN
- PANEL MOUNTED INSTRUMENT
- LOCALLY MOUNTED INSTRUMENT
- PROCESS LINES
- INSTRUMENT AIR LINES
- INSTRUMENT ELECTRICAL LINES
- PNEUMATICALLY OPERATED VALVE
- REACTOR PANEL MOUNTED
- ELECTRICALLY OPERATED VALVE

REVISIONS

NO.	DATE	DESCRIPTION	LOC.	APPVD.	AEC APPVD.
4	8-8-56	REVISED VALVES TO CARBON STEEL	G-6		PLR
		DELETED 1/2" WB PER DETAIL DWG	H-7		
3	7-19-56	ADDED CONTROL LINE BETWEEN [illegible]	[illegible]		PLR
2	6-18-56	RELOCATED EMERGENCY & SHUTDOWN LINE	[illegible]	WM	PLR
		RELOCATED PRESSURE SURGE TANK	I-6		
		ADD. SAFETY RELIEVE VALVES	[illegible]		
1	4-17-56	GENERAL REVISIONS		WM	PLR
		ADDED LI & LAS			
		DELETED "STAND-BY" DESIGNATION			
		RELOCATED "LIA", ADDED REDUCERS	H-3		
		ADDED ORIFICE & VALVE	C-7		
		REMOVED HOLD AREAS	F-1		

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REF. NO.		DWG. NO.
1	FIRE PROTECTION & DOMESTIC WATER PIPING PLANS & DETAILS	ETR 5528 MTR 201-13
2	DEMINERALIZER ADDITION WATER SYSTEM P & I DIAGRAM	ETR 5528 MTR 608-P6
3	LIQUID WASTE DISPOSAL FLOW DIAGRAM	ETR 5528 MTR 642-P7
4	PROCESS WATER CONTROL PANEL ARRANGEMENT	ETR 5528 MTR 644-T-2
5	PRIMARY COOLANT BYPASS DEMINERALIZER P & I.D.	ETR 5528 MTR 644-P35
6	PLANT & INST. AIR PIPING P & I D	ETR 5528 MTR 609-P4
7	INSTRUMENT LINE SCHEDULE	ETR 5528 MTR 644-T6
8	SECONDARY COOLANT SYSTEM P & I D	ETR 5528 MTR 644-P-27

	BY	DATE
DRAWN	J.B.C.	10-18-55
CHECKED	H.B.L.	2-20-56
APPROVED	[illegible]	2-22-56
APPROVED	[illegible]	2-23-56
APPROVED	[illegible]	2-23-56
APPROVED	[illegible]	2-27-56
APPROVED		
AEC APPROVED		
AEC APPROVED	P.L.R.	2-29-56
SCALE: NONE		
DATE: 2-29-56		

E.T.R. M.T.R. 644

PRIMARY COOLANT SYSTEM PIPING & INSTRUMENT DIAGRAM

KAISER ENGINEERS
DIVISION OF HENRY J. KAISER COMPANY
OAKLAND, CALIFORNIA

FOR

U. S. ATOMIC ENERGY COMMISSION
IDAHO OPERATIONS OFFICE
IDAHO FALLS, IDAHO

DWG. No. ETR-5528-MTR-644-P26 (4)

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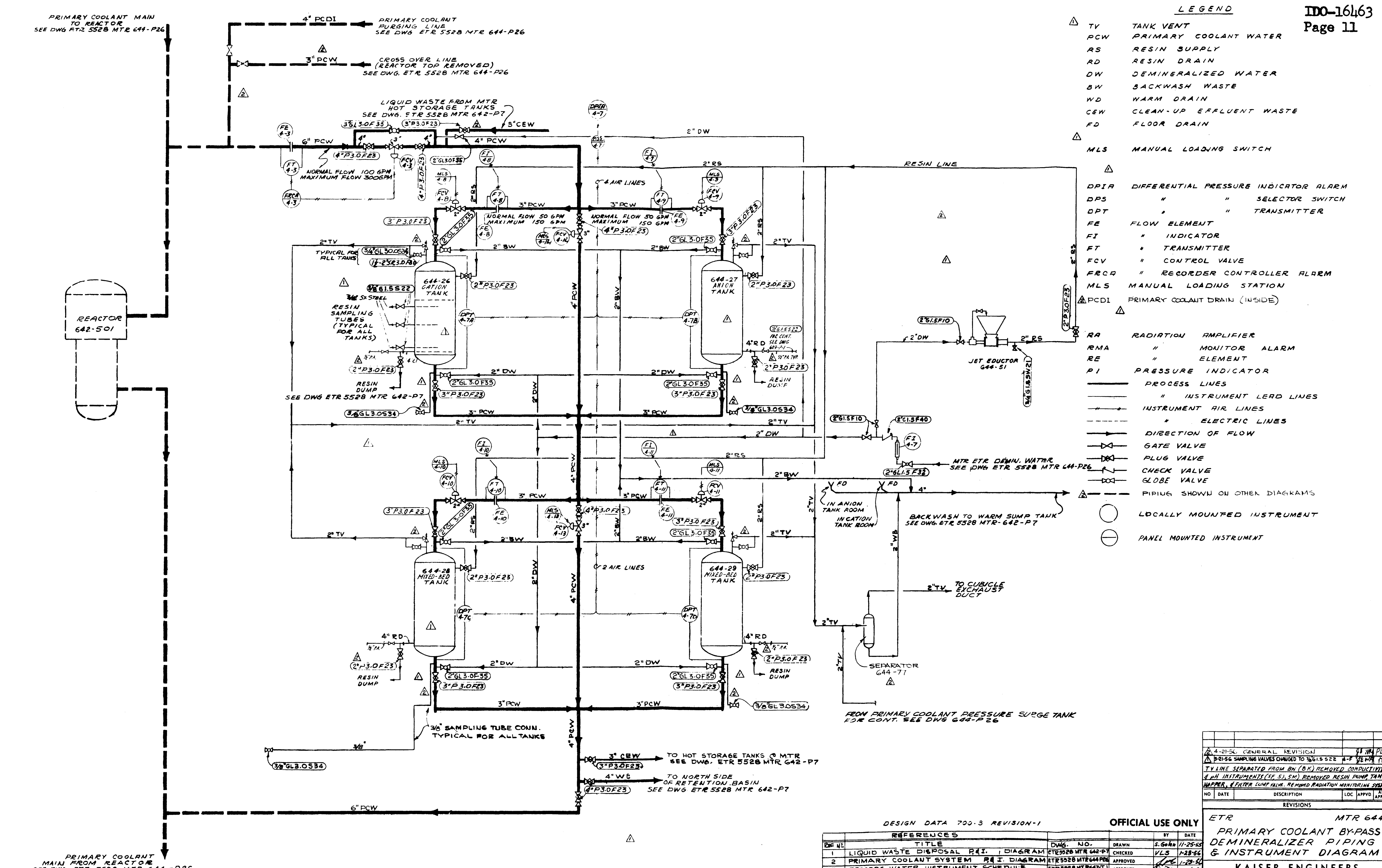

NO.	DATE	DESCRIPTION	LOC.	APPVD.	AEC APPVD.
2	4-21-56	GENERAL REVISION			PLR 4-24
1	3-21-56	SAMPLING VALVES CHANGED TO 3/8"G1.5 S22	4-F		3-27
		TV LINE SEPARATED FROM BW (BK) REMOVED CONDUCTIVITY & pH INSTRUMENTS (5F, 5J, 5M) REMOVED RESIN PUMP, TANK, HOPPER, & FILTER CUMP VALVE. REMOVED RADIATION MONITORING SYSTEM			

REVISIONS

DESIGN DATA 700-3 REVISION-1

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REF NO.	REFERENCES TITLE	DWG. NO.
1	LIQUID WASTE DISPOSAL P&I. DIAGRAM	ETR 5528 MTR 642-P7
2	PRIMARY COOLANT SYSTEM P&I. DIAGRAM	ETR 5528 MTR 644 P26
3	PROCESS WATER INSTRUMENT SCHEDULE	ETR 5528 MTR 647-T1
4	PROCESS WATER CONTROL PANEL ARRANGEMENT	ETR 5528 MTR 644-T2
5	PLANT & INSTRUMENT AIR-PIPING & INSTRUMENT DIAGRAM	ETR 5528 MTR 609-P-1

	BY	DATE
DRAWN	S. Golan	11-25-55
CHECKED	VLS	1-23-56
APPROVED		1-23-56
APPROVED		1-24-56
APPROVED		1-25-56
APPROVED		1-24-56
APPROVED		
AEC APPROVED		
AEC APPROVED		1-27-56

SCALE: None
DATE: 1-27-56

ETR MTR 644

PRIMARY COOLANT BY-PASS DEMINERALIZER PIPING & INSTRUMENT DIAGRAM

KAISER ENGINEERS
DIVISION OF HENRY J. KAISER COMPANY
OAKLAND, CALIFORNIA
FOR
U. S. ATOMIC ENERGY COMMISSION
IDAHO OPERATIONS OFFICE
IDAHO FALLS, IDAHO

DWG. No. ETR 5528 MTR 644 P-35 REV. 2

IDO-16463 ERRATUM

Page 6, Part V. Gaseous Activity, line 4 -- make read:

".... activity decreased appreciably over what it had been with the 80 megawatt core loading when the reactor was operated with the 175 megawatt core loading; at 80 megawatt operation of the 175 megawatt core the activity discharged to the ....."

Phillips 66