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RECIP.NAME	RECIPIENT AFFILIATION

SUBJECT: LER 92-017-00:on 920508,personnel determined that heat removal capability of Train "A" RHR heat exchanger less than design allowable.Caused by insufficient monitoring of Plant components.Corrective actions not required.W/920623 ltr.

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WASHINGTON PUBLIC POWER SUPPLY SYSTEM

P.O. Box 968 • 3000 George Washington Way • Richland, Washington 99352

June 23, 1992
G02-92-149

Docket No. 50-397

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U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

SUBJECT: NUCLEAR PLANT WNP-2, OPERATING LICENSE NPF-21 LICENSEE EVENT REPORT NO. 92-17

Transmitted herewith is Licensee Event Report No. 92-17 for the WNP-2 Plant. In conversation with P. Johnson and K. Perkins on May 26, 1992, an extension to June 23, 1992, for reporting this condition was requested and received. This report is submitted in response to the report requirements of 10CFR50.73 and discusses the items of reportability, corrective action taken, and action taken to preclude recurrence. A supplement will be provided if significantly new or different information becomes available during the completion of the corrective actions identified herein.

Sincerely,

LT Harold for

J. W. Baker
WNP-2 Plant Manager (Mail Drop 927M)

JWB/REF/cgek
Enclosure

cc: Mr. J. B. Martin, NRC - Region V
Mr. C. Sorensen, NRC Resident Inspector (Mail Drop 901A, 2 Copies)
INPO Records Center - Atlanta, GA
Mr. D. L. Williams, BPA (Mail Drop 399)

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LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
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TITLE (4)
FOULING OF RESIDUAL HEAT REMOVAL (RHR) TRAIN "A" HEAT EXCHANGER ON STANDBY SERVICE WATER (SSW) SIDE

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAMES	DOCKET NUMBER(S)
0 5	0 8	9 2	9 2	-- 0 1 7	-- 0 0	0 6	2 3	9 2		0 5 0 0 0
										0 5 0 0 0

OPERATING MODE (9): 5

POWER LEVEL (10): 0 0 0

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)

20.402(b)	20.405(C)	50.73(a)(2)(iv)	77.71(b)
20.405(a)(1)(i)	50.36(c)(1)	X 50.73(a)(2)(v)	73.73(c)
20.405(a)(1)(ii)	50.36(c)(2)	50.73(a)(2)(vii)	OTHER (Specify in Abstract below and in Text, NRC Form 366A)
20.405(a)(1)(iii)	X 50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	
20.405(a)(1)(iv)	50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)	
20.405(a)(1)(v)	50.73(a)(2)(iii)	50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER
R. E. Fuller, Compliance Engineer	AREA CODE 5 0 9 3 7 7 - 4 7 3 7

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS

SUPPLEMENTAL REPORT EXPECTED (14)

YES (If yes, complete EXPECTED SUBMISSION DATE) X NO

EXPECTED SUBMISSION DATE (15) MONTH DAY YEAR

ABSTRACT (16)

On May 8, 1992, Supply System personnel determined from thermal performance tests that the heat removal capability of the Train "A" Residual Heat Removal (RHR) heat exchanger was less than the design allowable. During shutdown of the Plant on April 19, 1992, degraded heat transfer performance was observed for the RHR "A" heat exchanger while in the Shutdown Cooling mode. Thermal performance tests had been conducted on this heat exchanger just prior to this observation. Analyses of the test data were promptly initiated by management. The results indicated that the RHR "A" heat exchanger was unable to perform its safety function under design basis conditions.

The root cause of this event is insufficient monitoring of Plant components. Monitoring of the Standby Service Water (SSW) System was not adequate in predicting fouling magnitude and rates experienced in the system.

Immediate corrective actions were not required because RHR "B" was available and capable of providing decay heat removal and cool down of the Reactor.

Due to the significant implications of fouling on equipment served by SSW, management initiated a corrective action program. Corrective actions were implemented to test, inspect and clean affected equipment. Evaluations are being conducted on the SSW treatment program to identify improvements to preclude recurrence. A consultant has been retained to assist.

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (8) Year	Number	Rev. No.	PAGE (3)
Washington Nuclear Plant - Unit 2	0 5 0 0 0 3 9 7	9 2	0 1 7	0 0	2 OF 10

TITLE (4)
FOULING OF RESIDUAL HEAT REMOVAL (RHR) TRAIN "A" HEAT EXCHANGER ON STANDBY SERVICE WATER (SSW) SIDE

Testing and inspection of several heat exchangers served by SSW were planned for the 1992 Refueling Outage. Fouling from SSW would probably have been identified and corrected prior to startup. This condition posed no threat to the health and safety of the public or Plant personnel. There were no events during the time period this condition existed that required the RHR System to perform its safety function.

Plant Conditions

Power Level - 0%
Plant Mode - 5 (Refueling)

Event Description

On May 8, 1992, Supply System personnel determined from thermal performance tests that the heat removal capability of the Train "A" Residual Heat Removal (RHR) heat exchanger was less than the design allowable. During shutdown of the Plant on April 19, 1992, degraded heat transfer performance was observed for the RHR "A" heat exchanger while in the Shutdown Cooling mode. Thermal performance tests had been conducted on this heat exchanger just prior to this observation. Analyses of the test data were promptly initiated by management. The results indicated that the RHR "A" heat exchanger was unable to perform its safety function under design basis conditions.

During shutdown of the Plant for the annual refueling and maintenance outage, RHR "A" was placed in the Shutdown Cooling mode. The Reactor Operators were able to achieve a peak cool down rate of the Reactor of only 10°F/hr.

RHR Train "A" was subsequently shutdown, and RHR Train "B" was placed in the Shutdown Cooling mode. Even though more capacity was available, the Reactor Operators chose and readily achieved a cool down rate of 20°F/hr with RHR "B". A faster cool down rate was not required because the Reactor coolant temperature was much lower than 200°F.

Immediate Corrective Action

Since Operations readily achieved a cool down rate of 20°F/hr without full closure of the bypass valve, the heat removal capability of the RHR "B" heat exchanger was acceptable. Plant shutdown continued normally. No further immediate corrective actions were required.

Further Evaluation and Corrective Action

A. Further Evaluation

1. This event is considered reportable per 10CFR50.73(a)(2)(v)(B) as a condition alone that could have prevented the fulfillment of the safety function of the RHR System from removing residual heat. On March 24, 1992, while the Reactor was in Mode 1, RHR Train "B" was placed in the Fuel Pool Cooling (FPC) Assist mode. While in the FPC assist mode, RHR "B" is not immediately available for residual heat removal. Valves have to be manually realigned to perform the Shutdown Cooling function. This left RHR "A" to provide the required residual heat removal capability. Since the RHR "A" heat exchanger may have been degraded to the point of being unable to perform its safety function during this period of time, no operable RHR subsystem was readily available if needed.

   This event is also considered reportable per 10CFR50.73(a)(2)(i)(B) as a condition prohibited by the Plant's Technical Specifications, Section 3.5.1 (ECCS - Operating). The Limiting Condition for Operation (LCO) for this section was not met.

   The NRC was initially notified of the observed degraded capacity of the RHR "A" heat exchanger at 1215 hours PST on April 24, 1992. The NRC was verbally notified to confirm the degraded condition of the RHR "A" heat exchanger at 1200 hours PST on May 8, 1992, per 10CFR50.72(b)(2)(iii)(B) as a condition alone that could have prevented the fulfillment of the safety function of the RHR System from removing residual heat.

2. There were no structures, components, or systems inoperable prior to the discovery of the condition which contributed to the condition.

3. The RHR System has two heat exchangers, one for RHR "A" and one for RHR "B", which remove heat from the shell side fluid. The shell side fluid is the reactor coolant. The tube side fluid is Stand-By Service Water (SSW). The heat exchangers are a "vertical U-tube in shell" type with service water passing through the U-tubes via the tube sheet at the bottom. The "U" portion of the tubes is at the top of the heat exchanger precluding silt deposits from occurring. The fluid being cooled enters the shell from the top and exits at the bottom just above the tube sheet.

4. The attached Figure 1 depicts the Shutdown Cooling mode of Trains "A" and "B" of the RHR System. Each of the two heat exchangers have a bypass throttle valve (RHR-V-48A/B) and an outlet throttle valve (RHR-V-3A/B) on the shell side. They are used to control the amount of reactor coolant flowing through the heat exchanger. The valves are throttled to achieve the desired heat removal rate for the given heat exchanger.

The administrative cool down rate limit for the reactor coolant is 80°F/hr. The Technical Specification limit is 100°F/hr. With RHR Train "B" in the Shutdown Cooling mode between 0604 hours and 1043 hours on April 19, 1992, the initial cool down rate of the reactor coolant from approximately 280°F was observed to be approximately 40°F/hr. The bypass valve, RHR-V-48B, was open. This indicates that the heat exchanger was not being used to its full thermal capacity. Yet, an acceptable cool down rate was achieved.

The Shutdown Cooling function was later transferred to RHR Train "A" at 1107 hours the same day to perform thermal performance testing of the "A" heat exchanger. The test required throttling the bypass and outlet valves until near steady-state conditions were achieved, i.e., the heat removal rate was equivalent to the decay heat generation rate.

Upon completion of the test, cool down of the reactor coolant was resumed using RHR "A". The associated bypass valve was closed down further to increase the heat removal rate. However, the cool down rate did not increase significantly as the bypass valve was closed. In an attempt to achieve increased cooling, the Reactor Operator closed the bypass valve until the panel lights indicated "closed". A throttle valve may be as much as 10% open when the panel lights indicate closed. Therefore, the Operator held the switch in the closed position a few seconds longer in an attempt to assure full closure. The peak cool down rate achieved by RHR "A" was approximately 10°F/hr.

Due to the slow cool down rate, RHR "A" was shutdown at 1346 hours April 19, 1992, and RHR "B" was restarted at 1428 hours the same day. The chosen cool down rate of approximately 20°F/hr was readily achieved by RHR "B".

The associated bypass valve for RHR "B" indicated partially open during the 20°F/hr cool down rate. When the RHR "A" heat exchanger was being used and could only achieve a 10°F/hr cool down rate, the panel lights indicated the bypass valve was closed. Consequently, it is surmised that even if the RHR "A" bypass valve was partially open, it was further closed than the RHR "B" bypass valve. The result would be less bypass flow around the "A" heat exchanger. This provides further indication that the RHR "A" heat exchanger may have been more degraded than RHR "B".

5. The Supply System personnel analyzed the RHR "A" heat exchanger flow and temperature data. The increase in thermal resistance was determined to exceed the allowable value. The thermal performance data were also analyzed by a consultant. The calculated thermal resistances were similar.

The heat transfer surfaces of a heat exchanger may become coated with various deposits present in the flow systems after a period of time of operation. This coating represents an additional resistance to the heat flow, and thus results in decreased performance. The overall effect is represented by a fouling resistance, or fouling factor.

The design basis allowable fouling factor for the RHR heat exchanger tubes is 0.0026 hr-ft^2-°F/Btu based upon the inside diameter of the tubes. The fouling factor for the RHR "A" heat exchanger for the as-found condition was calculated to be 0.0044 hr-ft^2-°F/Btu. Since the calculated value exceeded the allowable value, the heat exchanger was determined to be unable to perform its safety function and declared inoperable for power operations. The heat exchanger was capable of performing its function during shutdown (Modes 4 & 5) because of the lower heat loads.

Based on the flow and temperature data for the RHR Train "B" heat exchanger, the fouling factor was calculated to be 0.0024 hr-ft^2-°F/Btu. Since this value was less than the allowable fouling factor of 0.0026 hr-ft^2-°F/Btu, the RHR "B" heat exchanger was capable of performing is safety function.

6. Inspection of the RHR Train "A" heat exchanger tubes revealed some biological fouling on the inside surface of the tubes and on the tubesheet of the discharge end. Based on visual examination, the coating consisted of silt trapped within a slime matrix. The slime is believed to have originated from a slime forming bacteria within the SSW Spray Pond water. The inlet end of the tubes were relatively free of biological fouling. There was no evidence of scale or tube side corrosion.

   Chemical samples were taken of the coating found on the inside of the tubes to RHR-HX-1A. The results confirmed the fouling was biological in nature.

   Eddy current testing was performed on 335 of the 750 tubes in the heat exchanger. The integrity of the tubes tested was found to be satisfactory.

7. Performance data showed that the Diesel Cooling Water (DCW) heat exchanger for the High Pressure Core Spray (HPCS) diesel engine, DCW-HX-1C, was performing adequately but the capacity was on a downward trend. Inspection of the heat exchanger revealed some biological fouling of the tube surfaces on the SSW side similar to that found on the RHR Train "A" heat exchanger.

8. The root cause of this condition is **Plant Equipment/Plant/System Operation/Insufficient Monitoring of Plant Components.** The SSW System was not adequately monitored to assess the magnitude and rate of fouling buildup. Therefore, appropriate corrective actions were not implemented to minimize or preclude degradation of SSW equipment. In addition, performance monitoring techniques of the SSW heat exchangers were inadequate to accurately predict the amount of fouling that had occurred.

9. The fouling factors calculated for the RHR "A" and "B" heat exchangers were based primarily on the equilibrium thermal performance tests. The slow cool down rate observed on the RHR "A" heat exchanger simply prompted analyses of the test results to be performed earlier than planned by several days. Therefore, the thermal performance monitoring tests would have prompted further investigation and ultimate identification of biofouling from the SSW System.

   In addition, thermal performance tests were scheduled for all water-to-water heat exchangers (RHR-HX-1A, 1B; DCW-HX-1A1, 1A2, 1B1, 1B2, & 1C) during the 1992 Refueling Outage. Inspection of DCW-HX-1A1 and -1A2 heat exchangers was also scheduled for this outage. The inspection results would have also indicated biofouling from the SSW System. Therefore, the heat exchanger performance monitoring and inspection programs in place at WNP-2 prior to the event would probably have identified and prompted the same corrective actions that are currently being taken to restore degraded equipment, verify acceptability, and preclude recurrence.

B. Corrective Action Taken

1. Management recognized the potential effect biofouling from SSW could have on redundant safety related equipment. As a result, a corrective action program was immediately initiated to more accurately assess the degradation on associated equipment through tests and inspections. Cleaning was initiated to restore degraded equipment. A consultant has been retained to assist in the development of a corrective action program to correct biofouling in the SSW heat exchangers.

2. The inside surfaces of all of the tubes in the RHR "A" heat exchanger were mechanically cleaned of the biological fouling. An internal inspection of selected tubes using a boroscope revealed the tubes had been cleaned of fouling.

   A boroscope inspection of a limited area of the shell side surface of the tubes revealed no visible fouling on the tubes. Based upon the mechanical cleaning and inspections, the RHR "A" heat exchanger was reassembled, declared operable, and returned to service.

3. Since the fouling factor calculated from performance test data for the RHR-HX-1B was close to exceeding the allowable value, acceptable performance could not be assured through the next operating cycle. The SSW side of the RHR-HX-1B heat exchanger was opened for inspection and cleaning. The inside surface of the tubes biofouled similarly to RHR-HX-1A.

   Chemical samples were taken of the coating. The results of the analyses are pending. All of the tubes were mechanically cleaned. Eddy current testing was performed on 270 of 750 tubes. All tubes tested were found to be in satisfactory condition.

4. The HPCS DCW heat exchanger, DCW-HX-1C, was mechanically cleaned and inspected for tube integrity using the eddy current testing method. Based on the cleaning and the inspection, the heat exchanger was determined capable of performing its safety function.

5. As-found thermal performance testing was conducted on the remaining four (4) DCW heat exchangers. Some degradation in performance was identified, but the heat exchangers were determined to be capable of transferring their required design heat loads.

   Tube side inspection of the four DCW heat exchangers revealed similar biofouling to that found in the HPCS DCW heat exchanger. All of the DCW heat exchangers were cleaned, eddy current inspected and reassembled. Thermal performance testing after cleaning indicated the heat exchangers were restored to performance levels equivalent to previous tests of clean heat exchangers.

6. Differential pressure for both the tube side and the shell side of RHR "A" and RHR "B" was measured. The values for both heat exchangers were essentially equivalent to the manufacturer's predicted values.

7. Differential pressure tests of all air-to-water heat exchangers per our commitment to Generic Letter 89-13 were planned to be completed after the 1992 Refueling Outage. However, differential pressure tests were performed on 3 heat exchangers (RRA-CC-1, RRA-CC-12 & WMA-CC-53B1) during the outage. The differential pressure tests of the air-to-water units, did not provide any clear trend.

8. As-found inspection on three air-to-water heat exchangers (DMA-CC-31, RRA-CC-6, & RRA-CC-5) revealed deposits of zinc anode corrosion products and biological film. The deposits were not significant enough to cause reduced SSW flow through the heat exchanger, but would affect the heat transfer to some degree. All 28 of the air-to-water heat exchangers were scheduled to be cleaned prior to startup from the 1992 Refueling Outage. To date 20 have been cleaned and post cleaning inspections revealed almost all of the fouling material has been removed.

9. Thermal performance test were performed on two air-to-water heat exchangers ("A" and "B" SSW pumphouse room coolers) in the as-found condition. Results of both revealed degraded performance, but performance was adequate to remove design heat loads and maintain room temperatures within design limits. A post-cleaning test was performed on the "B" pumphouse room cooler. The cooler's performance improved to 100% of the manufacturer's design capability and considerably greater than design requirements. The "A" pumphouse room cooler will be tested after cleaning but prior to startup.

C. Further Corrective Action

1. Temporary biofouling monitoring equipment is being installed to provide data to assess the fouling tendencies of SSW on plant heat exchangers. A consultant is assisting in the setup of this equipment and will be assisting in evaluation of monitoring data. The equipment will be functional by August 30, 1992.

2. The biofouling monitoring program of the SSW System will be evaluated and recommendations for improvement will be provided by October 31, 1992.

3. The water treatment program of the SSW ponds will be evaluated and short term plans for improvement will be provided by August 1, 1992. We expect this program to be on-going, which will include the development and implementation of long-term plans.

4. Performance monitoring methods of all SSW heat exchangers will be evaluated and recommendations for improvement will be provided by September 1, 1992.

Safety Significance

Both RHR "A" heat exchanger was degraded and "B" was considered unavailable at the same time during full power operation. However, if Reactor Building environmental conditions were acceptable during an accident, RHR "B" could have been manually realigned from the FPC assist mode.

The RHR "A" heat exchanger was determined to be unable to perform its safety function for a design basis accident. Specifically, the heat exchanger may not have been able to remove enough residual heat following a LOCA with the Suppression Pool and the SSW pond temperature at their design basis limits. However, the probability of these high temperatures occurring is extremely low. Under most postulated design basis events, the Suppression Pool temperature remains well below the design basis limits. Based on engineering judgement, the heat exchanger would have performed its safety function under those postulated events.

The bypass valve RHR-V-48A may have been partially open, although panel lights indicated the valve was closed. A partially open bypass valve decreases the heat transfer capability of the heat exchanger. However, actual valve position was not verified.

There were no events during the time period the heat exchanger may have been inoperable that required the RHR to perform its safety function. Consequently, this condition is determined to have minimal safety significance.

Similar Events

There were no similar events.

EIIS Information

Text Reference	EIIS Reference System	Component
Diesel Cool Water System Heat Exchanger	LB	HX
Diesel Building HVAC Heat Exchanger	VJ	HX
High Pressure Core Spray System	BG	
RHR/Containment Spray Heat Exchanger	BO	HX
Reactor Building HVAC Heat Exchanger	VA	HX
Essential Service Water System	BI	

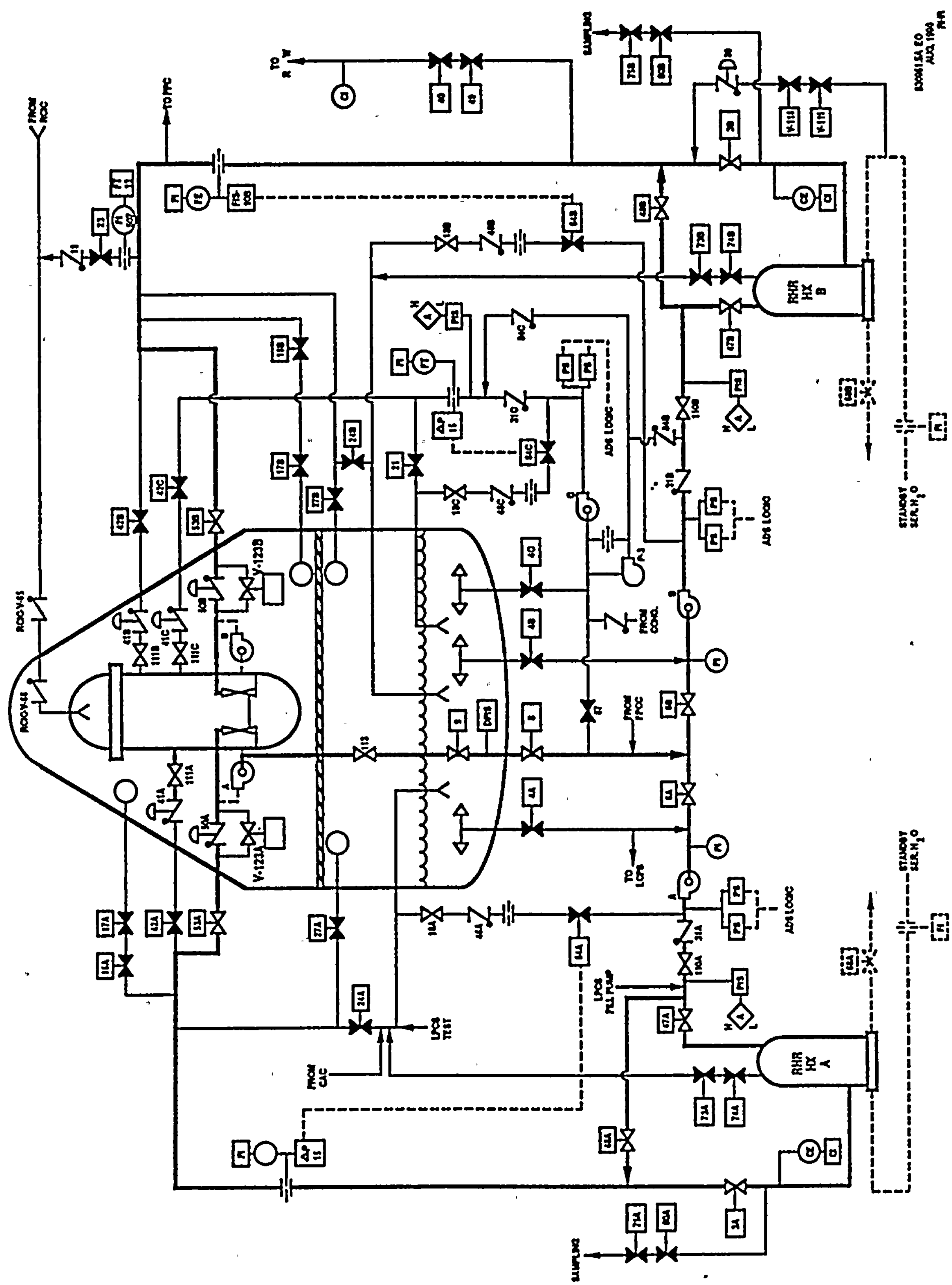

FIGURE 1 RHR SYSTEM SHUTDOWN COOLING MODE