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JAFP-93-0105

United States Nuclear Regulatory Commission
Document Control Desk
Mail Station P1-137
Washington, D.C. 20555

SUBJECT: DOCKET NO. 50-333
LICENSEE EVENT REPORT: 88-009-02 - Potential Inadequate Cooling of ECCS Due to Procedure Inadequacies

Dear Sir:

This updated report is submitted in accordance with 10 CFR 50.73(a)(2)(v) and (vii).

Questions concerning this report may be addressed to Mr. W. Verne Childs at (315) 349-6071.

Very truly yours,

HARRY P. SALMON, JR.

HPS:WVC:tld
Enclosure

cc: USNRC, Region 1
USNRC Resident Manager
INPO Records Center

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NRC FORM 366 (6-89)

U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER)

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TITLE (4)
Potential Inadequate Cooling of ECCS Due to Procedure Inadequacies

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)
1 0	2 1	8 8	8 8	0 0 9	0 2					0 5 0 0 0
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OPERATING MODE (9): N

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)	[ ]	73.71(b)
[ ]	20.405(a)(1)(i)	[ ]	50.36(c)(1)	[X]	50.73(a)(2)(v)	[ ]	73.71(c)
[ ]	20.405(a)(1)(ii)	[ ]	50.36(c)(2)	[X]	50.73(a)(2)(vii)	[ ]	OTHER (Specify in Abstract below and in Text, NRC Form 366A)
[ ]	20.405(a)(1)(iii)	[ ]	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
W. Verne Childs, Senior Licensing Engineer	AREA CODE 3 1 5 3 4 9 - 6 0 7 1

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
X	K G	V	V 0 8 5	Y					

SUPPLEMENTAL REPORT EXPECTED (14)

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

EXPECTED SUBMISSION DATE (15): MONTH | DAY | YEAR

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines) (16)

UPDATE REPORT - PREVIOUS REPORT DATE 6/15/89

EIIS Codes are in []

On 10/21/88, while shutdown for refuel, plant personnel found part of one unit cooler in the Reactor Building [NG] ventilation system [VA] blank flanged out of service. In addition, extensive fouling of unit coolers by mud and silt was revealed. The unit coolers are required to be operable by Technical Specification 3.11.B to provide cooling of Engineered Safety Features Residual Heat Removal/Low Pressure Coolant Injection [BO], Low Pressure Core Spray [BM], High Pressure Coolant Injection [BJ], Reactor Core Isolation Cooling [BN], and portions of several support systems during normal and accident conditions.

Correction of deficiencies, modifications, thermal performance monitoring, and reevaluation of cooling requirements restored unit coolers to operable status and verified adequate capacity.

Procedure deficiencies were the primary cause. Design deficiencies were contributing causes.

LER-88-005 and 88-008 are similar events.

UPDATE REPORT - PREVIOUS REPORT DATE June 15, 1989

EIIS Codes are in []

Description of Event

While shutdown for refuel, maintenance, and modification, a check valve in the Normal Service Water [KG] supply to the Division I unit coolers was found inoperable during Inservice Test (IST) disassembly and inspection on September 30, 1988. The valve internals were heavily corroded and the valve was stuck approximately one-fourth open. This discovery by itself was not a condition requiring submittal of a Licensee Event Report (LER) because of the redundant cooling water supply to Division II unit coolers. Investigation of the root cause of the event and review of prior history as well as unit cooler performance testing was initiated as a result.

On October 21, 1988, during performance testing, plant personnel found the lower cooling coils on unit cooler 66UC-22J had been removed from service by use of a blank flange in the cooling water return line. Each unit cooler is provided with both an upper and lower cooling coil assembly, and each assembly consists of two series connected coil banks. The upper cooling coil of unit cooler 66UC-22J was properly connected the cooling water inlet and return lines. Unit cooler 66UC-22J is part of the Reactor Building [NG] (Secondary Containment) Ventilation System [VA].

Engineered Safety Features Residual Heat Removal (RHR)/Low Pressure Coolant Injection (LPCI) [BO], Low Pressure Core Spray (LPCS) [BM], High Pressure Coolant Injection (HPCI) [BJ] and Reactor Core Isolation Cooling (RCIC) [BN] pumps, motors, turbines and valves are located in a crescent-shaped area at the lowest level of the Reactor Building [NG] adjacent to the Primary Containment (Reactor Containment Building [NH]) Pressure Suppression Pool.

The crescent area is cooled by ten (10) unit coolers and is divided into two sections partially separated by a flood wall. Some additional cooling is provided for both safety divisions by a supply of fresh air. Each crescent area section contains one safety division of RHR/LPCI, LPCS, HPCI and RCIC [BO, BM, BJ and BN].

The crescent area also contains portions of several other support systems.

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TEXT (If more space is required, use additional NRC Form 366A's) (17)

These systems include the following:

- Part of the instruments and controls which make up the Engineered Safety Feature Actuation Systems (ESFAS) [JE].
- The Reactor Building Equipment and Floor Drain Sumps [WK] and part of the associated instrument and control systems.
- Part of the Reactor Recirculation System [AD] instrument and control system.
- Portions of Class IE Medium Voltage Power Systems [EB] such as 4160 VAC power cables to large pump motors.
- Portions of Class IE Low Voltage Power Systems [ED] such as 600 VAC motor control centers, power cables to small pump motors, and motor operated valves.
- Portions of Class IE DC Power Systems [EJ] such as motor control centers and power cables to small 125 VDC pumps and motor operated valves.

Crescent area unit coolers are normally supplied cooling water from the Normal (non-essential) Service Water System [KG]. In the event of loss of Normal AC Power [EK], Emergency Service Water (ESW) [BI] automatically provides cooling water to the crescent area unit coolers. Each unit cooler is provided with backup cooling water from the ESW system in the same division. Check valves in both the normal service water and ESW supplies to the unit coolers are provided to prevent diversion of cooling water from the operating supply to the idle supply.

Each unit cooler was provided with a fan powered from the Class IE Low Voltage Power System (600 VAC) [EC] and a temperature control valve in the cooling water flow path which modulates to control air temperature at the point corresponding to the setting of a local thermostat. The fan on each unit cooler operated continually with power provided from the same division as the systems which it cools.

Technical Specification 3.11.B requires crescent area ventilation (unit coolers 66UC-22A, B, C, D, E, F, G, H, J & K) to be operable on a continuous basis whenever RHR/LPCI [BO], LPCS [BM], HPCI [BJ] or the primary containment (Reactor Containment Building [NH]) cooling mode of RHR is required to be operable. Technical Specification 3.11.B

allows one unit cooler serving a division to be out of service indefinitely. When two or more unit coolers for one division are out of service, the engineered safety features systems (LPCI, LPCS, HPCI and RHR containment cooling mode) in the same division are considered inoperable. Technical Specification 3.5.A.6, 3.5.B.5, and 3.5.C.1.b require plant shutdown and cooldown to the cold condition within 24 hours when more than one of the engineered safety features (LPCI, LPCS, HPCI, and RHR containment cooling mode) is inoperable. Since unit cooler 66UC-22J was found to have diminished cooling capability due to one of the two cooling coils being out of service since the fall of 1981 (see "Cause of Event" for additional information), planned or corrective maintenance which removed additional Division I unit coolers from service resulted in operation of the plant with two unit coolers in Division I being out of service.

Discovery of part of one unit cooler being out of service due to the blanked cooling water return line was the result of inspection, testing, and cleaning of the unit coolers due to the earlier indication of an inoperable normal service water check valve discovered during Inservice Test (IST) and inspection. Review of plant records determined that prior indications, now viewed in hindsight, possibly identified earlier problems. These include:

- An engineering study performed in 1987 primarily to provide accurate, up-to-date information on the effluent flow of Reactor Building Ventilation [VA], Turbine Building Ventilation [VK] and Radwaste Building Ventilation [VH] also noted that crescent area unit coolers and a number of other unit coolers apparently had low cooling water flow as indicated by small differential temperatures across the air side of the unit coolers. Due to a lack of instrumentation for measuring unit cooling performance data and the historical method of determining unit cooler operability during surveillance testing, this indication of a problem was treated as a standard (routine) work item. The unit coolers were subsequently backflushed using the same method which had been used for years.

- ESW [BI] check valves that supply cooling water to ventilation coolers for the electric bays were found inoperable due to an accumulation of scale and mud during February 1987. (Refer to LER-88-005 for additional details).

The performance testing, which was initiated as a result of the unit cooler problems, measured air flow, air and cooling water inlet temperatures, and air and cooling water outlet temperatures of each unit cooler while the temperature control valve was fully open. Measured air flow was between 85% and 103% of design. Calculated cooling water flows indicated that two unit coolers in each division had flows at or near zero. The calculated average cooling water flow for the remaining six unit coolers (3 in each division) was approximately 8.6 gpm. Only one unit cooler had a cooling water flow of more than 50% of the design flow of 24 gpm. It was during this performance testing that the blank flange in the lower cooling coil cooling water return line for unit cooler 66UC-22J was found.

Partial disassembly of cooling water piping, valves, inlet Y-strainers and the unit cooler assemblies revealed accumulations of sludge, sand, and mud. Unit coolers with no cooling water flow were found with plugged Y-strainers or inlet piping. Some of the cooling water tubes were found plugged. Some of the valves and piping revealed indications of hardened deposits of mud. Since the cooling water supply and return piping is large for the required flow rates, cleaning and flushing restored design flow rates.

Finally, during performance testing following cleaning and flushing, unit cooler 66UC-22D was found to have the cooling water supply and return lines improperly connected to the unit cooler. Each unit cooler is designed to approximate a counterflow heat exchanger with the cold inlet cooling water entering the air outlet side of the cooling coils. In the case of 66UC-22D, this arrangement was reversed limiting unit cooler performance to approximately 58% of the original design heat removal capacity. Based on a review of available plant documentation and considering installed adjacent interferences, it is believed that this piping arrangement had existed since initial plant construction.

In order to determine the minimum acceptable performance level (cooling capability) of crescent area coolers necessary for the safety functions to be fulfilled, the nuclear steam supply system vendor (General Electric) and the plant architect-engineer (Stone and Webster Engineering Corporation) evaluated the crescent area cooling requirements and capabilities and found that temperatures in the crescent area would be acceptable for operation of the ECCS under

accident conditions discussed in the Final Safety Analysis Report (FSAR) provided the deficiencies discussed above were addressed. The crescent area temperature would also be acceptable with respect to environmental qualification requirements during the accident conditions described in the FSAR. The evaluation included a number of conservative assumptions including the following:

- Cooling water temperature was assumed to be 82°F which is 5° higher than assumed in the original design.

- Unit cooler thermal efficiency was assumed to be 75%.

- One unit cooler in each half of the crescent area was assumed to be out of service. This is consistent with Technical Specification 3.11.B.1 which allows one unit cooler in each half of the crescent area to be inoperable for an indefinite time period.

- Other systems such as normal ventilation and electric power systems were assumed to be operable (or inoperable), as appropriate, to provide maximum heat input and minimum heat removal.

- Operator actions in response to accidents in accordance with Emergency Operating Procedure (EOPs) were assumed to be conservative with respect to crescent area heat loads. That is, large pump motors, which are the major source of heat, were assumed to be operating for longer time periods that would be expected when EOPs are followed.

In addition to the above listed conservative assumptions, it was assumed that the west half of the crescent is cooled by only 4-1/2 coolers rather than 5 coolers. This assumption was used in the calculations because one (1) of the 5 west crescent area coolers is actually physically located on the center line between the east and west halves of the crescent area.

Cause of Event

The primary cause of the event was inadequate surveillance procedures. Prior to October, 1988, the surveillance test procedure addressed operability of individual unit cooler subcomponents such as fan motors, temperature controllers, and temperature control valves. The testing did not assess air or cooling water temperature changes or flow rates to determine actual unit cooler thermal performance.

Thermal performance testing would have provided direct indication of the improper cooling water arrangements on unit coolers 66UC-22D and -22J and also provided early indication of cooling coil fouling or low cooling water flow conditions.

Design deficiencies were contributing causes. Full cooling water flow is demanded by the temperature controllers only during postulated design basis emergency events such as a loss of coolant accident. During normal plant operations (including normal plant shutdown conditions) the cooling water flow is restricted to a small fraction of design flow resulting in low cooling water velocity that allows suspended solids to foul the unit cooler heat exchanger surfaces and deposition of silt in the cooling water lines resulting in low thermal efficiency.

An installation error during plant construction caused incorrect piping of 66UC-22D. Inadequate test procedures used during preoperational testing (during 1973 and 1974) resulted in the piping error remaining undiscovered until this event. The preoperational test did not measure thermal performance of the unit coolers and was the basis of the surveillance test procedure used until October, 1988.

Deficiencies in modification control procedures and procedures for control of temporary modifications were the primary cause of the undetected blank flanged cooling water line on unit cooler 66UC-22J.

Review of modification documents reveals that the lower cooling water return line was disconnected and blank flanged during an outage in the fall of 1981. The line was disconnected to provide a flow path for the return of cooling water from a temporary air conditioning unit that was installed in support of extensive modification work in the Primary Containment (Reactor Containment Building) [NH] Pressure Suppression Chamber (Torus). The work was part of the upgrade of the Boiling Water Reactor Mark-I Containment System.

Modification procedures and documents used to track the work (including providing cooling water for the temporary air conditioning equipment) provided general instructions for disconnecting and restoring the cooling water return line on unit cooler 66UC-22J but did not provide adequate control of individual activities such as restoration of the cooling water lines. In addition, no specific Quality Control (QC) verification of the restoration of the cooling water lines was provided in the procedures. Restoration work disconnected the line from the temporary air conditioning equipment and failed to reinstall the unit cooler cooling water return line.

Also, personnel performing this work may not have been involved with providing the temporary cooling water some months earlier, and may not have been provided with adequate verbal or written instructions. Post work testing of the unit cooler did not demonstrate thermal performance.

It should also be noted that procedures for the control of jumpers, lifted leads, and blocked relays (temporary modifications), in general, did not adequately address mechanical temporary modifications such as hoses and blanked flanges in 1981 when the temporary modification of the cooling water line was performed as part of other modifications. Significant upgrade of the control of temporary modifications has since been implemented. Current procedural control of temporary modifications and detailed installation procedures for permanent modifications now prevent events of this type and no additional corrective action to prevent recurrence is considered necessary.

Analysis of Event

The crescent area unit coolers provide cooling for the Emergency Core Cooling Systems and portions of other systems as noted above in Description of Event. Operation of the Emergency Core Cooling Systems (ECCS) and supporting components such as the crescent area coolers are required for mitigation of accidents discussed in the Final Safety Analysis Report (FSAR). As a result of the deficiencies, the crescent area coolers could not perform the intended safety functions and the event is reportable under 10CFR50.73 (a)(2)(v) and (vii). That is, the inoperability of the crescent area cooling could result in the RHR/LPCI, Core Spray, HPCI and/or RCIC systems being incapable of performing the intended safety functions of residual heat removal, control of the release of radioactive material and the mitigation of the consequences of an accident as a result of inadequate crescent area cooling.

Corrective Actions

1. The unit cooler 66UC-22J cooling water return piping was restored to its design configuration.

2. The internals of the normal service water check valve in the supply line to the unit coolers were cleaned and restored to an operable condition.

3. Portions of three unit coolers were disassembled and inspected to assess the condition of the cooling water piping to and from the unit coolers and within the unit cooler cooling coils. These internal inspections were also used to assess the effectiveness of the cooling water flushing. Disassembled components were cleaned prior to reassembly.

   Results of the inspections and subsequent thermal performance testing indicates that inservice flushing of the cooling water lines and the cooling coils by fully opening the temperature control valve bypass valve, cooling water inlet valve, and cooling water outlet valves combined with flushing the Y-strainer is an effective method of restoring unit cooler performance.

4. Each of the ten unit coolers was flushed as described above. The Y-strainer in the cooling water inlet line to each unit cooler has been replaced with a new, larger mesh strainer to reduce the potential for plugging. Some cooling water tubes were cleaned and tube air-side fins were brushed and vacuumed. New inlet air filters were installed on all ten unit coolers.

5. Unit cooler 66UC-22D cooling water piping arrangement was modified so that the cooler approximates a counterflow heat exchanger as assumed in the original design.

6. The surveillance test procedure was revised to measure unit cooler thermal performance to verify that it meets design requirements for heat removal and the assumptions used to meet the requirements of 10CFR50.49 (Environmental Qualification).

7. Other susceptible safety-related coolers and heat exchangers have been inspected or their performance assessed with minor problems identified.

8. The revised surveillance test procedure, which measures unit cooler thermal performance was performed at a biweekly interval to obtain performance trend data. The increased test frequency continued until modifications (described in Corrective Action 9 and 10 below) were completed and verified to be effective in maintaining unit cooler thermal performance at an acceptable level. Trending of the thermal performance data continues to be used to establish the minimum acceptable test frequency and to determine when preventive maintenance such as flushing is necessary to maintain adequate crescent area cooling.

9. Crescent area unit coolers were modified to improve the collection of data used to evaluate and trend thermal performance of the coolers.

10. The unit cooler fan and cooling water controls for eight of the ten unit coolers were modified prior to plant startup following the 1990 Refuel Outage to provide full-time (unmodulated) cooling water flow and to cycle the unit cooler fan on demand from the temperature controller. This will mitigate the design deficiency that allows silt accumulation due to low cooling water flow rates and reduce unit cooler air-side fouling.

Additional Information

Failed Components:
- Valve Manufacturer: Velan Valve Corporation
- Valve Model Number: B12-0114B-2T
- Manufacturer NPRD Code: V085

Similar Events:
LER-88-005 reported a similar event in which check valves in the cooling water flow path were not operable.
LER-88-008 reported a similar event in which plant components were not properly restored to service following work.

Reason for update:
Revision 2 to this LER is submitted to correct errors in the event analysis which were noted in NRC Inspection 50-333/92-81. Additional minor changes were made to reflect the current status of corrective actions and reflect the correct event reporting criteria. A vertical bar in the right-hand margin indicates text changes made in this revision except where minor typographical or editorial changes were made.