NRC Form 366 (9-83)

U.S. NUCLEAR REGULATORY COMMISSION
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LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
JAMES A. FITZPATRICK NUCLEAR POWER PLANT	0 5 0 0 0 3 3 3	1 OF 1 1

TITLE (4) Residual Heat Removal, Emergency Diesel Generators, and Fire Pumps Potentially Made Inoperable Due to Inadequate Modification Installation Activities

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 9	0 4	9 1	9 1	— 0 2 1	— 0 0	1 1	2 7	9 1		0 5 0 0 0
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OPERATING MODE (9)	N	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)			
POWER LEVEL (10)	1 0 0	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)	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)	X 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	

SUPPLEMENTAL REPORT EXPECTED (14)

		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE)	X NO				

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

EIIS Codes are in []

The exhaust ventilation fan for one of two safety-related pump rooms tripped on thermal overload at 1400 on 9/4/91 with the plant at full power. The fan trip was the result of a restricted ventilation air supply due to closure of 6 fire dampers to allow modification of the dampers. The restricted air supply resulted in overload during fan auto start while windmilling in reverse or due to low flow during operation. An engineering review formalized on 10/9/91 identified a fire scenario with potential for damage to the fan and fire damper controls and resulting loss of exhaust fans and closure of ventilation fire dampers. Ventilation loss during pump operation would degrade performance of the residual heat removal [BO] residual heat removal service water [BI]; emergency service water (ESW) [BI], and electric and diesel driven fire pumps [KP]. Loss of the ESW flow would degrade the emergency diesel generators [EK]. Inadequate ventilation following fire damper closure results from inadequate analysis of the NRC required 1980 fire damper installation. A fire watch in place prior to the event will remain until adequate ventilation is assured. Installation procedure review adequacy and alternate ventilation designs are being evaluated.

LER-91-010 is related.

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Description

This LER reports actual and potential degradations of the ventilation heat removal capability [UA] for safety-related pump rooms [MK] containing the residual heat removal service water (RHRSW) [BI] pumps, emergency service water (ESW) [BI] pumps, and the electric and diesel driven fire water pumps [KP]. The operability of the emergency diesel generators (EDG) [EK] in turn depends upon the operability of the ESW system. Residual heat removal (RHR) [BO] containment cooling mode and shutdown cooling (decay heat removal) mode operability is dependent upon operability of the RHRSW system.

Fire Damper Closure Makes Exhaust Fan Inoperable

The plant was operating at full power on September 4, 1991. Modification (M1-91-198) was in progress to replace ventilation system fire dampers (see sketch on last page of this LER) as one of the corrective actions for LER-91-010 of July 9, 1991. A fire watch person was on duty in the areas discussed in this LER. An initial step in the removal of the existing fire dampers was opening the circuit breaker in the power supply to the fire protection heat detector system. (Protective Tagging Request (PTR) 91-1638.) Next the electro-thermal links (ETL) were removed from each of the six fire dampers located in the ventilation openings in the walls of the fire and safety-related pump rooms. Removal of the ETLs (which are designed to release latches on the dampers in response to fire protection system heat detector operation) resulted in closure of the existing fire dampers.

At 1400 an annunciator activated indicating trouble with the safety-related pump room B (south) ventilation system. Investigation of the annunciator activation by operating personnel revealed the south safety-related pump room ventilation exhaust fan had tripped. The fan was observed to be rotating (possibly in the reverse direction). At 1630 fan 73FN-3B was declared to have been inoperable since the fan tripped at 1400 resulting in activation of the annunciator.

The annunciator response procedure called for the operator to monitor the south safety-related pump room temperature. If temperature exceeded 100 degrees F, temporary ventilation was to be established. Work Request 087394 was issued to determine the cause of fan failure, and additional investigation into the cause of fan 73FN-3B tripping revealed the Phase B overload relay tripped. In addition, electricians noted that all of the fire dampers in the ventilation supply openings were closed. During the next few hours the conditions that existed just prior to tripping of fan 73FN-3B were duplicated and

it was confirmed that with the dampers closed and safety-related pump room A (north) exhaust fan 73FN-3A operating, air drawn through the idle fan (73FN-3B) resulted in reverse rotation of the fan. No attempt was made to start 73FN-3B while it was rotating in the reverse direction. The dampers were restored to the normal (open) position, fan 73FN-3B was observed to operate normally (with normal current draw) for approximately 2 hours.

At 1940 (approximately 5.2 hours after fan 73FN-3B tripped) the ventilation system for safety-related pump room B (south) was declared operable. Opening the fire dampers removed the conditions that degraded the fire and safety-related pump room ventilation. A fire watch was present at all times to minimize the probability of (and limit the spread of) potential fires. The fire watch would have immediately notified the control room of a fire resulting in operating personnel responding to open or close fire dampers as appropriate in addition to initiating manual fire fighting activities.

Postulated Fire in Circulating Water Intake Structure (Screenwell)

In 1979, to meet NRC regulatory requirements, fire dampers were installed in previously unrestricted openings (except for security gratings) which had been designed into the pump room walls to provide adequate ventilation for the equipment in the rooms.

As a result of the ongoing review of the requirements of NRC Branch Technical Position (BTP) 9.5-1, Appendix A, and 10CFR50, Appendix R, a scenario was identified (see LER-91-010) in which the exhaust fans for both of the RHRSW/ESW pump rooms would be lost due to a postulated fire in the east cable tunnel. (The power supply cables for both fans pass through the same east cable tunnel.) This was reported on July 12, 1991. The issue of whether the pump room exhaust fans were required to be operable to assure operability of the RHRSW/ESW pumps was identified at that time. One corrective action for this event was to wrap fire retardant material on the conduit in the east cable tunnel for one of the fans.

In addition, calculations were performed to address the issue of whether the fans were required for RHRSW/ESW pump operability. Heat build-up calculations assumed that the fire dampers would be open and that a chimney effect convection heat transfer condition would occur. However, these calculations did not apply to a scenario in which the fire dampers are closed by mechanical events (such as those discussed in the first part of this LER), nor to fire scenarios in which the fire dampers close due to increasing temperatures. In fact, the temperatures which would result from pump operation alone, with a ventilation fan failure, would result in temperatures which would activate the fire damper closure mechanisms and invalidate these calculations.

The concerns raised by these calculations were elevated when the actual closure of the fire dampers occurred. In addition, concerns with the Quality Assurance category classification of the fans and dampers as non-safety-related QA Category II/III or M resulted in additional study of the issue. As a result, Occurrence Report 91-252 was issued on October 9, 1991 and was reported to the NRC using the emergency notification system.

This report (OR-91-252) identified a potentially non-conforming condition relative to 10CFR50, Appendix R, in which a postulated fire in the circulating water intake structure (screenwell) [NN], would result in the closure of the fire dampers and/or loss of power to the ventilation exhaust fans (and subsequent damper closure if the RHRSW/ESW pumps were operating). The fire damper controls for the RHRSW, ESW, and fire pumps rooms and the exhaust fan controls for the fire pump rooms are located on the below grade 255 level of the screenwell near the south entrance to the south pump room. The exhaust fan controls for the safety-related pump rooms are located directly above the rooms on the 272-foot elevation ground level of the same building behind the weld shop area with no intervening walls or barriers to smoke or heat propagation. As a result, a postulated fire in this structure could damage the fire protection damper control panel and close the fire dampers to safety-related pump rooms and the fire pump rooms, and/or damage the fan control cabinets resulting in loss of fan operability.

Acting on initial indications of the problem, all work was stopped on the fire dampers on October 1, 1991 and the Resident Inspector was notified. The installation procedure was revised. A temporary jumper (91-201) was installed to prevent fire protection heat detection system from closing the fire dampers. In addition, the existing fire watch in the work area was maintained.

Cause

Fan 73FN-3B failed (tripped) because the ventilation air supply to the pump rooms was restricted. Electricians found the fan 73FN-3B Phase B overload relay tripped. The relay was reset, the fan restarted, and measurements of motor current were found to be near full load current. Upon inspection of the pump room it was observed that all fire dampers to both pump rooms were failed closed. All fire dampers to the rooms were reopened and the fan was then observed to run with no abnormal conditions. As a result of the damper closure and the north pump room fan operating, air was drawn into the south room through fan 73FN-3B in the reverse direction. This caused the fan to freewheel in the reverse direction. Operators duplicated the reverse direction rotation condition by reclosing the dampers. While no attempt was made to manually start the fan under these conditions, an auto start

signal may have resulted in the fan trip at 1400. Alternatively, the fan may have been operating (or successfully started automatically) while the closed dampers restricted the ventilation air supply resulting in sufficient overload to cause the fan to trip. No testing was conducted to confirm (or rule out) the validity of either theory. (That is, that the fan tripped on overload during an auto start while overcoming the inertia of the reverse rotation or, the fan tripped on overload as a result of reduced air flow during operation as a result of the restriction of the ventilation air supply.)

As originally designed and constructed, the safety-related pump rooms were equipped with ventilation exhaust fans designed, purchased, and installed as QA Category I components to draw ventilation air through the unrestricted openings through the room walls. Subsequent to the design, construction, and start-up operation of the plant, the NRC imposed new fire protection requirements in the form of NRC Branch Technical Position (BTP) 9.5-1, Appendix A. As a result of these requirements, the Authority committed, as documented in an NRC letter dated August 1, 1979 (which issued Amendment No. 47 to the Technical Specifications), to install "physically separated supply ventilation systems with automatically actuated 3-hour rated dampers ... in safety-related pump rooms SP-1 and SP-2." (Page 3-4, Item 3.1.8)

As part of the ongoing Authority review of compliance with fire protection requirements (see LER-91-010), a significant number of fire damper closure concerns were identified as a result of thermal expansion and inadequate mechanical clearances. As a result, these dampers were scheduled for replacement to fulfill the commitment in LER-91-010. As a part of the corrective action for this concern, the six fire dampers (labeled A through E on the sketch at the end of this LER) in the ventilation openings in the walls of the fire and safety-related pump rooms were scheduled to be replaced by Minor Modification M1-91-198, "Repair and Upgrade of Appendix R Fire Dampers". The combined minor modification package, Nuclear Safety Evaluation JAF-SE-91-082, and installation procedure (IP-1) were sent for review by the Plant Operations Review Committee (PORC) on August 13, 1991 and approved on August 20, 1991 at Meeting 91-086.

Engineers for the current project (Modification M1-91-198) may have relied upon the previous (but subsequently found to be flawed) assumptions of the 1980 fire damper installation modification and therefore may not have considered the scenario of simultaneous closure of all six fire dampers to be a problem even if that scenario had occurred to them.

The actual closure of the dampers is attributed to:

1. Inadequate installation procedure in that it did not:

   a. Consider the possibility of, and consequences of, a simultaneous closure of all dampers, and therefore did not expressly caution against closing dampers or prohibit working on more than one section at a time.

   b. Correctly identify or sufficiently investigate the actual method required to remove the ETL (pop out vs. hard wired to junction box), and therefore may not have recognized the consequences of ETL removal (damper closure).

   c. Adequately consider the actual methods and craft management practices which would be required to implement the procedure.

   d. Address plant operating conditions or consider the possible effects on nuclear plant operation or safety (as opposed to fire protection safety).

2. The inadequate procedure was contributed to by:

   a. Lack of a formal training program and guide for writing installation procedures addressing the understanding actual field conditions of the installation, effect on plant operation, installation practices, and integrated nuclear plant scenarios.

   b. Failure to provide thorough and adequate review by assigned reviewers to the engineer responsible for the IP, prior to presenting the IP to PORC.

   c. Classification of the fans and dampers as other than Cat. I, thus misleading personnel concerning the potential safety significance of the modification.

   d. A compressed implementation schedule which provided inadequate time for thorough inter-department review and identification of problems.

3. A generic (as demonstrated in one or more other fire barrier LERs) mode of thinking that for a fire barrier (door or damper) the safe position is the closed position, and therefore no further consideration of the impact of the closed position on normal or emergency plant operation is required.

4. A nuclear safety evaluation which did not consider the function of the fire dampers with respect to ventilation and operability of equipment in the room. Due to the existence of the dampers, plant operations with closed dampers was presumed to have been previously considered. In fact, the nuclear safety evaluation for the 1980 installation did not adequately consider the issue of ventilation.

Circulating Water Intake Structure Fire Scenario

The determination for the reasons why the consequences of this scenario were not recognized at the time of the initial response to 10CFR50, Appendix B, are part of a root cause analysis currently in progress by a consultant. The initial engineering review of the 1980 fire damper installation which assumed adequate ventilation through the east cable tunnel door certainly contributed to failure to recognize this as a credible scenario.

This LER will be updated upon completion of the root cause analysis if the analysis results in significant changes in the conclusions or corrective actions.

Analysis

The discovery of the closed fire dampers, which may have (subject to further analysis) the potential to render the RHRSW, ESW, and fire pumps inoperable and subsequently degrade RHR, ESW, EDG, and fire system performance is reported under the provisions of 10CFR50.73(a)(2)(v)(B) as an event which may have prevented the systems from fulfilling their safety functions required to shutdown the reactor or remove residual heat. The unanalyzed fire scenario is reported in accordance with the provisions of 10CFR50.73(a)(2)(ii) as a condition outside the design basis of the plant as updated in the FSAR to meet the requirements of NRC Branch Technical Position 9.5-1, Appendix A, and under 10CFR50, Appendix R, as a condition not covered by plant operating and emergency procedures.

RHRSW/ESW Pump Operability

A calculation was initially performed to determine the temperature which the pump rooms would reach following failure of an exhaust fan during operation of the two RHRSW pumps and one ESW pump in one pump room. It was determined that the temperature would reach 171 degrees F. However, the calculation assumed the fire dampers would remain open. In fact, the heat detector system would have closed the fire dampers at 135 degrees F. Further, the fusible links would have melted at 165 degrees F. Thus, the actual rate of heat-up and maximum temperature would both be considerably higher. The

temperature has been estimated to increase from 70 degrees F to 240 degrees F within the first ten minutes with the fire dampers closed and fans inoperable. The maximum temperature determination will require a detailed evaluation of the heat sinks in the rooms.

Accordingly, subject to further investigation and engineering calculation, it may be conservatively projected that loss of the exhaust fans and/or the closure of the fire dampers would result in elevated temperatures which would materially shorten the expected service life of the pump motors. Further analysis is required. However, a preliminary calculation indicates that at a room temperature of 194 degrees F, the remaining motor service life will be approximately 19,600 hours which provides a significant margin above the 4320 operating hours required for post accident operation.

Additional analysis is also required to determine the effect of prolonged operation at elevated temperatures on the bearings, lubrication systems, and other components of the pumps and motors.

Electric Fire Pump

The electric motor driven fire pump is located in the north safety-related pump room as indicated on the sketch on the last page of the LER. This room is supplied with an additional exhaust fan designated as Fan 7 on the sketch. This room has the advantage of direct access to air intake from the east cable tunnel. However, because the cable tunnel supply fan is designed to supply on the order of 4,000 CFM total flow (some of which is diverted to the EDG switchgear rooms) while the safety-related pump room exhaust fans 73FN-3A&B are rated on the order of 12,000 CFM. Accordingly, fire damper closure in the north safety-related pump room has the potential to render the electric fire pump inoperable.

Diesel Fire Pump

The diesel fire pump is located in a separate room which shares two walls in common with the north pump room as shown on the sketch. The dampers supplying the diesel fire pump room from the north safety-related pump room and the screenwell were also closed during this event and would also be closed by the postulated fire in the intake structure (screenwell) scenario. This room is cooled by a separate fan designated as Fan 12 on the sketch. Although the engine has a water jacket cooling system, the engine combustion air intake comes from within the room. Accordingly, the dampers must be open for proper operation.

Calculations are necessary to determine whether the engine operation would be capable of collapsing the fire dampers or door inward to support its air intake requirements and to deliver the power required to meet design conditions. It would, of course, draw air in reverse

through the exhaust fan duct which would in turn most probably prevent the fan from operating due to reverse rotation. In either case, elevated temperatures could result. The fuel supply tank is located in the same room with the engine. A calculation is necessary to determine maximum room temperature relative to the flash point of the diesel fuel. Such a calculation would also consider the cooling effect of the air drawn into the room by the combustion intake of the engine.

An additional diesel fire pump is available. It is enclosed in a separate room a few feet from the room just described. However, this room also has fire dampers installed in the ventilation openings which would close in the event of an actual fire thus impacting the operation of this second diesel fire pump. No credit is taken for this second diesel fire pump in the Technical Specifications.

Corrective Actions

1. A fire watch will remain posted until the consequences of closed fire dampers on the pump operability has been determined.

2. An alternate method of providing adequate ventilation to the fire safety-related pump rooms, while maintaining adequate barriers to prevent the spread of a fire, will be investigated.

3. The fire damper installation procedure was extensively revised following this event to address the issue of fire damper closure as it related to plant operability.

4. Engineering calculations will be performed to:

   a. Determine the maximum temperatures which will be experienced in each of the three pump rooms assuming the closure of the fire dampers, loss of exhaust fans, and occurrence of a fire in the adjacent screenwell.

   b. Define the expected operating time of the RHRSW, ESW, and fire pumps under these conditions.

   c. Determine the temperature in the diesel fire pump room relative to the flash point of the fuel.

   d. Assess diesel fire pump performance with the dampers closed and/or with failure of the exhaust fan.

5. An assessment will be made of the adequacy of training, guidance, and procedures relative to improving the writing of installation procedures. This will include consideration of operability issues, total plant system safety consequences, and the necessity

to assess actual field conditions and acquire knowledge of the installation practices which will be used, and the necessity to transcend the boundaries of any given engineering discipline when preparing installation and/or test procedures.

6. The process by which installation procedures are developed, reviewed, and approved will be assessed for adequacy.

Additional Information

Related LER-91-010.

DOCKET NO. 50-333

LER 91-021-00

RHRSW / ESW & FIRE PUMP ROOMS