NRC FORM 366 (4-95) U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Prairie Island Nuclear Generating Plant Unit 1	05000 282	1 OF 5

TITLE (4)
Fire Areas 58/73 Appendix R Safe Shutdown Analysis Issues

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20.2201(b)	20.2203(a)(2)(v)	50.73(a)(2)(i)	50.73(a)(2)(viii)
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20.2203(a)(2)(iii)	50.36(c)(1)	50.73(a)(2)(v)	Specify in Abstract below or in NRC Form 366A
20.2203(a)(2)(iv)	50.36(c)(2)	50.73(a)(2)(vii)	

LICENSEE CONTACT FOR THIS LER (12)

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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).	√ NO	EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

On August 26, 1998, site staff determined that some cables in two Fire Areas in the auxiliary building were not protected by a 1-hour fire barrier (as required by an exemption to 10CFR50 Appendix R granted for those areas). These cables had been originally protected but the protective barriers had been removed following revision to the Safe Shutdown Analysis which erroneously concluded that protection was not required.

During this event both units were operating at 100% power.

Appropriate compensatory measures had been established and will be maintained until the fire barrier issues are resolved.

EVENT DESCRIPTION

On August 26, 1998, while both Unit 1 and Unit 2 were operating at 100% power, the Prairie Island Nuclear Generating Plant (PINGP) staff determined that some cables in Fire Area 58 and 73 in the auxiliary building (695' elevation) were not protected by a one-hour fire barrier (as required by an exemption to 10CFR50 Appendix R granted for these areas). As a result of an action item generated by the Fire Protection Functional Inspection (FPFI) self-assessment team (on March 11, 1998), PINGP staff was re-evaluating the current Safe Shutdown Analysis (SSA) against the approved Appendix R exemptions and Appendix R compliance for Fire Areas 58 and 73. This issue was assessed via the PINGP nonconformance report (NCR) process (NCR 19981988). The assessment of NCR 19981988 determined that the current configuration for these areas did not provide an equivalent level of fire protection as that approved by the NRC's safety evaluation report (SER) for the exemption to 10CFR50 Appendix R.

The current SSA (which had been revised in 1997) allowed removing the one-hour fire barriers for motor operated valves (MOVs) associated with the Train B reactor coolant system (RCS) inventory makeup function (Train B SI pump) and local manual action was credited. Guidance for these manual actions was provided in F5, Appendix D. The one-hour fire barrier protection was removed in April 1998.

In addition to the non-compliance with the exemption to 10CFR50 Appendix R affecting these cables, crediting local manual action for these valves created a configuration which may have allowed a fire to result in loss of pressurizer level indication, a violation of Appendix R requirements. As a part of the continuing investigation associated with the FPFI self assessment PINGP staff compared the current (1998) compliance assessment for Fire Areas 58 and 73 against the compliance assessment in the 1983 approved exemption. PINGP staff then determined that removal of the one-hour fire barrier and the change in methodology to credit local manual actions would not provide a level of fire protection equivalent to that previously approved. The need to perform the local manual actions would have required an operator to enter the fire area affected by the fire. This operator action was estimated to be completed in 1.5 hours (one hour waiting for fire brigade activities and 30 minutes to align the valves). A preliminary transient analysis calculation for a postulated fire scenario in these fire areas determined that the pressurizer level could go off-scale low within approximately 35 minutes without RCS makeup and without component cooling (CC) flow. This would place the plant in a condition outside its performance goal of maintaining the RCS inventory within the level indication of the pressurizer.

CAUSE OF THE EVENT

The Appendix R SSA was completely reconstituted (finished in 1997) due to:

- Addition of two additional safety-related diesel generators for Station Blackout (SBO) coping.
- Installation of and/or relocation of new 480 volt electrical switchgear and new Unit 2 4kV electrical switchgear as part of the Electrical System Upgrade (ESU) modification.

- Resolution of issues associated with Thermo-Lag assessed in response to GL 92-08.

As part of this reconstitution effort, each fire area was re-evaluated and several changes were made to the original compliance strategy of the previous SSA. These changes were based on the new plant electrical configuration, the revised cable routing philosophy implemented in the SBO/ESU modifications and additional review of new regulatory guidance documents.

The cause of the non-compliance with the exemption to 10CFR50 Appendix R was crediting local manual actions in lieu of remote (control room) operation for compliance. While this crediting may be allowed under the guidance of Generic Letter 86-10, the exemptions for the areas claimed credit for remote operation.

The non-compliance (with the Appendix R requirement that pressurizer level indication be maintained throughout the fire) developed because the PINGP SSA failed to assume that reactor coolant pump seal leakage would occur during certain postulated fire scenarios, as required by guidance. Without that condition to cope with, pressurizer level indication would have been maintained even with the time delay that could result from using local manual action in this case.

ANALYSIS OF THE EVENT

Fire Areas 58 and 73 are located at the 695-ft elevation of the Auxiliary Building for Units 1 and 2, respectively. The boundary between the fire areas is an open space; thus, Fire Areas 58 and 73 can essentially be treated as one fire area. This area contains redundant equipment and circuits associated with component cooling (CC), chemical and volume control (VC), safety injection (SI), and residual heat removal (RH) systems.

A one-hour fire barrier was originally installed to protect circuits associated with the Train B (12) SI pump and its RWST supply valve (MV-32080) and SI suction valve (MV-32163). As a result of the SSA reconstitution effort the one-hour rated fire barriers were removed from these cables.

A. Deterministic Evaluation of the Safety Significance of the Non-compliance

An evaluation of the sequence, that could have occurred if a fire had affected these valves, concluded:

> "In the event of a fire on the ground floor of the Auxiliary Building, sufficient time would be available to initiate SI and restore CC using local manual line-ups and the plant would not be put in an unrecoverable condition.
>
> "The safety significance of the period during which the Safety Injection System valve cables lacked fire barrier protection is considered low. Based on the comparison of the

Appendix R scenario and calculations performed for the IPE studies, pressurizer level would go off scale low at greater than 34 minutes and the pressurizer would be drained but core uncovery would not occur because SI and AFW flows would be restored in a timely manner."

B. Risk Significance Evaluation

(1) Fires in Fire Area 58
The results of the IPEEE Fire PRA, Rev. 2, show that fires in Fire Area 58 are not significant contributors to Unit 1 plant risk. The total core damage frequency (CDF) for fires in Fire Area 58 was 6.3E-7/rx-yr, which is below the IPEEE area screening criteria of 1E-6/rx-yr. The area contains a large number of safe shutdown components and cables, and the majority of the area is not protected by an automatic fire suppression system. However, an assessment of credible fire events in this fire area shows that the extent of system failures would be limited due to the specific physical features of the area (including the large distances between diverse equipment, intervening walls, berms, etc.), the spatial arrangement of circuits and equipment, and the volume of and distribution of combustible materials. In addition, a fire watch had been established in this area throughout the period of non-compliance that provides further assurance that the risk due to fires in this fire area is very low.

(2) Fires in Fire Area 73
The discussion presented above for Fire Area 58 also applies to Fire Area 73. A nearly identical set of major equipment and combustible hazards to that in Fire Area 58 also exists in Fire Area 73. Also, the equipment arrangement and barrier configurations are nearly identical. The total Unit 1 CDF for fires in Fire Area 73 was calculated to be 1.3E-6/rx-yr, which is above the IPEEE area screening criteria of 1E-6/rx-yr. However, it should be understood that no specific fire modeling was credited in Fire Area 73, other than that necessary to determine that fire propagation from 58 to 73 and vice-versa was not credible. If fire modeling had been performed for Fire Area 73, it is expected that the results for this fire area would have also fallen below the screening criteria (and would likely have been below that calculated for Fire Area 58). It would be expected that fires in Fire Area 73 would be more significant to Unit 2 risk than to Unit 1 risk, but would be on the same order as that seen for Fire Area 58 relative to Unit 1.

C. Compensatory Measures Established

As part of the resolution program for Thermo-Lag issues, Special Order SO-236, was put in effect in 1992 and continued to be in effect when the subject cables were unwrapped. Therefore the one-hour fire barrier protection that was removed in April 1998, was automatically compensated for by the presence of the roving hourly fire watch. In addition, NCR 19981794 (IN 92-18 MOV Hot Shorts issue submitted to NRC as LER 1-98-10), also has compensatory measures in place for this area which consists of utilization of the roving fire watch under SO-236. The adequacy of the hourly fire watch is evaluated and justified as part of the assessment of NCR 19981794.

Since one-hour barriers (as required by an exemption to 10CFR50, Appendix R) were missing from some cables in Fire Area 58 and 73 and pressurizer level going off-scale could be postulated, this nonconformance is reportable per 10CFR50.73(a)(2)(v) as affecting the safe shutdown capability and per 10CFR50.73(a)(2)(ii)(B) as being outside of the PINGP design basis for 10CFR50, Appendix R.

CORRECTIVE ACTIONS

1. One-hour fire rated barriers to protect MV-32080 and MV-32163 for the Unit 1 Train B SI Pump flow path have been installed.

2. Review compliance with exemptions to 10CFR50 Appendix R for all Fire Areas. This review will be completed by March 31, 1999. Operability/compensatory measure determinations will be documented by the NCR process. Following completion of this review, necessary changes to the SSA and implementing procedures will be made. Reportable findings will be submitted within 30 days of the completion of the review as a supplement to this LER.

   The compensatory actions that are in place shall remain in effect until the above review is complete and its resulting corrective actions have been implemented.

FAILED COMPONENT IDENTIFICATION

None.

PREVIOUS SIMILAR EVENTS

Cases of missing Appendix R fire barriers have been identified previously as LERs 19810 and 29803.

Attachment 2

<u>Deterministic Evaluation of the Safety Significance of a Fire in FA 58/73 Which Requires Fire Area Re-Entry</u>

In response to a fire in Fire Area 58 or 73 (FA 58/73), safe shutdown requires the use of the B-train SI system for RCS inventory control and use of B-train CC for SI pump and RCP cooling to achieve and maintain hot shutdown. The fire is assumed to disable all three charging pumps for the respective unit. An operator must re-enter the fire area to perform a system line-up on the SI system and possibly a portion of the CC system.

This assessment evaluates the safety significance while the fire barrier protective wrap for cables for the RWST supply and suction valves for 12 SI pump was removed.

Effects of the Fire on Systems of Interest

Off-site Power

A fire in this fire area would not likely cause a loss of off-site power. Nor would it cause a loss of all AC power to the safeguards busses. Safeguards power is available for 12 SI pump operation when required.

Safety Injection:

An event could be postulated in which the SI pump suction valve spuriously closes prior to completing the valve lineup. Due to loss of inventory, the SI pump could start on a low pressurizer pressure SI Signal (<1815 psi). With the suction path closed, the pump may be subject to damage. The cable route drawings were reviewed to determine where the suction valves would be subject to spurious operation compared to the availability of 12 charging pump.

The power and control cables for the SI pump are protected in the area. The cables for the 12 charging pump and suction valve cross at the H.3/6.3 grid location (Reference 1). The cable tray and conduits carrying the SI valve control cables were previously protected with Kaowool. Fire barrier protection was partially removed from cables for the valves required to change position or remain in position. Thus, a local manual valve line-up was required to align the SI pump to the RWST. When the protection was removed, the tray run was protected at the cable crossing to approximately 15 feet south (i.e., the nearest unprotected valve control cable was 15 feet south). The fire loading in this vicinity consists almost entirely of IEEE-383 cables. Thus, it is not likely that a fire which disabled the credited charging pump could also cause spurious operation of 12 SI Pump suction valve. However, for a fire in this area, the SI line-up is assumed to require local manual actions.

Component Cooling:

During normal plant operation, either or both trains of Component Cooling (CC) are in operation. Therefore, the credited B-Train may be in operation when the postulated fire occurs.

With the exception of cooling water (CL) supply to the CC heat exchanger, the B-Train CC System for both units is adequately protected in this area and can be operated remotely. For the

CL supply valve, the control cables are partially protected in the areas of interest. The valve opens on interlock with the starting of the CC pumps. However, for a fire in this area, the CL valve is assumed to require a local manual line-up when the SI system is lined up.

Letdown and Other Leakage Paths:

Letdown, pressurizer PORVs, etc. are unaffected and capable of being closed immediately from the Control Room.

Decay Heat Removal:

Due to cables in the area, local operation of the AFW System (12 MDAFW Pump and valves) and S/G PORVs may be required. These manual actions are outside FA 58/73. Therefore, AFW will be available for this situation.

Plant Response Calculations

RCP Seal Leakage:

Normal RCP seal leakoff is 6 gpm (3 gpm/pump) during normal operation. If seal injection and thermal barrier cooling are affected during plant operation, RCPs are secured by procedure to prevent degradation of the seals. Seal injection would be assumed lost as the result of losing the charging pumps. If cooling water to the CC heat exchanger was not restored on starting the CC Pump, the system would heat up until it could no longer remove sufficient heat from the thermal barriers. As a conservatism in the Appendix R scenario, CC to the thermal barriers is assumed to be lost immediately, as well as seal injection.

As discussed in the PINGP USAR (Reference 3), RCP seal leakage would be limited to 21 gpm following a loss of seal injection and thermal barrier cooling event assuming integrity of the secondary sealing elastomers. WCAP 10541, Rev 2, (Reference 4) analyzes and discusses the loss of RCP seal cooling event. A description of the general effects on the pumps and primary system are discussed in detail in Section 3 of the WCAP. Essentially, it takes 10-12 minutes to flush the cool water out of the RCP past the seal. After that, the leakage fluid is at higher temperatures and the seals may degrade. When 2-phase flow conditions exist at the seals, the leakage rate is self limiting. If seal cooling or injection is maintained or restored within 10 minutes, no seal degradation will occur since the seals will not have overheated.

Since seal injection and thermal barrier cooling may be lost, the following cases must be considered:

1. If seal injection and thermal barrier cooling are lost, seal leak-off may increase to 21 gpm/pump.
2. If seal injection or thermal barrier cooling are maintained, seal leak-off would remain at 3 gpm/pump throughout plant recovery.

Time Line:

For a fire in this scenario, the following time line can be used.

Time	Event
0	Fire on the ground floor disables charging pumps. RCP seal leakoff is 3 gpm/pump (6 gpm total). Letdown is secured. Attempt to start B-train CC pump
10 min	Seal leakage may increase to 21 gpm/pump or 42 gpm total (Case 1)
30 min	Local operation of AFW is established if required.
60 min	Operators re-enter the fire area and commence system line-up

IPE Calculations

To support the IPE project, calculations were performed to investigate plant response to loss of all AC considering RCP seal leakage (References 5,6,7). Since the Appendix R (Case 1, above) and IPE scenarios are similar, the assumptions and results of the IPE calculations can be compared to the assumptions of an Appendix R scenario to provide a qualitative conclusion. The Reference 5 calculation most closely resembles the Appendix R scenario in question and is used for the comparison.

The description of the event analyzed in Reference 5 is a loss of all AC power with an immediate RCP seal failure, due to loss of seal cooling. The station batteries and TDAFW pump are available at the outset and operators maintain S/G wide range level at 10 to 50% in both steam generators. In two hours (since AC power has not been restored) the batteries are depleted, disabling the TDAFW pump, the pressurizer PORVs, and the S/G PORVs; the S/G Safety Valves remain available.

A time line of plant response from Reference 5 shows that the pressurizer goes off scale at about 34 minutes. The top of the core is uncovered at 4.9 hours and core damage is predicted to occur at 5.8 hours.

Comparison of Appendix R and IPE Scenarios

Differences between the Appendix R scenario and IPE scenario are as follows:

<u>AC Power Availability</u>

The IPE scenario assumes loss of all AC, thus loss of both RCPs and all motor-driven equipment. The Appendix R scenario does not assume loss of all AC or loss of off-site power. The RCPs may remain running until operator action to stop them. Other equipment may continue to operate or be available for heat removal and inventory replenishment.

<u>Assumed RCS Inventory Loss and Make-up</u>

The IPE case never restores make-up capability and assumes RCP leakoff at 42 gpm from time zero, leading to draining the pressurizer in approximately 34 minutes and core uncovery in 4.9 hours (Reference 5)

The initial RCS inventory loss rate for the Appendix R scenario is 6 gpm. If restoration of CC was successful, this loss rate is constant through the event and the pressurizer would not empty before SI is initiated. Even if cooling water supply is not restored to the CC system, the heatup of the CC system and subsequently the overheating of the RCP seals would be delayed. In the event that restoration of B-train CC is unsuccessful, RCP seal leakage increases to 42 gpm total after the first 10 minutes. This slightly increases the time to drain the pressurizer.

Auxiliary Feed Water System Operation

Both the IPE and Appendix R cases assume that an AFW pump will be used for decay heat removal. In Reference 5, the TDAFW Pump was assumed to be operating immediately on loss of off-site power. The Reference 7 IPE calculation assumed no AFW flow. Comparing the results of the two calculations indicates that no AFW flow decreases the time to core uncovery and damage. Reference 7 predicts core uncovery in 2.5 hours with no AFW flow. Due to the conservative treatment of seal leakage in Reference 7, the actual time would be longer.

The Appendix R scenario assumes a local lineup of the AFW system may be required. This lineup is completed within the 30 minute time prior to S/G dryout. Thus, operation of AFW in the Appendix R scenario would be closer to Reference 5 than to Reference 7.

RCP Operation

The IPE calculations assume no heat input from the RCPs, since they are lost at time 0 when off-site power is lost. For the Appendix R scenario, operators are instructed to secure RCPs when bearing temperature reaches 200°F. As a result, the Appendix R scenario is similar to the IPE scenario due to the short time until the bearing temperature limit is reached.

Comparison Summary

In order to utilize existing calculations, comparisons were made to IPE calcs which approximated the potential Appendix R scenario. The IPE calc (Reference 5) which most closely resembles the Appendix R case predicts core uncovery at 4.9 hours. This calc is non-conservative for the Appendix R scenario in that it assumes AFW is available from the beginning but is overly conservative with regard to the assumption of failure of RCP seals at time zero. The IPE calc (Reference 7, which next most closely resembles the Appendix R scenario), which assumes no AFW throughout, is overly conservative because AFW could be made available within 30 minutes in the Appendix R scenario because required manual actions are in unaffected fire areas. Reference 7 predicts core uncovery in 2.5 hours. The Appendix R scenario, then, would lead to core uncovery in something greater than 2.5 hours except that SI would be restored and providing inventory makeup in a 1.5 hour timeframe. Pressurizer level would go off scale low at greater than 34 minutes and the pressurizer would be drained but, since inventory makeup has been restored, core uncovery would not occur and pressurizer level would be restored.

Operator Response

Upon recognition of the fire in Fire Area 58/73, the operators would enter F5 Appendix D, "Impact of Fire Outside Control/Relay Room" which identifies the potential impact of a fire, in areas outside the Control Room or Relay Room, on the minimum credited set of Appendix R, Safe Shutdown Equipment and provide guidance to the alternate method of support.

Procedurally F5 Appendix D directs the operators to start 12 CC Pump, if not already running, in the event of a fire in this area. If the cooling water inlet to 12 CC heat exchanger failed to open on pump start, rising CC system temperatures would be observed in the Control Room. Once the CC system demonstrated that it was unable to support RCP bearing or seal cooling, the operators would trip the RCPs on loss of support conditions per either C14 AOP1, Loss of Component Cooling or C3 AOP2, Loss of RCP Seal Cooling.

If the fire is severe enough, a reactor trip would be either automatically or manually initiated. On reactor trip, the Control Room operators would enter E-0, Reactor Trip or Safety Injection. After performing their verification steps of Reactor Trip, Turbine Trip, and Safeguards Busses Powered, they would observe that at this time there is not a Safety Injection signal nor should there be one. This would prompt them to transition to ES-0.1, Reactor Trip Recovery.

Assuming all fire damage occurs at the instant the reactor trips, the operators would observe that there is no charging pump running. Loss of all charging would automatically isolate letdown. In addition, when pressurizer level decreases to 14.8%, a separate letdown isolation occurs. The net leakage from the RCS will then be reduced to 6 gpm.

Decay heat will be removed from the RCS by the secondary heat sink which will be maintained per the guidance afforded by F5 Appendix D (manual alignment by control room operators may be required).

Once pressurizer level decreases to the point that a safety injection is required (<5% pressurizer level) the operators would initiate SI and return to E-0 in accordance with the SI Actuation criteria of the information page of ES-0.1.

Since the SI pump suction path is assumed to be closed, the observation that there is no SI pump discharge pressure or flow would trigger the operator to trip the running SI pump(s).

Not meeting the criteria for transition to an optimal recovery guideline for a specific accident, the operators would remain in E-0 beyond the diagnostic steps and monitor Critical Safety Function Status Trees. All CSF Status trees except Core Cooling and Inventory would be green at this time. Core cooling may be yellow if RCS pressure has decayed to saturation due to loss of all coolant inventory from the pressurizer. Inventory would be yellow when pressurizer level dropped below 15%.

None of the actions in the Functional Restoration Guidelines can be performed at this time since no injection capability has been restored.

Since the secondary heat sink is removing decay heat, RCP seal leakage causing a loss of primary inventory with no makeup capability is the parameter of concern. The operators would remain in a loop in E-0. RCS pressure would have decayed to saturation for the temperature being maintained by the secondary heat sink (~1000 PSIA). RCPs may be tripped at this point due to CC problems, however if CC temperature was not a problem, they would still be running and would not be tripped because no injection flow exists (per RCP trip criteria as RCS pressure decreases below 1250 psig).

When the fire in area 58/73 is out and smoke removed, a manual alignment (of at most 3 motor valves) of the suction path to 12 SI pump and cooling water to 12 CCHX could be performed easily within 1/2 hour by available fire brigade operators. 12 SI pump could then be started to add inventory to the RCS. Once the SI pump is running, the operators would observe refill of the pressurizer and can meet the termination criteria and continue through the EOPs.

The most likely sequence would be a transition to E-1, Loss of Reactor or Secondary Coolant, based on containment radiation, due to RCP seal leakage. This would lead to a transition to ES-1.1, Post LOCA Cooldown and Depressurization.

Conclusions

In the event of a fire on the ground floor of the Auxiliary Building, sufficient time would be available to initiate SI and restore CC using local manual line-ups and the plant would not be put in an unrecoverable condition.

The safety significance of the period during which the Safety Injection System valve cables lacked fire barrier protection is considered low. Based on the comparison of the Appendix R scenario and calculations performed for the IPE studies, pressurizer level would go off scale low at greater than 34 minutes and the pressurizer would be drained but core uncovery would not occur because SI and AFW flows would be restored in a timely manner.

References

1. PINGP Drawing FHA-007-1, Revision 1.
2. PINGP Procedure F5, Appendix D, "Impact of Fire Outside the Relay Room," Revision 2.
3. PINGP USAR, Section 4.3.3, "Reactor Coolant Pumps," Revision 15.
4. WCAP-10541, "Reactor Coolant Pump Seal Performance Following a Loss of All AC Power," Revision 2.
5. NAD File Number V.SPA.92.008, Prairie Island MAAP Case Number: MPP020/92, Dated May 10, 1993.
6. NAD File Number V.SPA.92.009, Prairie Island MAAP Case Number: MPP021/92, Dated May 10, 1993.
7. NAD File Number V.SPA.92.011, Prairie Island MAAP Case Number: MPP004/92, Dated August 26, 1993.