CR 99-1391

CR	99	-	1391/1844

OPERABILITY DETERMINATION	*REV*	01

Unit Applicability:	☒ Unit 0	☒ Unit 1	☒ Unit 2	System	AF

	PART I DETAILED ENGINEERING REVIEW (24 hours to complete for Tech Spec issues, otherwise 3 business days to complete)
1.	Describe the condition.
	The Auxiliary Feedwater (AF) pump recirculation piping sockets welds have experienced 3 pinhole leaks in a one year period from 6/98 to 6/99. 2 leaks were found on the P-38A recirculation piping and 1 leak was found on the P-38B recirculation piping. This condition was originally evaluated by revision 0 of the Operability Determination for CR 99-1391. During the root cause evaluation into these failures, it was discovered that the some of the recirculation line socket welds were undersized. The piping was designed and constructed to USAS B31.1, 1967 Power Piping Code. This code stipulates that the leg length of fillet welds for a socket weld fitting are to be equal to 1.25 times the nominal pipe wall thickness. The Schedule 80 recirculation piping (DB-3 pipe class) has a nominal pipe wall thickness of 0.218 inches. Therefore, the acceptable weld leg length is approximately 5/16". Most of the weld legs measured are 3/16". This condition was identified in CR 99-1844 and evaluated in revision 0 of the Operability Determination for CR 99-1844. The purpose of this revision is to combine the above CRs into a common Operability Determination which addresses the condition of the AF recirculation piping socket welds. This revision also includes information obtained from a failure analysis performed on one of the pinhole leaks. The failure analysis was performed by Structural Integrity Associates.
2.	Identify the Current Licensing Basis (CLB) functions and performance requirements. If no CLB function, requirement or commitment is affected, no further action is required. N/A steps 3 and 4 and proceed with step 5.
	The AF pump recirculation lines are designed to ensure a minimum flow rate through the AF pumps to protect from adverse effects of hydraulic instability at low flow rates. The piping also maintains the AF system pressure boundary to ensure proper flow rates are provided for accident scenarios. FSAR Appendix A.5 requires that the piping is designed and constructed to USAS B31.1, 1967 Power Piping Code. The construction code provides the necessary design criteria and the FSAR provides the appropriate load combinations and acceptance limits to ensure pressure and structural integrity of the piping system.
3.	Compare the performance requirements identified in step 2 with the as found condition being evaluated. Evaluate if the affected system, structure, or component is capable of performing its identified CLB functions and to what extent. The basis for this evaluation may include: ➢ analysis, ➢ test or partial test, ➢ operating experience, ➢ engineering judgement. Document the evaluation results below.
	The most limiting FSAR Chapter 14 Accident for the AF system is the Loss of Normal Feedwater (LONF). This accident analysis assumes that one motor driven AF pump provides 200 gpm of flow to one SG, 5 minutes following the low-low SG water level setpoint. The recirculation line isolation AOV for the MDAFP will automatically open on the start of the pump and then begin to close 45 seconds after 95 gpm of flow to the SG is achieved. The recirculation line isolation AOV for the TDAFP will automatically open on the start of the pump and then begin to close 45 seconds after 145 gpm of flow to the SG is achieved. Based on DBD-01 Rev. 0, the acceptable delay for the TDAFP to reach full acceleration is 39 seconds and the acceptable delay for the MDAFP to reach full capacity is 35 seconds. Westinghouse LONF/LOAC Analysis requires that the valve is full closed 60 seconds after the setpoint has been

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obtained. Therefore, the recirculation line AOV will not be open for longer than 100 seconds. The recent recirculation line failures were all located downstream of the isolation AOV near the flow restriction orifice and remained pinhole type leaks for a duration much longer than the 100 seconds the recirculation line would be open for the accident scenario. Structural Integrity (SI) Associates performed an evaluation of one of the weld failures. The evaluation included a review of a metallurgical report performed by Technimet Inc. and a review of vibration data from the P-38A and P-38B pump recirculation lines. SI's evaluation concluded that the failure was a result of vibration induced fatigue. The likely vibration source is the cavitation occurring in the restriction orifice. The orifice was found to be improperly sized for the application. The pinhole leaks have developed in socket welds near the orifice. Based on this data, the failure of a weld upstream of the isolation AOV is not probable because the cavitation pressure pulses would be dampened before being transmitted back through the flow orifice and recirculation AOV. Therefore, the ability of the AF system to provide a redundant decay heat removal of 200 gpm has not been degraded.

Various PBNP EOPs require the use of AF to maintain SG levels. This may require operation at low flows such that the recirculation AOV could be open. This would result in the potential for a pinhole leak to develop in a recirculation line weld. Based on SI's experience with vibration fatigue socket welds, these failures tend to leak for a relatively long time prior to pipe rupture. Therefore, the leak could be detected long before it would degrade the operation of the AF system. The three pinhole leaks were all identified during normal operating rounds. All Affects of the recirculation line weld failure on the CST volume are not applicable since SW provides the safety related water source for AF. Therefore, the AF system remains operable for maintaining SG levels during accident scenarios.

The only equipment in the area of the recirculation lines that could be adversely affected by a leak are the motors for the MDAFPs. The motors are drip proof with air inlets located on the outboard underside of the motor. Based on field inspection of the arrangement of the recirculation piping with respect to motor, the probability of water entering the motor from a recirculation line leak is not physically possible.

The recirculation line weld failure probability described above has been minimized by the recent repairs completed. The welds have been installed since 1991 and did not display a failure until 1998. Repairs to the P-38A recirculation line in the past year have replaced 5 of the 8 welds (reference attached sketch) between the AOV and manual valve, AF-00027. The recent repair (5/19/99) to the P-38B recirculation line replaced 2 of the 8 welds (reference attached sketch) between the AOV and manual valve, AF-00040. The recirculation lines for the TDAFPs have not experienced any weld failures. The limited run time of the TDAFPs with respect to the MDAFPs have not allowed the piping vibrations to accelerate any weld flaws. The MDAFPs have been operated for extended periods during plant startup and shutdown activities where the TDAFPs remain idle. Based on the life of the previous welds, the new welds are expected to be leak free until the failure mechanism can be identified and corrective actions taken to eliminate the failure mechanism.

The following paragraphs address the undersized weld conditions identified for the recirculation piping socket welds.

The code of construction for the AF pump recirculation piping (2" DB-3 and 2" JG-4) is USAS B31.1, 1967 Ed. The code requires a socket weld leg size of approximately 5/16" for Sch. 80 piping as described above. Code Case N-316 (which was incorporated in the 1989 ASME BP&V Section III Power Piping Code) was written to address undersized fillet welds for socket weld fittings. The code case stipulates that the minimum weld size for socket weld fittings is 0.75 times the nominal pipe wall thickness, t_n. The required leg size is reduced to 0.75 x 0.218" = 0.164" which is less than the minimum as built weld sizes. (The minimum weld throat was 1/8" which is equivalent to a weld leg of 1/8"/0.7071= 0.1767". Therefore, the existing welds meet the reduced criteria specified in Code Case N-316.

However, the stress intensification factor (SIF) for piping needs to be increased to account for the decreased weld size and the piping stresses adjusted accordingly. The SIF is defined as $i = 2.1 \times t_n / C_x$ where C_x is the measured weld leg size. For the measured weld throat lengths, the increased SIF is determined to be $i = 2.1 \times (0.218) / (0.125/0.7071) = 2.6$. The minimum required SIF is 2.1. Consequently, the design basis piping stresses need to be adjusted by a factor of 2.6/2.1 = 1.24 at the identified weld locations.

The design basis stresses for the welds in question are contained in piping stress report WE 100070, Rev. 01, Addendum C. The highest stress level in the four AF recirculation lines is 9560 psi for service level C (SSE loading conditions). Increasing this stress by 1.24 yields 11860 psi which remains below the minimum stress acceptance limit of 1.0 x S_h of 15,000 psi (normal operating loading condition),

Therefore, since the increased stresses for the undersized welds meet the stress acceptance limits specified

	in FSAR Appendix A.5 and the as-built welds meet the reduced weld leg size for socket weld fittings, the undersized welds are code compliant. The condition is nonconforming since the undersized welds are not evaluated in the design basis piping stress report WE 100070, Rev. 01 Addendum C.
4.	What (if any) compensatory measures need to be implemented in order to support the evaluation presented in step 3?
	None.
5.	Conclusion: ☐ Does not perform a CLB function. No further action required. ☐ Inoperable – does not meet the minimum level of performance (notify the Control Room SRO immediately) ☐ Operable – fully meets performance requirements. No further action required. ☒ Operable But Degraded or Operable But Nonconforming - meets the minimum required level of performance.

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	PART II CORRECTIVE ACTION PLAN, SCHEDULE AND JUSTIFICATION This plan should be developed as a part of the EAC process. (30 days to complete)
1.	For those Operable But Degraded or Nonconforming items, what action(s) need to be done to restore the condition to its "fully operable" or "fully qualified" status? ➢ Also consider any compensatory measures in place and what needs to be done for their removal.
	1. The recirculation line flow restriction orifices (RO-4015, RO-4008, 1/2RO-4003) shall be replaced. MR 99-029*A/B/C/D are the applicable modifications to perform this change. 2. Build up all socket welds on the recirculation piping from the connection to the pump discharge pipe to the downstream socket weld on recirculation line manual isolation valve (AF-40, AF-27, 1AF-15 and 2AF-53). The welds should be built up with oversized weld legs on the pipe side to improve its resistance to fatigue as described in EPRI Document TR-111188, Vibration Fatigue Testing of Socket Welds. The oversized welds will also ensure that the suspect recirculation piping socket welds meet size requirements of the code. The applicable WOs are 9914182, 9914183, 9914181 and 9914184. (Note that oversized weld legs will be used for the installation of the above MRs in order to reduce system unavailability and take advantage of prefabrication of welds.)
2.	When should the action(s) listed in question 1 be performed? This schedule represents the earliest available opportunity to perform the corrective actions, allowing reasonable time for planning, scheduling, design, procurement, etc.
	1. At the earliest, the new restriction orifices will be available for installation in April 2000. Based on the history of pinhole leaks at PBNP, the restriction orifices for the P-38A and P-38B recirculation line shall be installed in the year 2000. Based on satisfactory results of these MRs, the restriction orifices for the 2P-29 and 1P-29 shall be replaced during U2R24 and U1R26 respectively. 2. The installation of the oversized weld legs shall be completed during U2R24 for P-38B and 2P-29 recirculation lines and during U1R26 for the P-38A and 1P-29 recirculation lines.
3.	Please provide justification for this schedule based on: ➢ the amount of time required for design, review, and approval of the corrective action, ➢ procurement for replacement or repair, ➢ availability of specialized equipment to perform the repair, ➢ the need to be in hot or cold shutdown to implement the corrective action, ➢ or other factors that constrain the corrective action schedule. The most important factor to prevent recurrence of a pinhole leak is to reduce the vibration in the recirculation line. This will be accomplished by the installation of a properly sized restriction orifice designed to reduce cavitation. Since the welds on the MDAFP recirculation lines have already experienced pinhole leaks and have substantially more operation time than the TDAFPs, it is prudent to perform the MRs on these pumps as soon as possible. The TDAFPs do not have nearly the amount of run time as the MDAFPs therefore, the next refuel outage is acceptable for installation of the new restriction orifice. For 1P-29, P-38A and P-38B, there are 11 socket welds that need to be oversized. 5 of these socket welds may be replaced in conjunction with the MR to replace the restriction orifice. For 2P-29, there are 13 socket welds that need to be oversized. 7 of these socket welds may be replaced in conjunction with the MR to replace the restriction orifice. Therefore, a minimum of 6 sockets welds will need to be built up/oversized with each WO. However, the welds most susceptible to the vibration fatigue will be oversized via the MR to replace the restriction orifice. The AF unavailability time required to perform this work and the small probability that one of these welds will develop a leak justifies the scheduling of these WOs within a refueling outage.

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Route Part II to the Control Room CR in-basket in WCC for processing.			

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