CR	99	-	1391/1844

OPERABILITY DETERMINATION	*REV*	02

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 4 pinhole leaks in the period from 6/98 to 5/00. 2 leaks were found on the P-38A recirculation piping and 2 leaks were 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. Revision 1 of this OD combined the above CRs into a common Operability Determination which addresses the condition of the AF recirculation piping socket welds. This revision also included information obtained from a failure analysis performed on one of the pinhole leaks. The failure analysis was performed by Structural Integrity Associates. Revision 2 updates the OD with respect to current plant conditions. The recirculation line restriction orifices, RO-4008 and RO-4015, for P-38A and P-38B respectively have been replaced via MR 99-029*A/B. The result was a decrease in pipe vibration by approximately a factor of 10 and the cavitation noise from the orifice has been eliminated. Therefore, the MDAFPs are fully operable with respect to weld fatigue failures. This revision also clarifies the operability status of the Turbine Driven AFW pumps, 1P-29 and 2P-29, recirculation lines.
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.

A/110

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 AF 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 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. Westinghouse LONF/LOAC Analysis requires that the valve is full closed 60 seconds after the setpoint has been obtained. Therefore, the recirculation line AOV will not be open for longer than 100 seconds. The recirculation line failures experienced for the MDAFPs 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 TDAFP 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. The four pinhole leaks were all identified during normal operating rounds. There were no other signs of abnormal system operation as a result of the leakage. All affects of the recirculation line weld failure on the CST inventory are not applicable since SW provides an unlimited safety related water source for AF. Therefore, the AF system remains operable for maintaining SG levels during accident scenarios. 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 same weld failed on P-38B after approximately 375 hours of operation. The TDAFPs only operate with the recirculation line open for approximately 5 hours per year for IST testing. Since the welds have been installed for less than 12 years, they have been exposed to the vibration fatigue for approximately 60 hours. Therefore, the expected life of these welds is sufficient to ensure that they will not leak during an event requiring TDAFP operation. In summary, the TDAFPs and their recirculation lines are fully operable based on the following: 1. Weld leaks upstream of the recirculation line AOV isolation are not probable. 2. The previous weld failures displayed a leak before break failure mechanism. This ensures that the leak is small enough to allow sufficient forward flow to isolate the recirculation line AOV. 3. The recirculation line welds have not been exposed to the vibration for as many hours as it took to fail a P-38B recirculation line weld. 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 would need 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 would 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 $1.0 \times S_h$ 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.

Prepared by:	John P. Schroeder John P. Schroeder	Date/Time:	03/06/2001 1045
Engineering Manager Approval:	Duane D. Olson	Date/Time:	3/6/2001 1233
DSS Approval:	Tom Harper	Date/Time:	3/6/2001 1355

	CR	99	-	1391/1844

OPERABILITY DETERMINATION	REV	02

	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. 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-27, 1AF-15 and 2AF-53) for AF pump P-38A, 1P-29 and 2P-29. The oversized welds will ensure that the suspect recirculation piping socket welds meet size requirements of the code. The built up welds improve the resistance to fatigue as described in EPRI Document TR-111188, Vibration Fatigue Testing of Socket Welds.. WOs are 9914181 (U1R26), 9914182 (U1R26), and 9914184 (U2R25) are in place for to perform the weld build ups. WO 9914183 completed the weld build up for the P-38B recirculation line welds in U2R24.
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. The installation of the oversized weld legs shall be completed during U1R26 for the P-38A and 1P-29 recirculation lines (WOs 9914181 and 9914182) and during U2R25 for the 2P-29 recirculation line (WO 9914184).
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 WOs are scheduled for the next refuel outage for each unit (U1R26 and U2R25). This installation period is acceptable based on the following reasons: 1. The AF unavailability time required to perform this work and the small probability that one of these welds will develop a leak justifies the wait to schedule these WOs within a refuel outage. Note that the vibration fatigue mechanism on the P-38A and P-38B recirculation lines has been removed by MR 99-029*A/B and the TDAFPs have not experience any recirculation line socket weld leaks. 2. Delay of WO 9914184 until U2R25 allows some the oversized welds to be prefabricated in conjunction with the MR 99-029*D which will replace restriction orifice 2RO-4003 in the same refuel outage.

Prepared by:	John P. Schroeder J. P. Schroeder	Date/Time:	03/06/2001 1045
Engineering Manager Approval:	Duane D. Filler	Date/Time:	3/6/2001 1233

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

RECD MAR 14 2001