**From:** "dak2@nrc.gov" <dak2@nrc.gov> D Karjala, R-III
**To:** PLynch RIII "PLL@NRC.GOV" <pll@nrc.gov>, "HKC@NRC.GOV" <hkc@nrc.gov>
**Date:** Fri, Apr 30, 2004 4:11 PM
**Subject:** AFW Pump Operability

H Chernoff, NRR

RIII

Release in Entirety

A-9

QF-1100 Rev. 0 (FP-OP-OL-01)
Point Beach Nuclear Plant

| NMC | OPERABILITY RECOMMENDATION FORM |
|---|---|

(The information concerning the MSSVs is included because of its relevance to OPR000044 The information concerning the turbine – driven pumps is included only because the source documents refer to both types of pumps.).
Tech Spec Surveillance Requirement. SR 3.7.6.1

Evaluate the effects of the condition, including potential failure modes, on the ability of the SSC to perform its specified safety, or safety support, function(s)

The most limiting requirement for the MDAFW pump (in terms of flow) is to provide 200 gpm to a single SG [See Note 2] 5 min following a LONF or a LOAC. The ability to provide this flow is dependent on the following items:

- The pump suction pressure – This is controlled by CST level. The CST minimum level is based on Tech Spec level less tank drawdown for 30 minutes of pump operation at 200 gpm. A lower CST level is used in this evaluation than was used in OPR000044. Lower CST level results in lower flow to the SG.
- The AFW pump capacity – This is evidenced by the degree of degradation from the design pump curve. If the AFW pump performance is degraded from its design operating conditions, the pump will provide less flow for the required TDH to overcome downstream resistance and backpressure. The amount of allowable degradation is now specified by the Inservice Testing program (IT-10). This is an issue both in this OPR and OPR000044.
- The function of the MDAFW pump pressure control valve is to limit AFW flow from a particular pump both for

QF-1100 Rev. 0 (FP-OP-OL-01)
Point Beach Nuclear Plant

| NMC | OPERABILITY RECOMMENDATION FORM |
|---|---|

**Is the SSC in its present condition capable of performing its safety or safety support function(s)? Explain basis.**
(Use engineering analysis or engineering judgment to determine whether the design function can be provided given the existence of the deficiency. When using engineering judgment, provide supporting information from sources such as field walkdowns, industry experience, proven system/component performance under similar service conditions, etc.)

**The MDAFW pumps in their present condition are capable of performing their safety function.**

***Analysis of Flow Capability Using Current Plant Conditions (prior to uncertainty application):***
AFW flow problems can be analyzed using the Proto-Flo model (Calc 97-114, Rev. 2) with some minor corrections currently

QF-1100 Rev. 0 (FP-OP-OL-01)
Point Beach Nuclear Plant

| NMC | OPERABILITY RECOMMENDATION FORM |
|---|---|

(The information concerning the MSSVs is included because of its relevance to OPR000044. The information concerning the turbine – driven pumps is included only because the source documents refer to both types of pumps.).
Tech Spec Surveillance Requirement. SR 3.7.6.1

Evaluate the effects of the condition, including potential failure modes, on the ability of the SSC to perform its specified safety, or safety support, function(s)

The most limiting requirement for the MDAFW pump (in terms of flow) is to provide 200 gpm to a single SG [See Note 2] 5 min following a LONF or a LOAC. The ability to provide this flow is dependent on the following items:

- The pump suction pressure – This is controlled by CST level. The CST minimum level is based on Tech Spec level less tank drawdown for 30 minutes of pump operation at 200 gpm. A lower CST level is used in this evaluation than was used in OPR000044. Lower CST level results in lower flow to the SG.
- The AFW pump capacity -- This is evidenced by the degree of degradation from the design pump curve. If the AFW pump performance is degraded from its design operating conditions, the pump will provide less flow for the required TDH to overcome downstream resistance and backpressure. The amount of allowable degradation is now specified by the Inservice Testing program (IT-10). This is an issue both in this OPR and OPR000044.
- The function of the MDAFW pump pressure control valve—is to limit AFW flow from a particular pump both for runout and for containment pressurization from a ruptured steam line. This valve when functioning as designed, limits the MDAFW pump outlet pressure to 1200 psig. The flow associated with this pressure is dependent both on the pump suction pressure and the amount of pump degradation. This was not an issue in OPR000044.
- The remainder of the system flow resistance---This is constant and is not an issue in this OPR and OPR000044.
- The leakage out of the system--- This leakage is postulated to occur through the main feedwater check valves and is tested by IT 300 & 305. Although the allowable limit is 5 gpm, the current test results show no leakage and that will be used in this OPR and OPR000044.
- The Steam Generator Backpressure---This is a function of the decay heat input and the MSSV settings. However, the lowest MSSV setting (and its reseat pressure) dominates. Recent plant data have shown an average setting of 1085 psig with a single standard deviation of 0.8% of setpoint. Doubling that number to achieve a 2σ value (for a 95/95 confidence level) and then multiplying by the standard factor of 0.5867 to achieve a 75/75 confidence level (which is appropriate for this application) results in a maximum SG backpressure of 1095.2 psig (1109.9 psia). This backpressure is 1 psi below the value used in OPR000044. However, because of the PCV operation, the SG backpressure is not controlling and the evaluation done in OPR000044 is bounded by this evaluation.

| NMC | OPERABILITY RECOMMENDATION FORM |
|---|---|

**Is the SSC in its present condition capable of performing its safety or safety support function(s)? Explain basis.**

(Use engineering analysis or engineering judgment to determine whether the design function can be provided given the existence of the deficiency. When using engineering judgment, provide supporting information from sources such as field walkdowns, industry experience, proven system/component performance under similar service conditions, etc.)

**The MDAFW pumps in their present condition are capable of performing their safety function.**

**Analysis of Flow Capability Using Current Plant Conditions (prior to uncertainty application):**

AFW flow problems can be analyzed using the Proto-Flo model (Calc 97-114, Rev. 2) with some minor corrections currently being incorporated. A case was run using the current plant conditions (including the allowable AFW pump degradation per IT-10) to determine the flow to the SGs and to see whether the PCVs were throttling flow to maintain pressure. (When the valves are throttling, the PCVs are controlling flow; when they are 100% open flow is primarily controlled by the SG backpressure.) The conditions bound those described in OPR000044 including the PCV operation and the lower CST level. The following inputs were used:

CST level =33.5 feet (plant elevation) Tech Spec level less tank drawdown for 30 minutes of pump operation at 200 gpm

Pump curves -- degraded curves as specified by IT-10

PCV –controlling to a pump discharge pressure of 1200 psig

SG backpressure -- corresponds to current MSSV setting described earlier

The results of this analysis showed that the P38A would provide 198 gpm and P38B would provide 192 gpm.

**Flow Capability Including Uncertainty Application:**

The estimated uncertainty associated with this flow value to the SGs is ~7 gpm. [See Note 4 for more detail on uncertainties used in this evaluation]. The estimated uncertainty associated with the pressure control valve setting is ~18 gpm. Combining these two values of uncertainty using the standard square root of the sum of the squares of the independent variables yields ~20 gpm. Applying the uncertainties, results in a worst case predicted flows of 178 gpm and 172 gpm, respectively. Although the value of 172 gpm (192 – 20 for worst case pump) does not meet the stated design requirement of 200 gpm, the AFW pumps will perform their intended functions for the following reason:

**Conservatisms in the determination of the FSAR Requirements (initiation time)**

FSAR Delivery

The limiting License Basis analyses for the required delivered flow from AFW are the previously mentioned LONF and LOAC transients. In both cases, an analytical assumption of a 5 minute delay [See Note 1] in initiation of AFW flow is made.

As clarified in sections 10.2, 14.10.1, and 14.10.2 of the FSAR (as updated by approved FSAR Change Request FCR 03-042; pending incorporation), the 5 minute delay is an arbitrary one [See Note 1] and is not reflective of the plant design or response. Both of these events use the CST as a suction source and already incorporate single active failures of pumps to start. Therefore, no manual re-alignment of the AFW system is required and the remaining pump(s) start automatically and deliver their pre-set flow rate automatically.

Actual Delivery

In the case of a LONF, automatic pump start will occur immediately upon receipt of an AFW start signal because off site power is still available. In the more limiting case of a LOAC, off site power is lost and the AFW pumps sequence on with the EDGs. This occurs in less than one minute from initiation.

There is an additional 45 second delay before the minimum recirculation flow control valve shuts and all flow is delivered to the S.G. During this period, approximately 75 gpm is diverted from the pump discharge back to the CST via the recirculation line.

NMC

OPERABILITY RECOMMENDATION FORM

**Conservatism**
Therefore, despite the arbitrarily assumed delay of 5 minutes used in the analysis, it can be conservatively stated that 100 gpm of flow is delivered starting at 1 minute, with ~172 gpm delivered at 2 minutes in both the LOAC and LONF cases.

**Operator Action Timing Considerations**
The crux of this issue of reduced AFW flow to the SG centers around the conservatively interpreted statement in the FSAR that "The AF system shall automatically start and deliver adequate AF system flow to maintain adequate steam generator levels during accidents which may result in main steam safety valve opening". This implies no operator action. It is clear, however, from the Emergency Operating Procedures that address the two limiting scenarios, LONF and LOAC, that one of the earliest steps in these response procedures is to manually ensure proper AFW flow to the SG(s). As noted earlier, there are actually approximately 4 minutes of additional AFW pump run time that can be credited because of the design features of the actuation sequence. Therefore, the actual flow (using the additional 4 minutes) totaled over time for a degraded flow would inject the same mass of water as a flow initiated later in time (at time = 5 minutes) for some time following accident initiation.

Using the time analysis discussed earlier in this recommendation, results in a flow of ~100 gpm for 1 minute followed by a flow of 172 gpm until the operator could take manual control. This mass is equivalent to the mass injected for an AFW flow of 200 gpm lasting 22 minutes. This occurs at 27 minutes from event initiation. This time period is more than sufficient for the operator to implement the SG control steps in the response procedures which occurs 2 steps after the verification of immediate actions in EOP 0, "Reactor Trip or Safety Injection".

**Conclusion:**
This analysis was performed using the current allowable pump degradation allowed by IT-10 and therefore the current acceptance criteria it contains supports this OPR.

Therefore critical plant parameters in this postulated scenario would be bounded by the FSAR analyses and thus the MDAFW pumps could be relied on to perform their intended function. However, they are not in conformance with Section14.1.10 and Section 14.1.11, which state the system provides 200 gpm to the steam generators for a LONF and a LOAC. The status is therefore OPERABLE but NONCONFORMING.

The results of this OPR do not invalidate the conclusions of OPR000044 and bound the conditions evaluated therein.

QF-1100 Rev. 0 (FP-OP-OL-01)
Point Beach Nuclear Plant

| NMC | OPERABILITY RECOMMENDATION FORM |
|---|---|

**If the SSC is not fully capable (*Full Qualification*) of performing its safety or safely support function(s), then determine if Compensatory Measures are required to maintain OPERABILITY.**

(Describe the Compensatory Measures, basis for which the Compensatory Measures maintain OPERABILITY, implementation mechanism (procedure, temp mod, etc.), and under what conditions the Compensatory Measures may be terminated.)

No compensatory measures are required.

**If the SSC is not capable of performing its safety or safety support function(s), then provide an Aggregate Review of the condition. Identify related Action Requests (CAP numbers).**

NA

**Equipment recommended to be:**

☐ Operable ☐ Operable, But Degraded ☒ Nonconforming ☐ Inoperable *

**Engineering Management Approval Required** * **Notify Shift Manager immediately**

Responsible Engineer: _____ Date: 4/30/04 Ext: 7698

Verifier: Rob Chapman / _____ Date: 4-30-04 Ext: 7636

Cognizant Engineering supervisor: _____ Date: 4/30/04 Ext: 7416

Approval Recommendation

Cognizant Engineering Manager: _____

Date: 4/30/04 ☐ N/A

Shift Manager Concurrence and Approval: _____

Date and Time: 4/30/04 1425

NMC

## OPERABILITY RECOMMENDATION FORM

**Identify references used.** (Reference Name and Section (s))

1. PBNP FSAR 10.2 (06/03), "Auxiliary Feedwater System (AF)"
2. PBNP FSAR 14.1.10 (06/03), "Loss of Normal Feedwater"
3. PBNP FSAR 14.1.11 (06/03), "Loss of all AC Power to the Station Auxiliaries"
4. PBNP FSAR 8.8 (06/01), "Diesel Generator (DG) System"
5. IT 10, Rev. 48, "Test of Electrically Driven Auxiliary Feed Pumps and Valves (Quarterly)
6. CIM000265 BYRONJ, "AFW Pump Performance Curves"
7. IT 300(305), Rev. 16, "Main Feed Line Check Valves Unit 1(2)"
8. TLB 34, Rev. 5, "Condensate Storage Tank (T-34 A/B)"
9. STPT 14.11, Rev. 17, "Auxiliary Feedwater"
10. Calculation 97-114, Rev 2 "Development of Point Beach Auxiliary Feedwater System Proto-Flo Hydraulic Model"

**Continuation. (Notes)**

This section is being used to provide amplification of some portions of the text.

1. The 5 minute time delay for initiation of AFW in the analysis appears to come from a consideration of the time required to transfer AFW pump suction to the Service Water (SW) System following a seismic event. SW suction is not the limiting case because the inlet pressure of SW is much greater than that available from the CST. It is irrelevant in this evaluation because the CST is the more limiting suction source. Nonetheless, the value remains in the FSAR analyses as a conservatism.
2. The Westinghouse analyses consider the split flow configuration (one MDAFW pump feeding two SGs) to be more limiting but this is from an RCS response perspective. For purposes of this evaluation, this is immaterial because the acceptance criteria of the analysis is satisfied in either case. Both cases uses 200 gpm as their acceptance criteria. Therefore this evaluation focuses on the 200 gpm flow to the SG because it is more limiting hydraulically.
3. The equivalent mass injection calculation is done by defining the time ($t$) that the AFW flow is less than 200 gpm. An equation can be developed that equates mass injected in the degraded flow case to the 200 gpm case. The degraded flow case consists of 100 gpm from $T$=1 min to 2 min ($T$ is the time from event initiation) plus the degraded flowrate ($Q$) multiplied by $t$. The 200 gpm case consists of the time (t) that is credited for the degraded condition less the 3 min difference between full flow in the degraded case and the 5 min start time.
   $100 + Qt = 200(t-3)$ Inserting the value for $Q$ (172 gpm – based on the most limiting pump) and solving for $t$ yields 25 minutes.
   Therefore $T_{action} = t + 2 = 27$ min from event initiation. The following chart helps show the relationship between $T$ and $t$:

| (T)ime from event initiation | Degraded Flow Case(OPR) | Totalized | Design Flow (FSAR case) | Totalized |
|---|---|---|---|---|
| 0 min | 0 gpm | 0 gal | 0 gpm | 0 gal |
| 1 min | 100 gpm | 0 gal | 0 gpm | 0 gal |
| 2 min | 172 gpm | 100 gal | 0 gpm | 0 gal |
| 3 min | 172 gpm | 272 gal | 0 gpm | 0 gal |
| 4 min | 172 gpm | 444 gal | 0 gpm | 0 gal |
| 5 min | 172 gpm | 616 gal | 200 gpm | 0 gal |
| 6 min | 172 gpm | 788 gal | 200 gpm | 200 gal |
| 7 min | 172 gpm | 960 gal | 200 gpm | 400 gal |
| ... | | | | |
| 27 min | 172 gpm | 4400 gal | 200 gpm | 4400 gal |

4. There are two contributors to the uncertainty of the AFW flow to the SG. The values associated with these contributors are determined using a 75/75 confidence level (which is appropriate for this application). The first

QF-1100 Rev. 0 (FP-OP-OL-01)
Point Beach Nuclear Plant

| NMC | OPERABILITY RECOMMENDATION FORM |
|---|---|

**SSC affected by condition: OPR000109**

The motor-driven auxiliary feedwater (MDAFW) pumps, P38A and P38B are the SSCs affected by this condition. The condition is described in CAP056170, "IT-10 acceptance criteria does not ensure adequate AFW without operator action" and followed up with OPR000109. In addition to the condition described below, the motor-driven AFW pumps are also currently considered operable but nonconforming under OPR000044 and the relationship between the two operability determination/recommendations will be addressed in this OPR.

**Identify the overall scope of the condition that calls OPERABILITY into question.**

The condition that calls OPERABILITY into question is the potential for AFW flow to the SGs to fall below 200 gpm (the FSAR stated minimum) at certain levels of pump degradation which are currently within the IST acceptance criteria for the MDAFW pumps. This is due to the manner in which the motor-driven AFW (MDAFW) pump outlet pressure control valves (AF-4012 and AF-4019) are set up. This issue does not apply to the turbine-driven pumps because their flow is not controlled by an automatic pressure control valve.

The MDAFW pump outlet PCVs are set up to maintain a constant pressure of 1200 psig upstream of the valve (i.e. the pump outlet pressure). The outlet pressure of the AFW pump is equal to the total developed head (TDH) of the pump at the flow added to the suction pressure of the pump (as developed by the CST level). The TDH of the pump as a function of flow through the pump is shown on the pump curve. When solving for 1200 psig pump outlet pressure (using the Technical Specification limit for minimum CST level and the pump design curve), the pumps were able to just produce the required flow. However, when uncertainty was added and allowable degradation was applied, the pumps could no longer reach their licensing basis flow.

**Describe the specified safety, or safety support, function(s) of the SSC. Identify the Licensing Basis functions and performance requirements, including Technical Specifications, FSAR, NRC Commitments, or other appropriate information (*reference SCOPE section 5.3*).**

TS 3.7.1 Four MSSVs per steam generator shall be OPERABLE.

TS SR 3.7.1.1 Verify each required MSSV lift setpoint per Table 3.7.1-2 in accordance with the Inservice Testing Program. Following testing, lift setting shall be within +/- 1%.

TS Table 3.7.1-2 states that the lift setpoint for the lowest set valves is 1085 psig +/- 3%.

TS 3.7.5: The AFW System shall be OPERABLE with; one turbine driven AFW pump system and two motor driven AFW pump systems. Applicability: Modes 1, 2, and 3, MODE 4 when steam generator is relied upon for heat removal.

FSAR 10.2 The AF system shall automatically start and deliver adequate AF system flow to maintain adequate steam generator levels during accidents which may result in main steam safety valve opening. Such accidents include; LOSS OF NORMAL FEEDWATER (LONF), FSAR Chapter 14.1.10, and LOSS OF ALL AC POWER TO THE STATION AUXILIARIES (LOAC), FSAR Chapter 14.1.11, events. LONF and LOAC are time-sensitive to AF system start-up.

FSAR 14.1.10 The auxiliary feedwater system provides 200 gpm of flow split to two steam generators, 5 minutes following receipt of a low-low steam generator water level setpoint signal.

The capacity of the auxiliary feedwater system is such that the water level in the steam generators does not recede below the lowest level at which sufficient heat transfer area is available to dissipate core residual heat without water relief from the RCS relief or safety valves.

FSAR 14.1.11 The auxiliary feedwater system insures feedwater supply of at least 200 gpm upon loss of power to the station auxiliaries, since the steam turbine driven auxiliary feedwater pump has a capacity of 400 gpm and the motor driven auxiliary feedwater pumps have a capacity of 200 gpm each.

IST Program The auxiliary feedwater pumps and MSSVs are included in the program.

- The function of the MDAFW pump pressure control valve [illegible] runout and for containment pressurization from a ruptured steam line. This valve when functioning as designed, limits the MDAFW pump outlet pressure to 1200 psig. The flow associated with this pressure is dependent both on the pump suction pressure and the amount of pump degradation. This was not an issue in OPR000044.
- The remainder of the system flow resistance---This is constant and is not an issue in this OPR and OPR000044.
- The leakage out of the system--- This leakage is postulated to occur through the main feedwater check valves and is tested by IT 300 & 305. Although the allowable limit is 5 gpm, the current test results show no leakage and that will be used in this OPR and OPR000044.
- The Steam Generator Backpressure---This is a function of the decay heat input and the MSSV settings. However, the lowest MSSV setting (and its reseat pressure) dominates. Recent plant data have shown an average setting of 1085 psig with a single standard deviation of 0.8% of setpoint. Doubling that number to achieve a 2σ value (for a 95/95 confidence level) and then multiplying by the standard factor of 0.5867 to achieve a 75/75 confidence level (which is appropriate for this application) results in a maximum SG backpressure of 1095.2 psig (1109.9 psia). This backpressure is 1 psi below the value used in OPR000044. However, because of the PCV operation, the SG backpressure is not controlling and the evaluation done in OPR000044 is bounded by this evaluation.