10A.5 AUXILIARY FEEDWATER SYSTEM

The AFW System, shown in Figure 10A.5-1, is designed to provide feedwater for the removal of sensible and decay heat, and to cool the primary system to 300°F in case the MFW and Condensate Systems are not available. The AFW System may also be used for normal system cooldown to 300°F. During normal operation, the only portion of the AFW System that would have contained a high energy fluid (900 psia and 532°F) is the section of pipe downstream of the isolation valve before the steam generator. This system has been modified by installing a check valve inside the Containment, thus eliminating the line outside of Containment as a high energy system.

The AFW System is used for any one of the following conditions:

1. Loss of offsite electric power.
2. Complete loss of feedwater flow to the steam generators if any of the following conditions occur:
   a. Equipment malfunction (condensate pumps or SGFPs).
   b. Malfunction in the feedwater regulating systems for both steam generators cause all feedwater regulator CVs to close.
   c. In manual feedwater control, the operator either closes each of the feedwater regulator CVs or closes each feedwater stop valve.
   d. A MFW header ruptures.

The turbine-driven pump may be used for normal startup and shutdown. The MS line to the auxiliary SGFP turbine has been analyzed for 21,999 rapid full temperature cycles, which is equivalent to starting the plant from the cold condition to hot condition three times in every two days of plant life. The stress range reduction factor is chosen in accordance with Table 102.3.2(c) of the ANSI Code for Pressure Piping B31.1.

The check valves in the AFW lines located inside the containment are 4" nominal size with either a 600 or 900 lb ANSI rating. The original valves have a 600 lb rating but are being replaced on an as-needed basis with 900 lb tilting disc check valves, which have removable body sub-assemblies to facilitate maintenance. Each valve is cast carbon steel, A216 Gr. WCB, butt-weld ends, pressure seal cap or bolted body joint, stellited, welded or integral seat ring, tilting disc, with standard trim for steam or water service to 550°F. A pressure indicator is located upstream of the check valves to alert the operator of possible back-leakage through the check valves.

10A.5.1 PIPE WHIP

There are no postulated breaks or cracks in the piping of the pump train AFW System because a check valve inside Containment prevents high energy fluid from entering the lines outside Containment. Therefore, no pipe whip, jet impingement, or other reactive forces will occur.

The motor-driven pump trains were added in 1982-83. No pipe whips or breaks are postulated. Jet impingement from pipe cracks has been analyzed and is discussed in Section 10A.5.22.

10A.5.2 PIPE BREAK LOCATIONS

Not applicable (Section 10A.5.1).

10A.5.3 PIPE BREAK ORIENTATION

Not applicable (Section 10A.5.1).

10A.5.4 SUMMARY OF DYNAMIC ANALYSIS

Not applicable (Section 10A.5.1).

10A.5.5 PROTECTIVE MEASURES

Since the AFW System is not a high energy system outside the Containment, no protective measures are considered.

10A.5.6 SEISMIC CATEGORY I STRUCTURE EVALUATION

Since this system is only used for a short duration, a pipe break is not considered to be credible. Therefore, there will be no additional loadings to effect the adequacy of Category I structures which are designed in accordance with the design bases in Appendix 5A.

10A.5.7 STRUCTURAL DESIGN LOADS

There will be no additional loads in the Category I structures or structural components since this system is no longer a high energy system. All Category I structures are designed using the loads listed in Appendix 5A.

10A.5.8 LOAD REVERSAL ANALYSIS

There will be no reversal of loadings in Category I structures or structural components since this system is no longer a high energy system.

10A.5.9 EFFECTS OF NEW OPENINGS ON STRUCTURE

No new openings are required.

10A.5.10 VERIFICATION THAT ANY STRUCTURAL FAILURES WILL NOT AFFECT OTHER STRUCTURES REQUIRED FOR SAFETY

No structures will fail (Section 10A.1.10).

10A.5.11 VERIFICATION THAT PIPE RUPTURE WILL NOT AFFECT SAFETY

Not applicable (Section 10A.5.1).

10A.5.12 EFFECT ON CONTROL ROOM

Since there are no postulated ruptures in the system piping, there will be no effect on the Control Room.

10A.5.13 ENVIRONMENTAL QUALIFICATION OF AFFECTED REQUIRED EQUIPMENT

Not applicable (Section 10A.5.1).

10A.5.14 DESIGN DRAWINGS

Figures 10A.5-1 and 10A.5-2 show the AFW System.

10A.5.15 FLOODING

Not applicable (Section 10A.5.1).

10A.5.16 QUALITY CONTROL AND INSPECTION PROGRAMS

The quality control and inspection programs are presented in Section 10A.1.16.

10A.5.17 LEAK DETECTION

Not applicable (Section 10A.5.1).

10A.5.18 EMERGENCY PROCEDURES

Not applicable (Section 10A.5.1).

10A.5.19 SEISMIC AND QUALITY CLASSIFICATION

The turbine-driven train is designed and constructed in accordance with the ANSI B31.1 requirements, except for the isolation valve and the section penetrating the Containment which is designed and constructed to ANSI B31.7, Class II, requirements. The motor-driven train meets the requirements of ASME Section III, Class 3 and penetration systems are Class 2. The entire line is designed to withstand seismic loadings.

10A.5.20 DESCRIPTION OF ASSUMPTIONS, METHODS, AND RESULTS OF ANALYSIS FOR PRESSURE AND TEMPERATURE TRANSIENTS IN COMPARTMENTS

Not applicable (Section 10A.5.1).

10A.5.21 DESCRIPTION OF ASSUMPTIONS, METHODS, AND RESULTS OF ANALYSIS FOR EFFECT ON PRIMARY OR SECONDARY CONTAINMENT STRUCTURE DUE TO PIPE RUPTURE OUTSIDE

Not applicable (Section 10A.5.1).

10A.5.22 MODERATE ENERGY PIPE CRACK ANALYSIS

This section discusses an evaluation of the modification of Calvert Cliffs Units 1 and 2 AFW System against the NRC Standard Review Plan (SRP 3.6), NUREG 0800, dated July 1981. All postulated leakage crack locations were determined on the basis of that SRP.

10A.5.22.1 Analysis

The methods used in the analysis were:

a. Assume damage and evaluate the results
b. Verify by calculations whether any damage actually would occur.

The following assumptions were made for this analysis:

1. For subcooled fluid or cold water, the discharging fluids at the exit plane of the pipe are expanded at a uniform 10° half angle.
2. Jet deflections off solid objects (such as concrete walls, mechanical components) are assumed to result in dissipated flow energy. Impingement from deflection jets, therefore, does not require any analysis.
3. The effect of gravity on jet trajectory is assumed to be negligible and does not require any analysis.
4. Jet impingement against rigid steel electrical conduits or instrument sensing lines is assumed to cause no damage if the impacted portion is mounted flush against a wall or other structural member.
5. When a jet is obstructed by a floor grating which can be shown to remain in place, the jet effect downstream of the grating is assumed to be diminished and redirected, and does not require any further analysis.
6. Maximum jet distance is calculated based on a final pressure of 1 psig. This distance was calculated to be 12'.

7. Fluid flow from a crack is based on a circular opening area equal to that of a rectangle one half pipe diameter in length and one-half pipe wall thickness in width (SRP 3.6.2-18). The crack calculated for the 6" lines will also be used for the 4" lines to assure a conservative approach.
8. The boundary limits for the moderate energy pipe crack analysis are defined as being from the new AFW pump suction connection to the existing line, through to the check valve upstream of the tie into the existing AFW System, including recirculation piping (no portion of the turbine-driven system is included).
9. All the impingement forces on the targets are calculated taking into consideration a shape factor. That factor is a measure of the target's potential for changing the momentum of the jet as described in ANSI/ANS-58.2-1980, Appendix D.
10. A crack in a motor-driven AFW pump's discharge line is taken as resulting in loss of the use of that pumping train. Therefore, no analysis is required for impingement of a jet on equipment associated with that pump discharge line, except for equipment which could affect the steam-driven train.
11. The AFW pipe crack analysis does not involve flooding nor wetting of the components.
12. All safe shutdown evaluations were originally based on the Baltimore Gas and Electric Company Interactive Cable Analysis/Safe Shutdown Study generated in response to 10 CFR Part 50, Appendix R.
13. Instrument air copper tubing will be protected as necessary to assure operability of AFW System.
14. The jet impingement forces on the targets are not combined with seismic loads to see the effect on the targets.

10A.5.22.2 Evaluation

Following the performance of calculations to determine the physical dimensions of a leakage crack and its associated jet, all safety-related instruments, their associated conduits, cable trays, and instrument air line within that area, were located. Crack locations are shown in Figures 10A.5-3 Sheets 1 & 2 and 10A.5-4 Sheets 1 & 2. Both units are tabulated in Figure 10A.5-5.

Three preliminary evaluations were made at the outset to limit the scope of the review:

1. On the basis of SRP 3.6.2 method for determining postulated leakage cracks, no crack has been calculated to occur on the suction piping of Unit 1 or Unit 2 AFW motor-driven train. Therefore, it was concluded than no analysis was required.
2. The new AFW motor-driven train instrument tubing and conduits are routed in such a way that Unit 1 instrument tubing and conduits will not be effected by Unit 2 pipe cracks, and vice versa. Moreover, it has been assumed that any crack in the motor-driven pump AFW train will cause the loss of that train. Therefore, it was concluded that no analysis was required for the jet impingement on AFW instrument tubing and conduits associated with the new pump and its discharge. Tubing associated with the steam-driven pump train will be analyzed (Section 10A.5.22.1-10).
3. Only those items located within 12' of the crack location are considered as targets (Section 10A.5.22.1-6).

In all cases, the safety-related targets were shown to fail in the safe position if damage was assumed to occur due to pipe crack jet forces. Thus, no effect on safe shutdown of the plant would result.

To further confirm that no effects from jet impingement could occur, the jet forces were calculated in accordance with SRP 3.6.2 and the forces were applied to the targets - refer to Figure 10A.5-5 for a tabulation of these forces. A generalized stress analysis was then performed for tubing, conduit, or piping which assumes a maximum support span and an impact due to the jet force.

10A.5.22.3 Conclusions

All safety-related targets were shown to sustain the jet load and stay within their allowable stress limits. Tubing 3/4" and 1/2" diameter - both have a small thickness of Burmingham Wire Gauge 16 - were determined by the calculations to be able to withstand the associated load beyond 8.5' from the crack.