10.3 AUXILIARY FEEDWATER SYSTEM

10.3.1 DESIGN BASIS

The Auxiliary Feedwater (AFW) System (Figures 10-13 and 10-14) is designed to provide feedwater to the steam generators for the removal of sensible and decay heat, and to cool the primary system to 300°F in case the condensate or the main feedwater systems are inoperative. The AFW trains may also be used for normal system cooldown to 300°F. Component design data is contained in Table 10-1.

Reactor decay heat and sensible heat are transferred to the steam generators by natural circulation of the reactor coolant if power is not available for the reactor coolant pumps. Generic Letter 81-21 required an assessment of the facility's ability to properly manage a natural circulation cooldown event. In a natural circulation event, AFW must be available during the time the RCS is cooled to 300°F plus an additional period to allow cooling of the reactor vessel head. The assessment revealed that the facility has three condensate storage tanks, a demineralized water tank and a pretreated water storage tank, all of which can be used to mitigate this event. The emergency diesel generators can supply power to the well water pumps which transport water from the ground to the pretreated water storage tank and provide an unlimited supply of water. The NRC concluded, based on this information, there is sufficient water for a natural circulation cooldown (Sections 1.2.9.8, 9.4.4, 10.3.2).

Generic Letter 81-14 requested a walkdown of the non-seismically-qualified portions of the AFW systems to identify apparent and practically-correctable deficiencies of seismic qualification.

Baltimore Gas and Electric Company conducted an evaluation which concluded that the AFW systems exhibit a high degree of inherent seismic resistance. The majority of the system's original design was accomplished using the seismic design criteria typical for other Calvert Cliffs Category I systems. For those few portions of the system that were identified as non-seismic, the as-built configuration of the systems was examined and it was determined that the safe shutdown earthquake would not have a significant effect on system function.

The NRC concurred with the results except for the system manual valves. Subsequently, these valves were seismically-qualified by analysis and the results were accepted by the NRC.

10.3.2 SYSTEM DESCRIPTION

Three AFW pumps are installed, consisting of one motor-driven and two non-condensing steam turbine-driven pumps. For a shutdown, only one pump is required to be operating, the others are in standby. Upon automatic initiation of AFW, one motor-driven and one turbine-driven pump automatically start.

The turbine driver is supplied with steam from the steam generator as long as the pressure is above 50 psig. Each turbine has a manually-set governor for controlling turbine speed. Once set for a certain speed, the governor is designed to maintain approximately constant speed with a minimum of 50 psig steam pressure. The motor-driven pump is supplied from an electrical bus which can be powered by a site emergency diesel generator.

There is a bypass valve to each turbine steam supply valve. To avoid turbine overspeed on startup, initial steam flow is controlled by first opening the bypass valve and then opening the main supply valve after an appropriate time delay.

The steam-driven pumps have a capacity of 700 gpm at 2490' total discharge head at 3990 rpm. Shutoff head for the turbine-driven pump is 2950'. The motor-driven pump has a capacity of 450 gpm at 2800' total discharge head at 3560 rpm. Shutoff head for the motor-driven pump is 3300'. A feed rate of 300 gpm to the steam generator(s) is necessary to remove decay heat and reduce the RCS temperature to 300°F.

These pumps take suction from a 350,000 gallon condensate storage tank which is protected against tornadoes and horizontal tornado-generated missiles. The tank provides a net positive suction head (NPSH) in excess of that required. Tornado protection for the tank consists of a Seismic Category I concrete structure of sufficient thickness to stop horizontal tornado-generated missiles and to resist tornado wind pressures. Bursting pressures are relieved by baffled, missile-proof vents.

In addition to the enclosure for No. 12 Condensate Storage Tank (CST), there is an enclosure for the piping header from the CSTs to the AFW pump suctions. This Category I reinforced concrete enclosure is in the Tank Farm located adjacent to No. 11 CST and No. 21 CST. This enclosure protects the Category I AFW header, connecting piping, and associated valves from the various natural phenomenon discussed above.

At the low level alarm point, the CST provides 300,000 gallons of water for decay heat removal and cooldown of both units. By adjusting the feedwater flow to the permissible cooldown rate, decay heat removal and cooldown of both units can be accomplished in six hours. The 300,000 gallons are also adequate to maintain the RCS at hot standby conditions for 6 hours with steam discharge to atmosphere with concurrent and total loss of offsite power, or to remove decay heat from both units for more than 10 hours after initiation of cooldown and still maintain normal no-load water level in the steam generators. The contained water volume limit includes an allowance for water not usable because of tank discharge line location or other physical characteristics.

The motor-driven AFW pump has been provided with a fire hose connection on its suction as an alternate water source. Likewise, on loss of electric power, a siamese fire hose connection may be installed at the automatic recirculation valve on the discharge side of the pump.

The steam generated during decay heat removal and cooldown during an electric power failure will be discharged by the atmospheric dump valves, except for what is used for the turbine-driven auxiliary feed pump. If electric power and the condenser are available, it is planned to use the condenser as a heat sink and condense the generated steam except for the amount used in the non-condensing turbine.

10.3.3 DESIGN EVALUATION

These turbine-driven pumps operate reliably as long as there is steam pressure in excess of 50 psig in one of the steam generators. If necessary at this point, with site power available, the steam supply can be switched to the auxiliary boiler steam system. In addition, in an emergency the steam-driven train can operate independent of offsite power and the diesels for up to two hours. The AFW air accumulators provide a sufficient control air source until operators can manually regulate the system. The steam generator's AFW system is initiated by remote manual control or on low level in either steam generator.

Flow control valves are installed in each flow leg in order to allow automatic flow initiation to a value selected by the operator. The valves can be set for automatic operation or placed in remote manual control from the Control Room or auxiliary shutdown panel. Maximum flow to the steam generators from the motor-driven AFW pump powered from the diesel is 300 gpm when feeding both generators. The flow control valves installed in each leg supplied from the motor-driven AFW pump are set at a flow setpoint not to

exceed 150 gpm per leg. If the flow is only being directed to one steam generator, it is acceptable to deliver a maximum of 330 gpm because the flow error associated with the non-used loop is eliminated. These motor-driven AFW pump capacity limits are imposed to prevent exceeding the emergency diesel generator load limit. If diesel generator loading is not a limiting concern, the delivered flow from the motor-driven AFW pump may be increased to the maximum capacity of the motor, which will deliver 575 gpm of feedwater. These upper flow limits do not apply to the steam-driven pumps.

Each AFW discharge flow leg is supplied with two block valves in series. During a Main Steam Line Break, the block valve in the flow legs to the ruptured steam generator will automatically shut. A motor-driven pump discharge header cross connect is available to provide flow, if necessary, to a unit if either No. 13 or 23 pump is inoperable. On/off flow control is provided by a remote manual valve, with the affected unit's flow control valve being used for modulation. High or low level in No. 12 CST is annunciated in the Control Room and level indication for each tank is provided in the Control Room. Indication of flow, discharge pressure, and annunciation of low suction pressure, excess discharge flow, and pipe rupture are also provided in the Control Room.

Auxiliary feedwater flow and response times are conservatively accounted for in the analyses of design basis events. In main steam line break and excess load analyses where AFW flow would increase the consequences of the accidents, the delay time for AFW actuation is minimized and AFW flow is maximized. In feedline break, loss of feedwater, and loss of non-emergency AC power analyses, in which AFW flow would decrease the consequences of the accidents, the delay time for AFW actuation is maximized and AFW flow is minimized. At 10 minutes after an Auxiliary Feedwater Actuation Signal, the operator is assumed to be available to increase or decrease AFW flow to that required by the existing plant conditions.

10.3.4 TESTS AND INSPECTIONS

The AFW System can be tested during normal operation by recirculating the AFW pump flow to the CST.