10.2 CONDENSATE AND FEEDWATER SYSTEM

10.2.1 DESIGN BASIS

The Condensate and Feedwater System is designed to provide a means for transferring the condensate from the condenser hotwell to the steam generators (while at the same time raising the temperature and pressure) and providing a means for controlling the quantity of feedwater into the steam generators. Component design data is contained in Table 10-1.

In Bulletin 79-13, the NRC required an examination of feedwater piping welds. Baltimore Gas and Electric Company completed limited radiographic and visual examinations and found no evidence of cracking. After inspection of the radiographic procedure and film, the NRC found this examination acceptable.

10.2.2 SYSTEM DESCRIPTION

The Condensate and Feedwater System is shown in Figure 10-4 (Unit 1) and Figure 10-11 (Unit 2).

Condensate from the hotwells is pumped by two electric motor-driven condensate pumps (with another pump held on standby) through the gland steam condenser, the condensate demineralizer and precoat filtering system, the lowest feedwater heating stage drains coolers, and the two lowest pressure feedwater heating stages (three heaters per stage) to the suction of the three condensate booster pumps (two operating, one on standby). These pumps deliver the condensate to the two turbine-driven steam generator feed pumps (SGFPs) through two parallel sets of three feedwater heaters. The SGFPs pump the feedwater through two parallel high pressure heaters to the steam generators.

The heating steam for the feedwater heaters, as shown on Figure 10-5 (Unit 1) and Figure 10-10 (Unit 2), is extracted from the turbine as follows: extraction for High Pressure Heaters No. 16A and B and for the first stage reheater (two in parallel for Unit 1, four in parallel for Unit 2) is from the high pressure turbine; for Heaters No. 15A and B (25A and B) it is from the cold reheat line; for the remaining four heating stages it is from different stages of the low pressure turbine.

The drains from the second stage reheater are routed to the high pressure heaters, whereas those from the first stage are routed to Heaters No. 15A and B (25A and B). The steam which condenses in the three higher pressure feedwater heaters is collected (by cascading) in two heater drain tanks, which also collect drains from the moisture separator vessels. From this point, the drains are pumped via two heater drain pumps into the condensate system between Heaters No. 14 (24) and 15 (25). The three lower pressure feedwater heating stages cascade their drains back to the condenser hotwell. Chemicals are added to the condensate flow for oxygen scavenging and pH control. The chemicals approved for use are listed and controlled by Chemistry Section procedures.

10.2.2.1 Feedwater Pumps

Two turbine-driven pumps supply the required feedwater flow rate to the steam generators to match the steam flow demand by the plant turbine generator and auxiliaries. The driving steam for high load operation is hot reheat, whereas for low load, an automatic changeover to main steam takes place. Auxiliary steam from the auxiliary boiler may also be used. Several provisions, i.e., low vacuum, loss-of-turbine lube oil pressure, thrust bearing wear, turbine overspeed, and manual turbine trip, are made available to protect the turbine-driver/pump units during operation. Specific critical values of the operating parameters for the turbine drivers and the feed pumps are established; a trip of a driver-pump unit set will occur when any of the preselected values is exceeded. The feed pump high discharge pressure trip and pump speed controls are credited as the means to limit the feedwater system pressure to within the system design pressure rating.

10.2.2.2 Automatic Control in Conjunction With Feedwater Regulating Valves

Each steam generator is equipped with three-element control in order to produce a demand signal for feedwater flow which is a function of the difference between the feedwater and steam flows, trimmed by the steam generator downcomer level error. The feedwater flow demand signal for each steam generator is sent to the corresponding feedwater regulating valve and in combination with the turbine driver speed control system, controls the level in each steam generator by modulating the feedwater flow.

Between approximately 2 and 100% power, the feedwater control system automatically controls the steam generator water level. Manual control capability can be utilized at any power level.

Upon reactor trip, the main feedwater valves are automatically closed and the feedwater bypass valves are automatically opened to approximately 3.8% of main feedwater valve flow. When an abnormally high steam generator level is sensed, the turbine is tripped.

10.2.2.3 Main Feedwater Pump Turbine Speed Control

The speed of each main feedwater pump turbine is controlled as a function of the main feedwater control valve demand signal which regulates the flow of condensate to the SGs.

The main feedwater control system demand signal is converted to a pump speed demand signal by a function that produces a relatively constant differential pressure across the control valve with the varied flow demands. Each set of feedwater pump manual/auto control stations have manual bias adjustment to adjust the fraction of feedwater flow through each pump to accommodate for any process abnormalities.

The steam supply source for normal operation up to approximately 40% of the SGFP output is main steam. Above this point, hot reheated steam is used. A connection to the auxiliary steam supply is provided on the hot reheat inlet and can be used if required.

10.2.2.4 Radioactivity Monitoring

A radioactivity monitor is located in the steam generator blowdown line. When a high radioactivity level is detected, an alarm is annunciated in the Control Room and the liquid effluent from the steam generators is diverted to the miscellaneous waste processing system. This blowdown liquid monitor has an alarm setpoint selected and adjusted in accordance with the Offsite Dose Calculation Manual. The steam generator blowdown tank vents alternatively to the heater drain tank or to the Feedwater Heaters No. 13A and 13B shell side for Unit 1 (Figure 10-1), and to the heater drain tank only for Unit 2 (Figure 10-9). Chapter 11 contains additional information on the radiation monitoring system.

10.2.3 DESIGN EVALUATION

The plant can carry more than half load with one-half of the feedwater heaters, i.e., No. 13, 14, and 15 (23, 24, and 25), shut down and isolated entirely from the system, with only one condensate pump in operation, and/or with only one SGFP in service.

The feedwater heaters are designed to meet Tubular Exchanger Manufacturers Association (TEMA) Standards and the ASME B&PV Code, Section VIII, Pressure Vessels, with the exception that the SGFP speed controls and high discharge pressure trips (in addition to the thermal relief valves) are credited for providing overpressure protection.

Because overpressure protection of the high pressure feedwater heaters (16 A/B and 26 A/B) is not strictly in accordance with ASME B&PV Code, Section VIII, a variance was obtained from the Maryland boiler and pressure vessel safety requirements defined in the Code of Maryland Regulations. The basis for this variance was that the feedwater system is protected by the SGFP steam turbine governors and modified high discharge pressure trips. The modification to each pump's high discharge pressure trip included the addition of two pressure switches and corresponding contacts in the alarm and trip circuits to ensure that the failure of one pressure switch will not disable the SGFP high discharge pressure trip (Facility Change Request [FCR] 88-0128 and FCR 90-26).

10.2.4 TESTS AND INSPECTIONS

Equipment, instruments, and controls are regularly inspected in order to ensure proper functioning of the system. The motor-driven pumps and controls can be given preoperational tests after erection and before plant warm-up.

A long-term program, consisting of systematic measures to ensure that erosion/corrosion does not affect high energy carbon steel systems, is in place. This program, which meets the intent of the Nuclear Management and Resources Council guidelines per NUREG-1344, Appendix A, applies to both single-phase and two-phase systems.

10.2.4.1 Tank Reliability

The Quality Control requirements for Condensate Storage Tank Nos. 11 and 21 and Fuel Oil Storage Tank Nos. 11 and 21 were included entirely within the applicable equipment specification and not supplemented by the requirements of the Bechtel generic specification BQC-200. The specification for these tanks invoked specific codes and standards to set forth material, fabrication and erection requirements, as well as to stipulate performance of certain tests and the documentation of the results of those tests.

The vendor for these tanks was selected from the Bechtel Approved Bidders' List which includes only those vendors who have undergone a quality assurance audit by Bechtel in accordance with Bechtel's requirements. Vendors on this list were audited periodically to ensure that Bechtel's quality assurance standards were satisfied.

After release of the order to the vendor for these tanks, a Bechtel shop inspector was assigned to follow this order by the Bechtel Procurement Department to assure that the tank materials were produced in accordance with the specification, drawings and purchase order requirements. Since these tanks are field erected, shop work was limited to the cutting and forming of plate and the Bechtel shop inspector's duties included the checking of incoming material for heat numbers and mill test certifications and the inspection of materials after shop operations.

At the site, the vendor erected the tanks and was responsible for ensuring that code and specification requirements were met. For Condensate Storage Tank Nos. 11 and 21, these requirements included welder and welding procedure qualifications according to ASME Code, Section IX, spot radiography, vacuum box testing and hydrostatic testing according to American Water Works Association Code D-100. For Fuel Oil Storage Tank Nos. 11 and 21, these requirements included welder and welding procedure qualifications according to ASME Code, Section IX, spot radiography, vacuum box testing and hydrostatic testing according to American Petroleum Institute Code 650. During the erection, Bechtel welding personnel maintained surveillance over welding and non-destructive examination. Documentation of satisfactory acceptance of the required tests has been completed and is on file at the job site. These surveillance activities included reviewing of welding procedures and welder qualifications, accepting non-destructive examination results, including radiographs, and maintaining a surveillance of storage and general construction practices followed at the site.

Additional design and quality control requirements for the condensate storage tank are given in Section 6.3.5.1.