10.3 MAIN STEAM SYSTEM

10.3.1 Design Bases

The Main Steam System is designed to convey saturated steam to the turbine from the four steam generators. Steam is also supplied to the steam generator feedpump turbines, auxiliary feedpump turbine, moisture separator-reheaters, gland sealing steam controllers, and No. 15 feedwater heater. Provision is made to dump up to 40 percent of full load steam flow directly into the condenser (turbine bypass) to aid the reactor in accommodating electric generator load rejections without reactor trip.

The main steam piping from the steam generators through the main steam isolation valves (MSIVs) is classified as Seismic Category I. Beyond the MSIVs, the main steam piping is designed to conventional standards.

The main steam piping in the containment has been analyzed to ascertain the effects of guillotine-type pipe rupture, and restraints have been provided to ensure that such a rupture will not compromise containment integrity.

The pressure retaining components or compartments utilize the following codes as minimum design criteria:

1. System pressure vessels - ASME Boiler and Pressure Vessel Code, Section VIII.

2. System fittings and piping - ANSI Standard Code for Pressure Piping ANSI-B31.1.0, Power Piping. For nuclear piping not supplied by the Nuclear Steam Supply System (NSSS) supplier, material, inspections, fabrication, and quality control conform to ANSI Code for Pressure Piping, ANSI-B31.7, Nuclear Power Piping. Where not possible to comply with ANSI B31.7, the requirements of

ASME III-1971, which incorporated ANSI B31.7, were adhered to. Main Steam piping fabrication, installation welding, and examination involved in installing the Unit 2 replacement Steam Generators utilized ASME Section XI (1998 Edition with 2000 Addenda) and ASME Section III, Subsection NC (1995 Edition with 1996 Addenda). Both of these later codes are NRC-endorsed per 10CFR50.55a and were reconciled to the original construction codes.

Principal system valves - Main Steam Safety Valves - ASME Boiler and Pressure Vessel Code, Section III, Class A.

Main Steam Relief Valves - ASME Boiler and Pressure Vessel Code, Section III, Class II (Class I for materials, inspections, fabrication, and quality control).

MSIVs - ASME Boiler and Pressure Vessel Code, Section III, Class II (Class I for materials, inspections, fabrication, and quality control).

Feedwater Isolation Valves - ASME Boiler and Pressure Vessel Code, Section III, Class II or ASME Code for Pumps and Valves for Nuclear Power, Class II (Class I for materials, inspections, fabrication, and quality control) as applicable for individual valves based on procurement documents.

10.3.2 System Description

10.3.2.1 Main Steam System

The Main Steam System is shown on Plant Drawings 205203 and 205303.

The Main Steam System for each unit conveys saturated steam from four steam generators to the high pressure (HP) turbine with less than 40 psi pressure drop. The steam conditions of approximately 3,900,000 pounds per hour, and a density based on 750 psig (nominal) 513°F steam, were used for the system design of both units. Reheat is provided, external to the steam generators, between the HP and low pressure (LP) turbines.

For Unit 1, the steam pressure is 814 psig, and the temperature is 522°F at the steam generator exit nozzle. For Unit 2, the steam pressure is 885 psig, and the temperature is 532°F at the steam generator exit nozzle.

A turbine bypass system bypasses up to 40 percent of full load flow directly from the main steam lines to the condenser.

In addition, the bypass system supplies steam to the main steam coils of the moisture separator - reheaters (MSR), steam generator feed pump turbines (during low load operation) and the gland steam controller. The auxiliary feed pump turbine is fed from the Main Steam System. Cold reheat steam is used in the No. 3 feedwater heater while hot reheat steam is used to supply the steam generator feed pump turbines.

Four lines convey the steam from the steam generators, in the containment, through the wall penetrations to an anchored mixing bottle in the yard. This piping is 30 inches outside diameter (OD) within the containment, 32 inches OD within the penetrations, 32 inches OD inside the penetration areas (except 34 inches OD from the safety valve headers) and 32 inches OD from the MSIVs to the mixing bottle. The mixing bottle has an OD of 43 inches.*

Following temperature and pressure equalization in the mixing bottle, steam is carried to the turbine by two parallel 40-inch OD pipes. Each of these pipes bifurcates to a pair of 28-inch lines which supply the four sets of turbine stop and governor control valves.

Equalization of steam pressure near the turbine is provided by a 24-inch OD pipe interconnecting the two main steam pipes just upstream of their respective bifurcations.

The exhaust from the high pressure turbine (cold reheat steam) is carried to six combination MSR assemblies. These assemblies have

*All piping outside diameters (OD) given are nominal sizes.

horizontal cylindrical shells and are located alongside the LP turbine elements, three to a side. On each side of the turbine the cold reheat steam passes through two 44-inch OD pipes into a 62-inch OD pipe. The 62-inch pipes reduce to 54.5 inches and then 37.5 inches OD after feeding No. 1 and 2 MSRs respectively. The feed pipes to the No. 1 and 3 MSRs are 37.5-inches OD, while those to the No. 2 MSRs are 42-inch OD. The steam leaving each of the six MSRs is conveyed to its respective LP turbine element by a 37.5-inch OD pipe.

The Turbine Bypass System removes steam from the two 40-inch OD main steam pipes through two 16-inch OD pipes just upstream of the main steam line bifurcations. A portion (up to 40 percent of full load flow) of the steam thus removed can be routed to the condenser through six 12-inch OD pipes, each of which branches into two 10-inch OD pipes, while the remainder of this flow is used to feed the MSR main steam coils through six additional 10-inch OD pipes.

The main steam piping is in compliance with ANSI B31.1.0, and was designed using the appropriate wall thickness formula from the ASME Boiler and Pressure Vessel Code (1965 edition and summer addendum of 1966) with allowable stress values from ANSI B31.1.0. Main Steam piping fabrication, installation welding, and examination involved in installing the Unit 2 replacement Steam Generators utilized ASME Section XI (1998 Edition with 2000 Addenda) and ASME Section III, Subsection NC (1995 Edition with 1996 Addenda). Both of these later codes are NRC-endorsed per 10CFR50.55a and were reconciled to the original construction codes.

The piping between the steam generators and the MSIVs outside the containment is designed to Seismic Category I criteria with materials quality governed by ANSI B31.7. The principal piping is rolled electric - fusion welded carbon steel, manufactured to ASTM Specification A155, Grade KC 70, Class I, or a substitutable chrome alloy or stainless steel material. A portion of the main steam piping replaced during the Steam Generator Replacement Project for Units 1 and 2, uses ASME SA 672, Grade C70, Class 22 material. The entire system has been stress analyzed for the forces and moments resulting from thermal growth, and the piping upstream of the MSIVs has been dynamically analyzed for seismically induced stresses. The main steam piping within the containment has been analyzed to ascertain the effects of a guillotine rupture and restraints have been provided to ensure that such a rupture will not compromise containment integrity. Main steam piping at the safety and relief valves has been analyzed to determine its ability to withstand full valve force and moment reaction loadings.

Steam flow is metered and limited in each line by a dual purpose flow restrictor located inside the containment. Outside the containment a power-operated relief valve (PORV), five safety valves and a quick acting self-actuating MSIV are provided in each of the four lines to the mixing bottle. The main steam safety valves, set at 1070, 1100, 1110, 1120 and 1125 psig respectively, have a total relief capacity of 100 percent of full load flow, while the PORVs can pass a total of 10 percent of full load flow to atmosphere. Hot reheat stop and intercept valves are provided in each of the six hot reheat lines (as are bypass stop and control valves in each turbine bypass line).

A pneumatically-operated bypass valve around each MSIV, steam traps, strainer/orifice assemblies and power-and manually-operated startup drain valves are provided at appropriate locations to ensure proper warmup of the entire Main Steam System to prevent condensate collection during operation and to prevent freezeup during outages.

During operational transients, the excess steam generated is normally bypassed directly to the condenser through the Bypass System. The Bypass System can accommodate 40 percent of full load flow, which, in conjunction with the 10-percent step load change capability of the NSSS, enables the plant to accept a 50-percent load rejection from full load without reactor trip, turbine trip, or safety valve actuation. A description of the operation of the Bypass System is included in Section 10.4.4.

10.3.2.2 <u>Main Steam Isolation Valves</u>

A schematic diagram of the MSIVs is provided on Figure 10.3-2. The MSIVs are installed in each main steam header at the outlet of each steam generator. The valves are located outside of the containment, downstream of the safety valve manifold.

The valves are 32 x 24 x 32-inch Hopkinson parallel slide gate valves with double discs. They are operated by means of an integral piston and cylinder, utilizing steam within the valve and piping. The piston, attached to the valve stem, is at the lower end of its cylinder when the valve is in the open position. It has a small orifice to permit pressure equalization in the open position. A vent line from the upper end of the cylinder branches to two diaphragm-operated dump valves which are connected in parallel to provide redundant control of the main valve.

Upon receipt of a closure signal, the dump valves open and release steam from the upper side of the main valve piston, thereby closing the valve. The movement of the valve stem is damped at the upper end of its travel by a hydraulic cylinder and piston (snubber) mounted integrally on the valve. The snubber incorporates an integral electric motor-operated hydraulic power unit which permits remote manual operation of the valve at conventional speed.

The valves can be operated from the Control Room. They may be partially closed by remote manual (electro- hydraulic) control for testing operability at any steam flow or pressure.

A motor-operated three-way valve is installed in the steam cylinder vent line of each MSIV, and is normally in the mid-position; however, it does permit isolation of one dump valve and its controls without affecting the operation of the remaining one. Each valve has a local control station with position indicating lights in the Control Room.

The MSIVs have a detent mechanism which maintains the valves in the open or closed position and yet permits operation when sufficient differential pressure across the steam piston is established or the valve is operated hydraulically. Position indicating lights and control switches are provided on the valves for open, closed, and test positions.

The MSIVs close automatically on the initiation of a steam line isolation signal. If the closure time of the MSIV during a Tech. Spec. Surveillance test (between 800 psig and 1000 psig Steam Generator pressure) is 5.0 seconds or less and the ESF response time (including valve closure time) for the steam line isolation signal (Table 3.3-5) is 5.5 seconds or less, then assurance is provided that main steam isolation (MSI) occurs within 12 seconds under accident conditions, where Steam Generator pressure may be lower. The 5.0 seconds of the surveillance test consists of a 1.5 second timer delay and a 3.5 second mechanical stroke time.

This method of testing assures that for main steam line ruptures that are initiated from Modes 1-3 conditions that generate a MSI signal via automatic or manual initiation and have adequate steam line pressure to close, the main steam lines isolate within the time required by the accident analysis. Fast closure of the MSIVs is assured at a minimum steam pressure of 170 psia. However, the MSIVs will still close via the steam assist function between 118 - 170 psia with slightly greater closure times. For main steam line ruptures that receive an automatic or manual signal for MSI and do not have adequate steam pressure to close the MSIVs (less than 118 psia), the event does not require MSIV closure to provide protection to satisfy design basis requirements (i.e., DNBR remains above the minimum DNBR limit value and peak containment pressure remains below 47 psig).

In summary, steam line breaks that occur in Mode 3 and that require steam line isolation will result in a steam line isolation signal and have sufficient steam pressure to close the MSIVs within the time assumed for fast closure in the Chapter 15 accident analyses. Any steam line breaks that occur in Mode 3 and that are too small to generate a steam line isolation signal do not require steam line isolation for core protection and are not limiting with respect to DNBR.

The valves are operated by an integral piston and cylinder utilizing steam within the valve and piping as the power media. The valve is maintained in the open position by steam applied to the upper side of the piston which is attached to the valve stem. Valve closure is achieved by venting the steam from the upper side of the piston cylinder through either of two redundant diaphragm operated vent valves.

Valve stem travel is damped by a hydraulic cylinder and piston integrally mounted on the topworks. In addition, the hydraulic cylinder and piston includes an electric motor to permit remote manual hydraulic operation of the valve.

A motor-operated three-way valve is installed between the MSIV vent connection and the two redundant vent valves. The three-way valve is normally in the mid-position permitting venting of the cylinder through either vent valve. The three-way valve may be positioned in either of its extreme positions to isolate one vent valve without affecting operation of the other.

The MSIV vent valves are normally closed, air to close, solenoid actuated diaphragm-operated valves. The vent valve solenoid actuators are normally de-energized requiring the initiation of a steam line isolation signal to energize the solenoid to perform the following sequence of events:

1. Initiation of main steam isolation signal energizes solenoid.

2. Solenoid exhausts vent valve diaphragm opening vent valve.

3. Vent valve relieves steam from MSIV upper cylinder which closes the MSIV.

Design features to meet the single failure criterion are as follows:

1. Each MSIV cylinder may be exhausted through one of two redundant vent valves piped in parallel.

2. The solenoid actuators for the vent valves are powered by redundant vital buses.

3. The air supply for the vent valves are fed from redundant air headers.

4. The vent valves are actuated from separate protection system logic trains.

A failure of an air supply, logic train, power supply, or vent valve will not prohibit isolation of the steam line by the redundant equipment.

A failure of the pressure boundary at any point in the steam cylinder above the piston, in the vent line, or in the three-way or vent valve bodies will result in one of two consequences, either of which is considered acceptable:

1. If the pressure boundary failure is of such a size that steam leaks from above the piston at a rate greater than that which can be replenished through the equalizing orifice in the piston, the valve will close.

2. If the pressure boundary failure is of such a size that its leakage can be replenished by flow through the piston orifice, the valve will remain in its open position until closed by the appropriate isolation signal.

If the valve fails to close upon venting of the steam above the piston, the hydraulic operator may be used to close the valve.

10.3.2.3 Flow Limiters

Each steam line is provided with a venturi-type restrictor. The flow restrictors are designed to increase the margin to departure from nucleate boiling (DNB), and thereby reduce fuel clad damage, by limiting steam flow rate consequent to a steam line rupture and thereby reducing the cooldown rate of the primary system.

Design criteria for the steam line flow restrictors provide the following:

1. Provide plant protection in event of a steam line rupture downstream of the restrictor. In such an event, the flow restrictor reduces steam flow rate from the break, which in turn reduces the cooling rate of the primary system. This increases the margin to DNB and fuel clad damage, as shown in Section 15.

2. Minimize unrecovered pressure loss across the restrictor coincident with limiting accident flow rate to an acceptable value (less than 5 psi at 120 percent of rated steam flow).

Design requirements imposed in addition to the design criteria include the following:

1. Reduce thrust forces on the main steam piping in the event of a steam line rupture, thereby minimizing the potential for pipe whip.

2. Provide a portion of the pressure differential necessary for steam flow measurement.

3. Withstand the number of pressure and thermal cycles experienced in the life of the plant.

4. Maintain restrictor integrity in event of double-ended severance of a main steam line immediately downstream of the restrictor.

The location of the flow restrictors is shown on Plant Drawings 205203 and 205303. Restrictors are positioned approximately 24 pipe diameters downstream of each steam generator in vertical sections of piping in order to minimize the length of piping preceding the restrictor, thereby reducing the probability of an upstream pipe break.

Each flow restrictor is provided with two steam flow transmitters which provide inputs to the Reactor Protection System. These transmitters have variable damping which is adjusted to minimize false safety injection signals caused by spurious transient high steam flow signals. The damping is selected so that the transmitter and protection channel response times do not exceed Technical Specification time response requirements and hence do not affect any safety margin.

All the statements above are applicable to both units. In addition, each steam generator also has an integral flow restricting device in the steam nozzle, with a flow area of 1.4 ft^2.

10.3.3 Evaluation

10.3.3.1 Transient Effects

A reactor trip from power requires subsequent removal of core stored and decay heat. Immediate heat removal requirements are normally satisfied by the steam bypass to the condensers and pressure relief system. Thereafter, core decay heat can be continuously dissipated as feedwater in the steam generator is converted to steam by heat absorption. The capability to return feedwater flow to the steam generators is provided by operation of the Main or Auxiliary Feedwater Systems.

In the unlikely event of a loss of offsite power, decay heat removal would continue to be assured by the availability of one steam-driven and two motor-driven auxiliary feed pumps, and steam discharge to atmosphere via the power relief valves and/or the steam generator safety valves. In this case, feedwater is available from the auxiliary feedwater storage tank by gravity feed to the auxiliary feed pumps. The water supply in the auxiliary feed storage tank is adequate for decay heat removal for a period of about eight hours. Alternate sources of water are available from the demineralized water storage tanks, fresh water storage tanks and Service Water System. The analyses of the effects of loss of load and steam line breaks on the Reactor Coolant System are discussed in Section 15.

10.3.3.2 Reliability and Integrity of Safety-Related Equipment

All Steam and Power Conversion System equipment required for reactor plant safety is designed as Seismic Category I and the appropriate systems are sufficiently redundant to ensure performance of their safety functions. Specifically, the Auxiliary Feedwater System and portions of the Service Water System are required to perform various plant safety functions.

The effects of a main steam pipe break outside the containment have been evaluated with regard to potential damage to safeguards equipment.

The main steam pipes penetrate the containment into an enclosed penetration area. From this space, the pipes are routed vertically through the roof to the outdoors. This space is the only enclosed space that the pipes pass through before they reach the Turbine Building, as indicated on Plant Drawings 204803, 204804 and 204808.

The main steam pipe is restrained within the penetration area in order to prevent damage to safeguards equipment in those areas due to pipe whip. The penetration areas are provided with blow-out dampers which vent to atmosphere when pressure within the penetration area exceeds 2 psig.

Outside of the penetration areas, two out of the four main steam lines for each unit run adjacent to the Auxiliary Building outdoors. To preclude damage to safeguards equipment within the Seismic Category I Auxiliary Building, however, a 13-foot space has been provided between the pipes and the building wall. Additionally, the wall has been designed as a missile barrier with a 2-foot concrete thickness.

10.3.3.3 Pressure Relief

Self-actuated safety valves are provided to insure the integrity of the Steam and Power Conversion System. These valves are designed to pass 100 percent of the maximum calculated steam generator capacity. Five valves are installed on each steam generator outlet steam line with the lowest set pressure at 1070 psig. In addition to the above, each steam generator has a 10-percent capacity PORV.

A turbine bypass system having a capacity to exhaust 40 percent of maximum calculated turbine flow to the condenser is also provided.

10.3.3.4 Radioactivity

HISTORICAL NOTE:

The radiological dose values contained in this section were calculated in support of initial licensing. Currently, occupational dose is managed through the Radiological Controls Program, ALARA, and the Technical Specifications.

Under normal conditions, there is no radioactivity present in the system. The system may only become contaminated through primary to secondary leaks in the steam generators. Should this occur, radiation monitors installed in the steam generator blowdown, each main steam line, and condenser vacuum pump effluent streams detect and indicate the presence of radioactivity.

(Historical Information)

Assuming operation with the maximum permissible primary system activity and a greater than maximum permissible primary to secondary system leakage rate, the dose rate around the steam generator is approximately 325 mR/hr at contact with the steam generator secondary water section just above the U-tubes. The dose rate on the operating floor outside the steam generator biological shield would be approximately 150 mR/hr, due to the secondary water in the steam generator which is above the top of the biological shield.

The dose rates from a main steam line were calculated to be about 8 mR/hr at contact and less than 1 mR/hr at 10 feet away. Dose rates from the turbine will be less than this due to the thick steel turbine casing serving as a shield, and lower source densities as the steam travels through the turbine. The primary contributors to the dose rates from the main steam lines and turbine are the noble gases and N-16. Since the noble gases are removed at the condenser by the condenser Air Removal System and there is sufficient storage time in the hotwell to allow for the decay of the N-16 to negligible levels, the only remaining source in the feedwater is 0.25 percent of the nongaseous fission products that are carried over with the steam. Dose rates from feedwater lines were calculated to be approximately 4 mR/hr at contact and less than 1 mR/hr at 10 feet away.

Dose rates from a 3-inch blowdown line were calculated to be approximately 280 mR/hr at 1 foot away and 75 mR/hr at 3 feet away. The dose rate from the blowdown tank was approximately 800 mR/hr at 3 feet away.

Shielding around the steam generators is designed to reduce radiation levels from the U-tubes. Since primary to secondary leakage is not expected to occur at all times, and access to the containment is minimal during operation, higher dose rates on the operating floor are acceptable. However, high dose rates in this area may require reduced access time. Radiation levels in other accessible areas of the containment (outside the crane wall and below the operating floor) will not be severely affected.

Shielding around the main steam line, turbine, condenser, feedwater and heat recovery blowdown system piping is not necessary since radiation levels in this area would only occur in the event of primary to secondary leakage, and the dose rates would be low. In this event, access to the Turbine Building would be controlled.

The blowdown lines pass through the mechanical penetration area where some higher radiation levels normally exist, and no additional shielding is required. The blowdown tank is in a relatively low radiation area, but can be temporarily shielded if access to the area is necessary. Piping to the blowdown demineralizer is in a shielded pipe alley and the demineralizer is in a shielded cubicle. The remainder of the system is in an area where access can be controlled. If access to Blowdown System components is necessary for maintenance while the higher dose rates exist, temporary shielding can be installed and access times limited.

Assumptions

(Historical Information)

1. A conservative primary to secondary leak rate of 8 gpm was assumed (the expected leak rate is currently being determined - a lower value will decrease the main steam line and turbine dose rates).

2. 100 percent of noble gases

3. Fission product carryover: 0.25 percent

4. Steam generator flow rate: 3.6×10^6 lb/hr/stm gen

5. Calculations based on 1 defective steam generator

(Historical Information -cont'd)

6. N-16 concentration at steam generator inlet used (no further decay assumed before condenser)

7. Steam generator secondary side dose rates:

   a. Steam: noble gases plus N-16

   b. Secondary water: Fission product activity associated with 1 percent fuel defects. Noble gas activity associated with 1 percent fuel defects (adjusted for dilution in steam generator) and N-16

8. Blowdown sources: same as steam generator

9. Condenser has water storage capacity of 3 to 5 minutes

10.3.3.5 Main Steam Isolation Valve Integrity and Reliability Test

(Historical Information)

The capability of the main steam isolation valves (MSIVs) to fully close under full differential pressure, occasioned by a main steam line rupture immediately downstream of the valve, was demonstrated by testing a full size valve, similar to the Salem valves, at the manufacturer's facility. The following tests were made:

1. Hydrostatic test of valve body, with valve in open position, at 2175 psig - one hour - no leakage.

2. Seat tightness test with valve closed and 1500 psi intergate pressure (full differential across each seat) and valve ends open for inspection - one hour - no leakage; valve operated over seat overlap range (1-inch) with 600 psig intergate pressure and held one hour - no leakage.

3. For steam testing, the valve itself was made to simulate a boiler and generate steam by carefully controlled

(Historical Information - cont'd)

electric heating. In 409 hours of steam testing 62 fast closings were made at steam pressures of 80-1050 psig (sat.). These closings were made from full open to full close with no differential across the seats. Closure speed at 640 psig steam pressure was 3 seconds with nominally uniform travel speed. Steam operation tests were made over the seat overlap range (1-inch) at pressures from 80-1050 psig between discs (intergate) to check capability of valves to operate on steam with full differential across seats and maximum seat contact. During this testing the valve ends were vented to atmosphere.

4. Tests were made with the hydraulic unit uncoupled using nitrogen at 400 psig and 360 psig as the operating media. Closure times were 0.94 and 1.03 seconds, respectively.

At the conclusion of operational tests a seat tightness test produced leakage of 16 cc/hr at one seat and 275 cc/hr at the other seat. Little wear was evidenced on seats. However, there was indication that the discs, as anticipated, do rotate during the valve stroke.

The valves are periodically exercised in accordance with the requirements set forth in the Technical Specifications.

10.3.3.6 Main Steam Isolation Valve Restraints

Mechanical restraints have been provided at and adjacent to the MSIVs. Several types of restraints have been used, each serving a distinct function. Restraints are provided on the steam lines adjacent to the MSIVs. These restraints serve to limit pipe motion following a postulated rupture such that neither excessive moments nor physical impact can damage the containment, containment penetrations, or MSIVs. Supports are provided on the valve body to aid in supporting valve weight and supply restraint against undesired motion. Where necessary, the valve operator has also been restrained to limit seismically induced motions.

10.3.4 Inspection and Testing Requirements

The MSIVs (MS167) and automatic drain stop valves (MS7) shall be tested periodically as set forth in the Technical Specifications.

The main steam drain traps are periodically tested to ascertain their proper functioning and, hence, prevent any unnecessary water accumulations.

Removable insulation panels have been provided at welds in the Main Steam System between the steam generator and the MSIVs in order to accommodate volumetric and surface weld examination as specified by periodic inservice inspection requirements.

A functional test of the turbine governor control valves is performed periodically and can be made while the unit is carrying load. The purpose of this test is to ensure proper operation of the turbine stop valves, control valves, reheat stop valves, and interceptor valves.

The controls and protective devices associated with system components, including steam generator safety valves, are tested as set forth in the Technical Specifications.

10.3.5 Water Chemistry

10.3.5.1 Chemical Feed System

The Chemical Feed System is shown on Plant Drawing 205214. Chemical feed equipment is provided to add hydrazine, ammonium hydroxide, ethanolamine (ETA), polyacrylic acid (PAA), and/or ammonium chloride to various locations throughout the feedwater and condensate systems, including the discharge of each condensate pump, the outlet of each condensate polisher and the discharge header, and the inlet of the steam generators. In addition, equipment is available to feed a solution of hydrazine and ammonium hydroxide to the inlet main and auxiliary feedwater line of each steam generator.

Hydrazine is added to the Condensate System and the main and auxiliary feedwater system for control of residual oxygen. Ammonium hydroxide and/or ethanolamine (ETA), which is an alternate amine, is added for corrosion and pH control and minimizes metal pickup through the cycle. Ammonium chloride is used to decrease the sodium to chloride molar ratio in SG blowdown. Polyacrylic acid (PAA) is added to hold iron in suspension in order to prevent its plating out on steam generator tubing.

The chemical solutions are stored in totes (tanks). All chemicals are injected by motor-driven positive displacement pumps with manual and/or automatic control. Hydrazine can alternatively be injected by vacuum drag into the suction side of the condensate pump.

10.3.5.2 Secondary Water Chemistry Control Program

The Secondary Water Chemistry Control Program is designed to limit the corrosion of the tubing and internals of the steam generators. The basis of the program is to control the levels of the critical parameters in the steam generator bulk water such that maximum protection to the steam generators is provided and tube integrity is maintained.

Protection of the steam generator tubing is accomplished by maintaining the water quality of the condensate and condensate polishing effluent and adjusting the blowdown on each of the four steam generators. The feedwater and steam generator bulk water treatment consists of introducing ammonium hydroxide and/or ethanolamine (ETA), which is an alternate amine for pH control and hydrazine for oxygen scavenging. This treatment is recommended by industry guidelines.

Ammonium chloride also treats the feedwater and steam generator systems. Ammonium chloride is used to decrease the sodium to chloride molar ratio in steam generator blowdown. Polyacrylic acid (PPA) holds iron, from sources throughout the secondary plant, in suspension such that it is removed via the steam generator blowdown.

Steam Generator Blowdown Sample is measured for the following critical parameters: pH, cation conductivity, and sodium. The critical parameters measured at the condensate pump discharge include cation conductivity and sodium. The critical parameter measured at the condensate polishing effluent is total conductivity.

Steam Generator Blowdown Sample is analyzed in accordance with industry and vendor guidelines. Sampling frequencies and specifications may be found in the following industry and vendor guidelines: The EPRI PWR Secondary Water Chemistry Guidelines, INPO document 88-021, Westinghouse Technical Bulletin NISD-TB-85-12 and Westinghouse Report 83428. The sample frequency is increased when the normal control limits are exceeded to assure that operation is within the limiting specifications indicated in the above guidelines. The secondary system is monitored on a continuous basis with online chemistry monitors.

Out-of-specification chemistry is returned to within the normal limits of control within the times specified in the limiting specifications contained in the above guidelines. In the event that the limiting specifications cannot be maintained, a review is conducted by the Operations Director who will initiate additional corrective actions (which can include removing the Unit from service if conditions warrant this course of action).

Should a condenser leak be confirmed, corrective actions will be taken to mitigate the leak in a time period consistent with its impact upon the Action Levels specified in the guidelines.