CHAPTER 10.0 - STEAM AND POWER CONVERSION SYSTEM

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* The listed drawings are included as “General References” only; i.e., refer to the drawings to obtain additional detail or to obtain background information. These drawings are not part of the UFSAR. They are controlled by the Controlled Documents Program.

CHAPTER 10.0 STEAM AND POWER CONVERSION SYSTEM

10.1 SUMMARY DESCRIPTION

The components of the steam and power conversion system are designed to produce electrical power from the steam coming from the reactor, condense the steam, demineralize the resulting condensate, and return it to the reactor as heated feedwater.

The power conversion system includes the turbine-generator, moisture separator reheaters, reactor feed pump turbines, main condenser, air ejectors, steam packing exhauster, off-gas condensers, turbine bypass valves, condensate prefilters and demineralizers, and feedwater pumping and heating equipment. Heat rejected to the main condenser is removed by a closed-cycle circulating water system using a cooling lake. Drawing Nos. M-55, M-56, M-57, M-60 and M-61 are simplified flow diagrams of the steam and power conversion system. Table 10.1-1 summarizes the important design and performance characteristics of the major components of the power conversion system. The principal flow quantities and fluid energy levels are shown on the turbine cycle heat balances, Figures 10.1-1a and 10.1-1b and 10.1-2a and 10.1-2b.

Steam, supplied by the reactor at a reactor dome pressure of 1020 psia, enters the high-pressure turbine at 976 psia. The high-pressure turbine exhaust is reheated before it enters the low-pressure turbines. Reheating is accomplished in the two moisture separators and two-stage reheater assemblies. A portion of the turbine steam is extracted for feedwater heating. The moisture separator drains, the reheater drains, and the drains from the third-stage through the sixth-stage feedwater heaters are pumped forward into the feedwater stream. The drains from the first and second-stage feedwater heaters are each routed directly to the main condenser.

Steam exhausted from the low-pressure turbines is condensed and deaerated in the single-pass condenser. The condensate pumps take suction from the condenser hotwell, delivering the condensate through the steam jet air ejectors, steam packing exhausters, off-gas condensers, and condensate prefilters and demineralizers to the condensate booster pumps, which discharge through the low- pressure feedwater heaters to the reactor feed pumps. The steam turbine-driven reactor feed pumps and/or motor-driven reactor feed pump discharge through the sixth-stage, high-pressure feedwater heater to the reactor.

Normally, the turbine and auxiliaries use all the steam being generated by the reactor; however, automatic pressure-controlled turbine bypass valves are provided to discharge approximately 23% of reactor rated steam flow directly to the condenser.

The steam and power conversion system is designed to use the energy available from the reactor. This system is capable of accepting at least 103% of the reactor rated steam flow.

The design of all auxiliary equipment can accommodate the valves- wide-open heat balance as shown in Figure 10.1-1a and 10.1-1b.

In general, the steam and power conversion system is not required to effect or support safe shutdown of the reactor or to perform in the operation of reactor safety features with the exception of four safety-related pressure switches on the condenser which are used to trip the turbine-generator and close the MSIV's (see Subsection 7.7.5).

The specific classifications and locations of all major components of the steam and power conversion system are discussed in Section 3.2.

There are numerous features of the steam and power conversion system that improve the overall safety of the plant. These features are discussed in detail in Sections 10.2, 10.3, and 10.4

TABLE 10.1-1

MAJOR COMPONENT DESIGN AND PERFORMANCE CHARACTERISTICS OF THE POWER-CONVERSION SYSTEM*

1.	Turbine data			
	a.	Manufacturer	General Electric	
	b.	Type/LSB length (in.)	TC6F/38LSB	
	c.	Number of HP sections	1	
	d.	Number of LP sections	3	
2a.	Gross generator output (kW)(Unit 1)		1,206,769	
2b.	Gross generator output (kW)(Unit 2)		1,206,088	
3a.	Final feedwater temperature (°F)(Unit 1)		423.3	
3b.	Final feedwater temperature (°F)(Unit 2)		425.1	
4.	Steam conditions at throttle valve		Unit 1	Unit 2
	a.	Flow (x 10^6 lb/h)	14.58	14.61
	b.	Pressure (psia)	976	976
	c.	Temperature (°F)	541.6	541.6
	d.	Enthalpy (Btu/lb)	1191.5	1191.5
	e.	Moisture content (%)	0.36	0.36
5.	Turbine cycle arrangement			
	a.	Steam reheat, stages	2	
	b.	Number of feedwater heating stages	6	
	c.	Heater drain system	3rd through 6th heater pumped forward	
	d.	Feedwater heaters stages in condenser neck	2	
6.	Type of condensate demineralizer		Deep bed with prefilters upstream	
7.	Main steam bypass capacity (%)		23	

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* Based on maximum guaranteed heat balance (Figure 10.1-2a and 10.1-2b) calculation with turbine exhaust pressure as shown on the heat balances.

10.2 TURBINE-GENERATOR

The purpose of this section is generally to discuss the overall design of the LSCS turbine-generator and specifically to discuss the features of the turbine-generator which are included to minimize the possibility of a turbine rotor failure.

10.2.1 Design Bases

10.2.1.1 Safety Design Bases

The turbine-generator is not required to effect or support safe shutdown of the reactor or to perform in the operation of reactor safety features. The turbine-generator is, however, designed to minimize the possibility of a failure of a turbine rotor that might produce a high-energy missile that could damage a safety-related component.

10.2.1.2 Power-Generation Design Bases

The turbine-generator is designed for the conditions listed in Table 10.1-1. At guarantee load the turbine-generator is designed to receive approximately 14,580,000 (Unit 1) and 14,610,000 (Unit 2) pounds of steam per hour at 976 psia, with 0.36% moisture and at an enthalpy of 1191.5 Btu per pound and convert this energy into approximately 1207 MWe at the generator terminals based on a turbine exhaust pressure of approximately 2 in. Hg abs.

The turbine-generator is designed for load-following operation within the limit of the nuclear steam supply system. The turbine-generator will accept a step load reduction of approximately 23% of full power without reactor trip by using steam bypass to the condenser.

10.2.2 Description

The turbine-generator consists of the turbine, generator, exciter, controls, and required subsystems. The 1800-rpm, tandem-compound, six-flow, reheat steam turbine has 38-inch last stage blades.

There are two extraction points for steam as it passes through the high-pressure turbine. The higher pressure extraction steam is used for the first-stage reheater. Steam from the second extraction point is used for the sixth stage of feedwater heating. The exhaust flow from the high-pressure turbine goes to the moisture separator-reheaters. The drying and reheating processes, which take place between the high-pressure turbine exhaust and the low-pressure turbine inlets, improve the cycle efficiency. A portion of the reheated steam is directed to the turbines which drive the reactor feed pumps. The remainder of the reheated steam is conducted equally to three low-pressure turbines. The saturated water extracted from the moisture separator is taken to the fourth stage of feedwater heating.

There are five extraction points in the low-pressure turbines. Extraction steam for these points is used as the heating supply to the first five stages of feedwater heating. In addition to the external moisture separator, all turbine stages are designed to separate water from the steam and drain to the next lowest extraction.

The main turbine includes one double-flow, high-pressure turbine and three double-flow, low-pressure turbines.

The turbine is equipped for normal operation with a shaft-driven lubricating oil pump, and with an a-c motor-driven lubricating oil pump for startup and shutdown or for emergencies whenever oil pressure may fall below set pressure. The turbine is also provided with a d-c motor-driven lubricating oil pump with power supplied from station batteries for emergency operation.

The turbine is equipped with a steam shaft seal system which is discussed in greater detail in Subsection 10.4.3.

The generator is a direct-driven, 3-phase, 60-hertz, 25,000-volt, 1800-rpm, conductor-cooled, synchronous generator rated at 1,355,400 kVA at .904 power factor 0.58 short circuit ratio at maximum hydrogen pressure of 75 psig. The exciter is the stationary rectifier type and is direct driven.

The generator is equipped with an a-c motor-driven seal oil pump and also a backup d-c motor-driven seal oil pump with power supplied from station batteries for emergency operation.

The turbine-generator is equipped with an electrohydraulic control (EHC) system. The EHC system consists of an electronic governor using solid-state control techniques in combination with a high-pressure hydraulic system completely independent of the turbine lubricating system. The high-pressure fluid supply is from a dual pump system in which one pump is a complete backup for the other. The hydraulic fluid is fire-resistant. The system includes electrical control circuits for pressure control, speed control, load control, and valve positioning.

The turbine-generator is provided with an emergency trip system that closes the main stop valves, control valves, and combined intermediate valves, shutting down the turbine on the following signals:

a. overspeed

    1. turbine approximately 10% above rated speed (primary trip from EHC);

    2. turbine approximately 10.1% above rated speed (emergency trip from EHC);

b. overspeed testing trip device;

c. loss of vacuum trip;

d. excessive thrust bearing wear;

e. prolonged loss of generator stator coolant at loads in excess of a predetermined value;

f. external trip signals, including remote manual trip on the control panel;

g. loss of hydraulic fluid supply pressure (loss of emergency trip system fluid pressure automatically closes the turbine valves and then energizes a software logic block to prevent a false restart);

h. low lubrication oil pressure;

i. signal from turbine supervisory instruments (high vibration level, etc.); (vibration trip is operator bypassable);

j. loss of two speed signals;

k. loss of both primary and secondary electrohydraulic control power supplies;

l. operation of the manual trip pushbuttons at front standard;

m. high level in moisture separators; or

n. high reactor water level.

The primary overspeed protection algorithm uses the same three speed pickups as the speed control algorithm. If the turbine speed increases to approximately 110%, a primary overspeed trip (turbine controller) will occur, closing the main stop valves as well as the control and intercept valves. The primary overspeed protection algorithm resides in the Triple Modular Redundant (TRM) controllers used for turbine related processes.

A totally redundant emergency overspeed protection function is provided by an independent emergency trip (protection module) at 110.1% increasing and uses three separate speed pickups and separate TRM control system to monitor and control the turbine tripping logic during a turbine overspeed or excessive acceleration event.

The turbine-generator is provided with an extraction air relay dump valve to control a group of air-operated check valves located in extraction steamlines in order to provide overspeed protection. See Subsection 10.4.8 for additional information.

10.2.3 Turbine Rotor Integrity

10.2.3.1 Materials Selection

Turbine rotors for turbines operating with light water reactors are made from electric furnace melted, vacuum carbon deoxidized, quenched and tempered degassed Ni-Cr-Mo-V alloy steel by processes which minimize flaw occurrence and provide adequate fracture toughness. Tramp elements are controlled to the lowest practical concentrations consistent with good scrap selection and melting practices, and consistent with obtaining adequate initial and long-life fracture toughness for the environment in which the parts operate. The turbine rotor materials have the lowest fracture appearance transition temperatures (FATT) and highest Charpy V-notch energies obtainable on a consistent basis from water-quenched Ni-Cr-Mo-V material at the sizes and strength levels used. Since actual levels of FATT and Charpy V-notch energy vary depending upon the size of the part and the location within the part, etc., these variations are taken into account in accepting specific forgings for use in turbines for nuclear application. Charpy tests are performed essentially in accordance with Specification ASTM A-370 (or equivalent).

10.2.3.2 Fracture Toughness

Suitable material toughness is obtained through the use of materials described in Subsection 10.2.3.1 to produce a balance of adequate material strength and toughness to ensure safety while simultaneously providing high reliability, availability, efficiency, etc. during operation. Bore stress calculations include components due to centrifugal loads and thermal gradients where applicable. Material fracture toughness is required to be ≥ 200 ksi $\sqrt{\text{in}}$ minimum at 90 ° F and is assured by destructive tests on material taken from the rotors.

Turbine operating procedures are employed to preclude brittle fracture at startup by ensuring that the metal temperature of the rotors is adequately above the FATT.

10.2.3.3 Turbine Design

The turbine assembly is designed to withstand normal conditions and anticipated transients including those resulting in turbine trip without loss of structural integrity. The design of the turbine assembly meets the following criteria:

a. Turbine shaft bearings are designed to retain their structural integrity under normal operating loads and anticipated transients, including those leading to turbine trips.

b. The multitude of natural critical frequencies of the turbine rotor assemblies existing between zero speed and 20% overspeed are controlled in the design and operation so as to cause no distress to the unit during operation. The Torsional Resonating Frequency has been addressed by designing the L.P. Rotors with Torsional Resonating Frequencies outside of the range of concern for normal operating speed.

c. The maximum applied stress in the rotors resulting from centrifugal forces and thermal gradients (at he highest stress point) does not exceed 60% of the yield strength of the materials at the rated speed.

10.2.3.4 Preservice Inspection

The manufacturer's preservice inspection program is as follows:

a. After heat treatment, the rotor is machined and given a thorough dimensional and visual inspection.

b. Each finish machined wheel and rotor is subjected to 100% volumetric (ultrasonic), surface, and visual examinations using GE acceptance criteria. These criteria are more restrictive than those specified for Class 1 components in the ASME Boiler and Pressure Vessel Code, Sections III and V, and include the requirement that subsurface sonic indications are either removed or evaluated to assure that they do not grow to a size which compromises the integrity of the unit during the service life of the unit.

c. All finish machined surfaces are subjected to a magnetic particle test with no flaw indications permissible.

d. Each fully bucketed turbine rotor assembly is spintested at or above the maximum speed anticipated following a turbine trip from full load. Two of the six replacement LP rotors were tested in the fully bucketed state. The remaining four LP rotors were spin tested minus the last row of buckets, since the last stage buckets from the original rotors were utilized for these rotors.

10.2.3.5 Inservice Inspection

The normal inspection and maintenance program used by EGC for turbines includes disassembly of the turbine at appropriate intervals during plant shutdown coinciding with the outage schedules as required for nuclear steam supply system components, and includes inspection of all normally inaccessible parts, such as couplings, coupling bolts, turbine buckets, low and high-pressure turbine rotors.

10.2.4 Safety Evaluation

The turbine-generator is not safety related.

The turbine is designed, constructed and inspected to minimize the possibility of a rotor failure.

The normal maintenance and inspection program will minimize the possibility of a rotor failure.

EGC's experience with turbines in its nuclear power plants has not shown significant radioactive contaminants during maintenance. (See Chapter 12.0 for details.)

10.2.5 References

1. Specification No. T-3780, Replacement of LP Rotors, Addendum 1, dated December 16, 1988.

10.3 MAIN STEAM SUPPLY SYSTEM

The main steam supply system discussed in this section consists of the main steamlines from the outermost MSIV's to the turbine-generator stop valves and all main steam feed lines to auxiliary equipment including the feed pump turbines. The main steam supply system from the reactor vessel to the outermost MSIV's is discussed in Subsection 5.4.9.

10.3.1 Design Bases

10.3.1.1 Safety Design Bases

The main steam supply system is not required to effect or support safe shutdown of the reactor or to perform in the operation of reactor safety features, however the main steam supply system is designed:

a. in accordance with applicable codes and standards in order to accommodate operational stresses such as internal pressure, seismic loads, and pipe whip;

b. to accommodate normal and abnormal environmental conditions; and

c. to allow MSIV testing.

10.3.1.2 Power Generation Design Bases

The main steam system is designed to:

a. deliver steam from the reactor to the turbine generator from warmup to reactor rated flow and pressure;

b. deliver steam from the reactor to the second stage reheaters, feedwater pump turbines, and other auxiliary equipment; and

c. deliver steam to the bypass valve manifold in order to bypass steam around the turbine-generator to the condenser.

10.3.2 System Description

The main steam supply system is shown in Drawing Nos. M-55 and M- 116. The main steam piping consists of four 26-inch-diameter lines from the outermost main steamline isolation valves to the 36-inch-diameter main steam equalizing header and four 28-inch-diameter lines from this header to the main turbine stop valves.

The use of four main steamlines and the equalizing header permits testing of the turbine stop valves and MSIV's during station operation.

During cold shutdown and refueling modes only, any combination of the four 26-inch diameter lines may be partially filled with water thereby creating a loop seal which will help maintain secondary containment isolation as required by Technical Specification. This loading condition will be implemented if one or more of the outermost MSIVs and one or more of the turbine stop valves require concurrent maintenance. The portion of the steamlines which may be flooded include the horizontal low point pipe legs (approximate elevation 691'-3") and the risers up to, but not exceeding an eleven foot one inch (11'-1") column of water. All variable and constant supports must remain unpinned. Since this loading condition occurs only during an outage, postulated accident loadings, transient loadings, and thermal loadings above 200 °F need not be considered. Internal pressure stress need not be considered since the steamlines may be vented during this event. Seismic qualification is not required for secondary containment functional design based on industry practices and criteria in existence at the time of plant design and licensing (see the letter from B. Rybak to G. J. Diederich dated November 12, 1987). Pipe supports are qualified to upset condition allowables and pipe stresses to ASME Section III, equation 8 allowables consistent with the qualification methods used for the hydrostatic test condition. The steamlines must be completely drained prior to returning this system to service.

Two 18-inch-diameter lines from the main steam equalizing header provide steam for the second stage reheaters, feedwater pump turbines, and other auxiliary equipment. Each main steam auxiliary supply header is supplied with a motor-operated shut-off valve.

Two 18-inch-diameter lines from the main steam equalizing header supply steam to the turbine bypass valve manifold. The turbine bypass valve manifold is connected to the condenser by five 12-inch-diameter lines.

Drain lines are connected to the low points of each main steamline, both inside the drywell and outside the containment. Each set of drains from associated low points is individually headered and connected through valved lines to the main condenser. The drain lines also process MSIV leakage to the main condenser and offgas system. To permit continuous draining of the steamline low points, an orificed bypass is provided around the final valve to the main condenser. The steamline drains maintain a continuous downward slope to the main condenser where physical arrangement permits. To permit purging the lines for maintenance, additional drains are provided from each set of drains to the radwaste system.

The drains from the steamlines inside containment are provided with a connection to the steamlines outside containment to permit equalizing pressure across the main steamline isolation valves during startup and following a steamline isolation. The isolation valves outside the drywell are opened first and then the connection is used to warm up and pressurize the outside steamlines. The main steamline isolation valves inside the drywell are then opened in preparation for plant operation.

Each feed pump turbine has two steam supplies connected to a common valve manifold. During normal plant operation, steam is supplied to the feed pump turbines from the cross-around piping between the high-pressure and low-pressure turbines after the moisture separator reheaters.

During startup conditions when the main steam stop valves are closed, steam is supplied to the feed pump turbines from the main steam auxiliary supply headers. The process of changing from main steam to cross-around steam for operation of the feed pump turbines is automatic and does not require operator attention.

The classification of the components and piping of the main steam supply system is listed in Table 3.2-1. All components and piping for the main steam supply system are designed in accordance with the codes and standards listed in Table 3.2-2 for the applicable classification.

10.3.3 Safety Evaluation

All components and piping for the main steam supply system are designed in accordance with the codes and standards listed in Table 3.2-2 for the classifications listed in Table 3.2-1 and are protected from damage due to pipe whip as discussed in Section 3.6. Design of the piping and components in accordance with these requirements ensures that the main steam supply system accommodates operational stresses including internal pressure, seismic loads, and pipe whip and also accommodates normal and abnormal environmental conditions as well as the loop seal loading condition defined in the previous section.

10.3.4 Inspection and Testing Requirements

All components and piping for the main steam supply system are inspected and tested in accordance with the requirements of the codes and standards listed in Table 3.2-2 for the classifications listed in Table 3.2-1.

10.3.5 Water Chemistry (PWR)

Not applicable.

10.3.6 Steam and Feedwater System Materials

10.3.6.1 Fracture Toughness

The main steam system is classified as either Quality Group A, D+, or D as described in Section 3.2. The feedwater system is classified as either Quality Group A, B or D as described in Section 3.2. Quality Group A portions of the main steam and feedwater systems will be impact tested in accordance with Paragraph NB-2300 of the ASME B&PV Code, Section III. Impact testing is not specified for the Quality Group D and D+ portions of the main steam and feedwater systems, since impact testing is not required by ANSI B31.1. The material used in the main pipeline in the Quality Group D+ main steam and Quality Group D feedwater systems is ASTM A155 Gr KCF70. This material would meet the impact testing requirements of Paragraph NB-2300 of the ASME B&PV Code, Section III if testing were performed.

10.3.6.2 Materials Selection and Fabrication

All materials used in the main steam and feedwater systems are listed in Appendix I to the 1974 Edition of Section III of the ASME Code.

Austenitic stainless steel is utilized in the tubes in the high-pressure feedwater heaters in the feedwater system. The feedwater heaters are constructed in accordance with Section VIII of the ASME Code.

10.4 OTHER FEATURES OF STEAM AND POWER CONVERSION SYSTEM

10.4.1 Main Condenser

The purpose of the main condenser is to provide the heat sink for the turbine exhaust steam, turbine bypass steam, and other turbine cycle flows, and to receive and collect flows for return to the reactor.

10.4.1.1 Design Bases

10.4.1.1.1 Safety Design Bases

The main condenser is not required to effect or support safe shutdown of the reactor or to perform in the operation of reactor safety features. It is, however, designed with the necessary shielding and controlled access to protect plant personnel.

10.4.1.1.2 Power-Generation Design Bases

The main condenser has been analyzed for operation at up to 3559 MWth core with the following conditions:

	Unit 1	Unit 2
a. total turbine exhaust steam (lb/hr)	8.49×10^6	8.45×10^6
b. condenser duty (Btu/hr)	8.17×10^9	8.16×10^9
c. condenser surface area (ft2)	950,000	950,000
d. number of condenser shells	1	1
e. condenser shell design pressure	30 in. Hg abs vacuum to 15 psig	
f. circulating water		
1. flow (gpm)	616,500	616,500
2. number of passes	1	1
3. temperature rise (°F)	26.68	26.65

The following conditions occur at design load and an inlet circulating water temperature of 100°F:

	Unit 1	Unit 2
a. circulating water outlet temperature (°F)	126.68	126.65

b. shell side conditions

	Unit 1	Unit 2
1. Zone 1	4.11 in. Hg abs/126.4° F	3.87 in. Hg abs/124.2° F
2. Zone 2	4.97 in. Hg abs/133.5° F	4.76 in. Hg abs/131.9° F
3. Zone 3	6.17 in. Hg abs/141.9° F	5.98 in. Hg abs/140.7° F

The main condenser is designed:

a. to accept approximately 23% of the main steam flow from the turbine bypass system described in Subsection 10.4.4. This condition is accommodated without increasing the condenser backpressure to the turbine trip setpoint or exceeding the allowable turbine exhaust temperature.

b. to deaerate the condensate to the required water quality. The dissolved oxygen in the condensate hotwell effluent is about 0.005 cc per liter or less under normal full-load operation.

c. to minimize air leakage. Welded construction is used for the condenser shell and, wherever practicable, for condenser shell connections and penetrations. Equipment and piping connected to the condenser shell are also designed to minimize air leakage to the main condenser.

d. to store a sufficient volume of condensate to provide, under normal conditions, a 2-minute effective retention of condensate for radioactive decay and an additional 2-minute storage volume.

e. in accordance with the requirements of the Heat Exchange Institute standards.

10.4.1.2 <u>System Description</u>

During plant operation, steam expanding through the low-pressure turbine is directed downward into the single-shell condenser through exhaust openings in the bottom of the turbine casings and is condensed. The condenser also serves as a heat sink for several other flows, such as exhaust steam from the feed pump turbines, cascading heater drains, feedwater heater shell operating vents, and condensate pump suction vents.

Other flows, occurring periodically or continuously, originate from the minimum recirculation flows of the reactor feed pumps and condensate booster pumps; feedwater line startup flushing; A and B RHR Warmup flows; turbine equipment clean drains; low-point drains; deaerating steam; condensate; makeup; etc. During transient conditions the condenser is designed to receive turbine bypass steam and feed-water heater and drain tank high-level dumps. These drain tanks include the moisture separator, reheater, and feedwater heater drain tanks. The condenser also is designed to receive relief valve discharges from the power conversion system equipment.

The condenser is cooled by the circulating water system (described in Subsection 10.4.5) which removes the heat rejected from the condenser. The condensate is pumped from the condenser hotwell by the condensate pumps described in Subsection 10.4.7.

The main condenser is a single-shell, single-pass, deaerating-type condenser with divided water box. The condenser shell is supported on the turbine foundation mat, with expansion joints provided between each turbine exhaust opening and the steam inlet connections of the condenser shell.

The condenser hotwell has horizontal and vertical baffles to ensure a normal retention of a 2-minute duration for all condensate from the time it enters the hotwell until it is removed by the condensate pumps. Condensate is retained in the main condenser for a minimum of 2 minutes to permit radioactive decay before the condensate enters the condensate system. Valves are provided in the circulating water system to permit either half of the condenser to be removed from service.

Air inleakage and noncondensible gases in the turbine exhaust, including dissociated hydrogen and oxygen gases, are collected in the condenser and passed through the air-removal section of the condenser, from which they are removed by the main condenser evacuation system described in Subsection 10.4.2.

The condensate is deaerated before leaving the condenser to reduce the concentration of dissolved oxygen to the required level.

10.4.1.3 Safety Evaluation

The main condenser is not safety related. During operation, radioactive steam, gases, and condensate are present in the shell of the main condenser. The anticipated inventory of radioactive contaminants during operation and during shutdown is discussed in Section 12.2. In order to protect plant personnel, necessary shielding and controlled access are provided for the main condenser as discussed in Section 12.3.

Leakage of circulating water into the condensate is detected by the tube leakage detection system. A collection trough is provided on the shell side of each tube sheet to collect any leakage from the tube to tube sheet joints. Chemistry samples hotwell on a daily basis to identify tube leaks among other parameters.

Tube leakage is controlled by isolating and draining the tube side half of the unit which is leaking and plugging defective tubes.

Flood protection for the plant in the event of a main condenser failure is discussed in Section 3.4.

10.4.1.4 Tests and Inspections

Inservice inspection of the condenser consists of monitoring the following variables: Condenser vacuum, conductivity, air accumulation of the water boxes, and circulating water pressure drop. All tests and inspections of the condenser are in accordance with the normal inspection and maintenance program of EGC.

10.4.1.5 Instrumentation Application

The condenser shell is provided with local and remote hotwell level and pressure indication. Remote indication is accomplished by means of indicators and alarms in the control room. The condensate level in the condenser hotwell is maintained within proper limits by automatic controls that provide for transfer of condensate to and from the cycled condensate storage tank, as needed, to satisfy the requirements of the steam system. Condensate temperature is measured in the outlet lines to the condensate pumps. Turbine exhaust hood temperature is monitored and controlled with water sprays to provide protection from exhaust hood overheating.

The condenser high backpressure limit is 6.5 in. Hg abs and a high backpressure alarm is provided at approximately 6.3 in. Hg abs. Turbine trip is activated on loss of main condenser vacuum, with condenser backpressure reaching or exceeding a setpoint of approximately 8.4 in. Hg abs. Pressure switches are provided to trip close the main steam isolation valves in the event that condenser pressure rises to approximately 23 in. Hg abs. Water box pressure and temperature measurements are also provided.

Conductivity elements detect leakage of circulating water into the condenser steam space. Air inleakage is monitored by the off gas system flow instrumentation.

10.4.2 Main Condenser Evacuation System

The purpose of the main condenser evacuation system is to maintain a vacuum in the condenser for the three low-pressure turbine exhausts and to remove the noncondensible gases from the condenser, including air inleakage and dissociation products originating in the reactor, and discharge them to the gaseous radwaste system.

10.4.2.1 Design Bases

10.4.2.1.1 Safety Design Bases

The main condenser evacuation system is not required to effect or support safe shutdown of the reactor or to perform in the operation of reactor safety features. The system is, however, designed to minimize the possibility of a hydrogen detonation due to the concentration of dissociated hydrogen in the condenser off-gas by dilution and strength requirements.

10.4.2.1.2 Power-Generation Design Bases

The main condenser evacuation system is designed to maintain a vacuum in the main condenser during startup and normal operation of the unit. The main condenser evacuation system is designed to meet Heat Exchange Institute standards for condenser air inleakage.

10.4.2.2 System Description

The main condenser evacuation system is shown in Drawing Nos. M-88 and M-135.

The main condenser evacuation system for each unit consists of two 100%-capacity, twin-element, two-stage, steam jet air ejector (SJAE) units, complete with intercondensers for normal plant operation and a mechanical vacuum pump for use during startup and shutdown. The last stage of each SJAE is a noncondensing stage.

During startup and shutdown, when the desired rate of air and gas removal exceeds the capacity of the steam jet air ejectors or when the steam pressure is not adequate to operate the air ejector units, the mechanical vacuum pump removes the air from the main condenser. The discharge from the vacuum pump is then routed to the station vent stack. The off-gases from the vacuum pump are discharged directly to the environs, because this pump is in service during startups and shutdowns only when there is little or no radioactive gas present. Radiation detectors in the station vent stack activate a control room alarm if abnormal radioactivity is detected.

The steam jet air ejector is put into service to remove the gases from the main condenser when the pressure is adequate for stable operation. Main steam, reduced in pressure by an automatic steam-pressure-reducing valve station, is supplied as the driving medium to the air ejectors. The first stage takes suction from the main condenser and exhausts the gas vapor mixture to the intercondenser and to the second-stage suction. The second stage exhausts the suction gas vapor mixture from the intercondenser to the gaseous radwaste system. See Section 11.3 for a discussion of the gaseous radwaste system.

The intercondenser is cooled by condensate from the condensate pumps, and the resulting condensate from the air ejector condensers is drained back to the main condenser.

10.4.2.3 Safety Evaluation

The main condenser evacuation system is not safety related. The off-gas from the main condenser is one source of radioactive gas in the station. Normally it includes the activation gases nitrogen-16, oxygen-19, and nitrogen-13, plus the radioactive noble gases. An inventory of radioactive contaminants in the effluent from the steam jet air ejectors is evaluated in Section 12.2. The gaseous radwaste system that treats the off-gas prior to discharge is discussed in Section 11.3.

The off-gas flow from the main condenser is automatically isolated if the main steam flow to the second stage ejector fails. The main steam flow to the first stage ejector serves as a dilution medium for the off-gas to minimize the possibility of a hydrogen detonation. The piping from the main condenser to the second-stage ejector is designed to contain a hydrogen detonation.

10.4.2.4 Tests and Inspections

Tests and inspections of the equipment that is part of the main condenser evacuation system are performed in accordance with normal EGC station practices.

10.4.2.5 Instrumentation Application

Flow meters are provided in each steam supply line to the second stage of each SJAE. Should steam flow drop below acceptable limits for dilution of the off-gas to prevent hydrogen detonation, the off-gas flow to the SJAE is automatically isolated.

10.4.3 Turbine Gland Sealing System

The purpose of the turbine gland sealing system is to prevent air leakage into, or radioactive steam leakage out of, the turbine.

10.4.3.1 Design Bases

10.4.3.1.1 Safety Design Bases

The turbine gland sealing system is not required to effect or support safe shutdown of the reactor or to perform in the operation of reactor safety features. The system is, however, designed to primarily use low-radioactivity steam from the steam packing exhauster rather than high- radioactivity steam from Main Steam in order to minimize the release of radioactivity to the environment.

10.4.3.1.2 Power-Generation Design Bases

The turbine gland sealing system is designed to provide the means of sealing (using steam from the steam seal evaporator) the turbine shaft glands and valve stems (main stop, control, combined stop and intercept, and bypass valves). The condensed steam from the sealing system is returned to the main condenser, and the noncondensible gases entrained with the condensed steam are exhausted to the station vent stack.

10.4.3.2 System Description

The turbine gland sealing system is shown in Drawing Nos. M-55 (sheet 5), M-116 (sheet 5), M-88 (sheet 1), and M-135 (sheet 1).

The turbine gland sealing system consists of a steam evaporator, steam seal pressure regulator, steam seal header, two full-capacity gland steam condensers, each with two full-capacity exhauster blowers, and the associated piping, valves, and instrumentation.

Shaft packings are required to provide sealing of the turbine shells against atmosphere. They keep the steam in and the air out. A series of spring-backed segmented packing rings is fastened in the bores of the turbine shells wherever the rotor emerges from the steam atmosphere. These rings are machined with specially designed teeth which are fitted with minimum radial clearances between the teeth and the turbine rotor. The small clearance and the resistance offered by the particular tooth construction so restricts the steam and air flow that it is held to a minimum.

The turbine is equipped with seals arranged for a separate steam seal system. Both high-pressure and low-pressure turbine packings are fed with steam from a low-radioactivity source separate from the turbine. This arrangement minimizes the radioactivity in the off-gas from the steam packing exhauster (SPE). The second outermost packing annulus is fed from the steam seal header (SSH). The SSH pressure is regulated at approximately 4 psig, with low-radioactivity steam, by the steam seal feed valve. Because of pressure differences, the low-radioactivity steam flows from the SSH annulus in two opposite directions through the clearance between the packing teeth and turbine shaft. It flows inward to the vacuum (or subatmospheric leakoff annulus), and outward to the outermost annulus which is vented to the SPE. Since the SPE maintains a slight vacuum of approximately 5 inches of water, a quantity of air will be drawn in through the outermost packing ring. This air, plus the low-radioactivity steam, will be vented to the SPE. With this arrangement, the radioactive steam is contained within the turbine loop, and the steam-air mixture flowing to the SPE is low-radioactivity steam. If low-radioactivity steam is not available from the SPE, main steam is supplied to the SSH.

The steam seal evaporator (SSE) is a shell-and-tube heat exchanger designed to provide a continuous supply of sealing steam to the SSH. The steam supply to the evaporator is supplied at low loads by main steam and at normal loads from a turbine extraction.

The SPE is cooled by the main condensate flow after it passes through the steam jet air ejector intercondenser.

The motor-driven exhauster blowers are designed to discharge the air inleakage to the atmosphere through the station vent stack.

10.4.3.3 Safety Evaluation

The turbine gland sealing system is not safety related.

The turbine gland sealing system is designed to provide a continuous supply of steam that is essentially free of nitrogen-16, noble gases, and other radioactive gases to the turbine shaft glands and the valve stems.

Relief valves on the steam seal header prevent excessive steam seal pressure.

10.4.3.4 Tests and Inspections

All tests and inspections of equipment that is part of the turbine gland sealing system are performed in accordance with the normal EGC station practices.

10.4.3.5 Instrumentation Application

Both the shell and tube sides of the steam evaporator are controlled by level-control valves: the condensate (shell) side by maintaining water surrounding the tubes; and the steam (tube) side by maintaining the water level in the steam evaporator drain tank. The flow of heating steam is regulated by the seal steam pressure control valve.

Liquid level in the steam packing exhauster (SPE) shell side is maintained by a loop seal which maintains a constant hold up volume in the SPE. Local pressure and level instruments are provided. Temperature and pressure gauges and test points are provided, as required, to monitor operation and testing of the system.

10.4.4 Turbine Bypass System

The purpose of the turbine bypass system is to bypass approximately 23% of reactor rated steam flow around the turbine.

10.4.4.1 Design Bases

10.4.4.1.1 Safety Design Bases

The turbine bypass system is not required to effect or support safe shutdown of the reactor or to perform in the operation of reactor safety features.

10.4.4.1.2 Power-Generation Design Bases

The turbine bypass system is designed to control reactor pressure as follows:

a. during the reactor heatup to rated pressure while the turbine generator is being brought up to speed and synchronized,

b. during power operation when the reactor steam generation exceeds the transient turbine steam requirements, and

c. during reactor cooldown.

The turbine bypass system is designed to bypass approximately 23% of the reactor rated steam flow to the main condenser. The bypass system works in conjunction with the turbine EHC system.

The turbine bypass valves are designed to be capable of remote manual operation in their normal sequence, during plant startup and shutdown, and individually for exercising to verify that the valves are operable.

10.4.4.2 System Description

The turbine bypass system, shown in Drawing Nos. M-55 (sheet 3) and M-116 (sheet 3), consists of multiple hydraulically operated control valves mounted on a valve manifold. These valves are operated automatically and in sequence. The manifold is connected to the main steamlines upstream of the turbine main stop valves. The bypass valve outlet manifold is piped directly to the main condenser through five separate pressure breakdown assemblies. Each assembly reduces pressure by successive throttlings through a series of multiple orifice plates. Each of the five condenser nozzles is designed for a flow of 710,000 lb/hr at an inlet pressure of 250 psig.

The Digital Electro-Hydraulic Controls (DEHC) Pressure Regulator and Turbine-Generator Controls utilize a triple modular redundant (TRM) design with a separate Turbine Controller, Pressure Controller and Overspeed Protection Module. Each controller / module consists of three (3) separate processors, utilizing a software-implemented fault-tolerance (SIFT) technology that allows the controller to remain on-line if one of the processors fails.

The DEHC TMR Turbine Controller is tasked with turbine control and protection, the TMR Pressure Controller performs the steam bypass and pressure control functions and the TMR Protection Module provides a second level of overspeed protection. The Turbine Controller and Pressure Controller communicate over redundant unit data highways to coordinate turbine and pressure control requirements. The Protection Module functions independent from the Turbine and Pressure Controllers with dedicated speed sensor inputs.

The separate TMR system for control of the turbine bypass valves and control of the turbine allows the two functions to maintain independence from a control hardware and software standpoint. For critical functions, the controllers utilize triple-redundant process sensors and will continue operation if one of the process sensors fail. The Pressure Controller is designed to continue operation even if two (2) of the three (3) sensors fail. System diagnostics are provided and alert plant operators when a problem with the system occurs with actions for these alarms indicated in various plant procedures.

The bypass valves automatically trip closed whenever the vacuum in the main condenser falls below approximately 23 in. Hg abs.

The bypass system accommodates an approximately 23% turbine load rejection without causing a significant change in reactor steam flow. The turbine bypass system valves and piping conform to the applicable codes as referenced in Section 3.2.

10.4.4.3 Safety Evaluation

The turbine bypass system is not safety related.

The turbine bypass valves are designed to fail closed on loss of main condenser vacuum or loss of the turbine EHC system.

The effects of a malfunction of the turbine bypass system valves, as well as the effects of such failures on other systems and components, are evaluated in Chapter 15.0.

10.4.4.4 Tests and Inspections

The opening and closing of the turbine bypass system valves are checked during initial startup and shutdown for performance and timing.

10.4.4.5 Instrumentation Application

Controls are designed so that the turbine bypass valves close if the turbine EHC system loses its electric power or hydraulic system pressure.

On turbine trip or generator load rejection, the start of the bypass valve flow is not delayed more than 0.1 second after the start of the stop valve or the control valve closure. A minimum of 80% of the rated bypass flow is established within 0.3 second after the start of the stop valve or the control valve closure. For additional information, see Subsection 7.7.5.

10.4.5 Circulating Water System

The purpose of the circulating water system is to remove the heat rejected from the main condenser.

10.4.5.1 Design Bases

10.4.5.1.1 Safety Design Bases

The circulating water system is not required to effect or support safe shutdown of the reactor or to perform in the operation of reactor safety features.

10.4.5.1.2 Power-Generation Design Bases

The circulating water system is designed to convey water between the main condenser and the cooling lake; and to provide blowdown and makeup water to and from the Illinois River.

10.4.5.2 System Description

The circulating water system consists of the main condenser, circulating water pump structure, cooling lake, intake screens, circulating water pumps, condenser tube cleaning system, pipes, and valves, as shown in Drawing No. M-63. The physical arrangements of the circulating water screen house are shown in Drawing No. M-19. The circulating water system supplies the main condenser with cooling water at temperatures normally ranging from 32° F to 100° F maximum. The Technical Specification temperature limit for cooling water supplied to the plant from the UHS / CSCS pond is between 101.25 °F and 104 °F depending on the time of day (Figure 9.2-8). The circulating water system and main condenser are evaluated for elevated inlet cooling water temperatures in Ref. 39 of Section 9.1.5, and load curtailment may be required at water temperatures above 100 °F.

Biocide and scale inhibitor are injected into the circulating water piping by the Chemical Feed (CF) system (section 9.2.12) to minimize biofouling, silting and scaling problems in the Main Condenser.

Refer to Subsection 10.4.1.1 for design data.

Three one-third-sized, motor-driven, vertical, dry-pit circulating water pumps per unit located in the lake screen house take suction from the lake screen house and discharge the circulating water through the main condenser back to the cooling lake.

The river screen house is situated at the Illinois River approximately 3.5 miles from the north dike of the lake. The physical arrangement of the river screen house is shown in Drawing No. M-20. Makeup pumps are designed to supply approximately 90,000 gpm. The installation includes three pumps of 30,000-gpm capacity each, which permits the lake to be filled in a reasonable time while concurrently meeting the makeup capacity requirement of a two-unit complex. The piping arrangements of the lake makeup and blowdown system are shown in Drawing No. M-64 FD.

A blowdown capability up to a maximum of 90,000 gpm is provided by a lake discharge pipeline. The discharge pipeline is a 66-inch-diameter pipeline and is connected directly to the lake at one end and to the river at the other. The pipe is valved at both the lake and the river.

The lake discharge pipeline is utilized by the radwaste system for liquid waste discharge as noted in Section 11.2. The blowdown flow in the pipeline provides necessary dilution for low-level liquid radwaste discharges.

10.4.5.3 Safety Evaluation

The circulating water system is not safety related.

Flood protection in the event of circulating water system failure is discussed in Section 3.4.

A radiation monitor on the lake blowdown line automatically isolates the radwaste discharge line in the event of a high radiation signal, the limits and functions of which are discussed in Section 11.5.

10.4.5.4 Tests and Inspections

Performance and leak tests are conducted on the circulating water system in accordance with normal EGC station practices.

10.4.5.5 Instrumentation Application

The condenser shell water boxes are equipped with isolation valves enabling either half of the tube side of the condenser to be isolated. All shut-off valves are operated by remote manual switches on the main control board. Temperature and pressure are measured on each condenser section. Necessary level controls and alarms also are provided.

10.4.6 Condensate Polishing System

The condensate polishing system is designed to accomplish the following functions during normal operations:

a. to remove dissolved and suspended solids as follows from the condensate in order to maintain high quality reactor feedwater. The maximum calculated purity (not measured) is:

1.	conductivity at 25°C	0.1 μmho/cm,
2.	chlorides (as Cl)	10.0 ppb,
3.	silica (as SiO_2)	5.0 ppb,
4.	insolubles	10.0 ppb,
5.	dissolved O_2 (as O_2)	14.0 ppb
6.	total metallic impurities	30.0 ppb, and

7. pH at 25°C	6.5 to 7.5;

b. to protect the reactor from condenser cooling water leaks;

c. to provide final polishing of makeup water entering the power cycle; and

d. to protect the purity of water sent to condensate storage and transfer system.

The total metallic impurities and conductivity could increase significantly, due to potentially high soluble-iron levels caused by noble metal chemical application (NMCA). Therefore, an optional deduction for the contribution of soluble iron to the total metallic impurities and to the conductivity is permitted. See Section 5.2.3.2.1 for more details.

The condensate polishing system is also used during refueling operations to treat suppression pool water during its transfer to and from the reactor cavity.

High quality feedwater minimizes the possibility of scaling and the buildup of solids in the reactor which degrades fuel performance and adversely affects other reactor system components. High quality feedwater also decreases the capacity requirements of the fuel pool cleanup demineralizing system. The condensate polishing system removes silica from the condensate, thus preventing silica from entering the reactor and ultimately being deposited on the turbine blades. The radiation level of the reactor feedwater due to impurities present in the reactor is discussed in Section 11.1. Feedwater quality is maintained by treating approximately two-thirds of the total feedwater flow to the reactor vessel.

The condensate polishing system and its auxiliaries include all associated piping, valves, prefilters and other appurtenances, and instruments and controls for proper operation and protection against malfunction.

10.4.6.1 Design Bases

10.4.6.1.1 Safety Design Bases

The condensate polishing system is not required to effect or support safe shutdown of the reactor or to perform in the operation of reactor safety features, however the system is designed:

a. to limit the conductivity and chloride limits for the reactor vessel, and

b. with the necessary shielding and controlled access to protect plant personnel.

10.4.6.1.2 Power-Generation Design Bases

The units have sufficient capacity to treat the total normal condensate flow and flow surges based on a design flow rate of 40 to 60 gal/min/ft^2 . The condensate polishing system is designed to treat 114% of rated condensate flow from the condensate pumps. The total feedwater flow consists of this rated condensate flow as well as flow from heater drains which bypass the condensate prefilters and demineralizers.

The condensate demineralizer is sized to process condensate with peak impurity concentrations resulting from plant startup operations of 1-week duration, or from condenser leaks. The vessels are sized to handle cooling water condenser leaks of up to 50 gpm for 1 hour with a maximum chloride concentration of 200 ppb at a resin capacity of 50% of the original operating capacity, and an effluent conductivity as stated in Subsection 10.4.6.2.

The condensate demineralizers, prefilters, and the regeneration and ultrasonic resin cleaner (URC) tanks meet the design requirements of ASME Section VIII, Division I for unfired pressure vessels. All piping and valves in the system are designed to meet ASME Class D requirements.

10.4.6.2 System Description

The condensate polishing system is shown in Drawing Nos. M-60 and M-121. The condensate polishing system consists of seven mixed-bed type demineralizers for each unit (one spare) to clean the condensate from the main condenser. A prefilter upstream of each demineralizer removes suspended solids. During unit coastdown when utilizing Final Feedwater Temperature Reduction, seven demineralizers and prefilters may be used. The condensate pumps take suction from the main condenser hotwell and discharge through the steam jet air ejector condensers, the steam packing exhauster, the off-gas condenser, and the prefilters to the condensate demineralizers. The effluent from the demineralizers discharges into the suction header of the condensate booster pumps.

A bypass line with motor-operated valve is provided across the polishing system to maintain the required system flow in case the operable demineralizer units are insufficient to maintain system flow. This condition is normally not expected to exist. However, during maintenance work, a fraction of the condensate may be bypassed if conditions do not warrant a gradual load rejection or plant shutdown. Each demineralizer has an effluent resin strainer to prevent resin carryover with the condensate. Each demineralizer with its inlet, outlet, recycle, sluice water, vent, drain and relief valves, instruments, elements, and controls is protected against malfunction and improper operation.

Upon exhaustion of the resin capacity in a demineralizer, the resin bed is replaced by new resin. A regeneration subsystem was supplied to regenerate the resin, but this subsystem is no longer used for regeneration.* The regeneration subsystem includes acid and caustic day tanks, acid and caustic dilution equipment, regeneration tanks, resin transfer valves, motive air inlet and outlet valves, backwash valves, waste header, flow and conductivity elements, and instruments and controls.** The subsystem is protected against corrosion and malfunction and is designed for remote manual operation. An ultrasonic resin cleaning subsystem is also provided to clean the resin as required when no chemical regeneration is required. All wastes resulting from resin regeneration or URC cleaning are treated in the station radwaste facility.

The condensate prefilters are backwashed when indicated by high differential pressure. Prefilter backwash may also be initiated for ALARA purposes prior to maintenance activities. Cycled Condensate is used for backwashing and filling the prefilter vessel. Service Air aids the backwashing process. A dedicated air receiver tank stores compressed air from the Service Air system for use during prefilter backwash. Backwash is routed to the Ultrasonic Resin Cleaner Sludge Tank.

Impurities in the condensate which require removal are attributed to the following sources:

a. corrosion products from main steamlines, turbine, main condenser, condensate and feedwater system, and the steam side of feedwater heaters;

b. corrosion products and solid fission product carry-over with reactor steam;

c. if fuel leaks are present in the reactor, fission products occurring in the condensate as a result of volatilized iodine and radioactive products of fission gases; and

d. chemical impurities introduced into the condenser from condenser tube failures which allow circulating water to enter the steam-condensate cycle.

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* Since the station has changed over to new resins that do not require resin separation or regeneration requiring acid or caustic.

** The regeneration subsystem tanks have been abandoned in place and some are now used as storage tanks

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The quality of the demineralizer effluent is expected to be as follows with a specific conductivity of 0.1 µmho/cm at 25°C (not all values can be measured):

Elemental Fe, Cu, Ni (total of all three):	10 ppb, of which copper will not exceed 2 ppb
Silica (as SiO_2):	5 ppb
Chloride (as Cl):	2 ppb
Suspended solids:	5 ppb
Sodium (as Na):	5 ppb

A condensate polishing system with the effluent quality as stated above removes most of the steam cycle impurities from the condensate.

The pH at 25°C of the condensate is expected to be maintained at 5.6 to 8.6 during startup and 5.6 to 8.6 during extended normal operation.

10.4.6.3 Safety Evaluation

The condensate polishing system is not safety related. Since the condensate polishing system also removes corrosion products which include radioactive material, adequate shielding is provided around the condensate prefilters and polishers and URC vessels. All gases vented from the condensate polishing system, chemical wastes, and other liquid wastes from the condensate polishing and regeneration system are treated in the station radwaste facility. Solid wastes are also treated in the radwaste facility, drummed, and handled as indicated in Section 11.4.

10.4.6.4 Tests and Inspection

Manual shut-off valves are provided in the system to isolate each demineralizer, prefilter, regeneration vessel, and URC cleaning vessel for testing and maintenance during normal plant operation.

10.4.6.5 Instrumentation Application

Conductivity elements are provided for the system influent pipe and in the effluent header; additionally, a conductivity element is provided for each demineralizer tank effluent. Any condenser cooling water leak can be determined by changes in influent conductivity. High demineralizer effluent and influent conductivities are alarmed at the demineralizer control panel for operator response. All demineralizer control panel alarms annunciate in the reactor control room via a single "trouble" alarm. The system influent and system effluent conductivity elements read-out at the demineralizer control panel.

Sample valves are provided in each demineralizer effluent line and the influent and effluent headers to permit tests of effluent quality when required. Locally mounted flow transmitters are provided to record the flow of condensate from each demineralizer. One differential pressure transmitter with high differential pressure alarm contact is furnished to record the pressure difference between the condensate inlet and outlet headers of the entire condensate demineralizer.

The demineralizer effluent conductivity elements also monitor the condensate being recycled through the bypass loop before its return to service. Conductivity, differential pressure, and flow measurements are recorded at various locations. A multipoint annunciator is included in the demineralizer control panel to sense, indicate, and alarm abnormal conditions within the condensate demineralizer system. Some alarms associated with the regeneration sub-system are abandoned-in-place. Electrical contacts for the local annunciator permit remote annunciation in the main control room. A differential pressure indicator for each resin strainer, flow indicators and pressure gauges for miscellaneous services are also included in the polishing system.

A Programmable Logic Controller (PLC) automatically controls the condensate prefilter backwash sequence after it has been manually initiated. High differential pressure across the prefilter, high vessel level, and air receiver pressure are input to the PLC. Operator Interface Units (OIUs) provide for monitoring and manual control of the backwash sequence. A local alarm panel provides audible and visual indication of abnormal parameters. Remote alarms for high differential pressure and loss of power are provided in the Radwaste Control Room.

10.4.7 Condensate and Feedwater System

The purpose of the condensate and feedwater system is to deliver condensate from the condenser to the reactor. This subsection discusses the condensate and feedwater system from the condenser to the outermost feedwater shut-off valve. The condensate and feedwater system from the outermost shut-off valve to the reactor is discussed in Subsection 5.4.9.

10.4.7.1 Design Bases

10.4.7.1.1 Safety Design Bases

The condensate and feedwater system is not required to effect or support safe shutdown of the reactor or to perform in the operation of reactor safety features.

The condensate and feedwater system is designed with necessary shielding and controlled access to protect plant personnel.

10.4.7.1.2 Power-Generation Design Bases

The condensate and feedwater system provides a dependable supply of high quality feedwater to the reactor. The system provides the required flow at the required pressure and temperature to the reactor, allowing sufficient margin to allow continued flow under anticipated transient conditions.

The feedwater system supplies the reactor with feedwater at a minimum pressure of 1000 psia from the reactor feed pumps. This system has sufficient capacity to provide at least 105% of the feedwater required for reactor rated flow. The feedwater heaters provide the required temperature of feedwater to the reactor with six stages of closed feedwater heating. The final feedwater temperature is 423.3° F (Unit 1) and 425.1° F (Unit 2).

Pumped-forward heater drains are sufficiently deaerated via continuous operating vents in the pumped (third-stage) feedwater heaters to maintain a level of 300 ppb (or less) oxygen content in the final feedwater supplied to the reactor during normal full load operation.

To minimize the corrosion product input to the reactor, a unit startup line is provided from the reactor feedwater supply lines, downstream of the high-pressure feedwater heaters, to the condenser.

All components of the condensate and feedwater system that contain the system pressure are designed and constructed in accordance with the applicable codes as referenced in Section 3.2.

10.4.7.2 System Description

The condensate and feedwater system consists of the piping, valves, pumps, heat exchangers, controls, instrumentation, and the associated equipment and subsystems that supply the reactor with heated feedwater in a closed steam cycle using regenerative feedwater heating.

The condensate system is shown by Drawing Nos. M-58 and M-119, the condensate booster system by Drawing Nos. M-59 and M-120, and the reactor feedwater system by Drawing Nos. M-57 and M-118. The condensate and feedwater system is a six-heater regenerative feedwater heating cycle.

The low-pressure feedwater heaters are divided into three 1/3-capacity parallel systems. The high-pressure heaters are divided into two 1/2-capacity parallel systems.

The final feedwater temperature is 423.3° F (Unit 1) and 425.1° F (Unit 2) at rated unit output. The two lowest pressure heaters are located in the condenser exhaust neck.

Drawing Nos. M-61 and M-122 show the heater drain system, and Drawing Nos. M-62 and M-123 show the feedwater vents and drains. Heaters 16 (26), 15 (25), and 14 (24), respectively, cascade to heaters 15 (25), 14 (24), and 13 (23). The heater drains from 13(23) are then pumped forward to the condensate outlet of heater 13 (23).

Condensate from the condenser hotwell is pumped by four motor-driven condensate pumps (one spare). The condensate is prepared through the steam jet air ejector, the gland steam packing exhauster, the off-gas condenser, and the condensate cleanup system, and then to the suction of the condensate booster pumps.

Four motor-driven condensate booster pumps are provided (one spare). The booster pumps provide the required head to pump the condensate through the five low-pressure heaters and to provide sufficient excess head to assure proper suction head on the reactor feedwater pumps.

Two turbine-driven reactor feedwater pumps and one motor-driven reactor feed pump are provided. Each turbine driven reactor feed pump has the target design capability of operating at 68% of reactor rated steam flow. Actual operational capability is approximately 57% to 60% of the reactor rated steam flow. The motor driven reactor feed pump has the capacity of operating at approximately 30% to 32% of reactor rated steam flow. Minimum flow through the reactor feed pumps is controlled by utilizing recirculation control valves located in the pump discharge lines to permit recirculation of feedwater to the condenser.

The turbine drives for the turbine-driven reactor feed pumps are provided by a multivalve, multistage condensing turbine. The turbine/coupling is rated at approximately 13,450 hp at 5500 rpm with inlet steam conditions of approximately 158 psia and with exhaust pressure to 4 in. Hg abs.

The feedwater control system automatically controls the flow of feedwater into the reactor pressure vessel to maintain the water level in the vessel within predetermined levels. The feedwater control system is described in Chapter 7.0.

Four condensate pumps (one spare) operate in parallel, as shown in Drawing Nos. M-58 and M-119. Each is a motor-driven, horizontal, single stage, centrifugal unit installed at an elevation that allows operation at low condensate level in the main condenser hotwell. The condensate pumps provide the necessary suction head at the condensate booster pumps.

Shut-off valves allow each condensate pump to be removed from service individually while system operability is maintained with the remaining condensate pumps.

Four condensate booster pumps (one spare) operate in parallel, as shown in Drawing Nos. M-59 and M-120. Each takes suction from the demineralizer outlet piping and discharges through the low-pressure feedwater heaters. Each is a motor-driven, horizontal, single-stage, centrifugal type. Each condensate and condensate booster pump combination is mounted on the same bedplate and is driven by a common motor. The condensate booster pumps provide the necessary suction head to the reactor feed pumps.

Shut-off valves allow each condensate booster pump to be removed from service individually while system operability is maintained with the remaining condensate booster pumps.

Controlled condensate recirculation is provided downstream of the condensate booster pumps to the main condenser. This provision ensures the maintenance during operation of the minimum safe flow through the condensate and condensate booster pumps, steam jet air ejector, and steam packing exhauster.

The feedwater heaters are arranged in three parallel strings. The first-stage and second-stage feedwater heaters are located in the necks of the three exhaust hoods of the main condenser. Drain cooling is provided at all stages of feedwater heating except at the third stage. Drain-cooling sections are integral with the feedwater heaters. Deaeration of the pumped-forward drains is provided by the third-stage feedwater heaters to limit the oxygen content in the pumped-forward drain flow.

Each feedwater heater and drain cooler is a closed type, installed at an elevation that allows proper shell drainage at all loads. Each feedwater heater uses U-tube construction. All feed-water heater and drain-cooler tubes are made of stainless steel.

Shut-off valves and bypasses allow the feedwater heaters and the drain coolers of one of the parallel groups to be removed from service. System operability is maintained with the remaining feedwater heaters and drain coolers.

The startup and operating vents from the steam side of the feedwater heaters are piped directly to the main condenser. Discharges from shell relief valves on the steam side of the feedwater heaters are piped directly to the main condenser.

The heater drain tank receives deaerated drains from the shells of the third-stage feedwater heaters and provides reservoir capacity for drain pumping. The heater drain tank is installed beneath the third-stage feedwater heaters at an elevation that allows the heaters to drain freely by gravity flow. Level controls permit draining the tank when required. Remote tank level indication is also provided.

The drain tank system is capable of diverting incoming drains to the main condenser.

Four heater drain pumps (one spare) operate in parallel, with each taking suction from the heater drain tank and discharging to the feedwater stream immediately before the fourth-stage heater. Each pump is a motor-driven, vertical, multistage, centrifugal-type pump located below the heater drain tank and designed for the available suction conditions.

The piping arrangement allows each heater drain pump to be removed from service individually while system operability is maintained with the remaining drain tank/drain pump combination.

Controlled drain recirculation is provided from the discharge side of each heater drain pump to the heater drain tank. This arrangement ensures that the minimum required flow through each heater drain pump is maintained during operation. During pump startup, heater drain pump recirculation is sustained for an extended period of time to promote better mixing (in the discharge header) of cold, stagnant water from the idle heater drain pump with warm water from the operating pumps.

Two approximately 57% to 60% capacity, turbine-driven reactor feed pumps operate in parallel, as shown in Drawing Nos. M-57 and M-118. These act in series with the condensate pumps and condensate booster pumps. The reactor feed pumps take suction from the fifth-stage, low-pressure feedwater heaters and discharge through the sixth-stage, high-pressure feedwater heaters to provide the pressure head required by the reactor.

One approximately 30% to 32% capacity, motor-driven reactor feed pump is supplied for startup convenience and use during an outage of a turbine-driven reactor feed pump.

Shut-off valves allow each reactor feed pump to be removed individually from service while maintaining system operability with the remaining reactor feed pumps.

Controlled feedwater recirculation is provided from the discharge side of each reactor feed pump to the main condenser hotwell. This provision ensures that the minimum required flow is maintained through each reactor feed pump during operation.

Each of the turbine-driven reactor feed pumps is driven by an individual steam turbine. The turbine drives are the dual-admission type, each equipped with two sets of main stop and control valves. One set of valves regulates low-pressure steam flow extracted from the main turbine crossover piping. The other set regulates high-pressure steam flow from the main steam supply. During normal operation, the turbine drives run on the low-pressure crossover steam. Main steam is used during plant startup, low load, or transient conditions when crossover steam either is not available or is of insufficient pressure. The turbine drives exhaust steam to the main condenser.

Shut-off valves allow each turbine drive to be removed individually from service while maintaining system operability with the remaining reactor feed pumps.

A condensate storage system is provided to fill the system during startup and serve as a reservoir during load changes. It will accept water when the unit load is reduced and provide water to the system when the unit load is increased. Two 350,000-gallon cycled condensate storage tanks (one per unit) are provided. In addition, one 200,000-gallon demineralized water tank is available for normal makeup use.

The condensate hotwell level will be the controlled variable for setting the rejection rate or addition rate of cycled condensate.

The makeup demineralizer (abandoned-in-place and replaced by a vendor trailer) will provide water to the cycled condensate storage tanks for initial startup of the system and as required during operation.

A zinc injection system is provided to inject a zinc oxide solution into the condensate booster and feedwater systems to reduce the level of Co-60 that is incorporated into the iron oxide coating on the recirculation piping. Studies done by General Electric have shown that elevated levels of ionic zinc (5-15 ppb) in the reactor water suppresses the amount of Co-60 that is released from the fuel cladding and subsequently incorporated into the oxide layers on the recirculation piping and components. (see References 1-3). By reducing the amount of Co-60 in the oxide layers, substantial reduction in the dose rates to personnel from the Co-60 is obtained.

LaSalle is injecting a solution of depleted zinc oxide into the suction header of the reactor feed pumps using a passive zinc injection skid. A tap off the discharge of the motor driven reactor feed pump supplies the skid. The driving force for the injection is the differential pressure between the discharge of the pump and the suction header. The water flows from the discharge through a vessel containing depleted zinc oxide pellets and to the feedwater suction header.

10.4.7.3 Safety Evaluation

The condensate and feedwater system is not safety related.

During operation, radioactive steam and condensate are present in the feedwater heating portion of the system, which includes the extraction steam piping, feedwater heater shells, heater drain piping, and heater vent piping. Shielding and controlled access are provided as necessary (see Section 12.1 for details). The condensate and feedwater system is designed to minimize leakage, with welded construction used where practicable. Relief valve discharges and operating vents are handled through closed systems.

If it is necessary to remove a component such as a feedwater heater, pump, or control valve from service, continued operation of the system is possible by use of the multistream arrangement and the provisions for removing from service and bypassing equipment and sections of the system.

An abnormal operational transient analysis of the loss of a feedwater heater string is included in Chapter 15.0.

10.4.7.4 Tests and Inspections

Periodic tests and inspections of the system are performed in conjunction with scheduled maintenance outages.

10.4.7.5 Instrumentation Application

Feedwater flow-control instrumentation measures the feedwater flow rate from the condensate and feedwater system. This measurement is used by the feedwater control system that regulates the feedwater flow to the reactor to meet system demands. The feedwater control system is described in Section 7.7.

Instrumentation and controls regulate pump recirculation flow rate for the condensate pumps, condensate booster pumps, and reactor feedwater pumps. Measurements of pump suction and discharge pressures are provided for all pumps in the system. Sampling means are provided for monitoring the quality of the final feedwater, as described in Subsection 9.3.2. Temperature measurements are provided for each stage of feedwater heating; these include measurements at the inlet and outlet on both the steam and water sides of the heaters. Steam-pressure measurements are provided at each feedwater heater. Instrumentation and controls are provided for regulating the heater drain flow rate to maintain the proper condensate level in each feedwater heater shell or heater drain tank. High-level alarm and automatic dump-to-condenser action on high level are provided.

10.4.8 Extraction Steam System

The purpose of the extraction steam system is to increase the temperature of the feedwater before it enters the reactor vessel.

10.4.8.1 Design Bases

10.4.8.1.1 Safety Design Bases

The extraction steam system is not required to effect or support safe shutdown of the reactor or to perform in the operation of reactor safety features.

The extraction steam system is designed to minimize the possibility of water induction into the turbine and to prevent steam backflow from the heaters after a turbine trip.

10.4.8.1.2 Power-Generation Design Bases

The extraction steam system is designed to:

a. increase feedwater temperature before the feedwater enters the reactor vessel in order to increase cycle efficiency,

b. provide first-stage reheating of the main steam prior to the main steam entering the low-pressure turbines, and

c. provide steam to the steam seal evaporator.

10.4.8.2 System Description

The extraction steam system is shown in Drawing Nos. M-56 and M-117. The extraction steam system consists of the piping, valves, heat exchangers, controls, instrumentation, and associated equipment and subsystems required to heat the feedwater prior to its entering the reactor.

The low-pressure section of the system consists of 15 feedwater heaters arranged in three strings, each with five stages. The feedwater heaters for stages one and two are located in the condenser neck. The remaining low-pressure feedwater heaters are horizontal U-tube heat exchangers with stainless steel tubes.

The high-pressure portion of the system consists of two feedwater heaters arranged in two strings with one stage. The high-pressure feedwater heaters are horizontal U-tube heat exchangers with stainless steel tubes.

The turbine is protected from steam backflow on turbine trip by a system of air-operated check valves. On a turbine trip, all air-operated check valves are tripped to a partially closed position in order to ensure check valve closure on reverse extraction steam flow.

The turbine is protected from water induction by the feedwater heater level controls that isolate the feedwater heater on a high water level. Drain lines with air-operated drain valves are provided where required to prevent formation of water pockets in the extraction steamlines.

10.4.8.3 Safety Evaluation

The extraction steam system is not safety related. During operation, radioactive steam is present in the extraction steam piping and feedwater heater shells. Shielding and controlled access are provided as necessary (see Section 12.1 for details). The extraction steam system is designed to minimize leakage, with welded construction used where practicable.

10.4.8.4 Tests and Inspections

Hydrostatic and leakage tests are conducted on the extraction steam system in accordance with normal EGC station practices.

10.4.8.5 Instrument Applications

Instruments and controls are provided to measure extraction steam temperature and pressure. Controls are provided to actuate automatically the extraction steam check valves, shut-off valves, and drain valves.

10.4.9 References

1. "Control of Radiation - Field Buildup in BWRs", EPRI Report NP-4072, WJ Marble, June 1985.

2. "BWR Radiation - Field Control Using Zinc Injection Passivation", EPRI Report NP-4474, WJ Marble, March 1986.

3. "Zinc Injection to Control Radiation Buildup at BWRs: Plant Demonstrations", EPRI Report NP-6168, WJ Marble, January 1989.

4. Design Analysis L-003521, Revision 0, "S&L Task Report 11 – Main Steam System", August 2010.

LASALLE COUNTY STATION
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 10.1-1a

HEAT BALANCE - VALVES WIDE OPEN -
1.7 % MUR UPRATE TO 106.7% OLTP -
NEW 1st STAGE NOZZLE PLATE (UNIT 1)

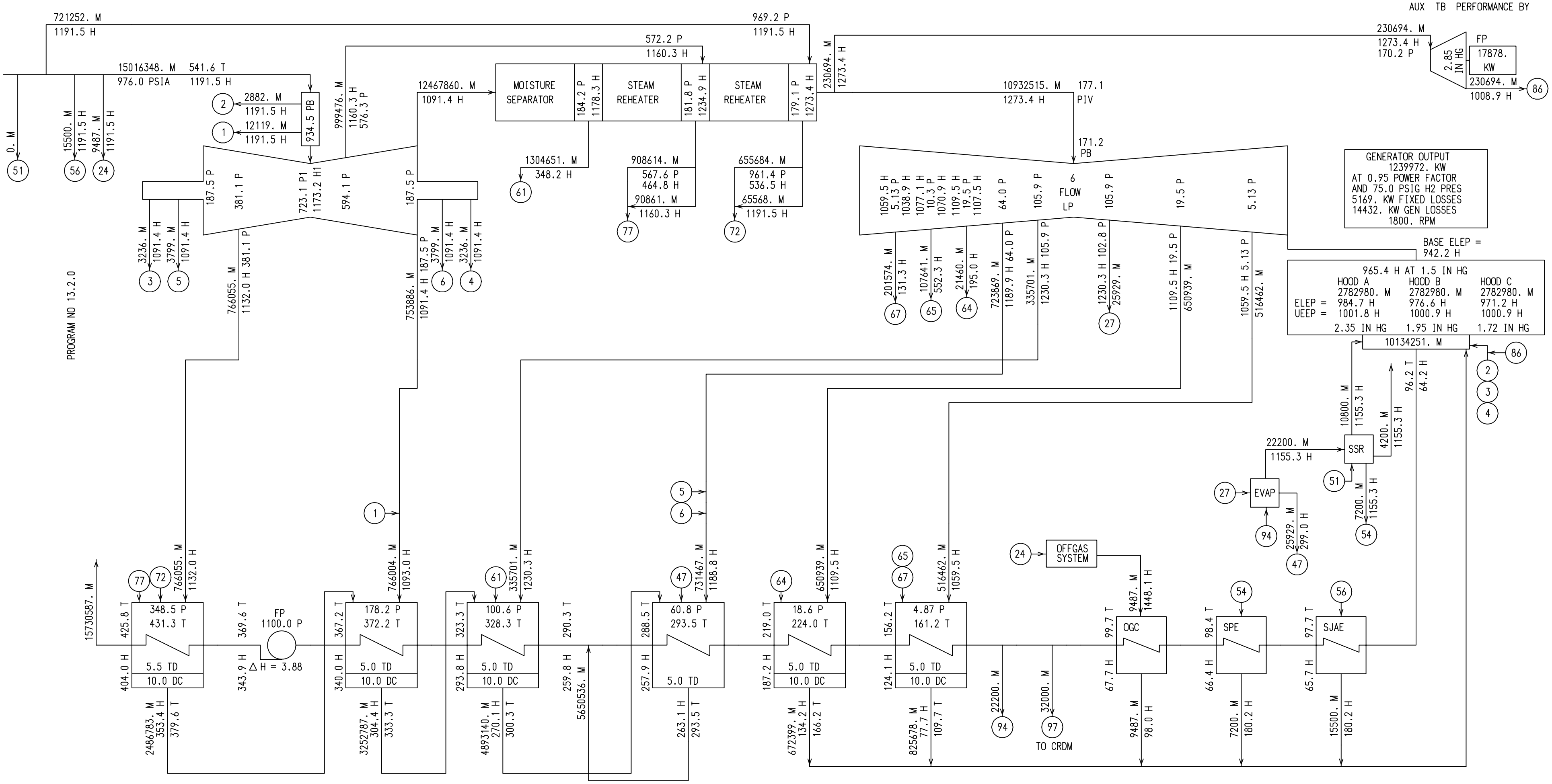
1LX0546-01

TURBINE AND EXTRACTION ARRANGEMENT IS SCHEMATIC ONLY

CALCULATED DATA - NOT GUARANTEED

RATING FLOW IS 14578979. M AT INLET STEAM CONDITIONS OF 976.0 PSIA AND 1191.5 H
TO MINIMIZE THE POSSIBILITY THAT THE TURBINE WILL BE UNABLE TO PASS RATING FLOW BECAUSE OF VARIATIONS IN FLOW COEFFICIENTS FROM EXPECTED VALUES, SHOP TOLERANCES ON DRAWINGS, ETC, THE TURBINE IS BEING DESIGNED FOR A DESIGN FLOW OF 15016348. M IF, IN OPERATION, THE FLOW CAPACITY OF THE TURBINE IS LESS THAN RATING FLOW THE GENERAL ELECTRIC COMPANY WILL ADJUST THE FLOW CAPACITY WHEN THE TURBINE IS MADE AVAILABLE AND OPENED BY THE CUSTOMER

THE VALUE OF GENERATOR OUTPUT SHOWN ON THIS HEAT BALANCE IS AFTER ALL POWER FOR EXCITATION AND OTHER TURBINE-GENERATOR AUXILIARIES HAS BEEN DEDUCTED



$$
\text{VALVE BEST POINT NET HEAT RATE} = \frac{\begin{array}{l} 14984348.\ (\ 1191.5 - 404.0\ ) \\ +\ 721252.\ (\ 1191.5 - 404.0\ ) \\ +\ 32000.\ (\ 1191.5 - 48.0\ ) \end{array}}{1239972.} = 10004\ \frac{\text{BTU}}{\text{KW-HR}}
$$

Exelon LaSalle Unit 1
Turbine No. 170X494
MPL No. 1LX0546
1.7% MUR Uprate to 106.7% OLTP
New 1st Stage Nozzle Plate
VWO Flow Heat Balance

LEGEND - CALCULATIONS BASED ON 1967 ASME STEAM TABLES
M - FLOW-LB/HR
P - PRESSURE-PSIA
H - ENTHALPY-BTU/LB
T - TEMPERATURE-F DEGREES

1206769. KW 2.35 / 1.95 / 1.72 IN HG ABS 0. PCT MU
TC6F 38.0 IN LSB 1800 RPM
976.0 PSIA 1191.5 BTU / LB 2-STAGE REHEAT
GEN- 1300300. KVA 0.90 PF LIQ 75.0 PSIG H2 PRES

GENERAL ELECTRIC COMPANY, SCHENECTADY NY

1LX0546-01 11/17/09

LASALLE COUNTY STATION
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 10.1-1b

HEAT BALANCE - VALVES WIDE OPEN -
1.7 % MUR UPRATE TO 106.7% OLTP -
NEW 1st STAGE NOZZLE PLATE (UNIT 2)

1LX0564-01

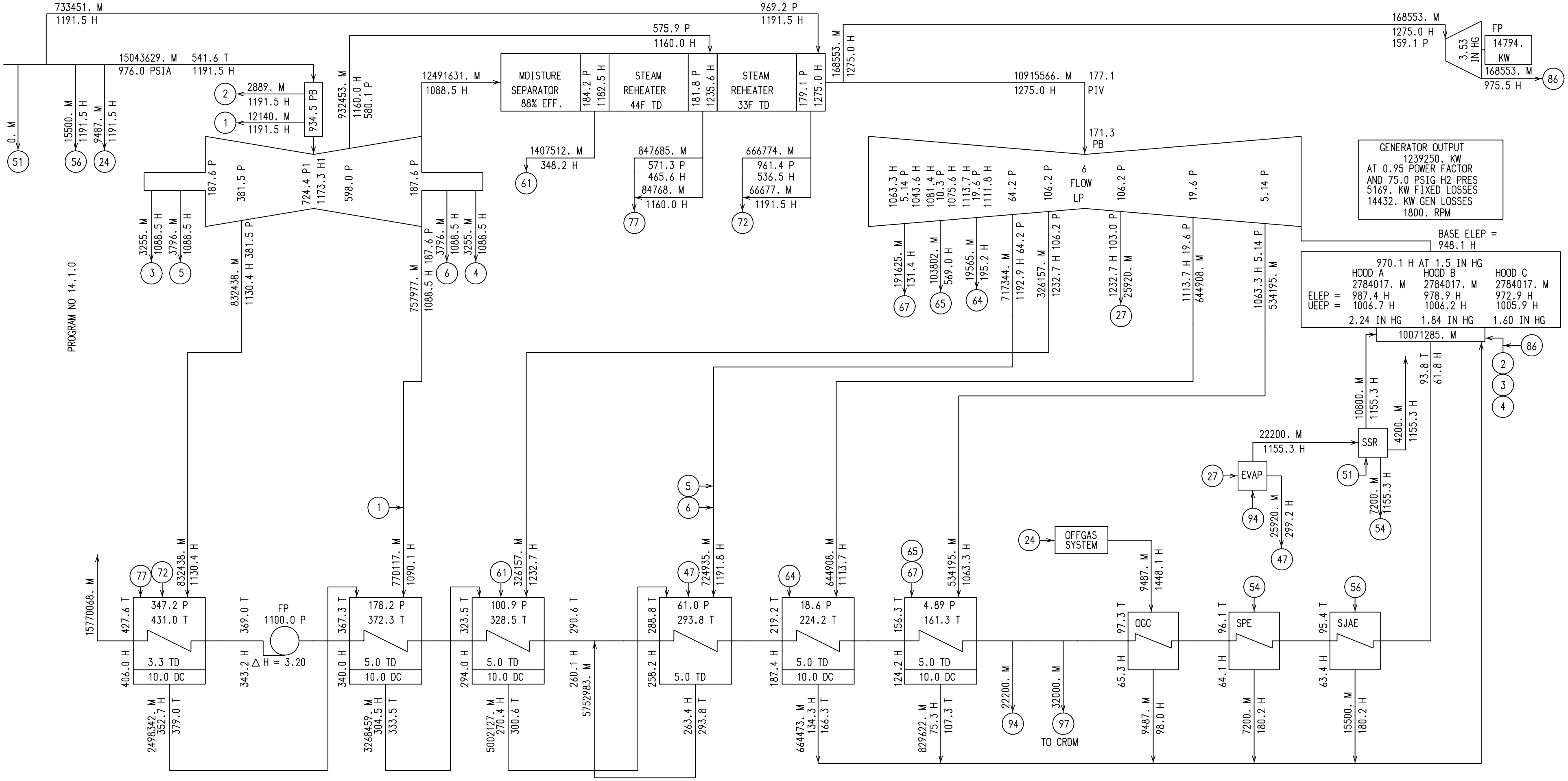
TURBINE AND EXTRACTION ARRANGEMENT IS SCHEMATIC ONLY

CALCULATED DATA – NOT GUARANTEED

RATING FLOW IS 14605465. M AT INLET STEAM CONDITIONS OF 976.0 PSIA AND 1191.5 H
TO MINIMIZE THE POSSIBILITY THAT THE TURBINE WILL BE UNABLE TO PASS RATING FLOW BECAUSE OF VARIATIONS IN FLOW COEFFICIENTS FROM EXPECTED VALUES, SHOP TOLERANCES ON DRAWINGS, ETC, THE TURBINE IS BEING DESIGNED FOR A DESIGN FLOW OF 15043629. M IF, IN OPERATION, THE FLOW CAPACITY OF THE TURBINE IS LESS THAN RATING FLOW THE GENERAL ELECTRIC COMPANY WILL ADJUST THE FLOW CAPACITY WHEN THE TURBINE IS MADE AVAILABLE AND OPENED BY THE CUSTOMER

THE VALUE OF GENERATOR OUTPUT SHOWN ON THIS HEAT BALANCE IS AFTER ALL POWER FOR EXCITATION AND OTHER TURBINE–GENERATOR AUXILIARIES HAS BEEN DEDUCTED

AUX TB PERFORMANCE BY



VALVE BEST POINT
NET HEAT RATE

$$= \frac{15011629.\ (\ 1191.5 - 406.0\ ) + 733451.\ (\ 1191.5 - 406.0\ ) + 32000.\ (\ 1191.5 - 48.0\ )}{1239250.} = 10010\ \frac{\text{BTU}}{\text{KW-HR}}$$

Exelon LaSalle Unit 2
Turbine No. 170X579
MPL No. 1LX0564
1.7% MUR Uprate to 106.7% OLTP
New 1st Stage Nozzle Plate
VWO Flow Heat Balance

LEGEND – CALCULATIONS BASED ON 1967 ASME STEAM TABLES
M – FLOW-LB/HR
P – PRESSURE-PSIA
H – ENTHALPY-BTU/LB
T – TEMPERATURE-F DEGREES

1206088. KW 2.24 / 1.84 / 1.60 IN HG ABS 0. PCT MU
TC6F 38.0 IN LSB 1800 RPM
976.0 PSIA 1191.5 BTU / LB 2 STAGE REHEAT
GEN-1300300 0.90 PF LIQ 75.0 PSIG H2 PRES

GENERAL ELECTRIC COMPANY, SCHENECTADY NY

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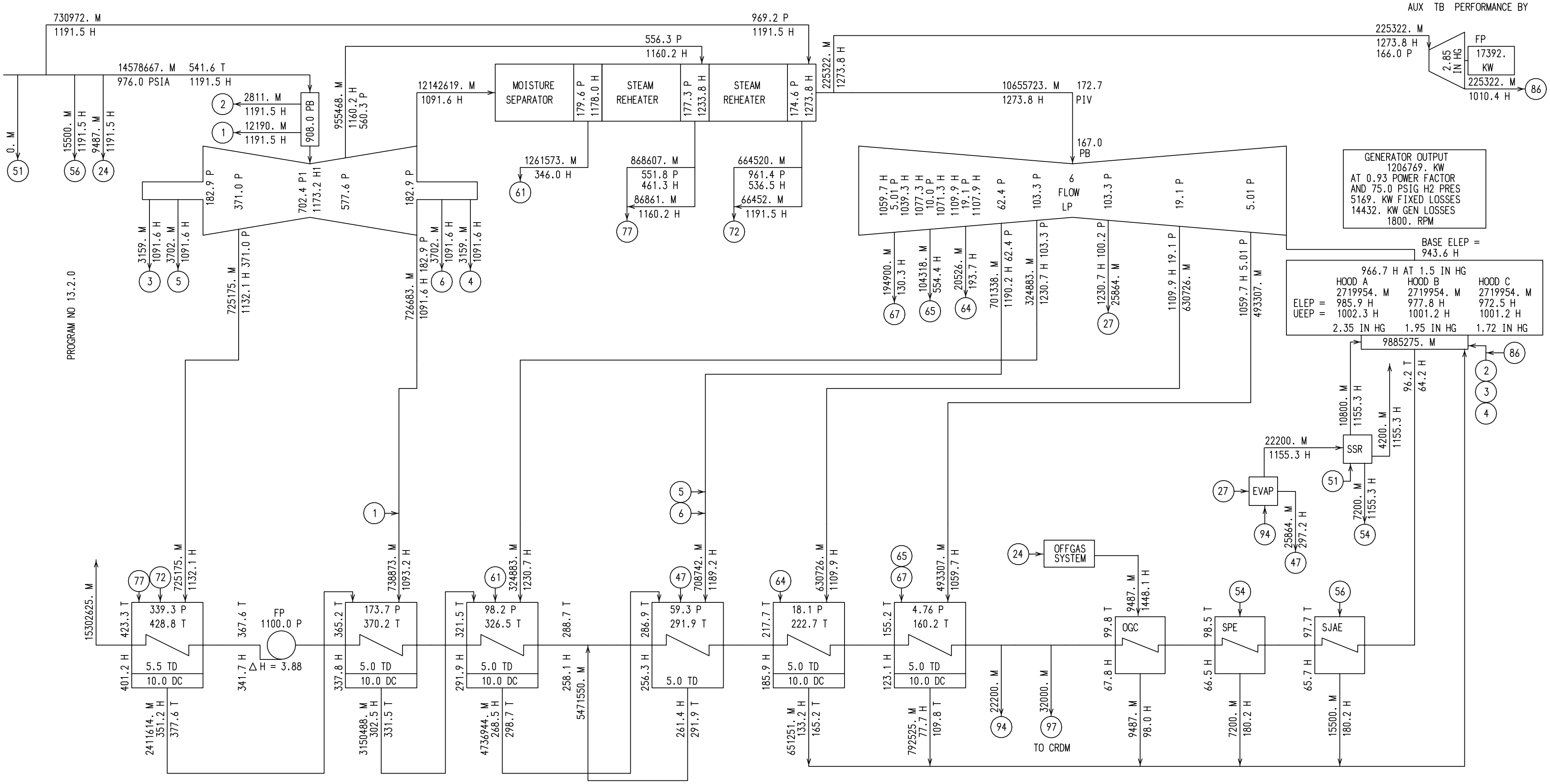
FIGURE 10.1-2a

HEAT BALANCE - GUARANTEE -
1.7 % MUR UPRATE TO 106.7% OLTP -
NEW 1st STAGE NOZZLE PLATE (UNIT 1)

1LX0546-02

TURBINE AND EXTRACTION ARRANGEMENT IS SCHEMATIC ONLY

THE VALUE OF GENERATOR OUTPUT SHOWN ON THIS HEAT BALANCE IS AFTER ALL POWER FOR EXCITATION AND OTHER TURBINE-GENERATOR AUXILIARIES HAS BEEN DEDUCTED



$$\text{VALVE BEST POINT NET HEAT RATE} = \frac{14546667.\,(1191.5 - 401.2) + 730972.\,(1191.5 - 401.2) + 32000.\,(1191.5 - 48.0)}{1206769.} = 10035\ \frac{\text{BTU}}{\text{KW-HR}}$$

Exelon LaSalle Unit 1
Turbine No. 170X494
MPL No. 1LX0546
1.7% MUR Uprate to 106.7% OLTP
New 1st Stage Nozzle Plate
Rated Flow Heat Balance

LEGEND - CALCULATIONS BASED ON 1967 ASME STEAM TABLES
M - FLOW-LB/HR
P - PRESSURE-PSIA
H - ENTHALPY-BTU/LB
T - TEMPERATURE-F DEGREES

1206769. KW 2.35 / 1.95 / 1.72 IN HG ABS 0. PCT MU
TC6F 38.0 IN LSB 1800 RPM
976.0 PSIA 1191.5 BTU / LB 2-STAGE REHEAT
GEN- 1300300. KVA 0.90 PF LIQ 75.0 PSIG H2 PRES

GENERAL ELECTRIC COMPANY, SCHENECTADY NY

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FIGURE 10.1-2b

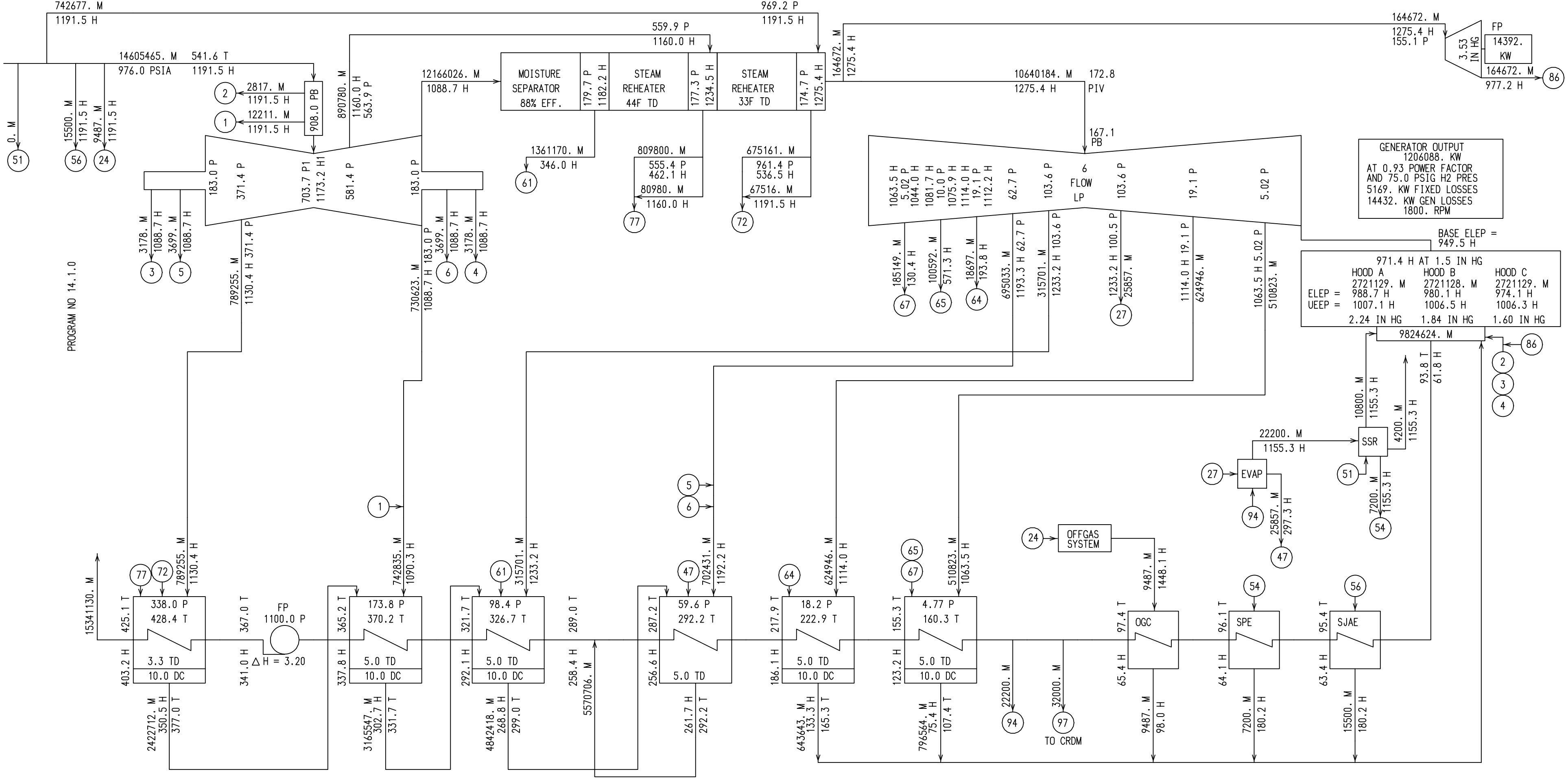
HEAT BALANCE - GUARANTEE -
1.7 % MUR UPRATE TO 106.7% OLTP -
NEW 1st STAGE NOZZLE PLATE (UNIT 2)

1LX0564-02

TURBINE AND EXTRACTION ARRANGEMENT IS SCHEMATIC ONLY

THE VALUE OF GENERATOR OUTPUT SHOWN ON THIS HEAT BALANCE IS AFTER ALL POWER FOR EXCITATION AND OTHER TURBINE-GENERATOR AUXILIARIES HAS BEEN DEDUCTED

AUX TB PERFORMANCE BY



VALVE BEST POINT NET HEAT RATE = $\dfrac{14573465.\ (1191.5 - 403.2) + 742677.\ (1191.5 - 403.2) + 32000.\ (1191.5 - 48.0)}{1206088.} = 10041\ \dfrac{\text{BTU}}{\text{KW-HR}}$

Exelon LaSalle Unit 2
Turbine No. 170X579
MPL No. 1LX0564
1.7% MUR Uprate to 106.7% OLTP
New 1st Stage Nozzle Plate
Rated Flow Heat Balance

LEGEND - CALCULATIONS BASED ON 1967 ASME STEAM TABLES
M - FLOW-LB/HR
P - PRESSURE-PSIA
H - ENTHALPY-BTU/LB
T - TEMPERATURE-F DEGREES

1206088. KW 2.24 / 1.84 / 1.60 IN HG ABS 0. PCT MU
TC6F 38.0 IN LSB 1800 RPM
976.0 PSIA 1191.5 BTU / LB 2 STAGE REHEAT
GEN-1300300 0.90 PF LIQ 75.0 PSIG H2 PRES

GENERAL ELECTRIC COMPANY, SCHENECTADY NY

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