3.2 Reactor Power Conversion System

The proposed plant will consist of STP 3 & 4 and their auxiliaries. The power source of each unit is an Advanced Boiling Water Reactor (ABWR) reactor design. The reference ABWR design was certified by the NRC under 10 CFR 52, Appendix A. The major components of the reactor power conversion system include the reactor pressure vessel, high pressure turbine, moisture separator/reheaters, low-pressure turbines, condenser, generator, feedwater heaters, condensate pumps, and reactor feedwater pumps. Figure 3.2-1 provides a simplified flow diagram of the reactor power conversion system.

The reactor pressure vessel contains internal pumps that send recirculated coolant and returning feedwater through the reactor core. The flow makes contact with the fuel rods that contain the enriched uranium dioxide fuel. As the flow passes through the reactor core, heat from the nuclear fission process generates steam. The steam is transported from the reactor vessel by main steam piping to drive the high-pressure and low-pressure turbines connected to an electric generator to produce electricity. After passing through the low-pressure turbines, the steam is condensed back to water by cooled circulating water inside tubes located in the main condenser. The condensate is then preheated and pumped back to the reactor as feedwater to repeat the steam cycle. The circulating water is cooled by the existing Main Cooling Reservoir (MCR).

3.2.1 Reactor Description

The rated and design core thermal power of the ABWR is 3926 MWt and 4005 MWt, respectively. The nominal rating of the turbine-generator is approximately 1400 MWe, and the gross electrical output of each unit is approximately 1356 MWe. Plant and site equipment will require approximately 56 MWe, resulting in net electrical output of approximately 1300 MWe per unit.

The ABWRs use uranium as their fissile material. The fuel to be used in the STP 3 & 4 reactors can be any fuel design that is approved by the USNRC or meets the appropriate criteria. A reference core of GE P8x8R fuel is assumed for STP 3 & 4 COL Application.

The reactor fuel consists of high-density uranium dioxide pellets enclosed in a sealed Zircaloy cladding tube to constitute a fuel rod. The ABWR P8x8R fuel assembly consists of 62 fuel rods and two water rods grouped in an 8 by 8 array. The reactor core contains 872 fuel assemblies consisting of 54,064 total fuel rods. The initial core total uranium dioxide fuel weight is 379,221 pounds. Enrichment of the uranium will be approximately 2.2 weight percent U-235 for the initial core load and 3.2 weight percent U-235 for core reloads. The expected equilibrium burn-up of discharged fuel will be approximately 32,300 megawatt-days per metric ton of uranium (MWD/MTU), with an expected equilibrium cycle burn-up of 9000 MWD/MTU. The maximum rod average exposure value for the P8x8R fuel is 60 MWD/MTU. The total fuel capacity of the ABWR with P8x8R fuel is approximately 151 MTU.

3.2.2 Engineered Safety Features

The engineered safety features for this plant are those systems provided to mitigate the consequences of postulated serious accidents. The features can be divided into three general groups: (1) containment systems, (2) emergency core cooling systems (ECCS), and (3) habitability systems. The ABWR design incorporates three redundant and independent divisions of ECCS and containment heat removal.

3.2.3 Power Conversion Systems

The components of the power conversion systems are designed to produce electrical power using the steam generated by the reactor, condense the steam into water, and return the water to the reactor as heated feedwater, with a major portion of its gaseous, dissolved, and particulate impurities removed in order to satisfy reactor water quality requirements.

The power conversion system includes the main steam system, the main turbine generator system, main condenser, condenser evacuation system, turbine gland seal system, turbine bypass system, extraction steam system, condensate cleanup system, and the condensate and feedwater pumping and heating system. The heat rejected to the main condenser is removed by the circulating water system and discharged to the power block heat sink, MCR. Each unit will reject approximately 8.566×10^9 Btu/hr of waste heat to the MCR. The condenser has approximately 1.104×10^6 square feet of surface area and uses titanium or stainless steel tubes. The overall unit thermal efficiency is approximately 36%.

Steam generated in the reactor is supplied to the high-pressure turbine and the steam moisture separators/reheaters. Steam leaving the high-pressure turbine passes through a combined moisture separator/reheater before entering the low-pressure turbines. The moisture separator drains, steam reheater drains, and the drains from the two high-pressure feedwater heaters are pumped forward to the suction of the reactor feed pump by the heater drain pumps. The low-pressure feedwater heater drains are cascaded to the condenser.

The condensate pumps take suction from the condenser hotwell and deliver the condensate through filters and demineralizers, gland steam condenser, steam jet air ejector condenser, offgas recombiner condensers, and through the low-pressure feedwater heaters to the reactor feed pumps. The reactor feed pumps discharge through the high-pressure feedwater heaters to the reactor.

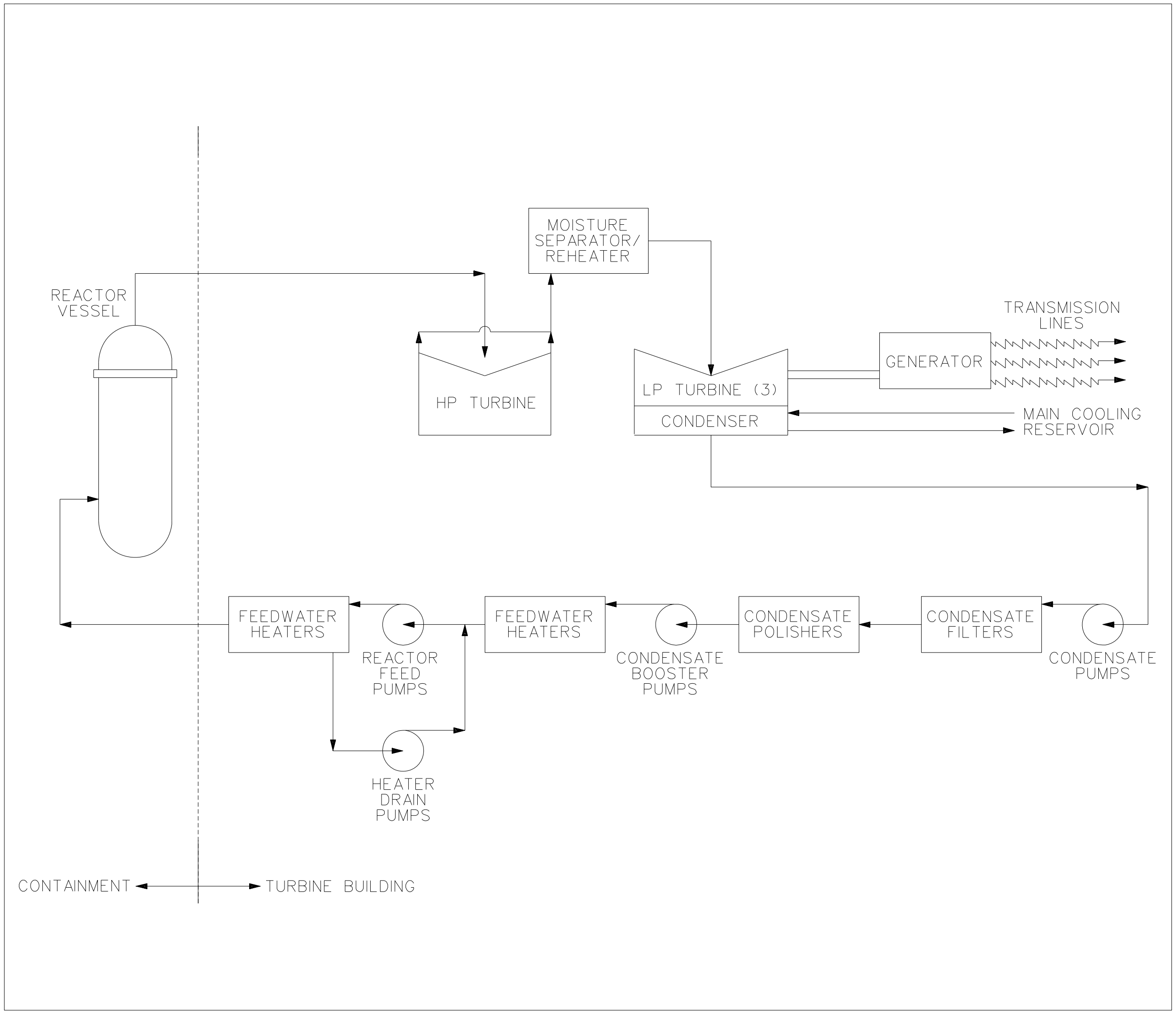

Figure 3.2-1 Simplified Flow Diagram of Reactor Power Conversion System