CHAPTER 10 STEAM AND POWER CONVERSION SYSTEM

10.1 DESIGN BASIS

The steam and feedwater system is designed to remove heat from the reactor coolant. Four steam generators provide sufficient surface to permit heat to be transferred from the reactor coolant to the main steam system. Sufficient steam is produced to drive a turbine-generator unit with a design rating of 1022 mw. This is not to be confused with the expected ultimate capability which corresponds to a valves wide open rating of the turbine generator of 1033 MWe net. The turbine by-pass system is designed to dissipate the heat in the reactor coolant following a full load trip.

10.2 SYSTEM DESIGN AND OPERATION

10.2.1 TURBINE-GENERATOR

The turbine (TC6F-44) is a four casing, tandem-compound, six flow exhaust, 1800 rpm unit with 44-inch last row blades. The turbine consists of one double-flow HP element in tandem with three double-flow LP elements. Six combination moisture-separator, reheater assemblies are provided and are arranged with three assemblies on each side of the LP turbine elements.

The turbine-generator design rating is 1,021,793 kilowatts with inlet steam conditions of 730 psia, 508° FTT, exhausting at 1.5 inches of Hg absolute, zero per cent makeup and six stages of feedwater heating. The turbine is coupled to a single hydrogen inner-cooled generator and a rotating rectifier exciter. The generator has sufficient capability to handle the gross kilowatt output of the steam turbine with its control valves wide open at rated steam conditions.

10.2.2 STEAM GENERATION

The preliminary arrangement of the equipment components associated with the steam and feedwater system is shown in Figure 10-1. Steam from each of four steam generators supplies the tandem-compound turbine-generator unit. After expanding through the high-pressure turbine, steam flows through reheaters to three low-pressure turbines. Six stages of extraction are provided, two from the high-pressure turbine and four from the low-pressure turbine.

There are six, horizontal-axis, cylindrical-shell, combined moisture-separator, steam reheater assemblies. Steam from the exhaust of the HP turbine element enters each assembly at one end. Internal manifolds in the lower section distribute the wet steam. The steam then rises through a wire mesh moisture separator where the moisture is removed and drained to a drain tank. The steam leaving the wire mesh separator flows over a tube bundle where it is reheated. This reheated steam leaves through nozzles in the top of the assemblies and flows to the LP turbines. The tube bundle is supplied with main steam (steam generator outlet) which condenses in the tubes and leaves as condensate. Condensate from the reheater assemblies flows to the high-pressure heater.

The condensing surface at the LP turbine exhaust is arranged in three separate welded steel shells with rectangular water boxes bolted to the shell at both ends. The hotwell is a deaerating type with sufficient storage for two minutes operation at maximum condenser steam loading with some volume for surge protection. Sufficient surface is provided to condense turbine by-pass steam under controlled start-up conditions and residual and decay heat steam at shutdown.

The air removal equipment for the condenser steam space will be steam jet air ejectors.

10.2.3 CONDENSATE AND FEEDWATER

The feedwater train is the closed type with deaeration accomplished in the condenser hotwell. Condensate is taken from the condenser hotwell through the condensate pumps, partial flow system heat exchangers (steam jet air ejector condensers and gland steam condenser), five stages of feedwater heating and into the feedwater pumps. The discharge of the feedwater pumps flows through the high-pressure heaters into the steam generators.

All feedwater heaters are horizontal, one-third size units (three strings).

There are three multi-stage one-third capacity, vertical, pit-type, centrifugal, condensate pumps with vertical motor drives and common suction and common discharge manifolds.

Two one-half capacity, high-speed, barrel-type, turbine driven feedwater pumps are provided with common suction and discharge manifolds. Each pump is equipped with minimum flow protective devices. The design discharge pressure will be the required steam generator pressure plus feedwater system losses including feedwater heaters, piping and valves and feedwater regulators losses plus the static head allowance.

Feedwater will enter the containment vessel through four lines penetrating the containment wall, one line feeding each steam generator. A flow regulator and a stop-check valve will be installed in each branch line outside the containment.

Three auxiliary feedwater pumps are provided to ensure minimum feed flow to the steam generators for decay heat removal during a complete loss of auxiliary power. One auxiliary feedwater pump, 100% duty, is steam turbine driven utilizing steam produced from decay heat removal to drive the turbine. Two reserve auxiliary feedwater pumps, each 50% duty, are motor driven utilizing power produced by the emergency generators.

Drains from the high pressure heater (No. 6) and low pressure heater No. 5 cascade to the drain tank. The heater drain pumps taking suction from the drain tank, discharges to the feedwater pump suction. Drains from the four lower pressure heaters cascade to the condenser.

10.2.4 CIRCULATING WATER

Condenser circulating water will be conveyed to the plant through six 84" O.D. conduits at a rate of 840,000 gpm. Condenser discharge water will flow through conduits and a discharge canal from the plant to the river. Six circulators are provided, one for each circulating water line. Each line services one-half of one condenser shell.

10.3 TURBINE CONTROLS

10.3.1 HYDRAULIC CONTROL SYSTEM

The high pressure steam from the steam generators enters the turbine through the individual turbine stop and control valves. The control valves adjust the turbine throttle flow to accommodate load requirements. For double protection against excessive overspeed of the turbine, the stop and control valves immediately shut off the steam flow to the turbine in case of an overspeed trip. A 300 psig, oil system is used to hydraulically operate the turbine control system.

The overspeed trip mechanism consists of an eccentric weight mounted in the end of the turbine shaft which is held in position by a spring until the turbine speed reaches the tripping speed. At the tripping speed, the centrifugal force then overcomes the restraining spring and the eccentric weight flies out, striking a trigger which trips the overspeed trip valve. The autostop fluid is then released to drain causing the immediate closing of the turbine stop valves, control valves, and automatic non-return valves.

The autostop valve is also tripped when any one of the protective devices is actuated. The protective devices include a low bearing oil pressure trip, a solenoid trip, a thrust bearing trip and a low vacuum trip.

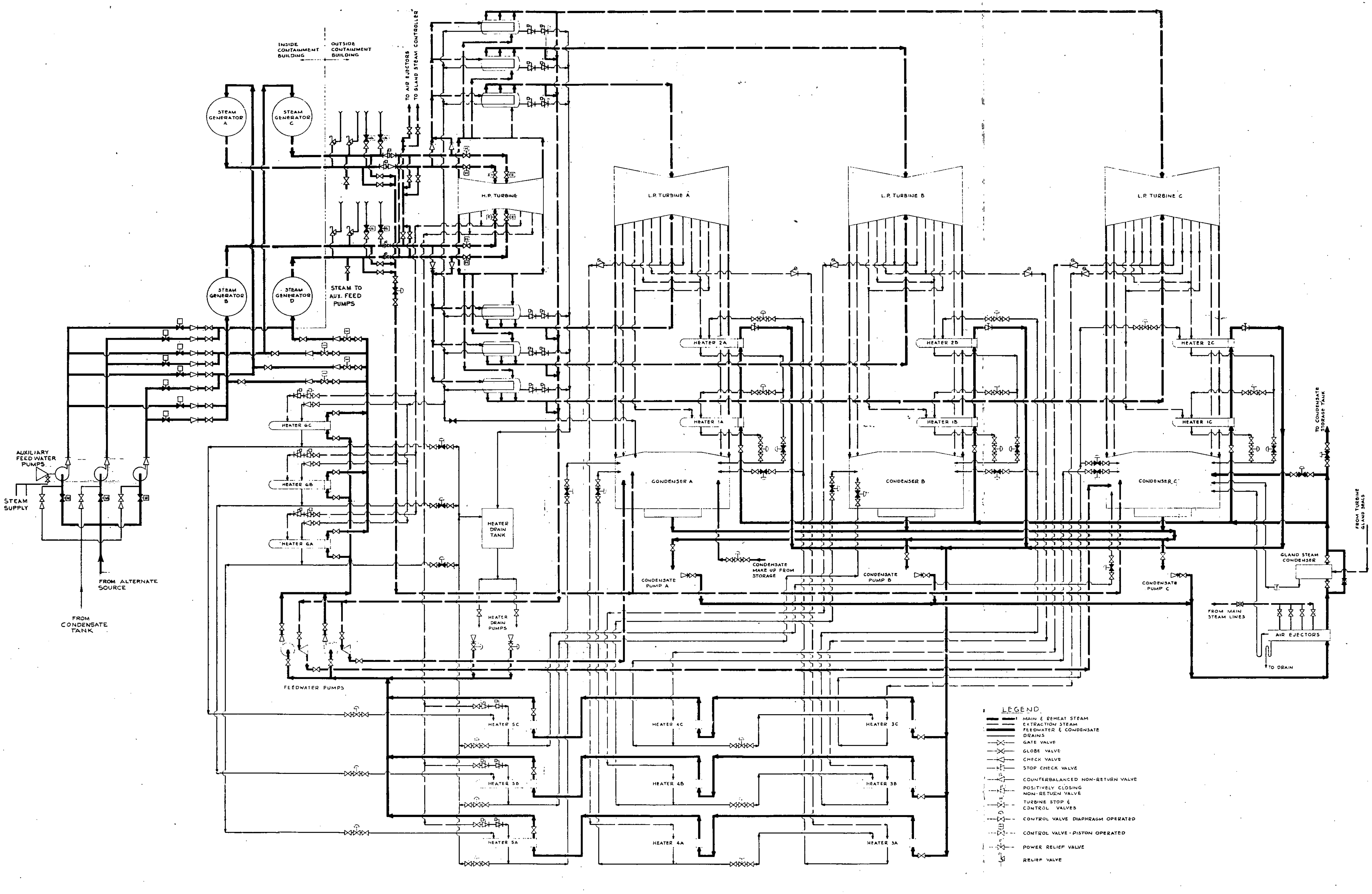
Additional protective features include:

1. Automatic load runback initiated by a dropped rod signal
2. Turbine trip following a reactor trip
3. Stop-check valve in each steam generator steam line
4. Safety valves in each steam generator outlets main steam lines
5. Extraction line non-return valves.

Trip of the turbine-generator, when unit load is greater than a preset value, initiates a reactor trip to prevent excessive reactor coolant temperature and/or pressure.

Automatic turbine load cutback is initiated by a signal from a dropped rod control cluster assembly as indicated by either a rapid decrease in nuclear flux or by the rod bottom on-off controllers. This will prevent high power operation which might lead to minimum DNB ratio less than 1.30 because of the asymmetric nuclear flux distribution resulting from a dropped rod cluster.

An air pilot valve, used to control the extraction non-return valves, is also actuated from the autostop pressure.



STEAM AND FEEDWATER SYSTEM
FIG. 10-1

SECTION 11

PSAR Section	Page	Remarks
11.1.3.7	11-7	A description of the pressure relief protection for the gas decay tanks is given in Item 17 (F - 8.0).
11.2.2	11-14	Additional information on the radiation monitoring system is given in Supplement 7, Question 6 (k).