10 STEAM AND POWER CONVERSION SYSTEM

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10-1	Schematic Flow Diagram

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10 STEAM AND POWER CONVERSION SYSTEM

10.1 DESIGN BASES

10.1.1 OPERATING AND PERFORMANCE REQUIREMENTS

The steam and power conversion system will be designed to remove heat energy from the reactor coolant in the two steam generators and convert it to electrical energy. The closed feedwater cycle will condense the steam, and the heated feedwater will be returned to the steam generators. The entire system will be designed for the maximum expected energy from the nuclear steam supply system.

Upon loss of full load, the system will dissipate all the energy existent or produced in the reactor coolant system through steam relief to the condenser and the atmosphere. The unit will be designed to maintain station auxiliary load without a reactor trip on loss of full load. The steam bypass to the condenser and atmospheric relief valves will be utilized as necessary to achieve this load reduction.

10.1.2 FUNCTIONAL LIMITATIONS

The rate of change of reactor power will be limited to values consistent with the characteristics of the reactor coolant system and its control systems. Further limitations in the steam power conversion system may reduce the reactor coolant system functional limits as given in Section 7.2.1.1.

10.1.3 SECONDARY FUNCTIONS

The steam and power conversion system will provide steam for driving the two steam generator feedwater pumps. Steam will also be used for the condenser air removal equipment and the 5 per cent emergency feedwater pump when required.

10.2 SYSTEM DESIGN AND OPERATION

10.2.1 SCHEMATIC FLOW DIAGRAM

The steam and power conversion system is shown in Figure 10-1. The closed cycle feedwater heaters will be half-size units (two parallel strings). Deaeration will be accomplished in the condenser hotwell. A bypass of 15 per cent of full-load main steam flow to the condenser will be provided.

Two of the three one-half capacity condensate pumps will be in normal use. Each of two feedwater pumps will be at least one-half capacity.

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There will be a total of six (6) minutes condensate storage at full load in the condenser hotwells.

There will also be a 5 per cent capacity, turbine-driven, emergency feedwater pump which takes its suction directly from the hotwell discharge and pumps to the steam generators. Steam for the turbine drive will come from the main steam line and exhaust to atmosphere.

The main steam lines and the feedwater lines will be the only lines of the steam and power conversion system which penetrate the Reactor Building. These lines can be isolated by the main stop valves and the feedwater line valving. Each of the lines leaving the main steam line before the main stop valves has valves to complete the isolation of a steam generator. These lines are:

(a) Steam bypass.

(b) Supply to feed pump turbines.

(c) Supply to steam reheaters.

(d) Supply to condenser air ejectors.

(e) Supply to emergency feed pump turbine.

10.2.2 CODES AND STANDARDS

The turbine-generator equipment will conform to the applicable ASA, ASME and IEEE standards.

The design, materials and details of construction of the feedwater heaters will be in accordance with both the ASME Code, Section VIII, Unfired Pressure Vessels and the Standards of Feedwater Heater Manufacturers Association, Inc.

10.2.3 DESIGN FEATURES

The condenser air ejector off-gas will be continuously monitored with an alarm to indicate high radiation levels. The air ejector off-gas will be released through the station vent.

10.2.4 SHIELDING

No radiation shielding will be required for the components of the steam and power conversion system. Continuous access to the components of this system will be possible during normal conditions.

10.2.5 CORROSION PROTECTION

Hydrazine will be added to the feedwater for oxygen control, and ammonia will be used to maintain the pH at the optimum value for the materials of construction for the system. No other additives are contemplated.

10.2.6 IMPURITIES CONTROL

Impurities in the steam and power conversion system will be controlled to maintain specified steam generator water purity. The condensate will be treated by a separate, at least one half size, demineralizer.

10.2.7 RADIOACTIVITY

Under normal operating conditions, there will be no radioactive contaminants present in the steam and power conversion system. It is possible for this system to become contaminated only through steam generator tube leaks. In this event, monitoring of the steam generator shell side sample points and the air ejector off-gas will detect any contamination.

10.3 SYSTEM ANALYSIS

10.3.1 TRIPS, AUTOMATIC CONTROL ACTIONS AND ALARMS

Trips, automatic control actions and alarms will be initiated by deviations of system variables within the steam and power conversion system. In the case of automatic corrective action in the steam and power conversion system, appropriate corrective action will be taken to protect the reactor coolant system. The more significant malfunctions or faults which cause trips, automatic actions or alarms in the steam and power conversion system are:

(a) Turbine Trips

1. Generator/electrical faults.
2. Loss of condenser vacuum.
3. Thrust bearing wear.
4. Loss of generator coolant capability.
5. Loss of both feedwater pumps.
6. Turbine overspeed.
7. Reactor trip.

(b) Automatic Control Actions

1. Feedwater flow lagging feedwater demand results in a reduction in power demand.
2. Low feedwater temperature results in a reduction in power demand.
3. High level in steam generator results in a reduction in feedwater flow.
4. Low level in steam generator results in an increase in feedwater flow.

(c) Principal Alarms

1. Low pressure at feedwater pump suction.

2. Low vacuum in condenser.

3. Low water level in condenser hotwell.

4. High water level in condenser hotwell.

5. High water level in steam generator.

6. Low water level in steam generator.

7. High pressure in steam generator.

8. Low pressure in steam generator.

9. Low feedwater temperature.

10.3.2 TRANSIENT CONDITIONS

The analysis of the effects of loss of full load on the reactor coolant system is discussed in 14.1.2.8. Analysis of the effects of partial loss of load on the reactor coolant system is discussed in 7.2.3.4.

10.3.3 MALFUNCTIONS

The effects of inadvertent steam relief of steam bypass are covered by the analysis of the steam line failure given in 14.1.2.9. The effects of an inadvertent rapid throttle valve closure are covered by the loss of full load discussion in 14.1.2.8.

10.3.4 OVERPRESSURE PROTECTION

Pressure relief is required at the system design pressure of 1050 psig, and the first safety valve bank will be set to relieve at this pressure. The design pressure is based on the operating pressure of 925 psia plus a 10 per cent allowance for transients and a 4 per cent allowance for blowdown. Additional safety valve banks will be set at pressures up to 1102.5 psig, as allowed by the ASME Code.

The pressure relief capacity will be such that the energy generated at the reactor high-power level trip setting can be dissipated through this system.

10.3.5 INTERACTIONS

Following a turbine trip, the control system will reduce reactor power output immediately. The safety valves will relieve excess steam until the output is reduced to the point at which the steam bypass to the condenser can handle all the steam generated.

In the event of failure of a single feedwater pump, there will be an automatic runback of the power demand. The one feedwater pump remaining in service will carry approximately 60 per cent of full load feedwater flow. If both feedwater pumps fail, the turbine will be tripped, and the emergency feedwater pump started. If reactor coolant system conditions reach trip limits, the reactor will trip.

On failure of a condensate pump, the spare condensate pump will be automatically started.

10.3.6 OPERATIONAL LIMITS

The air ejector off-gas will be monitored for radioactivity, and safe operating limits will be established for the station.

10.4 TESTS AND INSPECTIONS

As is essential in successful operation of any modern power station, frequent functional operational checks will be made on vital valves, control systems and protective equipment.

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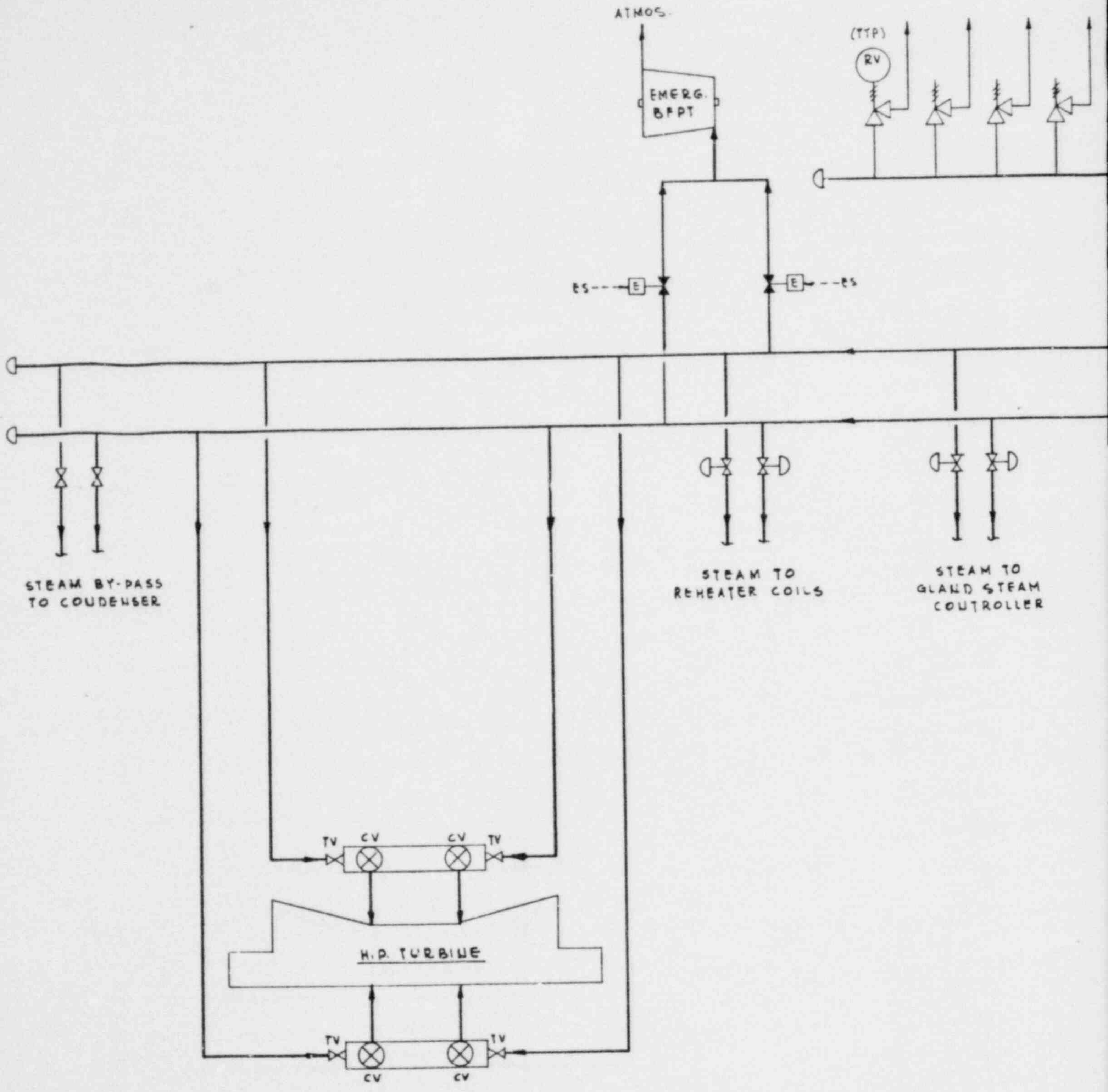
ATMOS.
EMERG. BFPT
(TTP)
RV
ES
E
STEAM BY-PASS TO CONDENSER
STEAM TO REHEATER COILS
STEAM TO GLAND STEAM CONTROLLER
TV
CV
H.P. TURBINE

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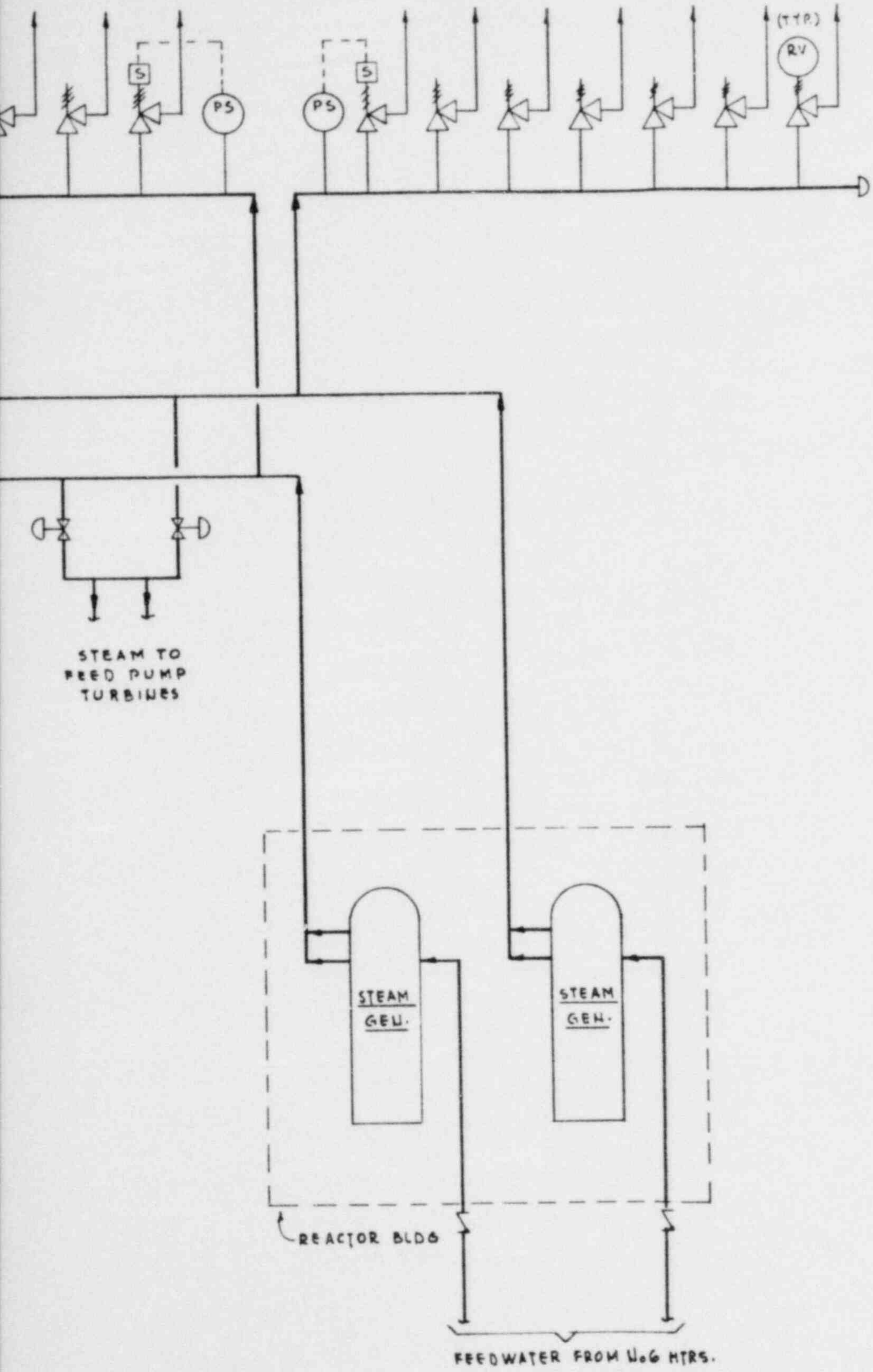

STEAM AND POWER

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Figure 10-1

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