10.3 Main Steam Supply System

The function of the Main Steam Supply System is to convey steam generated in the reactor to the turbine plant. This section discusses that portion of the main steam supply system bounded by, but does not include, the seismic interface restraint, turbine stop valves and turbine bypass valves. This portion does include the steam auxiliary valve(s). This portion of the main steam supply system is designated as the turbine main steam system.

The main steamline pressure relief system, main steamline flow restrictors, main steam-line isolation valves (MSIVs), and main steam piping from the reactor nozzles through the outboard MSIVs to the seismic interface restraint are described in Subsections 5.2.2, 5.4.4, 5.4.5, and 5.4.9, respectively.

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 supply system is designed:

(1) To accommodate operational stresses such as internal pressure and dynamic loads without failures.

(2) To provide a seismically analyzed fission product leakage path to the main condenser.

(3) With suitable accesses to permit inservice testing and inspections.

(4) To close the steam auxiliary valve(s) on an MSIV isolation signal. These valves fail closed on loss of electrical power to the valve actuating solenoid or on loss of pneumatic pressure.

The main steam system piping consists of four lines from the seismic interface restraint to the main turbine stop valves. The header arrangement upstream of the turbine stop valves allows them to be tested online and also supplies steam to the power cycle auxiliaries, as required.

The main steam system is analyzed, fabricated and examined to ASME Code Class 2 requirements, classified as non-Seismic Category I, and subject to pertinent QA requirements of Appendix B, 10CFR50. Inservice inspection shall be performed in accordance with ASME Section XI requirements for Code Class 2 piping. ASME authorized nuclear inspector and ASME Code stamping is not required.

Main steam piping from the seismic interface restraint to the main stop, main turbine bypass, including the steam auxiliary valves(s) is analyzed to demonstrate structural integrity under

safe shutdown earthquake (SSE) loading conditions. Refer to Subsection 3.2.5.3 for seismic classification for the lines.

10.3.1.2 Power Generation Design Bases

Power Generation Design Basis One—The system is designed to deliver steam from the reactor to the turbine-generator system for a range of flows and pressures varying from warmup to rated conditions. It also provides steam to the reheaters, the steam jet air ejectors, the turbine gland seal system, the offgas system and the deaerating section of the main condenser and the turbine bypass system.

10.3.2 Description

10.3.2.1 General Description

The Main Steam Supply System is illustrated in Figure 10.3-1. The system design data is provided in Table 10.3-1. The main steam piping consists of four 700A pipe size diameter lines from the outboard MSIVs to the main turbine stop valves. The four main steamlines are connected to a header upstream of the turbine stop valves to permit testing of these valves during plant operation with a minimum load reduction. This header arrangement is also provided to ensure that the turbine bypass and other main steam supplies are connected to operating steamlines and not to idle lines. The main steam process downstream of the turbine stop valves is illustrated in Figure 10.3-2.

Continued operation with an isolated MSL is only permitted if an analysis of the effects of flow-induced vibration on the remaining open MSIVs and other critical components in the reactor and steam systems has been performed. Continued plant operation must remain within the bounds of this analysis.

The design pressure and temperature of the main steam piping is 8.62 MPaG and 302°C, respectively, the same values as the design parameters of the reactor. The main steamlines are classified as discussed in Section 3.2.

Drain lines are connected to the low points of each main steamline, both inside and outside the containment. Both sets of drains are headered and connected with isolation valves to allow drainage to the main condenser. To permit intermittent draining of the steamline low points at low loads, orificed lines are provided around the final valve to the main condenser. The steamline drains, including the drains through Control Building, maintain a continuous downward slope in the direction of flow to the steam system line drain low points in the Reactor Building steam tunnel and then slope upward to reach the high point in the steam tunnel above the Control Building. From this high point in the Control Building, the lines slope downward in the direction of flow to the Nuclear Island-Balance of Plant piping interface one meter outside of the Control Building. Although the drain lines flow upward for a portion of their travel, the differential pressure between the condenser and main steam lines, combined with the bypass and orifice isolation valves in the drain lines, which are controlled by reactor pressure

and power, respectively, ensure complete drainage while preventing water hammer. To permit emptying the drain lines for maintenance, drains are provided from the line low points going to the radwaste system.

The drains from the steamlines inside containment are connected to the steamlines outside the containment to permit equalizing pressure across the MSIVs during startup and following a steamline isolation.

The Main Steam System contains the radioactive steam which passes the main steam isolation valves before they close to isolate the reactor under emergency conditions. This function of containing steam is done by the main steam piping, turbine bypass piping and steam drain piping discharging to the condenser.

The main steam piping and branch lines, 2-1/2 inches in diameter and larger, from (but not including) the outboard MSIVs to the turbine stop valves and to the turbine bypass valves are Quality Group B in accordance with the construction and quality requirements, ASME B&PV, Section III, Division 1, Subsection NC-Class 2, Nuclear Plant Components. The main steam lines from the seismic restraint on the outboard side of the outermost MSIVs, and all branch lines 2-1/2 inches in diameter and larger (including lines and valve supports), are designed by the use of an appropriate dynamic seismic system analysis, to withstand the safe shutdown earthquake (SSE) design loads for the ABWR standard plant in combination with other appropriate loads, within the limits specified for Class 2 pipe in Section III of the ASME B&PV Code. Lines smaller than 2-1/2 inches in diameter, the rupture of which could result in bypass of the main condenser, are designed to withstand the SSE design loads for the ABWR standard plant in combination with other appropriate loads. The mathematical model for the dynamic and seismic analyses of the main steam lines and branch line piping includes the turbine stop valves and piping to the turbine casing.

See Subsection 10.3.7.2 for COL license information pertaining to allowable MSIV leakage.

10.3.2.2 Component Description

The Main Steam Supply System lines are made of carbon steel and are sized for a normal steady-state velocity of 45.72 m/s, or less. The lines are designed to permit hydrotesting following construction and major repairs without addition of temporary pipe supports.

10.3.2.3 System Operation

Normal Operation—During startup, the turbine gland seal steam system is supplied from the auxiliary boiler. At a sufficient pressure during reactor startup and up to rated power operation, seal steam is supplied by the gland steam evaporator. The source of heating steam for the evaporator is main steam or turbine extraction steam.

Steam is supplied to the crossaround steam reheaters in the T-G system when the T-G load exceeds approximately 15% and supply steam pressure is controlled by regulating valves in the 15 to approximately 60% load range.

If a large, rapid reduction in T-G load occurs, steam is bypassed directly to the condenser via the turbine bypass system (see Subsection 10.4.4 for a description of the turbine bypass system).

10.3.3 Evaluation

All components and piping for the main steam supply system are designed in accordance with the codes and standards listed in Section 3.2. This ensures that the Main Steam Supply System accommodates operational stresses resulting from static and dynamic loads, including steam hammer and normal and abnormal environmental conditions. The COL applicant shall provide operating and maintenance procedures that include adequate precautions to avoid steam hammer and relief valve discharge loads (see Subsection 10.3.7.1 for COL license information requirements).

The break of a main steamline or any branch line will not result in radiation exposures in excess of the limits of 10CFR100 to persons located offsite because of the safety features designed into the system. The main steamline pipe break accident is addressed in Chapter 15, and high energy pipe failure is discussed in Section 3.6.

10.3.4 Inspection and Testing Requirements

Inspection and testing will be in accordance with the requirements of Section 3.2. The main steamline will be hydrostatically tested to confirm leaktightness.

10.3.5 Water Chemistry (PWR)

This section applies to a pressurized water reactor (PWR), and is therefore not applicable.

10.3.6 Steam and Feedwater System Materials

Steam and feedwater component materials are identified in Table 5.2-4.

10.3.6.1 Fracture Toughness of Class 2 Components

The fracture toughness properties of the ferritic materials of these components will meet the requirements of NC-2300, “Fracture Toughness Requirements for Materials” (Class 2) of ASME Code Section III, as invoked by Regulatory Guide 1.26, “Quality Group Classification and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants.” This also includes the portion of the main steam supply system defined in Section 10.3.

10.3.6.2 Materials Selection and Fabrication

The materials specified for use in Class 2 components will conform to Appendix I to ASME Code Section III, and to Parts A, B, and C of Section II of the Code.

Regulatory Guide 1.85, “Code Case Acceptability ASME Section III Materials”, describes acceptable code cases that will be used in conjunction with the above specifications.

The following criteria are applicable to all components:

(1) Regulatory Guide 1.71, “Welder Qualification for Areas of Limited Accessibility”, provides the following criteria for assuring the integrity of welds in locations of restricted direct physical and visual accessibility:

(a) The performance qualification should require testing of the welds when conditions of accessibility to production welds are less than 30 to 35 cm in any direction from the joint.

(b) Requalification is required for different accessibility conditions or when other essential variables listed in the Code, Section IX, are changed.

(c) The qualification and requalification tests required by (a) and (b) above may be waived, provided that the joint is to be 100% radiographed or ultrasonically examined after completion of the weldment. Examination procedures and acceptance standards should meet the requirements of ASME Code Section III. Records of the examination reports and radiographs should be retained and made part of the Quality Assurance documentation of the completed weld.

(2) Regulatory Guide 1.37, “Quality Assurance Requirements for Cleaning of Fluid Systems and Associated Components of Water-Cooled Nuclear Power Plants” describes acceptable procedures for cleaning and handling Class 2 components of the steam and feedwater systems. Vented tanks with deionized or demineralized water are an acceptable source of water for final cleaning or flushing of finished surfaces. The oxygen content of the water in these vented tanks need not be controlled.

(3) Acceptance criteria for nondestructive examination of tubular products are given in ASME Code Section III, Paragraphs NC 2550 through 2570.

10.3.7 COL License Information

10.3.7.1 Procedures to Avoid Steam Hammer and Discharge Loads

The COL applicant will provide operating and maintenance procedures that include adequate precautions to avoid steam hammer and discharge loads (Subsection 10.3.3).

10.3.7.2 MSIV Leakage

The COL applicant will provide the amount of allowable MSIV leakage for review by the NRC (Subsection 10.3.2).

Table 10.3-1 Main Steam Supply System Design Data

Main Steam Piping	
Design flow rate at 6.79 MPaA and 0.4% moisture, kg/h	~7.65E+06
Number of lines	4
Nominal diameter	700A
Minimum wall thickness, mm	38.1
Design pressure,MPaG	8.62
Design temperature, °C	302
Design code	ASME III, Class 2
Seismic design	Analyzed for SSE design loads

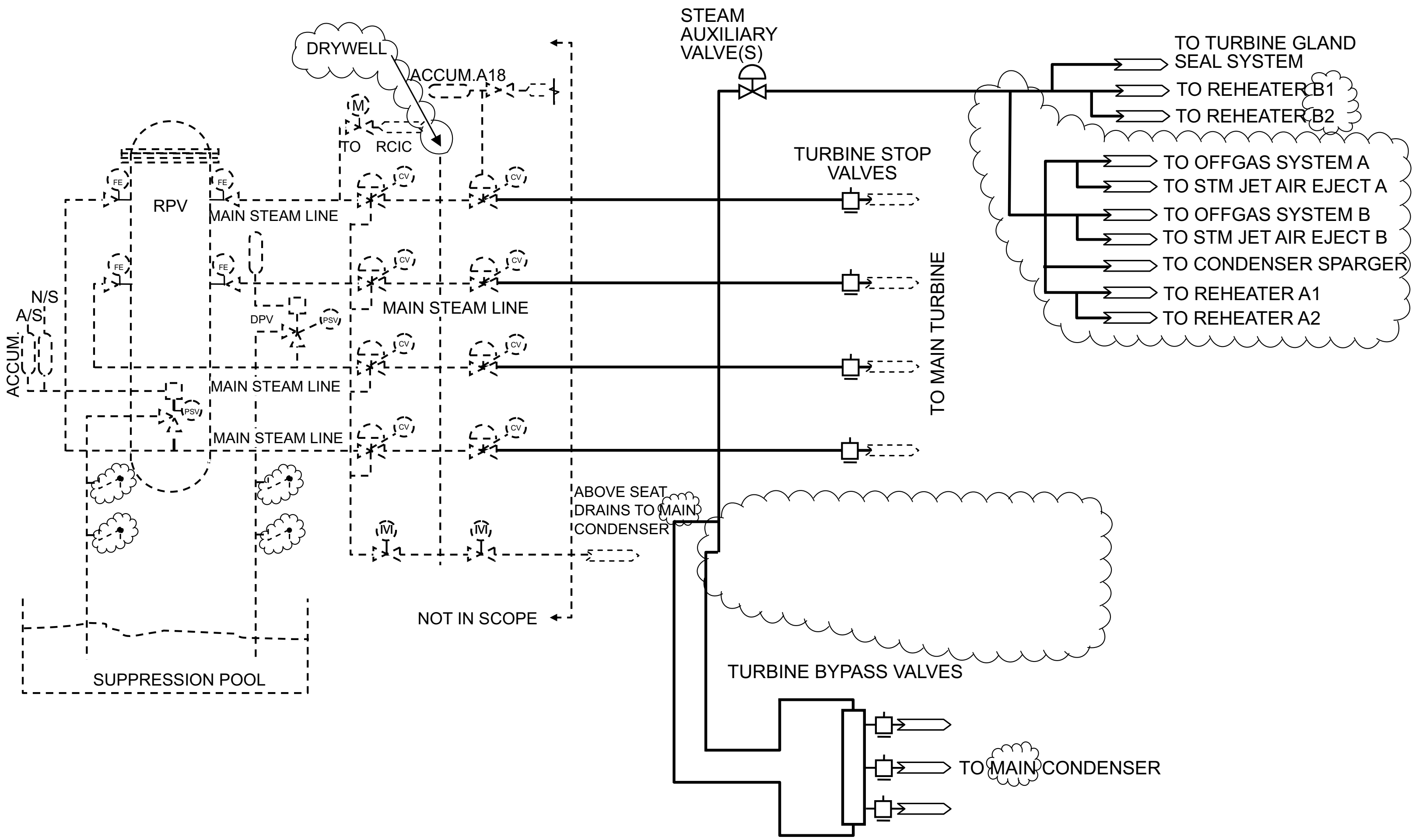

Figure 10.3-1 Main Steam Supply System

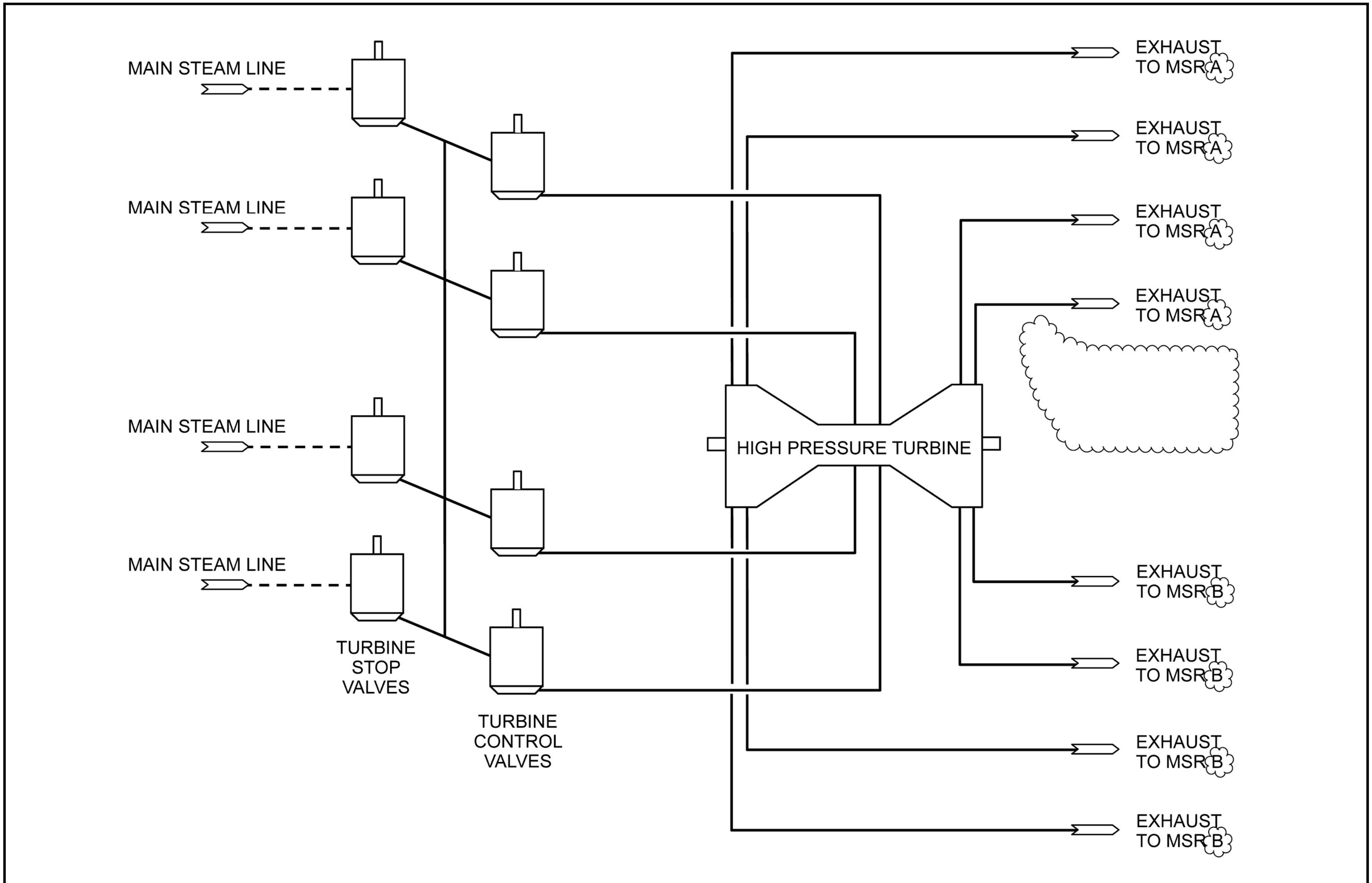

Figure 10.3-2 Main Turbine System

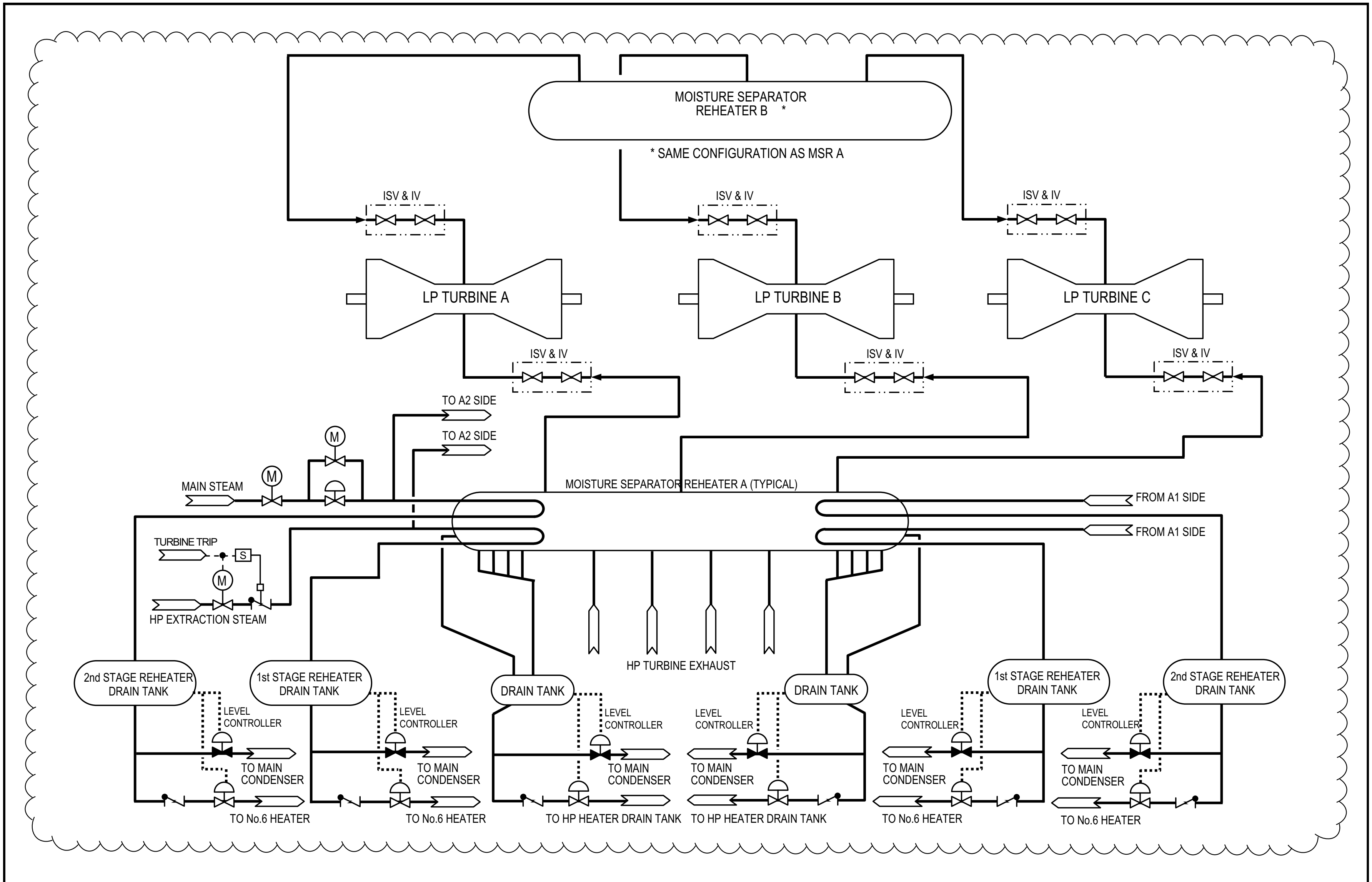

Figure 10.3-2 Main Turbine System (Continued)