6.7 High Pressure Nitrogen Gas Supply System

6.7.1 Functions

The High Pressure Nitrogen Gas Supply (HPIN) System is divided into two independent divisions, with each division containing a safety-related emergency stored nitrogen supply. The safety-related stored nitrogen supply is Safety Class 3, Seismic Category I, designed for operation of the main steam SRV ADS function accumulators.

The functions of the non-safety-related, makeup nitrogen gas supply system include providing nitrogen for:

(1) Relief function accumulators of main steam SRVs

(2) Pneumatically-operated valves and instruments inside the PCV

(3) Leak detection system radiation monitor calibration

(4) ADS function accumulators to compensate for the leakage from main steam SRV solenoid valves during normal operation

6.7.2 System Description

Normally, nitrogen gas for both safety-related and non-safety-related makeup systems is supplied from the nitrogen gas evaporator via the makeup line to the Atmospheric Control System (ACS). The nitrogen supply system shall supply nitrogen which is oil-free with a moisture content of less than 2.5 ppm. This nitrogen is filtered in the HPIN System to remove particles larger than 5 μm. All equipment using this nitrogen shall be capable of operating with nitrogen of the quality listed above. If nitrogen is not available from the ACS, nitrogen is supplied from high pressure nitrogen gas storage bottles. The safety-related system is separated into two divisions. There are tielines between the non-safety-related and each division of the safety-related system. Each tieline has a motor-operated shutoff valve (See Figure 6.7-1 and Table 6.7-1 for details).

During operation, all SRV accumulators are supplied from the non-divisional system. If the pressure sensor in either of the safety-related systems indicates low pressure, the valve between that system and the non-divisional system closes and the supply valve to the bottled nitrogen supply in that division opens. If the pressure sensor in the non-divisional system indicates a low pressure, the valves between the non-divisional and the divisional systems close. (See Figure 7.3-10)

Each division of the safety-related system has ten bottles. Normally, outlet valves from five of the ten bottles are kept open. Each division has a pressure control valve to depressurize the nitrogen gas from the bottles.The bottle racks are located in different rooms, see Figure 1.2-10. The nitrogen gas supply pressure shall be sufficient to fully open the SRVs at the maximum drywell backpressure specified in section 19.E.2.1.2.2.2(b).

The bottles are mechanically restrained to preclude generation of high-pressure missiles during an SSE. The bottles are also covered by a heavy steel plate, which serves as a barrier to potential missiles.

Flow rate and capacity requirements are divided into an initial requirement and a continuous supply. An initial requirement for each ADS SRV provides for actuations of the valve against drywell pressure. Two hundred liter accumulators are supplied for each main steam ADS SRV actuator. The continuous supply is divided into safety and nonsafety portions. Calculations shall be performed to confirm that an accumulator capacity of 200 liters, with the minimum required pneumatic supply pressure is sufficient for one actuation at drywell design pressure, or five actuations at normal drywell pressure with nominal pneumatic supply pressure. The analysis methods used to confirm that the accumulator capacity is sufficient are provided in Subsection 6.7.6.

Compressed nitrogen at a rate adequate to make up the nitrogen leakage of each serviced valve is provided by the safety-related portion. This assumes a leakage rate for each valve of 28.3 L/h for a period of at least seven days. The safety-related system with associated lines, valves and fittings are classified as Safety Class 3, Seismic Category I.

The non-safety-related portion provides compressed nitrogen at a rate adequate to recharge the ADS SRV accumulators. The non-safety-related system has two pressure control valves to depressurize the nitrogen gas from the AC system. One is to depressurize to a level for the SRV accumulators and the other is to depressurize to a lower level for other pneumatic uses per Figure 6.7-1.

The continuous supply portion of the pneumatic system, upstream of the non-safety-related HPIN System isolation valve, is not safety-related.

Non-safety-related piping and valves of the system are designed to ASME Code Section III, Class 3, Quality Group C, non-seismic Category I.

System design pressure and temperature are shown in Figure 6.7-1.

6.7.3 System Evaluation

Gas bottles, piping and valves of the safety-related portion of the system are designed to Seismic Category I, ASME Code III, Class 3, Quality Group C and Quality Assurance B requirements, except for the piping and valves for the containment penetrations which are designed to Seismic Category I, ASME Code III, Class 2, Quality Group B and Quality Assurance B requirements.

The safety-related high pressure nitrogen gas supply is separated into two independent divisions, with each division capable of supplying 100% of the requirements of the division being serviced. Each division is mechanically and electrically separated from the other. HPIN System, Division A, is powered from Class 1E Division I and HPIN System, Division B, is

powered from Class 1E Division II. The system satisfies the components' nitrogen demands during all plant operation conditions (normal through faulted).

The safety-related portions of the HPIN System are capable of being isolated from the nonsafety-related parts and retaining their function during LOCA-related and/or seismic events.

Pipe routing of Division A and Division B of the HPIN System is kept separated by enough space so that a single fire, equipment dropping accident, strike from a single high energy whipping pipe, jet force from a single broken pipe, internally generated missile or wetting equipment with spraying water cannot prevent the other division from accomplishing its safety function. Separation is accomplished by spatial separation or by a reinforced concrete barrier, to ensure separation of each pneumatic division from any systems and components which belong to the other pneumatic division.

6.7.4 Inspection and Testing Requirements

Mandatory periodic inservice inspection of components, in accordance with ASME Section XI, will be conducted to ensure the capability and integrity of the system. Nitrogen quality shall be tested periodically to assure compliance with ANSI MC11.1.

The HPIN containment isolation valves are capable of being tested to assure their operational integrity by manual actuation of a switch located in the control room and by observation of associated position indication lights. Test and vent connections are provided at the containment isolation valves in order to verify their leaktightness. Operation of valves and associated equipment used to switch from the non-safety-related to the safety-related nitrogen supply can be tested to assure operational integrity by manual actuation of a switch located in the control room and by observation of associated position indication lights. Periodic tests of the check valves and accumulators shall be conducted to assure valve operability. Periodic testing of the safety relief valves, the accumulator check valve, and the relief valve if present, shall be conducted to confirm that the nitrogen leakage is within the assumed value of 28 liters per hour for each safety relief valve.

6.7.5 Instrumentation Requirements

A pressure sensor is provided for the safety-related nitrogen supply, and an alarm signals low nitrogen pressure.

A remote manual switch and open/closed position lights are provided in the control room for valve operation and position indication.

6.7.6 Analysis and Testing of ADS Accumulator Capacity

Several methods can be used to confirm that the accumulator capacity meets the design requirements specified in Section 6.7.2. The simplest method, models the ADS actuation process as an adiabatic isentropic expansion. For a given accumulator capacity the number of

actuations is determined using the ideal gas law and adiabatic/isentropic relationships. For conservatism, the system can be assumed not to return to ambient temperature after each actuation.

The volume of the individual ADS accumulators shall be confirmed by measurement or test. This test may occur during production testing.

Table 6.7-1 Nitrogen Gas Demand

Use	Intermittent Demand (Normal Liters/Minute)	Continuous Demand (Normal Liters/Minute)
MS SRV Leakage	—	6
MS SRV Accumulator Recharging	400	—
Instrument Air Supply System	300	100

The following figure is located in Chapter 21:

Figure 6.7-1 High Pressure Nitrogen Gas Supply System P&ID