

6.7 Nitrogen Supply System (N2)

6.7.1 Functions

The Nitrogen Supply System (N2) 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 (MS) Safety Relief Valve (SRV) Automatic Depressurization System (ADS) function accumulators.

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

- (1) Relief function accumulators of MS SRVs
- (2) Pneumatically-operated valves and instruments inside the Primary Containment Vessel (PCV) via the Instrument Air System (IAIR)
- (3) ADS function accumulators to compensate for the leakage from MS SRV solenoid valves during normal operation

6.7.2 System Description

N2 consists of both safety-related divisional, and non-safety-related non-divisional portions. The non-safety-related portion consists of a single line that supplies nitrogen continuously to all pneumatically operated components in primary containment, via IAIR, and to the MS SRV relieving function accumulators.

The safety-related portion of the system consists of two independent divisions. Each division contains safety-related nitrogen gas bottles. The safety-related divisional portion of the system supplies makeup to the MS SRV ADS function accumulators.

During normal operation, nitrogen gas for both safety-related and non-safety-related makeup systems is supplied from the Atmospheric Control System (ACS). Nitrogen supplied from ACS is oil-free with a moisture content of less than 2.5 ppm. N2 is equipped with filters that remove particles larger than 1 μm from the nitrogen supplied from the ACS. All equipment using this nitrogen is capable of operating with nitrogen of the quality listed above. If nitrogen is not available from ACS, nitrogen is supplied from the high pressure nitrogen gas storage bottles. There are tielines between the non-safety-related portion and each division of the safety-related portions of the system. Each tieline has a motor-operated shutoff valve (see Figure 6.7-1 for details). The failure mode of these motor-operated valves between the non-divisional and divisional systems is to fail in-place.

During operation, all SRV accumulators are supplied from the non-divisional non-safety-related portion of the 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 and the supply valves to the bottled nitrogen supply in both divisions open.

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 regulate the pressure of the nitrogen gas from the bottles. These pressure control valves fail in the open position. The bottle racks are located in different rooms (see Figure 1.2-10). The nitrogen gas supply pressure is sufficient to fully open the SRVs at the maximum drywell backpressure specified in Section 19.3.1.2.1.

The bottles are mechanically restrained to preclude generation of high-pressure missiles during a SSE. The bottles are also covered by a 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. Accumulators with a volume of 200 liters are supplied for each main steam ADS SRV actuator. The continuous supply is divided into safety and non-safety 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 to be 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 is 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 reduce the pressure of the nitrogen gas from ACS. One is to reduce the pressure to a level for the SRV accumulators and the other is to reduce the pressure to a lower level for other pneumatic uses per Figure 6.7-1. These pressure control valves fail in the open position.

The continuous supply portion of the pneumatic system, upstream of the non-safety-related N2 isolation valve, is not safety-related.

Non-safety-related piping and valves of the system are designed to ASME Boiler & Pressure Vessel Code (B&PVC) Section III, Class 3, non-seismic Category I.

Nitrogen gas demand (consumption rates) are shown in Table 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 B&PVC Section III, Class 3, except for the piping and valves for the containment penetrations which are designed to Seismic Category I, ASME B&PVC Section III, Class 2.

The safety-related nitrogen gas supply is separated into two independent divisions, with each division capable of supplying 100% of the requirements of the division being serviced for seven days. Each division is mechanically and electrically separated from the other. N₂, Division A receives electrical power from Class 1E Division I and N₂, Division B receives electrical power 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 N₂ are capable of being isolated from the non-safety-related parts and retaining their function during LOCA-related and/or seismic events.

Pipe routing of Division A and Division B of N₂ is 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 B&PVC 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 N₂ containment isolation valves are capable of being tested to assure their operational integrity by manual actuation from the control room and by observation of associated valve position indication. 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 from the control room and by observation of associated valve position indication. 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 28.3 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.

Remote manual actuation and open/closed position indication is 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 Subsection 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	—	8.5
MS SRV Accumulator Recharging	400	—
Instrument Air Supply System	300	100

Figure 6.7-1 Nitrogen Supply System P&IDs (Sheets 1-2)

(Proprietary information provided in a separate proprietary volume.)