6.4 HABITABILITY SYSTEMS

The Salem Generating Station (SGS) Units 1 and 2 control rooms are located within a common Control Room Envelope (CRE). The control rooms are located at elevation 122 feet of the Auxiliary Building and contains those controls and instrumentation necessary for operation of the units under normal and abnormal conditions. The CRE is continuously occupied by operating personnel under all operating conditions.

The facilities located within the CRE are designed to be habitable throughout the course of a design basis accident (DBA) and the resulting radiological condition.

6.4.1 Design Bases

The control room habitability system provides for the access and occupancy of the CRE during normal conditions, radiological emergencies, hazardous chemical emergencies and fire emergencies. The system design conforms with the intent of AEC General Design Criterion (GDC) 19 (1971) as described in Section 3.1. To this end, administrative procedures, shielding, ventilation system, radiological monitoring and the fire protection system are used.

The control room habitability system also conforms with the intent of AEC GDC 5 (1971), Sharing of systems, as described in section 3.1.

The control room habitability systems functional design was evaluated for each of the following conditions:

(1) Normal operating conditions

(2) Radiological conditions resulting from a DBA

(3) Hazardous chemical release

(4) Fire or smoke inside or outside the common control room

6.4.2 System Design

6.4.2.1 Control Room Envelope

The Control Room Envelope (CRE) consists of the following rooms and facilities that the control room habitability system provides for continuous occupancy to support personnel during normal operating conditions and for the duration of an accident:

(1) Units 1 and 2 Control Rooms

(2) Units 1 and 2 Data Logging Rooms

(3) Conference Room

(4) Operations Superintendent Office

(5) Units 1 and 2 Control Room Supervisor Platform Area

(6) Operator Ready Room

The walls, recorder panels, doors, floors and ceiling for the rooms in the CRE make up the physical boundary between the adjacent rooms (relay, controls equipment, work control center, and HVAC equipment) and the outside environment.

As described in Section 12, the control room shielding consists of concrete walls, floor and roof. The control room shielding design ensures that the radiation exposure to the occupants in the control room is consistent with the GDC 19 limits.

6.4.2.2 Ventilation System Design

The control room ventilation system is designed to support personnel during normal operating conditions and during an accident. The design of the control room emergency air conditioning system conforms with the intent of the Regulatory Guide 1.52, Rev. 1 (1976) with the variances described in Section 3, Appendix 3A. Section 9.4 describes the control room ventilation and air conditioning systems.

As described in Section 11.4, the control room ventilation system consists of redundant radiation monitors that are shared by Units 1 and 2. Each unit consists of a digital microprocessor-based radiation monitor with two detection channels; one channel monitors the Unit 1 normal intake air and the other channel monitors the Unit 2 normal intake air. Each monitor provides actuation signals, based on high radiation, to the Unit 1 and 2 control area ventilation controls system.

Plant systems affecting control room habitability are the following:

(1)	Control Area Air Conditioning System (CAACS)	(Section 9.4.1)
(2)	Fire Protection	(Section 9.5.1)
(3)	Communications	(Section 9.5.2)
(4)	Lighting	(Section 9.5.3)
(5)	Radiological Monitoring	(Section 11.4)
(6)	Shielding	(Section 12.1)

Air Conditioning Units (per unit):

Three 50% capacity package chiller units are provided, each consisting of a reciprocating compressor, cooling coil or chiller unit and water cooled condenser. Two 100% capacity chilled water pumps (one standby) circulate water through all three chiller units. During emergency conditions, two chillers are available per unit supplying 48°F (nominal) chilled water to each units CAACS and CREACS coils for the removal of the design heat loads based on summer design conditions.

6.4.2.3 Leak Tightness

The control room habitability system is designed to pressurize the CRE to equal to or greater than a combination of 1/8 inwc and 1/16 inwc differential to adjacent rooms and the environment. The dp is 1/8 inwc for all areas except the control room boundary with the relay rooms, which is 1/16 inwc. The positive CRE pressure is achieved by providing a total of 2000 (nominal) scfm of filtered makeup air from a preferred selected intake. The Unit 1 and 2 control area ventilation system during an accident normally operates with two emergency filter trains providing 1000 (nominal) scfm of makeup air each, or during an abnormal alignment with a single emergency filter train providing 2000 (nominal) scfm makeup air. The pressurized CRE ensures contamination flow out of the CRE, thereby reducing operator dose.

In order to assess the amount of unfiltered air in-leakage into the CRE, tracer gas air in-leakage tests were performed in 2003. Air in-leakage rates of the CRE and associated ventilation boundary were determined with the ventilation in various pressurization modes. In all cases the nominal in-leakage rate was determined to be less than 100 cfm. A rate of 275 cfm is assumed in design basis accident radiological consequence analyses to provide margin with respect to the in-leakage rates determined by the tests and to account for additional in-leakage due to ingress and egress.

6.4.3 System Operational Procedures

Procedures are provided for operating the control room habitability system in the required modes of operation to protect operating personnel in the control room during an emergency condition. During emergency conditions, the control room habitability system is initiated automatically upon an SI or high radiation signal or manually to place the system in the preferred mode of operation to protect operating personnel in the control room.

6.4.4 Design Evaluation

Table 6.4-3 summarizes data in the control area ventilation, which is described in detail in Section 9.4.1.

6.4.4.1 Normal Operation

During normal operating conditions, the control area ventilation system operates to supply cool filtered air to maintain ambient room temperatures for personnel comfort and instrumentation accuracy. The ventilation system is set to maintain room temperatures at a nominal temperature of 76□F. The normal operating limits and equipment design temperature limitations in the control room and adjoining control equipment room are described in Section 3.11.1.3. In this mode, most of the air inside the control room areas is recirculated with some quantity of makeup air introduced to maintain the CRE and control room areas at a positive pressure to minimize the infiltration of dust, smoke and other airborne contaminants. Both Units 1 and 2 control area ventilation systems provide cool filtered air to the CRE during normal operation.

6.4.4.2 Radiological Protection

The adequacy of the control room shielding is evaluated for normal operating and accident conditions in Section 12.

The adequacy of the control area ventilation system is evaluated for radiological emergencies in Section 9.4.1 and 15.4.1.9.

Radiological consequences within the SGS control room envelope, which includes the control rooms for both units, are evaluated for the following design basis accidents at either unit:

- Loss of Offsite Power (Section 15.2.9)
- Small Line Break Outside Containment (Section 15.3.1)
- Volume Control Tank Rupture (Section 15.3.6.2)
- Waste Gas Decay Tank Rupture (Section 15.3.6.3)
- Loss-of-Coolant (Section 15.4.1)
- Main Steam Line Break (Section 15.4.2)
- Steam Generator Tube Rupture (Section 15.4.4)
- Locked RC Pump Rotor (Section 15.4.5)
- Fuel Handling Accident Inside Containment (Section 15.4.6)
- Fuel Handling Accident Inside Fuel Building (Section 15.4.6)
- Rod Ejection Accident (Section 15.4.7)

The parameters/assumptions used to evaluate offsite dose consequences following the above DBA's are discussed in the referenced Sections. These parameters/assumptions are also used to estimate the associated control room doses. The parameters associated with the control room design as used in the control room habitability analyses are provided in Table 6.4-3. The atmospheric dispersion factors used in the control room habitability analyses are based on the ARCON96 model described in NUREG/CR-6331, Revision 1. The atmospheric dispersion factors that are generally used in the control room habitability analyses are provided in Table 15.4-5D.

With the exception of the LOCA, which utilizes the safety injection signal, the redundant control room in-duct monitors initiate the control room emergency ventilation system. The design ensures that initiating instrumentation can select the less contaminated intake, i.e., the radiation monitors select the less contaminated intake based on a comparison of the radiation readings at either intake, whereas the SI signal selects the intake associated with the non-accident unit.

The 30 day accident dose in the control room is within 10 CFR 50.67 dose limits and is summarized in Table 15.4-5C. This dose value represents the post-LOCA dose in the control room.

6.4.4.3 Toxic and Chemical Gas Protection

Regulatory Guide 1.78 requires that hazardous chemicals, such as those indicated in Table C-1 of the Guide, be considered in an analysis of Control Room habitability if they are frequently shipped within a 5-mile radius of the station. The Guide also defines frequent shipments as being 50 or more trips per year for barge traffic and 10 or more trips per year for truck traffic. Chemicals stored or situated at distances greater than 5 miles from the facility need not be considered in the habitability analysis.

The Salem site is located in a rural area with no major manufacturing or chemical plants located with 5 miles of the site. The only major transportation route within 5 miles of the station is the Delaware River, with the intra-coastal waterway passing 1 mile west of the site.

The Salem Generating Station uses a hypochlorite biocide system, thus eliminating an onsite chlorine hazard. The Control Room area fresh air intake ducts are equipped with redundant radiation monitoring systems which provide annunciation, automatically isolate the Control Room, and switch the ventilation system to the accident pressurized mode on high radiation detection. Sections 2.2.3.2 and 2.2.3.3 discuss and conclude that a release of any of the hazardous chemicals stored onsite or shipped past the site will not impact control room habitability.

Hazardous chemicals shipped past the Salem site occur infrequently. The frequencies of the deliveries are listed in Table 2.2-4. Regulatory Guide 1.78 requires a control room habitability evaluation for shipments of hazardous chemicals that are considered "frequent" shipments. The frequent criteria for river barges are 50 per year. As seen from Table 2.2-4, none of the hazardous chemicals shipped past the site exceed this criteria, therefore, a control room habitability evaluation is not required.

As previously mentioned, several chemicals are stored onsite that are considered hazardous. Sulfuric acid is stored in 4,000 and 2,250 gallon tanks in the SGS Turbine Buildings and it is stored in 16,000 gallon tanks at the HCGS. Calculations indicated that the toxicity limit found in Regulatory Guide 1.78 will not be exceeded in the control rooms during a postulated release at any of the sources.

Liquid nitrogen and nitrogen stored as a compressed gas is stored at various locations onsite. According to the criteria contained in Regulatory Guide 1.78, the largest single source should be evaluated for its impact on control room habitability. The sources evaluated at the SGS are the portable nitrogen tube trailers located in various areas throughout the SGS yard area and the (2) liquid nitrogen tanks located behind Unit No. 1 & 2 Auxiliary Buildings which can contain up to 7500 gallons of liquid nitrogen. In addition to these sources, liquid nitrogen is also stored in 9,000 gallon tanks at the HCGS. Calculations indicated that the oxygen depletion is negligible in the control rooms during a postulated release at any of the significant sources.

Chemicals used as fire-fighting agents were evaluated. Carbon dioxide is stored on the 84 foot elevation of each of the Auxiliary Buildings.

It is also stored at HCGS. Calculations indicated that the toxicity limit established in Regulatory Guide 1.78 as well as asphyxiation levels would not be exceeded during postulated releases at the significant sources. The Halon storage vessels are relatively small and do not contain the volume of Halon required to cause asphyxiation in the control rooms, therefore, a postulated release will not pose a danger to the control rooms.

Ammonium hydroxide is stored in two 350 gallon vessel totes that are connected in series in the SGS Unit No. 1 and SGS Unit No. 2 Turbine Buildings. Evaluations concluded that the control rooms would remain habitable during a postulated release at either of the storage tank locations. The shipments to the site are considered "frequent" and are discussed in Section 2.2.3.3.

Ethanolamine is stored in two 350 gallon totes that are connected in series in the SGS Unit 2. The effective volume is 700 gallons. Evaluations concluded that the control rooms would remain habitable during a postulated release at the storage totes. The shipments to the site are considered "frequent" and are discussed in Section 2.2.3.3.

Hydrazine is stored in a 300 gallon vessel also in the Unit No. 1 side of the SGS Turbine Building. The calculations indicated that the control room concentrations will not exceed toxicity limits established in 29CFR Part 1910.1000, Subpart Z during a postulated release.

Aqueous sodium hydroxide is stored in various quantities and vessels at both the SGS and HCGS. Upon a release, sodium hydroxide vapors may form locally at the spill, but the physical properties of this chemical preclude the formation of a plume that will travel in the control room air intakes. The vapor pressure of aqueous sodium hydroxide is very low, especially as the concentration is increased. During a postulated release, mostly water will evaporate from the liquid pool, leaving the solid sodium hydroxide behind. The solid form of sodium hydroxide poses no danger to the control room due to its physical properties.

Helium is stored in 150 lb cylinders at both the SGS and HCGS. It is much lighter than air and upon a postulated failure of one of the cylinders, the helium would disperse rapidly into the atmosphere and not form a continuing plume.

It is concluded that Control Room personnel are adequately protected against the effects of accidental release of toxic and radioactive gases and that the plant can be safely operated or shut down under design basis accident conditions. Due to the use of sodium hypochlorite, there is no chlorine hazard.

6.4.4.4 Smoke and Fire Protection

The adequacy of the control room fire protection system is evaluated in Section 9.5.1. Smoke infiltration inside and outside the CRE is evaluated in Section 9.4.1.

6.4.4.5 Conclusion

The control room habitability systems are capable of performing their functions reliably during normal operating periods and under emergency conditions. It is concluded that control room personnel are adequately protected against the effects of accidental release of toxic and radioactive gases and that the plant can be safely operated or shutdown under design accident conditions.

6.4.5 Testing and Inspection

Surveillance requirements for inspection and testing of the control room ventilation system are contained in Technical Specifications. These requirements ensure that performance capability is maintained throughout the plant's lifetime.

6.4.6 References for Section 6.4

1. "Waterborne Commerce of the United States," U.S. Army Corps of Engineers Annual Publication.

2. Commodity traffic data for imports and exports collected by the Philadelphia Maritime Exchange.

3. Foreign trade cargo movements collected by the Delaware River Port Authority.

4. U.S. Dept. of Commerce, Census Bureau (handling foreign trade data for customs purposes).

5. Interstate Oil Transport, Inc. (which handles most of the barge operations of the Delaware River).

6. U.S. Coast Guard, Captain of the Port, Philadelphia (cognizant of all hazardous materials shipments in the Delaware River).

7. NUREG/CR-6331, "Atmospheric Relative Concentrations in Building Wakes", May 1, 1995

8. NUREG/CR-6331, Revision 1, "Atmospheric Relative Concentrations in Building Wakes", May 1, 1995