

9.4 Air Conditioning, Heating, Cooling and Ventilation Systems

The heating, ventilation, and air-conditioning (HVAC) system for each major building or area is provided in the following subsections.

9.4.1 Main Control Room Air Conditioning System

The main control room air conditioning system (CRACS) is designed to maintain a controlled environment in the control room envelope (CRE) area for the comfort and safety of control room personnel and to support operability of the control room components during normal operation, anticipated operational occurrences and design basis accidents. CRACS is also relied upon to cope with and recover from a station blackout (SBO) event.

The air conditioning system for the CRE area operates in the recirculation mode with fresh air makeup. The fresh outside air intake and recirculated air are filtered and conditioned through the filtration trains. The conditioned air is then supplied to the CRE area. During a site radiological contamination event, the fresh air intake is redirected through the iodine filtration trains.

The main control room (MCR) habitability system, including the definition of the CRE area, is addressed in Section 6.4.

Under emergency conditions, when the iodine filtration train subsystem of CRACS is utilized, the subsystem function is designated as control room emergency filtration (CREF). See Technical Specification 3.7.10 in Chapter 16.

9.4.1.1 Design Bases

All components of the CRACS are safety related and designed to Seismic Category I requirements.

- The CRACS components are located inside the Safeguard Building (SB) divisions two and three. These buildings are designed to withstand the effect of natural phenomena, such as earthquake, tornados, hurricanes, floods and external missiles (GDC 2).
- The quality group classification (Section 3.2) meets the requirements of RG 1.26. The seismic design of the system meets the guidance of RG 1.29 (Position C.1 for the safety-related portion and Position C.2 for the non-safety-related portion).
- The CRACS components are appropriately protected against dynamic effects and designed to accommodate the effects of, and be compatible with the environmental conditions of normal operation, maintenance, testing, and postulated accidents (GDC 4).

- The safety-related components and systems of the CRACS are not shared among nuclear power units (GDC 5).
- The CRACS provides adequate protection against radiation and hazardous chemical releases to permit access to and occupancy of the control room under accident conditions (GDC 19). The control room occupancy protection requirements meet the guidance of RG 1.78.
- The release of radioactive materials to the environment is controlled by meeting the guidance of RG 1.52 and 1.140 (GDC 60). In case of an alarm from the area radiation monitors, the CRACS directs the air intake automatically through activated carbon filtration beds. The air from CRE areas can also be recirculated through the same activated carbon filtration beds.
- Capability for withstanding or coping with a SBO event is provided to comply with the requirements of 10CFR 50.63. Acceptance is based on meeting the applicable guidance of RG 1.155, including position C.3.2.4. Refer to Section 8.4 for a description of the design features to cope with the SBO event.
- The CRACS maintains habitability of the CRE areas during a site radiological contamination event or toxic contamination of the environment (Refer to Section 6.4).
- Control and maintain a positive pressure of 0.125 inches water gauge as a minimum within the CRE areas with respect to the surrounding area to prevent uncontrolled incoming leakage.
- The CRACS maintains system performance in the event of failure of a single active safety-related component.
- The CRACS outside air intake is capable of detecting radiation, smoke, and toxic chemicals (see Section 6.4.2.4 for discussion of toxic gas sensors and COL applicant's responsibility to identify those sensors). Associated monitors actuate alarms in the MCR.
- Upon receipt of a containment isolation signal, or high radiation alarm signal in the air intake duct, the iodine filtration train starts automatically and the outside air and CRE recirculation air are automatically diverted through the iodine filtration train. The outside makeup air along with the CRE recirculation air maintains a positive pressure inside the CRE area relative to the adjacent areas. The CRE air inlet and recirculation dampers operate automatically.
- Upon actuation of the plant toxic gas alarm signal, the outside air intake dampers close automatically and the CRE air is automatically diverted in the recirculation mode without outside air.

The CRACS is capable of isolating all non-safety-related system penetrations of the CRE boundary so that occupation and habitability of the control room is not compromised.

- The CRACS maintains the following temperature and humidity ranges for the areas serviced:
 - Main Control Room: 65°F to 76°F (40 to 60 percent humidity).
 - Other areas of CRE: 68°F to 79°F (30 to 60 percent humidity).

9.4.1.2 System Description

9.4.1.2.1 General Description

The CRACS is designed to maintain acceptable ambient conditions inside the CRE areas to provide for proper operation of equipment and for personnel access to conduct inspection, testing and maintenance. The CRE area is shown in Figures 6.4-1 through 6.4-3.

The CRACS consists of following subsystems:

- Air intake.
- Iodine filtration train.
- Recirculation air handling.
- Air supply and recirculation.
- Kitchen and sanitary rooms exhaust.

Air Intake Subsystem

The air intake subsystem is illustrated in Figure 9.4.1-1—Control Room Air Intake and Iodine Filtration Train Subsystems.

Fresh air is supplied by an outside air intake through a wire mesh grille, one intake for SB division two and another for SB division three. Sensors on the outside air inlet protect against toxic gas (refer to Section 6.4.2.4) and radiological intrusion. Each outside air intake is equipped with an electrically heated, weather protected grille to prevent ice formation. Outside air is diverted into two fresh air intake trains for each division (total of four trains).

Two identical fresh air intake trains for each division are physically separated. In each train, air is directed through motorized dampers, an electric heater, and a prefilter. Fresh air is then mixed with the recirculated air from the CRE area prior to conditioning by the air handling units.

Iodine Filtration Train Subsystem

The iodine filtration train subsystem is illustrated in Figure 9.4.1-1.

There are two iodine filtration trains located separately in the SB divisions two and three (one train in each division) in parallel with the associated intake trains. These trains provide an alternate path for fresh air intake and CRE recirculated air when site contamination is detected. Each train consists of an inlet motorized isolation damper, an electric heater, a prefilter, an upstream high efficiency particulate air (HEPA) filter, an iodine filter with activated carbon, a downstream HEPA filter, an outlet motorized isolation damper, a supply air fan, and a backdraft damper. The motorized dampers operate automatically to isolate or align the iodine filtration trains.

Recirculation Air Handling Subsystem

The recirculation air handling subsystem is illustrated in Figure 9.4.1-2—Control Room Recirculation Air Handling Subsystem.

There are four recirculation air handling units located in the SB divisions two and three (two trains in each division). Recirculated and fresh air is processed through these air handling units and supplied to a common supply air plenum in divisions two and three. Each train includes an isolation damper, a volume control manual damper, a cooling coil, a moisture separator, fan suction and discharge silencers, a supply air fan, a HEPA filter, a steam humidifier, a non-return damper, and a volume control electric damper. The cooling coil is supplied with chilled water from the safety chilled water system (SCWS). The humidifier is supplied with water from the potable and sanitary water system (PSWS). The relative humidity in the rooms is controlled by modulation of the humidifiers.

The air conditioning system for the CRE area operates in the recirculation mode with fresh air makeup. The fresh air flow rate corresponds to the exhaust of kitchens and sanitary rooms and the leakage rate in the CRE area due to controlled overpressure. The exhaust from the kitchen and sanitary rooms is directed to the electrical division of the SB ventilation system (SBVSE) air outlet duct (refer to Section 9.4.6).

Air Supply and Recirculation Subsystem

The air supply and recirculation subsystem is illustrated in Figure 9.4.1-3— CRE Air Supply and Recirculation Subsystem.

The common supply air plenum (one in the SB division two and one in the SB division three) provides conditioned air to the CRE areas through the ductwork distribution network. Electric air heaters are installed in the supply air ducts to maintain individual room temperatures. The exhaust air from the CRE area, except the exhaust from kitchen and sanitary rooms, is recirculated through the recirculation air handling units. The exhaust from kitchen and sanitary rooms is separated from the recirculated return air and is processed separately through the SBVSE.

9.4.1.2.2 Component Description

The major components of the CRACS are listed below, along with the applicable codes and standards. Refer to Section 3.2 for the seismic and system quality group classification of these components.

Ductwork and Accessories

The main supply and exhaust air shafts are constructed of concrete with painted surfaces. The air supply and exhaust duct branches for each area are fed from the main supply and exhaust air shafts. These ducts are constructed of galvanized sheet steel and are structurally designed for fan shutoff pressures. The ductwork meets the design, testing and construction requirements per ASME AG-1-2003 (Reference 1).

Electric Heaters

The electric heaters are installed in the supply duct to maintain room ambient conditions. These are controlled by local room temperature sensors and control circuits. The heaters meet the requirements of Reference 1.

Filter Air Heaters

Filter air heaters are located upstream of iodine filtration units to prevent excessive moisture accumulation in the carbon filter beds. The heaters meet the requirements of Reference 1.

Prefilters

The prefilters are located upstream of the HEPA filters and collect large particles to increase the useful life of the high efficiency filters. The prefilters meet the requirements of ANSI/ASHRAE Standard 52.2-1999 (Reference 2).

HEPA Filters

HEPA filters are constructed, qualified and tested in accordance with Reference 1. The periodic inplace testing of HEPA filters to determine the leak tightness is performed per ASME N510-1989 (Reference 3).

Adsorbers

Carbon filters are used to remove radioactive iodine from the supply of fresh and recirculated air. The efficiency of removal of methyl iodine is based on the decontamination efficiency assigned during the laboratory tests. The periodic inplace testing of adsorbers to determine the leak tightness is performed per Reference 3.

Fans

The supply and exhaust fans are centrifugal or axial type with electric motor drivers. Fan performance is rated in accordance with ANSI/AMCA-210-99 (Reference 4), ANSI/AMCA-211-1987 (Reference 5) and ANSI/AMCA-300-1985 (Reference 6).

Isolation dampers

Manual dampers are adjusted during initial plant startup testing to establish accurate air flow balance between the rooms. The motor-operated dampers will fail to “close” or “open” position in case of power loss, depending on the safety function of the damper. The performance and testing requirements of the dampers are per Reference 1.

Fire Dampers

Fire dampers are installed where ductwork penetrates a fire barrier. Fire damper design meets the requirements of UL 555 (Reference 7) and the damper fire rating is commensurate with the fire rating of the barrier penetrated.

Cooling Coils and Moisture Separator

The cooling coils are of the finned tube, coil type and are connected to the safety chilled water system (SCWS). The cooling coils are designed in accordance with Reference 1. The moisture separator collects condensate which is directed to the drain system.

Humidifier

Humidifiers are installed to restore ambient humidity conditions as required for each area. Humidity levels are maintained in all areas within the acceptable range defined in the design basis. The humidifier is supplied with water from the PSWS. The relative humidity in the rooms is controlled by modulation of the humidifiers.

9.4.1.2.3 System Operation

Normal Plant Operation

During normal plant operation, fresh air is admitted via two of four air intake trains. The fresh air passes through two auto-opened isolation dampers and is heated by electric heaters depending on the fresh air temperature. The fresh air passes through a prefilter, and then mixes with the recirculated air from the CRE area.

The fresh and recirculated air is admitted through two of four air handling units which provide heating, cooling and humidity control of the supply air. The conditioned air is then distributed through a ductwork distribution network to the CRE area. The room air conditioning is provided by the supply and exhaust air flows based on minimum air

renewal rate, equipment and personnel heat loads and heat balance between the rooms.

Heating of air streams is provided by electric heaters located in the supply air ducts. The operation of heaters is automatically controlled by the temperature sensors located in the corresponding rooms.

The CRE area is maintained at a pressure above atmospheric pressure to provide habitability in the event of radioactive or toxic contamination of the environment.

Both iodine filtration trains are secured and fully bypassed with the motorized inlet dampers in the auto-closed position during normal plant operation.

The air conditioning system for the CRE area operates in the recirculation mode with fresh air makeup. During the recirculation mode, the fresh air supply rate is equal to the rate of exhaust air from the kitchens and sanitary rooms plus accounting for the leakage rate in the area due to controlled overpressure. The four fresh air intake trains are not cross-connected; therefore, the air intake in operation corresponds to the recirculation train in operation.

Exhaust air from the kitchen and sanitary rooms is not recirculated. The exhaust air is directed by a separate exhaust duct and exhaust fans to the SBVSE air outlet duct.

Abnormal Operating Conditions

Redundancy of air supply and air conditioning trains is provided. A loss of function or power to any single train or component does not affect overall system operation. The train separation and independent power source limit common mode failure of active multiple trains and abnormal operating conditions.

Loss of a single cooling train will not result in a loss of system functional capability because four cooling trains are provided. The iodine filtration trains do not operate during normal plant operation, but loss of a single iodine filtration train during any design basis accident will not result in a loss of iodine filtration capability because two iodine filtration trains are provided.

During a toxic gas accident event, the CRACS is placed in full recirculation mode without any outside air makeup (refer to Section 6.4.2.2).

Loss of Offsite Power

During loss of offsite power (LOOP), the air intake and recirculation air handling electrical components located inside SB division two receive power for one train from the emergency diesel generators (EDG) of division two, and for the other train from the EDGs of division one. The electrical components located inside the SB division

three receive power on one train from the EDGs of division three, and for the other train from the EDGs of division four. The humidity is not controlled during this event.

During LOOP, the iodine filtration train electrical components located inside the SB division two receive power from the EDGs of division one. The electrical components located inside the SB division three receive power from the EDGs of division four.

Station Blackout

- In the event of station blackout (SBO), the electrical components which receive power from the EDG of division one are backed-up by alternate AC (AAC) power from the SBO diesel generators (SBODG) of division one. The electrical components which receive power from the EDG of division four are backed up by the AAC power from the SBODGs of division four.
- In the event of a simultaneous SBO and site radiological event, the CRE area is isolated and CRACS is maintained in a full recirculation mode through the iodine filtration train until site power is restored or EDGs are started. Power restoration is assumed to occur within eight hours following the occurrence of a SBO event.

Loss of Ultimate Heat Sink

The conditioned air supply is cooled by chilled water provided by the SCWS. Two water-cooled chillers are located in SB divisions two and three, and two air-cooled chillers are located in SB divisions one and four. In case of loss of ultimate heat sink (LUHS), the water-cooled chillers are not available. The safety chilled water is then supplied by air-cooled chillers which provide the cooling function for the filtration trains located in divisions one and four, which also include both iodine filtration trains. The cooling function for the filtration trains in divisions two and three is not available.

Operation During Radiological Site Contamination

During a site radiological contamination event, the fresh air supply is automatically redirected through the iodine filtration trains, instead of the normal intake air supply, by closing and opening the associated dampers. When one iodine filtration train operates, the outside fresh airflow rate of 1000 cfm and CRE recirculation airflow rate of 3000 cfm (a total flow rate of 4000 cfm) provides an unlimited stay by the CRE personnel.

Exhaust from the kitchen and sanitary rooms is stopped and all other exhaust air is recirculated.

The operation of CRACS creates an overpressure of 0.125 inches water gauge as a minimum inside the CRE area with respect to the surrounding area, which limits unfiltered incoming air leakage into these areas.

Operation During a Toxic Gas Event

Outside air is continuously monitored for toxic gas by the toxic gas sensors located at the air intakes. Upon detection of a toxic gas condition, audible and visual alarms are actuated in the MCR.

Operation during External Fire, Smoke or Toxic Gas Release

In the event of an external fire, external toxic gas release, smoke, or excessive concentration of CO and CO₂, outside air to the CRACS is isolated manually or automatically and the system operates in full recirculation mode without fresh air.

9.4.1.3 Safety Evaluation

The CRACS is designed to maintain ambient conditions inside the CRE area for personnel comfort and to allow safe operation of the equipment during normal plant operation, outages, and under all anticipated occurrences including postulated accidental events (refer to Section 15.0.3 for a discussion of radiological consequences).

The CRACS keeps the CRE area at a positive pressure of 0.125 inches water gauge at a minimum with respect to the surrounding area to provide habitability in the event of radioactive contamination of the environment, and to prevent uncontrolled incoming air leakage.

During a site radiological contamination event, the fresh air intake is redirected through the iodine filtration trains. The CRACS also can be operated in full recirculation mode without fresh air during abnormal operation or postulated accident events.

Redundancy for air cooling and iodine filtration is provided by multiple independent trains for critical functions. Sufficient redundancy is provided for proper operation of the system when one active component is out of service.

In case of fire in any room within the CRE area, the room air supply and exhaust are isolated by fire dampers and, if necessary, the plant is controlled by the remote shutdown station (RSS). The four air conditioning trains are installed in four different fire zones. Two of these zones contain the two iodine filtration trains.

Capability for withstanding or coping with an SBO event is met by the design of the AAC power source satisfying the ten minutes criteria; that is, the AAC power source can be started from the MCR within ten minutes after the onset of an SBO event. The AAC diesel generators are designed to operate for a minimum of twenty-four hours with available onsite fuel supplies.

9.4.1.4 Inspection and Testing Requirements

Refer to Section 14.2 (test abstracts #082 and #203) for initial plant testing. Initial inplace acceptance testing of the CRACS components is performed in accordance with Reference 1 and Reference 3.

Periodic testing will be performed to verify the unfiltered in-leakage into the CRE area per RG 1.197.

Refer to Section 16 (SR 3.7.10 and SR 3.7.11) for surveillance requirements.

9.4.1.5 Instrumentation Requirements

Indication of the operational status of the equipment, position of dampers, and instrument indications and alarms are provided in the MCR. Fans, motor-operated dampers, heaters and cooling units are operable from the MCR. Local instruments are provided to monitor flow, temperature and pressure. The fire detection and sensor information are delivered to the fire detection system (refer to Section 9.5.1).

The minimum instrumentation, indication and alarms for ESF filter systems are provided in Table 9.4.1-1—Minimum Instrumentation, Indication, and Alarm Features for ESF Filter Systems.

9.4.1.6 References

1. ASME AG-1-2003, “Code on Nuclear Air and Gas Treatment,” The American Society of Mechanical Engineers, 2003 [including the AG-1a, 2004 Addenda].
2. ANSI/ASHRAE Standard 52.2-1999, “Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size,” American Society of Heating, Refrigerating and Air Conditioning Engineers, 1999.
3. ASME N510-1989 (R1995), “Testing of Nuclear Air-Treatment Systems,” The American Society of Mechanical Engineers, 1989.
4. ANSI/AMCA-210-99, “Laboratory Methods of Testing Fans for Aerodynamic Performance Rating,” American National Standards Institute/AMCA, December 1999.
5. ANSI/AMCA 211-1987, “Certified Ratings Program—Air Performance,” American National Standards Institute/AMCA, 1987.
6. ANSI/AMCA-300-1985, “Reverberant Room Method of Testing Fans for Rating Purposes,” American National Standards Institute/AMCA, 1985.
7. UL 555, “Standard for Fire Dampers,” Underwriter’s Laboratories, Sixth Edition, June 1999.

Table 9.4.1-1—Minimum Instrumentation, Indication, and Alarm Features for ESF Filter Systems

Sensing Location	Local Indication/Alarm	MCR Indication/Alarm
Unit inlet or outlet	Flow rate (indication)	Flow rate (recorded indication, high and low alarm signals)
Unit inlet	Radiation indication	Radiation indication / alarm
Unit inlet	Temperature indication	Temperature indication
Electric heater	On/Off indication	On/Off indication
Electric heater inlet	Temperature indication	Temperature indication /alarm
Electric heater outlet	Temperature indication	Temperature indication / alarm
Prefilter	Pressure drop (indication / high alarm signal)	
Upstream-HEPA	Pressure drop (indication / high alarm signal)	
Adsorber	Pressure drop (indication / high alarm signal)	
Downstream-HEPA	Pressure drop (indication / high alarm signal)	
System Filters inlet to outlet		Summation of pressure drop across entire filtration train (indication / high alarm signal)
Fan		Hand switch, status indication
Damper/Operator		Status indication
Unit outlet	Temperature indication	Temperature indication