6.4 HABITABILITY SYSTEMS

The main control room habitability systems include radiation shielding, air filtration and ventilation equipment, instruments, monitors, controls, missile protection, emergency lighting, food, water, kitchen, sleeping, sanitary facilities, fire protection equipment and, administrative emergency procedures.

→(DRN 04-705, R14)

Habitability systems are provided to assure that the operators can remain in the main control room and take effective actions to operate Waterford 3 safely under normal conditions and maintain a safe condition post accident, as required by General Design Criterion 19 of Appendix A to 10CFR50 and 10CFR50.67.

←(DRN 04-705, R14)

The Control Room Air Conditioning System is discussed in this section and in Subsection 9.4.1. This section addresses emergency operation of the system, while Subsection 9.4.1 is directed toward normal and emergency operation. Emergency lighting is described in Subsection 9.5.3. Protection of the main control room from wind and tornado effects is covered in Section 3.3. Flood design is discussed in Section 3.4. Missile protection is described in Section 3.5. Protection against dynamic effects associated with pipe break is described in Section 3.6. Environmental design conditions are given in Section 3.11. Fire protection is discussed in Subsection 9.5.1.

6.4.1 DESIGN BASES

The functional design of the habitability systems and the provisions for occupancy are based on the following:

a) A control room envelope, as defined in Subsection 6.4.2.1, is provided.

b) The main control room environment is suitable for continuous occupancy during normal operation and extended occupancy throughout the duration of any one of the postulated accidents discussed in Chapter 15.

c) Sufficient food, water, medical supplies and sanitary facilities are provided for at least five persons for a five day period following a design basis accident (LOCA).

→(DRN 04-705, R14)

d) The radiation exposure to main control room personnel, throughout the duration of any one of the postulated accidents discussed in Chapter 15, does not exceed the limits of General Design Criterion 19 of Appendix A to 10CFR50 and 10CFR50.67.

←(DRN 04-705, R14)

e) The habitability systems provide the capability to detect and protect the main control room personnel from smoke and toxic gases.

f) Respiratory protection is provided for emergency use within the control room envelope.

→(DRN 04-705, R14)

g) The control room air condition system is capable of automatic transfer from its normal operating mode to the recirculation or isolation mode and manually transferred to the pressurized mode as necessary.

←(DRN 04-705, R14)

h) Emergency monitors detectors and control equipment are provided at plant locations, as necessary, to ensure the ability to meet design bases b, d, e and g.

i) The control room envelope and the Control Room Air Conditioning System are designed to remain functional (e.g. maintain room temperature within limits acceptable to personnel, instruments and equipment) during and after a safe shutdown earthquake.

j) The habitability systems are capable of performing their functions assuming a single active component failure coincident with a loss of offsite power.

k) Additional design bases for the normal operation of the Control Room Air Conditioning System are given in Subsection 9.4.1.1.

6.4.2 SYSTEM DESIGN

6.4.2.1 Definition of Control Room Envelope

The control room envelope is defined to include the main control room, computer room, computer room air conditioning equipment room, control room HVAC equipment room, emergency living quarters, emergency food and water storage rooms, toilets, locker rooms, kitchen, kitchenette, supervisors office, corridors, conference room and vault (critical document reference file).

Control room operators will require access to the above areas immediately after and during an emergency.

The entire envelope floor is at elevation +46 ft. MSL inside the Reactor Auxiliary Building.

→

Drawing G134 is a layout drawing showing the control room envelope, and the placement of equipment.

←

6.4.2.2 Control Room Air Conditioning System Design

Subsection 9.4.1 contains an overall description of the Control Room Air Conditioning System and a system airflow diagram is shown on Figure 9.4-1.

Air flow diagram shown on Figures 6.4-1, 6.4-2 and 6.4-3 illustrate the normal, high radiation and toxic chemical operating modes respectively. Instrument schematics and logic diagrams number LOU1564 B-431 sheet 260S, 261S, 264S, 265S, 266S, and 267S concerning the Control Room Ventilation System, are submitted under a separate cover (See Section 1.7). Table 6.4-3 shows damper and isolation valve positions for all operating modes.

The type of system provided for Waterford 3 is zone isolation, with filtered recirculated air, widely separated, dual air inlets, and provisions for positive pressure (0.125 in. WG). Makeup air for pressurization is filtered before entering the control room envelope. During a toxic gas or radiological emergency, the modes of operation of the Control Room Air Conditioning System are, respectively:

a) Automatic isolation with automatic recirculation.

b) Automatic isolation with provisions for manual initiation of filtered pressurization, recirculation and partial filtration.

→(EC-5000081471, R301)
The volume of the control room envelope serviced by the Control Room Air-Conditioning System is approximately 220,000 cubic ft. (A minimum volume of 168,500 ft^3 is assumed in dose calculations where appropriate.)
←(EC-5000081471, R301)

The Control Room air-conditioning System consists of two full capacity redundant air handling units, designated AH-12 (3A-SA) and AH-12 (3B-SB), two toilet exhaust fans each with 100 percent capacity designated E-34 (3A-SA) and E-34 (3B-SB) and a conference room and kitchen exhaust fan designated E-42 (3).

Two full capacity, redundant Engineered Safety Features (ESF) air filtration units S-8 (3A-SA) and S-8 (3B-SB) provide continuous filtration following a design basis accident.

The action of all the "nonessential" fans is described in Subsection 9.4.1.

Design data for the Control Room Air Conditioning System components is given in Table 9.4-2.

The control room envelope penetrations of the emergency outside air intakes each contain one normally open and one normally closed fail-as-is butterfly valve in series. Each series valve is powered from a different emergency power source. In this manner an electrical fault precludes neither the ability to open the intake for control room pressurization nor close the intake for control room isolation. Redundant, normally open, air operated, fail closed butterfly valves are provided at the control room envelope penetration for the normal outside air intake. Redundant isolation butterfly valves on the normal exhausts are arranged as a channel A valve in series with a channel B valve so that an electrical fault does not jeopardize the safety function of the system.

→(DRN 01-663, R11-A)
Leakage characteristics of the isolation valves are given in Table 6.4-1. The closure time for the normal outdoor air isolation valves is two seconds or less.
←(DRN 01-663, R11-A)

The seismic classification of components, instrumentation and duct work is indicated in Table 3.2-1.

The system is located within the Reactor Auxiliary Building which is designed to withstand the effects of tornado generated missiles. All outside air intakes are protected from entry of tornado generated missiles. Internally-generated missiles resulting from fan blades would be stopped by the fan casing as described in Section 3.5.

Figure 1.2-1 is a plot plan showing the plant layout, including the location of onsite potential radiological and toxic gas release points with respect to the main control room air intakes. The elevations of release points and intakes are also indicated on Figure 1.2-1. Elevation and plan drawings showing building dimensions are given in Section 1.2. Potential sources of toxic gas release are identified in section 2.2.

A description of system controls and instrumentation is given in Subsection 9.4.1. CP18 is the HVAC control panel inside the main control room. Redundant radiation monitors are located at both the normal and emergency outside air intakes. These Class 1E radiation monitors are discussed in Subsection 12.3.4.

→(DRN 04-705, R14)
The main control room will be immediately isolated upon receipt of a Safety Injection Actuation Signal, or normal outside air intake high radiation signal. Control room isolation dampers are designed to ensure that the main control room is isolated prior to any unfiltered (and potentially contaminated) air reaching the control room atmosphere.
←(DRN 04-705, R14)

Five ionization smoke detector zones are located within the control room envelope. The main control room, the control room HVAC equipment room, and the emergency living quarters, each have one detector zone. The computer room has two detector zones, one above and one below the floor. The smoke removal mode of the Control Room Air-Conditioning System following postulated fires is discussed in Subsection 9.4.1.2.2.

Based on the evaluation of potential accidents in Subsection 2.2.3, redundant chlorine and broad range detectors are provided at the normal outside air intake. Analyses on other toxic chemicals are also provided in Subsection 2.2.3.

Design data for the HEPA and charcoal filter trains are given in Table 9.4-2. The degree to which the recommendations of Regulatory Guide 1.52 (673) are followed is indicated in Subsection 6.5.1.

The redundant air conditioning units are served by redundant loops of the Essential Services Chilled Water System (see Subsection 9.2.9) so that loss of one loop of the Essential Services Chilled Water System does not affect ability of the Control Room Air-Conditioning System to control the thermal environment in the control room envelope.

The redundant equipment which is essential for the safety functions are powered from divisions A and B of the Plant Electric Power Distribution System so that loss of one division does not prevent the Control Room Air-Conditioning System from fulfilling its safety functions.

6.4.2.3 Leak Tightness

→(DRN 04-705, R14)
The amount of unfiltered air inleakage was measured to address NRC Generic Letter (GL) 2003-01, “Control Room Habitability.” Specifically, testing was performed in accordance with ASTM Standard E2029-99, “Standard Test Method for Volumetric and Mass Flow Rate Measurement Using Tracer Gas Dilution,” and ASTM Standard E741-00, “Standard Test Method for Determining Air Change Rate in a Single Zone by Means of Tracer Gas Dilution.” This testing is the preferred method of testing by the NRC. The results of the tests are presented in Table 6.4-1. These results were conservatively modeled in the various Chapter 15 dose consequence analyses for postulated design basis accidents.
←(DRN 04-705, R14)

→(DRN 04-705, R14)
Gross leakage will be verified by periodic testing as described in Regulatory Guide 1.95 (2/75). Test procedures are summarized in Subsection 6.4.5.
←(DRN 04-705, R14)

An acceptance test will be performed to verify the adequacy of the air makeup rate to maintain a positive pressure inside the control room envelope of at least +0.125 in. WG.

6.4.2.4 Interaction With Other Zones and Pressure-Containing Equipment

→(DRN 04-705, R14)
The ventilation zones adjacent to the envelope are below or at atmospheric pressure, i.e., always negative with respect to the envelope. No other area is served by the Control Room Air Conditioning System.

The closest postulated main steam line break is at least 30 ft. away from any one of the main control room outside air intakes, and the steam jets resulting from a postulated main steam line break (see Section 3.6) are vertical and are not directed toward the intakes.

The east main steam Atmospheric Dump Valve (ADV) is located in close proximity to the east control room air intake (approximately 6.5 meters). Therefore, this combination of ADV and intake could result in fairly significant control room doses for events involving steaming releases.
←(DRN 04-705, R14)

→(DRN 00-998, R11)
The quantity of Halon in hand portable fire extinguishers inside the control room envelope is insignificant.
←(DRN 00-998, R11)

6.4.2.5 Shielding Design

Shielding design of the control room and the post-accident dose levels that may exist there is discussed in FSAR Section 12.3A.

6.4.3 SYSTEM OPERATIONAL PROCEDURES

6.4.3.1 Startup

The control room operator starts the system, selecting either SA or SB channels, and verifies open the main control room normal outside air intake and exhaust isolation valves. The emergency outside air intake trains are closed and remain closed in the normal mode. The air conditioning unit supply air temperature controller is set at the design set point.

6.4.3.2 Normal Operation

After the air conditioning unit and exhaust fans are started, the Control Room Air Conditioning System is controlled automatically to maintain the desired Control Room temperature.

Both trains of the Control Room Air Conditioning System and the interfacing systems are operated alternately to equalize their service times and to exercise them into the state of readiness.

Subsection 9.4.1.2.1 describes the normal operation of the system.

6.4.3.3 Emergency Operation

There are two modes of emergency operation, pressurized and isolated. Isolated emergency operation is initiated automatically following receipt of a Safety Injection Actuation Signal (SIAS), toxic gas emergency or a high radiation signal at the normal outside air intake.

→(DRN 04-705, R14)

During a radiological emergency, Figure 6.4-2 represents the operator action to manually initiate filtered pressurization, recirculation, and partial filtration. After the receipt of an SIAS, or a high radiation signal, the following automatic actions will occur to change the Control Room Air Conditioning System from its normal operating mode to this emergency mode. Refer to Table 6.4-3 for valve and damper position.

←(DRN 04-705, R14)

a) Close normal outside air isolation valves V-13 and V-14, close exhaust isolation valves V-9, V-10, V-11 and V-12 to isolate these air flow paths into and out of the control room areas.

b) Stop operating exhaust fans E-42 end E-34.

c) Open both pairs of recirculation dampers D-18 and D-19 associated with the operating air handling unit AH-12 to automatically recirculate all air supplied to all the control room areas.

→(DRN 04-705, R14; EC-5000081471, R301)

d) Start both Emergency Filtration Units S-8 to provide filtration and adsorption of all outside air and unit recirculation air at a flow rate of 3800 cfm for each filtration unit. Accident analyses assume a maximum filtered pressurization flow rate of 225 cfm of outside air into the control room envelope for the duration of the event.

Class 1E controls are provided in the control room to allow the operator to open any intake and to select the intake which is admitting air with the lowest concentration of radioactivity (refer to Subsection 12.3.4). Manual selection of the more favorable air intake is credited in design basis accident dose analyses. In accident analyses 100 cfm of unfiltered inleakage is assumed for the duration of the event.

←(DRN 04-705, R14; EC-5000081471, R301)

During a toxic gas emergency, the control room air conditioning system is automatically transferred to the emergency operation mode; however, such a transfer involving only toxic gas detection does not constitute an ESF actuation. Figure 6.4-3 shows the control room air conditioning system during a toxic gas emergency. Upon receipt of a toxic chemical signal, the following automatic actions will place the control room envelope in isolation and recirculation mode:

a) Close normal outside air isolation valves V-13 and V-14, close exhaust isolation valves V-9, V-10, V-11 and V-12 to isolate all air flow paths into and out of the control room areas.

b) Open both pairs of recirculation dampers D-18 and D-19 associated with the operating air handling unit AH-12 to automatically recirculate all air supplied to all control room areas.

c) Stop operating exhaust fans E-42 and E-34. The control room air conditioning system is operated in the isolated mode and provides recirculation.

In the event that a toxic gas signal is generated subsequent to a SIAS or high radiation signal, the toxic gas signal will override the previous signal and close all outside air intakes.

No outside air is drawn into the control room envelope during the toxic chemical emergency.

Manual initiation of emergency operation can occur whenever the control room operator desires.

Radiological protection and toxic gas protection are discussed in Subsections 6.4.4.1 and 6.4.4.2, respectively.

6.4.4 DESIGN EVALUATION

6.4.4.1 Radiological Protection

→(DRN 04-705, R14)

The evaluation of the radiological exposure to the control room operators is presented in the main control room accident dose analysis given in Chapter 15. Subsection 15.6.3.3 shows the doses following the design basis accident (LOCA) and demonstrates compliance with GDC 19 and 10CFR50.67.

←(DRN 04-705, R14)

Table 6.4-2 is a summary sheet of the Control Room Air Conditioning System parameters used in the main control room dose analysis.

6.4.4.2 Toxic Gas Protection

a) Protection from Chlorine

Redundant chlorine detectors are provided near the Control Room Air Conditioning System normal outside air intake. The chlorine detectors use diffusion-type electrochemical probes.

Upon detection of chlorine, the control room envelope is automatically placed in the isolated mode as described in Subsection 6.4.3.3 and the RAB Normal Ventilation System is shut down as described in Subsection 9.4.3.1.2. The chlorine detectors are provided with outputs to sound an alarm in the main control room. The chlorine concentration readout is available from the plant monitoring computer and appears on a digital display panel in the control room.

→(DRN M99001091; EC-5000082258, R301)

The response time of the chlorine detectors is a function of the instantaneous chlorine concentration. An analysis of the concentration buildup following a postulated worst-case release from a stationary chlorine storage tank indicates that the isolation time (the time interval from when the chlorine concentration at the isolation dampers reaches 5 ppm to when the dampers are completely closed) is less than or equal to 4 seconds. This is based on a chlorine sensor time constant of 12 seconds, a travel time in the duct between the sensors and the isolation damper of 4.76 seconds, and a isolation damper closure time of 2 seconds. Since the calculated isolation time is within 4 seconds, the Waterford 3 control room meets the RG 1.95 requirements for a Type II control room for stationary chlorine sources. Mobile sources are treated probabilistically, as described in Subsection 2.2.3.3.3.

←(DRN M99001091; EC-5000082258, R301)

→(EC-5000082258, R301)

The Chlorine Detection System, although originally purchased as non-seismic equipment, has been seismically qualified by laboratory testing in order to meet the Regulatory Guide1.95 requirements. In addition, the chlorine detection equipment has been installed in seismically qualified structures. The plant specific seismic response spectra as experienced by the equipment and the as-built installation were considered in the testing.

←(EC-5000082258, R301)

Redundant chlorine detectors are powered from independent nonsafety-related uninterruptible power supplies which in turn draw power from safety-related buses. The loss of power to a detector is annunciated in the control room.

→(DRN M9901096

There are no onsite Circulating Water System chlorination facilities.

←(DRN M9901096)

b) Protection from Anhydrous Ammonia

The Broad Range Gas Detection System detects ammonia. The operation of the Broad Range Gas Detection System is described in Subsection 6.4.4.2c.

Upon detection of ammonia, the control room envelope is automatically placed in the isolated mode as described in Subsection 6.4.3.3 and the RAB Normal Ventilation System is shut down as described in Subsection 9.4.3.1.2..

Redundant broad range detectors are powered from independent nonsafety-related uninterruptible power supplies which in turn draw power from safety-related buses. The loss of power to a detector is annunciated in the control room.

c) Broad Range Detectors

A Broad Range Gas Detection System which continuously monitors incoming control room air for the presence of a large variety of toxic gases is installed on the Control Room air intake duct. If toxic gas concentration equals or exceeds the high setting, the detector system sounds an alarm and automatically isolates the control room before toxic or IDLH levels can be reached.

The maximum detector response time is 17 seconds or less for gases listed in Table 6.4-4. Alarms are also actuated by a loss of power. As a safeguard against detection system failure, a backup Broad Range Gas Detection installation is provided.

Each Broad Range Detection system consists of an analyzer panel that utilizes continuous scan Fourier Transform Infrared (FTIR) sensing technology. The monitor samples the air and automatically analyzes for the presense of gases and vapors of chemicals for which the computer has been programmed.

The broad range gas detectors are designed to be very sensitive to numerous gases and are programmed to respond to the gases listed in Table 6.4-4. The control room will be isolated when the gases concentrations exceed the designated setpoint. A display of the specific gases and their concentrations is provided in the control room.

d) Industry Hot Line

Waterford 3 is a participant in the St. Charles Parish Emergency Preparedness/Industrial Hot Line System. This is a dedicated communication network between St. Charles Parish Emergency Operations Center (EOC) and industries in St. Charles Parish. In the event of an emergency, the affected industry would promptly notify the EOC of the class of emergency, the type of incident and the recommended actions. The EOC will then notify affected neighboring industries.

e) Carbon Dioxide Generation and Oxygen Depletion

→(DRN M99001091; EC-5435, R302)

Carbon dioxide production was calculated to demonstrate the capacity of the control room in terms of the number of people it can accommodate for an extended period of time and not exceed a CO_2 concentration of 1 percent when in isolate mode. Results show that the control room can accommodate 13 people for greater than 6 days without ventilating with fresh air. A oxygen level of 17 percent would be reached for 13 people after 19 days. The above results are based on the assumption that the control room envelope will be completely isolated. During periods of time the control room is isolated, access does not have to be limited if CO_2 levels are monitored and maintained below an administrative limit. When the CO_2 level reaches an administrative alert limit, administrative controls would be implemented to ensure CO_2 levels remain acceptable during a toxic chemical event. Due to wind speed, dispersion, etc., calculations show the duration the control room would have to remain isolated for a toxic chemical event is no greater than 30 hours. Therefore, control room staff limits, for a toxic chemical event, are based on a 30 hour duration.

←(DRN M99001091; EC-5435, R302)

f) Emergency Air Supply System

→(EC-5000082258, R301)

←(EC-5000082258, R301)

An Emergency Air Supply System for the Main Control Room (MCR) is provided to ensure a minimum six hour supply of air for control room and security personnel. The system

→(DRN M9901028)
is designed to provide Grade D breathable air (as defined by the Compressed Gas Association standards) at a rate of 6 scfm for each of 17 individuals. An air storage system with a capacity of 45,000 scf at 1800 psig is provided to maintain a supply of air for use upon demand. Figure 6.4-4 is a flow diagram of the system.
←(DRN M9901028

A breathable air compressor is manually operated to fill the storage tanks. This manual operation prevents accidental chemical contamination of the stored air. The air which leaves the tanks is reduced in pressure to approximately 100 psig prior to entering the control room. Air manifolds are located at strategic locations throughout the MCR envelope for easy personnel access. Air hoses, which will be stored in the MCR envelope, will be utilized to connect the user's breathing apparatus to the air manifold.

The tanks, support structures and piping to and in the control room which are required to operate following an earthquake are nonsafety, seismic Category I. The compressor and tank fill piping are not required for successful system operation and therefore, seismic considerations are not applicable. The tank system is located in the East Cooling Tower area which is part of the Nuclear Plant Island structure. It is protected from the effects of tornado generated missiles and is designed to withstand the loadings associated with tornado and hurricane force winds. Since it is possible that system operation would be required coincident with a loss of power (offsite or onsite), the system will perform its functions without relying on external power sources.

In addition, any postulated rupture of the pressurized tanks will not create high velocity missiles. The rupturing vessel will tend to "tear" instead of explosively shattering.

Instrumentation is provided to signal low pressure in the control room. Sampling of stored air will be performed on a periodic basis to ensure that stored air is maintained at Grade D levels.

Practice drills are conducted in accordance with Section 8 of the Waterford 3 Emergency Plan.

g) Other Provisions

Written emergency procedures to be initiated in the event of a toxic chemical release within or near Waterford 3 are provided. Procedures covering the evacuation of nonessential personnel are also provided.

A potable water supply of more than 1.0 gallon per man per day is provided in a number of plastic containers stored in the control room envelope. The total amount of potable water stored is at least 25 gallons. One gallon per day per man is the total recommended allowance for drinking, food preparation, personal hygiene and medical requirements.

A supply of food is stored in the control room envelope which is sufficient to maintain habitability for at least five men for five days. The main control room contains portable fire extinguishing equipment to permit the timely extinguishing of

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fires inside the envelope. Hoses from outside the envelope can reach all portions of the control room envelope.

6.4.5 TESTING AND INSPECTION

→(DRN M9901096)

Preoperational testing and inspection of the Control Room Air Conditioning System are described in Subsections 6.5.1.4 and 9.4.1.4. Automatic and manual operations important to the control room HVAC safety functions are tested periodically to ensure system operation as required by the plant Technical Specifications. The main control room air conditioning is normally operating and consequently under observation.

←(DRN M9901096)

Periodic testing of main control room emergency filtration units is described in the Technical Specifications.

Operability of the emergency filtration units is verified by test operation for at least 10 hours each month with the heaters on. The control room envelope is designed as a minimum leakage structure. During operational testing, a survey will be made by qualified personnel to insure that leakage barriers are in place and properly installed.

Periodic leak rate testing will be conducted every 18 months and after any major alteration that may affect the main control room leakage. The gross leakage characteristic of the control room envelope will be determined by pressurizing to +0.125 in. WG and determining the pressurization flow rate.

6.4.6 INSTRUMENTATION REQUIREMENTS

The Control Room Air Conditioning System is described in Subsection 9.4.1. The instruments for this system are designed to maintain habitability conditions in the main control room automatically, with the minimum attention from the operator. The instrumentation and alarms on the CP-18 associated with these systems provide the operator with the information concerning the status of the system, and to enable him to take the proper course of action. The CP-18 is designed to Class 1E requirements.

Valve or damper position and equipment status indications allow the operator to continuously monitor and test the operation of the system and confirm all automatic or manual actions taken. All abnormal conditions are annunciated.

6.4.6.1 Control Room Air Handling Units

→(EC-5000081434, R301)

A temperature of 75°F in summer, and a temperature of 70°F in winter can be maintained in the main control room by either air handling unit. Operators can also adjust temperatures as necessary. The following safety-related alarms (a,b,e) and nonsafety-related alarms (c,d,f) are provided for operator use:

←(EC-5000081434, R301)

a) Fan failure (low differential pressure across air handling unit casing).

b) High temperature of air entering main control room (the operator can manually start the standby unit if so desired).

c) Low temperature of air entering the cooling coil (normal intake dampers are closed automatically and air is recirculated).

d) Low-low temperature of air entering the cooling coil (the air handling unit is tripped automatically).

e) High alarm for differential pressure across air handling unit casing to indicate clogged filters.

f) High differential pressure across air handling unit filter bank.

In the highly unlikely event of a fire in a computer room the supply and exhaust dampers to the computer room are closed automatically, preventing the spread of smoke into the main control room. Also an alarm sounds.

6.4.6.2 Air Filtration Units

Two redundant trains of emergency air filtration units are started automatically by the following signals:

a) Safety Injection Actuation Signal (SIAS)

b) High radiation signal at the normal outside air intake

A SIAS or high radiation signal automatically closes the normal air intake and starts the emergency filtration units. Pressurization of the control room occurs by remote manually opening the "good" emergency outside air intake. Control room instrumentation indicates the radioactivity of each emergency outside air intake. A high toxic chemical signal will override operator action that has opened the emergency outside air intakes and the main control room will remain isolated.

A high radiation signal is detected by redundant radiation monitors, two pairs per each intake. The radiation monitors are Class 1E and diversified power is supplied by safety-related channels SA and SB.

The instrumentation provided in the main control room will enable the operator to determine:

a) Which side has higher radiation levels.

b) When normal or emergency air intake valves can be opened.

c) Radiation level at outside air intakes.

d) Status of filter train.

e) Amount of air from outside air intakes.

The following safety-related alarms are provided for the operator’s use:

a) High radiation levels of outside air intakes

b) High toxic chemical levels (nonsafety-related)

c) Status of filter train (high differential pressure)

d) Fan Failure (low differential pressure)

e) Electric heating coil failure (low differential temperature)

f) High temperature of charcoal adsorber.

The control room envelope is considered to be habitable at all times during and after any type of accident except for a fire in the main control room itself.

Design details and logic of the instrumentation is discussed in Sections 7.3 end 7.5.

→(DRN 04-705, R14)

SECTION 6.4: REFERENCES

1. S. Humphreys et. al., “RADTRAD: A Simplified Model for Radionuclide Transport and Removal and Dose Estimation,” NUREG/CR-6604, June, 1997 (including supplements 1, 2, and 3).

←(DRN 04-705, R14)

→(DRN 04-705, R14)

SUMMARY OF MAIN CONTROL ROOM LEAK RATE CALCULATIONS (1)(5)

←(DRN 04-705, R14)

PATH NO.	COMPONENT	UNIT	NUMBER OF UNITS	NUMBER OF (1) REFERENCE DETAIL	LEAKAGE COEFFICIENT A	LEAKAGE COEFFICIENT B	LEAKAGE PER UNIT $AP + BP^{1/2}$	TOTAL COMPONENT LEAKAGE (CFM)
1.	Hollow Metal Door with Gasketed Interlocking Weather Stripping (Fig. III-A-2) Door Opening Out	3'-0"x7'-0"	1	III-A-2 p.IV-305	5.0	27	10.171	10.171
2.	Double Door (Fig. III-A-2) Door Opening Out	6'-0"x7'-0"	2	III-A-2 p.IV-305	5.0	27	16.78215	33.5643
3.	Door Frames	Ft.	72	I-A-7 p.IV	$1.3x10^{-4}$	0	0.1625 x 10-4	0.0011
4.	Slab (3 ft. and 1 ft. thick)	$Ft.^2$	1,458		5.56×10^{-7}	0	0.695×10^{-7}	0.0001
		$Ft.^2$	13,461		1.67×10^{-6}	0	0.20875×10^{-6}	0.0028
5.	Wall: 1 Ft. thick	$Ft.^2$	1,247		1.67×10^{-6}	0	0.20875×10^{-6}	0.0003
	2 Ft. thick	$Ft.^2$	5,290		8.33×10^{-7}	0	0.041×10^{-7}	0.0005
	2.5 Ft. thick	$Ft.^2$	965		6.67×10^{-7}	0	0.8337×10^{-7}	0.0001
	3 Ft. thick	$Ft.^2$	1,482		5.56×10^{-7}	0	0.695×10^{-7}	0.0001
	4 Ft. thick	$Ft.^2$	554		4.17×10^{-7}	0	1.5212×10^{-7}	0.00003
6.	Roof: 3 Ft. thick	$Ft.^2$	4,835		5.13×10^{-7}	0	0.6412×10^{-7}	0.00031
	2 Ft. thick	$Ft.^2$	10,113		7.41×10^{-7}	0	0.9262×10^{-7}	0.00094
7.	Construction Joints	Ft.	1,754	I-A-9	2.4×10^{-4}	0	0.3×10^{-4}	0.0526
8.	Penetrations for Electrical Cable	4" Conduit	1,100 (Assumed)	A-3(2)	2×10^{-5}	1×10^{-9}	0.25×10^{-5}	0.00275
9.	Penetrations for HVAC Ducts	In. of Seal	800	ADS III-D-1 Case 2	1×10^{-6}	0	0.125×10^{-6}	0.0001
10.	Isolation Butterfly Valves To Outdoor Air (2)	12" Dia.	5	A-2 p. III-105	-	-	2×10^{-5}	0.0001
11.	Penetration for Normal Exhaust Louver	2'-0"x4'-0" (Ft. of Frame)	12 Ft.	I-A-7	4×10^{-6}	0	0.5×10^{-6}	Negligible
12.	Pipe Penetrations	In. of Seal	192	III-D-1 Detail 2	7×10^{-6}	0	0.875×10^{-5}	0.00168
			490	III-D-1 Detail 1	3.3×10^{-7}	0	0.4152×10^{-7}	0.00002
TOTAL								43.799 (4)

(1) Based on AEC R & D Report NAA-SR-10100
(2) Leakage rate of 0.02 $ft.^3$ day assumed.
(3) Leakage estimate based on ∆P=0.125 in. wg.

→(DRN 04-705, R14; EC-5000081471, R301)
(4) This value represents the original theoretical leakage. Actual design pressurization flow is 225 cfm (max).
←(EC-5000081471, R301)
(5) Initial tracer gas test results from April 2004 of 79 CFM (Recirculation Mode) and 36 CFM (Pressurized Mode) support the analysis assumptions of 100 CFM for Recirculation mode and 65 CFM for Pressurized Mode.
←(DRN 04-705, R14)

TABLE 6.4-2 Revision 301 (09/07)

SUMMARY SHEET FOR MAIN
CONTROL ROOM AIR CONDITIONING SYSTEM

→(DRN99-2461, R11)

1.	ESF Filter Efficiency (Accident Analysis Iodine Removal)	=	99%

←(DRN99-2461, R11)
→(DRN 04-705, R14; EC-5000081471, R301)

2.	Emergency Outside Air Makeup Rate	=	225 cfm

←(DRN 04-705, R14; EC-5000081471, R301)

3.	Normal Outside Air Makeup Rate	=	2,200 cfm (nom.)
4.	Filtered Recirculation Rate	=	3800 to 7600 cfm
5.	Selection of Intake	=	Manual

→(EC-5000081471, R301)

6.	Net Free Volume of Envelope	=	220,000 $ft.^3$ Maximum 168,500 ft^3 Minimum

←(EC-5000081471, R301)

7.	Elevation of Intakes		
	a) Normal Outside Air Intake	=	+ 73 ft. MSL (Northeast)
	b) Emergency Outside Air Intake	=	+ 73 ft. MSL (Northeast) and + 71 ft. MSL (Southwest)

TABLE 6.4-3 (Sheet 1 of 2)

CONTROL ROOM AIR CONDITIONING SYSTEM DAMPER AND ISOLATION VALVE POSITIONS

VALVE NO.	ACTUAL VALVE OR DAMPER TAG NO. TRAIN "A"	ACTUAL VALVE OR DAMPER TAG NO. TRAIN "B"	VALVE OR DAMPER FUNCTION	VALVE OR DAMPER POSITION FOR EACH OPERATING MODE			
				NORMAL MODE	ACCIDENT (HIGH RADIATION)	ACCIDENT (TOXIC CHEMICAL)	SMOKE PURGE
V- 1	3 HV - B196		Emergency Outside Air Isolation	CLOSED	OPEN (3)	CLOSED	CLOSED
V- 2		3 HV - B199	Emergency Outside Air Isolation	OPEN	OPEN	CLOSED	OPEN
V- 3		3 HV - B197	Emergency Outside Air Isolation	CLOSED	OPEN (3)	CLOSED	CLOSED
V- 4	3 HV - B198		Emergency Outside Air Isolation	OPEN	OPEN	CLOSED	OPEN
V- 5	3 HV - B201		Emergency Outside Air Isolation	CLOSED	OPEN (3)	CLOSED	CLOSED
V- 6		3 HV - B202	Emergency Outside Air Isolation	OPEN	OPEN	CLOSED	OPEN
V- 7		3 HV - B200	Emergency Outside Air Isolation	CLOSED	OPEN (3)	CLOSED	CLOSED
V- 8	3 HV - B203		Emergency Outside Air Isolation	OPEN	OPEN	CLOSED	OPEN
V- 9		3 HV - B172	Conference Room & Kitchen	OPEN	CLOSED	CLOSED	OPEN
V-10	3 HV - B171		Exhaust Isolation	OPEN	CLOSED	CLOSED	OPEN
V-11		3 HV - B178	Toilet Exhaust Isolation	OPEN	CLOSED	CLOSED	OPEN
V-12	3 HV - B177		Toilet Exhaust Isolation	OPEN	CLOSED	CLOSED	OPEN
V-13	3 HV - B169		Normal Outside Air Isolation	OPEN	CLOSED	CLOSED	OPEN
V-14		3 HV - B170	Normal Outside Air Isolation	OPEN	CLOSED	CLOSED	OPEN
DAMPER	D - 17 (SA)		Filtration Unit Inlet Damper	CLOSED	OPEN	CLOSED	CLOSED
NO.		D - 17 (SB)	Filtration Unit Inlet Damper	CLOSED	CLOSED	CLOSED	CLOSED
	D - 18 (SA)		Toilet Recirculation Air	CLOSED	OPEN	OPEN	CLOSED
		D - 18 (SB)	Toilet Recirculation Air	CLOSED	OPEN	OPEN	CLOSED
	D - 39 (SA)		A.H. Unit Recirculation Damper	OPEN	OPEN	OPEN	OPEN
		D - 39 (SB)	A.H. Unit Recirculation Damper	CLOSED	CLOSED	CLOSED	CLOSED
	D - 40 (SA)		A.H. Unit Outside Air Damper	OPEN	CLOSED	CLOSED	OPEN
		D - 40 (SB)	A.H. Unit Outside Air Damper	CLOSED	CLOSED	CLOSED	CLOSED
	D - 41 (SA)		Filtration Unit Recirc. Damper	CLOSED	OPEN	CLOSED	CLOSED
		D - 41 (SB)	Filtration Unit Recirc. Damper	CLOSED	CLOSED	CLOSED	CLOSED
	D - 19 (SA)		Conference Room & Kitchen Air	CLOSED	OPEN	OPEN	CLOSED
		D - 19 (SB)	Recirculation Dampers	CLOSED	OPEN	OPEN	CLOSED
D-43			Main Control Room Purge	CLOSED	CLOSED	CLOSED	OPEN (1)
D-44			Conference Room Exhaust Damper	OPEN	OPEN	OPEN	CLOSED
D-45			Main Control Room Purge	CLOSED	CLOSED	CLOSED	OPEN
D-46			Emergency Living Exhaust Air Damper	OPEN	OPEN	OPEN	CLOSED

TABLE 6.4-3 (Sheet 2 of 2)

CONTROL ROOM AIR CONDITIONING SYSTEM DAMPER AND ISOLATION VALVE POSITIONS

VALVE NO.	ACTUAL VALVE OR DAMPER TAG NO. TRAIN "A"	ACTUAL VALVE OR DAMPER TAG NO. TRAIN "B"	VALVE OR DAMPER FUNCTION	VALVE OR DAMPER POSITION FOR EACH OPERATING MODE			
				NORMAL MODE	ACCIDENT (HIGH RADIATION)	ACCIDENT (TOXIC CHEMICAL)	SMOKE PURGE
D-62			Computer Room Supply Air Damper	OPEN	OPEN	OPEN	CLOSED
D-63			Computer Room Return Air Damper	OPEN	OPEN	OPEN	CLOSED
D-64			Computer Room Plenum Purge Damper	CLOSED	CLOSED	CLOSED	CLOSED (2)
D-67			Kitchen Exhaust Damper	OPEN	OPEN	OPEN	CLOSED
D-68			Toilets Exhaust Damper	OPEN	OPEN	OPEN	CLOSED

NOTES:

(1) DAMPER D-43 IS OPEN WHEN PURGING MAIN CONTROL ROOM AND CLOSED WHEN PURGING COMPUTER ROOM RAISED FLOOR PLENUM.

(2) DAMPER D-64 IS CLOSED WHEN PURGING MAIN CONTROL ROOM AND IS OPEN WHEN PURGING COMPUTER ROOM. RAISED FLOOR PLENUM.

REFER TO FIGURES 6.4-1, 2 AND 3 RESPECTIVELY FOR NORMAL, HIGH RADIATION AND TOXIC CHEMICAL OPERATING MODES.

(3) MANUAL OPERATION - ONLY ONE OF THE FOUR VALVES (V-1, V-3, AND V-7) WILL BE OPENED BY THE OPERATOR DURING THE PRESSURIZATION MODE OF THE ACCIDENT (HIGH RADIATION).

→(DRN 02-1386; R13)

TABLE 6.4-4 Revision 13 (04/04)

GASES AND VAPORS DETECTABLE BY BROAD RANGE GAS DETECTION SYSTEM

Chemical	Chemical
Acetaldehyde	Hydrogen Cyanide
Acetic Acid	Hydrogen Fluoride Anhydrous
Acetonitrile	Isobutaraldehyde
Acrolein	Isobutyronitrile
Acrylonitrile	Isopropyl Alcohol
Allyl Chloride	Isopropylamine
Ammonia	Methoxydihydropyran
Benzene	2-Methoxyethanol
1, 3-Butadiene	Methylamine
2-Butanone (MEK)	Methyl Bromide
Butaraldehyde	Methyl Chloride
tert-Butyl Alcohol	Methyl Mercaptan
Carbon Disulfide	Phosphorus Trichloride
Carbon Tetrachloride	1-Propanol
Chloroform	Propylene Dichloride
1,2 - Dichloropropane	Propylene Oxide
cis- 1, 3-Dichlorpropene	Sulfur Dichloride
Dimethylamine	Sulfur Dioxide
Dipropylamine	Sulfur Monochloride
Epichlorohydrin	Sulfuric Acid
Ethyl Acrylate	1,1,1,2 – Tetrafluroethane
Ethylamine	Toluene
Ethylene Dichloride	Total Hydrocarbon
Ethylene Oxide	Triethylamine
Formaldehyde	Trimethylamine
Formic Acid	Vinyl Acetate
Hydrazine	Vinyl Chloride
Hydrogen Chloride	Vinylidene Chloride

←(DRN 02-1386; R13)

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TABLE 6.4-5 – INTENTIONALLY DELETED Revision 10 (10/99)

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