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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 388 Related to ESBWR Design Certification Application – Engineered Safety Systems – RAI Numbers 6.4-22 and 6.4-23**

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) response to portion of the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) sent by the Reference 1 NRC letter. GEH response to RAI Number 6.3-89 is addressed in Enclosure 1.

Enclosure 2 contains markups to DCD Tier 1 and Tier 2 as noted in the Enclosure 1 response.

If you have any questions or require additional information, please contact me.

Sincerely,

Richard E. Kingston

Richard E. Kingston
Vice President, ESBWR Licensing

Reference:

1. MFN 09-689, Letter from U.S. Nuclear Regulatory Commission to Jerald G. Head, *Request for Additional Information Letter No. 388 Related to ESBWR Design Certification Application,* November 2, 2009

Enclosures:

1. MFN 09-759 - Response to Portion of NRC Request for Additional Information Letter No. 388 Related to ESBWR Design Certification Application – Engineered Safety Features – RAI Numbers 6.4-22 and 6.4-23
2. MFN 09-759 - Response to Portion of NRC Request for Additional Information Letter No. 388 Related to ESBWR Design Certification Application – Engineered Safety Features – RAI Numbers 6.4-22 and 6.4-23 – Markups to ESBWR DCD Tier 1 and Tier 2

cc:	AE Cubbage	USNRC (with enclosures)
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Enclosure 1

MFN 09-759

Response to Portion of NRC Request for

Additional Information Letter No. 388

Related to ESBWR Design Certification Application

Engineered Safety Systems

RAI Numbers 6.4-22 and 6.4-23

NRC RAI 6.4-22

In letter MFN 09-551, dated August 17, 2009, GEH provided a detailed discussion in response to Control Room Habitability Area (CRHA) Meeting Open Topic #6 (see ML091760538 for the meeting summary). The GEH response provided justification as to why, as a result of the existence of the CRHA vestibules, a COL applicant could justify the establishment of a near zero limit for CRHA inleakage attributed to CRHA access/egress.

The assumption of such a low value, to be considered as an allowed departure from the 10 cfm infiltration value provided for such leakage by SRP 6.4, requires further justification in the DCD.

In consideration for this, include a discussion in the DCD Tier 2, Section 6.4 or in DCD Chapter 16, Technical Specification Section 5.5.12, that more explicitly states the unique ESBWR requirement for determining the unfiltered air in leakage past the CHRHA boundary; in that the ESBWR CHRA design assumes a zero or near zero value for CRHA access and egress leakage limit. Clarify in the DCD that a COL applicant must justify this limit in the leakage program manual, in view of SRP 6.4 section III.3.Eiii Note 4.

GEH Response

In letter MFN 09-551, dated August 17, 2009, GEH provided a detailed discussion in response to Control Room Habitability Area (CRHA) Meeting Open Topic #6 (see ML091760538 for the meeting summary). The GEH response provided justification as to why, as a result of the existence of the CRHA vestibules, a COL applicant could justify the establishment of a near zero limit for CRHA inleakage attributed to CRHA access/egress.

The assumption of such a low value, to be considered as an allowed departure from the 10 cfm infiltration value provided for such leakage by SRP 6.4, requires further justification in the DCD.

As discussed in Topic #6, the "near zero" ingress and egress inleakage due to vestibule doors is NOT a departure from the SRP requirements as discussed below. The insights associated with the infiltration value as elaborated upon in Topic #6 and related RAIs will be incorporated into the DCD.

In consideration for this, include a discussion in the DCD Tier 2, Section 6.4 or in DCD Chapter 16, Technical Specification Section 5.5.12, that more explicitly states the unique ESBWR requirement for determining the unfiltered air in leakage past the CHRHA boundary; in that the ESBWR CHRA design assumes a zero or near zero value for CRHA access and egress leakage limit. Clarify in the

DCD that a COL applicant must justify this limit in the leakage program manual, in view of SRP 6.4 section III.3.Eiii Note 4.

As discussed in Topic #6, the “near zero” ingress and egress inleakage due to vestibule doors is NOT a departure and as such requires no further justification.

The ESBWR CRHA design meets SRP 6.4 III.3.A.i, Zone Isolation with filtered incoming air and positive pressure. The EFUs include deep bed charcoal filter units and the CRHA boundary has automatic isolation with immediate automatic pressurization. The CRHA positive differential pressure with respect to adjacent areas is continuously maintained. The CRHAVS doesn’t have “recirculated” air nor is any portion of ductwork under any negative pressure outside the CRHA boundary. As such, SRP 6.4 Note 4 does not specifically apply but the basis for reduced or zero inleakage values associated with double door vestibules is applicable to the ESBWR CRHA.

The CRHA ingress and egress through the double door vestibules will be finalized during preparation of the CRHA Inleakage Test Procedure under COL applicant item 6.4-1-A, CRHA Procedures and Training. The CRHA ingress and egress leakage criteria must support the total 12 cfm leakage criteria assumed in the LOCA dose analysis and test requirements as described in Generic letter 2003-01.

GEH agrees that the insights gained during Topic #6 evaluation should be captured and incorporated into DCD Tier 2. DCD Tier 2 will be updated to include a discussion on how the specific design features of the plant allow one to arrive at the low inleakage value cited.

DCD Impact

DCD Tier # 2, Section 6.4.7, Testing and Inspection, Inservice Testing, will be revised as noted in the attached markup stating:

The Control Room EFU supplies air with a design flow rate of 220 l/s (466 cfm), and it is designed to maintain the control room envelope at a positive pressure with respect to adjacent compartments during normal operation and radiological events. An intake filter efficiency of 99% is assumed for particulate, elemental, and organic iodine species. The system does not include filtered recirculation and the design incorporates leak tightness design requirements (Section 6.4.3). Although the control room is maintained at a positive pressure, the dose analysis assumes a 5.66 l/s (12.0 cfm) unfiltered inleakage. Based on the ESBWR CRHA design and ventilation system operation the acceptance criteria for inleakage associated with CRHA access and egress will be near zero during development of the CRHA Unfiltered Inleakage Test.

DCD Tier #2, Section 6.4.9 will add reference back to subsection 6.4.7.

NRC RAI 6.4-23

DCD, Tier 2, Subsection 6.4.4 states that a variable leakage device, located under the raised floor to facilitate air circulation and mixing, is provided with sufficient adjustment to maintain the required airflow and CRHA positive pressure relative to adjacent areas under all normal and emergency conditions requiring operation of the CRHA air handling unit (AHU) or emergency filter unit (EFU). Periodic monitoring of the CRHA air intake flows and positive CRHA differential pressure is performed during operation of the CRHA AHU or EFU.

DCD, Tier 2, Figure 9.4-1, CRHAVS Simplified System Diagram shows the variable orifice relief device as a box like object, however there is no specific CBVS description of the device in the DCD. Staff cannot make a judgment if the design of this portion of the system meets SRP 9.4.1 design and inservice inspection and testing requirements.

DCD, Tier 2, Table 3.2.1 Classification summary does not list this device. Therefore it is unclear as to what Safety Classification or seismic category the device will be designed to meet.

The following information is requested:

1. Provide a more detailed description of the function of the device in DCD Tier 2 Section 9.4.1.2, System Description such that NRC staff can make a determination if this portion of the CRHAVS will meet SRP 9.4.1 guidelines. Detail should include but is not limited to a description of how backflow through the device will be prevented, a description of the purpose of MCR alarm function associated with this device. Provide a description of required operator actions as a result of main control room (MCR) alarm in DCD Tier 2 Section 9.4.4 and required operator actions.

2. List the device as part of U77 Control Building HVAC system in DCD, Tier 2, Table 3.2.1, provide seismic and safety related design criteria. Modify DCD, Tier 1, Table 2.16.2-3, as needed.

3. Add an ITAAC for the control building differential pressure alarm (e.g. in Table 2.16.2-4), or; alternatively, provide justification why it should not be listed.

GEH Response

DCD, Tier 2, Subsection 6.4.4 states that a variable leakage device, located under the raised floor to facilitate air circulation and mixing, is provided with sufficient adjustment to maintain the required airflow and CRHA positive pressure relative to adjacent areas under all normal and emergency conditions requiring operation of the CRHA air handling unit (AHU) or emergency filter unit (EFU). Periodic monitoring of the CRHA air intake flows and positive CRHA differential pressure is performed during operation of the CRHA AHU or EFU.

DCD, Tier 2, Figure 9.4-1, CRHAVS Simplified System Diagram shows the variable orifice relief device as a box like object, however there is no specific CBVS description of the device in the DCD. Staff cannot make a judgment if the design of this portion of the system meets SRP 9.4.1 design and inservice inspection and testing requirements.

The variable orifice relief device is integral with the CRHA pressure boundary and will be in service during normal and emergency operation since either the Outside Air Handling Unit or an EFU will be continuously running. This device functions to maintain a controlled vent path through the CRHA at design airflow and positive differential pressure with respect to adjacent areas. Failure of this safety related function would be detected during normal operation or during monthly periodic testing of the emergency lineup as well as during CRHA differential pressure and inleakage testing.

DCD, Tier 2, Table 3.2.1 Classification summary does not list this device. Therefore it is unclear as to what Safety Classification or seismic category the device will be designed to meet.

DCD Tier 2, Table 3.2.1 Classification summary does not specify all equipment details, including this device. The variable orifice relief device is a valve and it is considered part of U77 Control Building HVAC: "1. Ducts, valves, and dampers (including supports) supporting safety-related areas".

The following information is requested:

1. Provide a more detailed description of the function of the device in DCD Tier 2 Section 9.4.1.2, System Description such that NRC staff can make a determination if this portion of the CRHAVS will meet SRP 9.4.1 guidelines. Detail should include but is not limited to a description of how backflow through the device will be prevented, a description of the purpose of MCR alarm function associated with this device. Provide a description of required operator actions as a result of main control room (MCR) alarm in DCD Tier 2 Section 9.4.4 and required operator actions.

Additional detail will be provided in DCD Tier 2 subsections, 6.4.4 System Operation Procedures, Emergency Mode and 6.4.7, Testing, and 9.4.1.2, Detailed System Description. Backflow prevention through the variable orifice relief device is not required since the MCR will be at a positive differential pressure relative to adjacent areas for all modes of operation. Designing the variable orifice relief device without a backflow function will prevent a failure mechanism (failure to open). Failure of the variable orifice relief device to limit exfiltration (excess flow) results in a Low CRHA Differential Pressure alarm. Failure of the variable orifice relief device to maintain required flow (low flow) results in a Low Airflow alarm. Specific operator actions required to maintain CRHA design airflow and positive differential pressure as a result of conditions resulting in the applicable alarms listed in DCD Tier 2, subsection 6.4.8, Instrumentation Requirements and subsection 9.4.1.5, Instrumentation Requirements will be developed under COL applicant item 6.4-1-A, CRHA Procedures and Training. The low differential pressure alarm response could include, among others, the following operator response actions:

a) Check Air Filtration Unit or Emergency Filter Unit airflow.
b) Check that there are not doors or CRHA boundaries open.
c) Check position of the variable orifice leakage device.

2. List the device as part of U77 Control Building HVAC system in DCD, Tier 2, Table 3.2.1, provide seismic and safety related design criteria. Modify DCD, Tier 1, Table 2.16.2-3, as needed.

DCD Tier 2, Table 3.2-1 appropriately lists the Ducts, Valves and Dampers supporting Safety-related areas. The CRHA variable orifice relief device is included in this list. This table will not be updated.

DCD Tier 1, Table 2.16.2-3 will be updated to include a new equipment line, “CRHA Variable Orifice Relief Device”.

3. Add an ITAAC for the control building differential pressure alarm (e.g. in Table 2.16.2-4), or; alternatively, provide justification why it should not be listed.

Tier 1 subsection 2.16.2.2 (11), Design Description and ITAAC Table 2.16.2-4, Item 11 will verify the proper operation of the CRHA differential pressure alarm under normal, emergency and swap over modes of operation.

<u>DCD Impact</u>

DCD Tier 2 subsections 6.4; 6.4.2 System Design, Component Descriptions, and Leak Tightness; 6.4.4 System Operation Procedures and Emergency Mode; 6.4.7, Testing, 9.4.1.1, Design Bases and 9.4.1.2, Detailed System Description will be updated to provide additional detail related to the CRHA variable orifice relief device as shown in attached markups.

DCD Tier 1 subsection 2.16.2.2, Design Description and ITAAC Table 2.16.2-4 will be updated to include verification of proper operation of the CRHA differential pressure alarm under normal, emergency and swap over modes of operation as shown in attached markups.

DCD Tier 1, Table 2.16.2-3 will be updated to include a new equipment line, “CRHA Variable Orifice Relief Device” as shown in attached markups.

Enclosure 2

MFN 09-759

Response to Portion of NRC Request for

Additional Information Letter No. 388

Related to ESBWR Design Certification Application

Engineered Safety Features

RAI Numbers 6.4-22 and 6.4-23

Markups to ESBWR DCD Tier 1 and Tier 2

Equipment and systems are discussed in this section only as necessary to describe their connection with control room habitability. References to other sections are made where appropriate.

When alternating current (AC) power is available, the CRHAVS provides normal and abnormal HVAC service to the CRHA as described in Subsection 9.4.1. When AC power is unavailable for an extended time, or if high radioactivity is detected by the PRMS in the CRHA outside air supply duct, the CRHA normal air supply is automatically isolated and the habitability requirements are then met by the operation of an Emergency Filter Unit (EFU). Two trains of EFUs, consisting of two 100% capacity fans each, including High Efficiency Particulate Air (HEPA) and carbon filters, serve the CRHA envelope. Redundant fans are provided for each EFU to allow continued system operability during maintenance of electrical power supplies. The EFUs provide emergency ventilation and pressurization for the CRHA. The CRHA is equipped with a variable orifice relief device to ensure an equal amount of air is exhausted from the CRHA, as supplied. When AC power is unavailable, the CRHA is passively cooled by the CRHA passive heat sink.

The Process Radiation Monitoring System (PRMS) provides radiation monitoring of the CRHA environment and outside air intake. The FPS provides smoke detection and appropriate alarms. Emergency lighting is provided by the Lighting System. Storage capacity is provided in the main control room for personnel support equipment. Manual hose stations outside the CRHA and portable fire extinguishers provide fire suppression in the CRHA.

The CRHA includes the plant area in which actions can be taken to operate the plant safely under normal conditions and to maintain the reactor in a safe condition during accident situations. It includes the MCR area and areas adjacent to the MCR containing operator facilities.

The CRHA contains the following features:

- Main control consoles and associated equipment;
- Shielding and area radiation monitoring;
- Provisions for emergency food, water, storage and air supply systems;
- Kitchen and sanitary facilities; and
- Provision for protection from airborne radioactive contaminants.

Relevant to the ESBWR CRHS, this subsection addresses or refers to other DCD locations that address the applicable requirements of GDC 4, 5 and 19 discussed in SRP 6.4 Revison 3. See Subsection 9.4.1 for additional description of how GDC 4, 5, 19 and other habitability requirements are met.

The ESBWR:

- Meets GDC 4, as it relates to accommodating the effects of and being compatible with postulated accidents, including the effects of the release of toxic gases.
- Meets the intent of GDC 5, because each ESBWR unit at a multi-unit site has a separate control room for each unit. Thus the ability to perform safety functions including an orderly shutdown and cool down of any remaining unit(s) is not impaired.

The EFU delivery and a variable orifice relief device discharge system is optimized to ensure that there is adequate fresh air delivered and mixed in the CRHA. This is accomplished by using multiple supply registers, which distribute the incoming supply air with the control room air volume, and a remote exhaust to prevent any short cycling. The EFU delivered supply air is distributed in the MCR area of the CRHA. The EFU operation results in turning over the CR volume approximately seven to nine times per day. This diffusion design (mixing and displacement) in conjunction with the known convective air currents (due to heat loads/sinks) and personnel movement ensures that occupied zone temperature is within acceptable limits, buildup of contaminants (e.g., CO_2) is minimal and a freshness of air is maintained.

The "Occupied Zone" of the MCR region is normally occupied by personnel, and is generally considered to be between the raised floor and 2 m (6.6 ft) above the floor. Short Cycling refers to the poor design condition where the outside air transits the served space and exhausts to the outside without mixing. This occurs when the outside air inlet and room exhaust are in close proximity. The CRHA has the fresh air supplied at a high elevation and the exhaust removed low, below the floor so they are not in close proximity to each other.

6.4.3 Control Room Habitability Area

The CRHA boundary is located on elevation –2000 mm in the Control Building. The layout of the CRHA, which includes the MCR, is shown on Figure 3H-1, Control Room Habitability Area. The CRHA envelope includes the following areas:

- Admin Area (Room 3270)
- RE/Shift Technical Advisor Office (Room 3271)
- Shift Supervisor Office (Room 3272)
- Kitchen (Room 3273)
- Main Control Room (Room 3275)
- Restroom A (Room 3201)
- Restroom B (Room 3202)
- Main Control Room Storage Room (Room 3204)
- Electrical Panel Board Room (Room 3205)
- Gallery (Room 3206)
- Auxiliary Equipment Operators (AEOs) Workshop (Room 3207)
- Air Handling Unit (AHU) Room (Room 3208)

These areas constitute the operation control area, which can be isolated and remain habitable for the duration of a DBA if high radiation conditions exist. Potential sources of danger such as steam lines, pressurized piping, pressure vessels, CO_2 fire fighting containers, etc. are located outside of the CRHA.

Heat Sink

The function of providing a passive heat sink for the CRHA is part of the CRHA emergency habitability system. The heat sink for each room is designed to limit the temperature rise inside each room during the 72 hour period following a loss of CRHAVS operation. The heat sinks consist of the thermal mass of the concrete that makes up the ceilings and walls of these rooms. The CRHA heat sinks consist of the following: the CRHA walls, floor, ceiling, and interior walls, and access corridors; adjacent Safety-Related Distributed Control and Instrumentation System (Q-DCIS) and Nonsafety-Related Distributed Control and Information System (N-DCIS) equipment rooms and electrical chases; and, CRHA HVAC equipment rooms and HVAC chases. The Control Building concrete characteristics with the material properties of the concrete used in the thermal analysis are provided in Table 3H-14.

After the 72-hour period, the EFU maintains the habitability of the CRHA when RTNSS power supplies are available. The recirculation AHU with supporting auxiliary cooling units is required to remove heat to support main control room habitability post 72 hours.

Radiation Protection

Description of control room instrumentation for monitoring of radioactivity is given in Sections 11.5 and 12.3.

Shielding Design

The design basis radiological analysis presented in Chapter 15 crediting the control room protective features dictates the shielding requirements for the CRHA. Main control room shielding design bases are discussed in Section 12.3. Descriptions of the design basis LOCA source terms, main control room shielding parameters, and evaluation of doses to main control room personnel are presented in Section 15.4. The main control room location in the plant with respect to designated radiation zones is shown in Figure 12.3-3.

Fire Protection

A description of the smoke detectors is in Subsection 9.5.1. Smoke removal is described in Subsection 9.4.1.

Layout

The layout of the CRHA, which includes the MCR, is shown on Figures 3H-1 and 9A.2-3.

Release Points

Radiological release parameters are described in Sections 15.3 and 15.4.

Component Descriptions

The EFU outside air supply portion of the CRHAVS is safety-related and Seismic Category I. Single active failure protection is provided by the use of two trains, which are physically and electrically redundant and separated. In the event of failure in one train, the failed train is isolated and the alternate train is automatically initiated. Both trains are 100% capacity and capable of supplying 99% credited efficiency filtered air to the CRHA pressure boundary at the required flow rate. The exhaust from the CRHA is via a Variable Orifice Relief Device, which is safety-related and its location is optimized to ensure proper scavenging of air from the control room in an amount equal to the supply. Backflow prevention through the controlled leak path, the variable orifice relief device, is not required since the CRHA is at a positive pressure during normal and emergency operation.

- EFUs

The EFU design utilizes a pre-filter, HEPA filter, carbon filter, and post-filter to provide radiological protection of the CRHA outside air supply. The units, including the housings, internal components, ductwork, dampers, fans and controls are designed, constructed, and tested in accordance with ASME AG-1 to meet the requirements of RG 1.52. Each EFU design incorporates two 100% capacity upstream fans powered by the respective divisional power supply to maintain the entire filtration sequence and air delivery duct to the CRHA under positive pressure. See Table 6.4-1 for detailed filter efficiency requirements.

- EFU Fans

EFU fans are designed and rated in accordance with American National Standards Institute/Air Management and Control Association (ANSI/AMCA) 210, 301, 302, 303, and 410.

- Isolation Dampers and Valves (including Variable Orifice Relief Device)

The CRHA pressure boundary includes penetrations, dampers or valves, interconnecting duct or piping, and related test connections and manual valves. The isolation dampers or valves are classified as Safety Class 3 (Table 3.2-1) and Seismic Category I. The dampers or valves have spring return actuators that fail close on a loss of electrical power. Isolation dampers are constructed, qualified, and tested in accordance with ANSI/AMCA 500-D or ASME AG-1, Section DA. Isolation valves are qualified to provide a leak tight barrier for the CRHA envelope pressure.

The boundary isolation function of isolation dampers or valves is demonstrated by pressure testing of the CRHA and in-leakage testing in accordance with American Society for Testing and Materials (ASTM) E741.

- Tornado Protection Dampers

Tornado protection dampers are a split wing or equivalent type designed to close automatically. The tornado protection dampers are designed to mitigate the effect of a design basis tornado.

- Shutoff, Balancing, and Backdraft Dampers

All shutoff, balancing, and backdraft dampers in the EFU outside air delivery path are constructed, qualified, and tested in accordance with ANSI/AMCA 500-D or ASME AG-1, Section DA. Backdraft dampers meet the Leakage Class II requirements of ASME AG-1. Remotely operated two-position type shutoff dampers are designed for the maximum fan static pressure.

- Ductwork and Related Components

Ductwork, duct supports, and accessories are constructed of galvanized or stainless steel, or of carbon or stainless steel if standard pipe is utilized. Ductwork subject to fan shutoff pressures is structurally designed to accommodate fan shutoff pressures. The EFU related ductwork, including the EFUs and the related ductwork outside the CRHA boundary, is designed in accordance with ASME AG-1, Article SA-4500, to provide low leakage components necessary to maintain the CRHA habitability.

- Control Room Access Doors

Two sets of doors, with a vestibule between them that acts as an airlock, are provided at each access to the main control room.

Leak Tightness

The CRHA boundary envelope structures are designed with low leakage construction. The CRHA is located in an underground portion of the Control Building (CB). The boundary walls are adjacent to underground fill or underground internal areas of the CB. The construction consists of cast-in-place reinforced concrete walls and slabs, and is constructed to minimize leakage through joints and penetrations. The following features are applied as required to achieve the leak tightness objective:

- The EFU filter train is located downstream of the EFU fan. This maintains the filter train and delivery ductwork to the CRHA at a positive pressure, precluding any unfiltered in-leakage into the system.
- The access doors are designed with self-closing devices, which close and latch the doors automatically. There are double-door air locks for access and egress during emergencies.
- The outside surface of penetration sleeves in contact with concrete is sealed with epoxy or equivalent sealant. Piping and electrical cable penetrations are sealed with a qualified pressure resistant material compatible with penetration materials or cable jacketing.
- Inside surfaces of penetrations and sleeves in contact with commodities are sealed.
- Penetration sealing materials are designed to withstand at least a 62 Pa (1/4 inch w.g.) pressure differential. The bulk penetration sealing material is gypsum cement or equivalent, with epoxy or equivalent sealants applied to complement penetration sealing.
- The CRHA utilizes internal recirculation AHUs that preclude any AHU ductwork external to the CRHA envelope.

The following isolation dampers / components are safety-related and penetrate the CRHA boundary envelope as shown on Figure 6.4-1:

a. Smoke purge intake CRHA isolation dampers, two dampers.

b. Normal Outside Air Intake Supply CRHA isolation dampers, two dampers.

c. Restroom exhaust CRHA isolation dampers, two dampers.

d. Smoke purge exhaust CRHA isolation dampers, two dampers.

e. EFU supply CRHA isolation dampers, two dampers per division, total of four.

f. Variable Orifice Relief Device

The control room makeup air flow is sized for leakage from the control room boundary when the control room is pressurized to a positive pressure differential of 31 Pa (1/8 inch w. g). An analysis of the control room boundary was performed based on the planned leaktight design features in accordance with the requirements of Standard Review Plan (SRP) Section 6.4, Acceptance Criteria 3.B. This analysis included boundary leakage paths in the control room envelope such as CRHA doors, dampers, and penetrations for piping, electrical conduit, duct and HVAC equipment. Based on the control room total volume and design/construction features employed, the results of the analysis support the feasibility of maintaining the tested differential pressure with the design makeup air flow rate.

Interaction With Other Zones and Pressure-Containing Equipment

During normal operation the CRHA is heated, cooled, ventilated, and pressurized by either of a redundant set of recirculating AHUs and either of a redundant set of outside air intake fans for ventilation and pressurization purposes. See Figure 6.4-1 and Subsection 9.4.1 for a complete description of the CRHAVS.

During a radiological event or upon loss of normal AC power , the EFU maintains a positive pressure in the CRHA to minimize infiltration of airborne contamination. Interlocked double-vestibule type doors maintain the positive pressure, thereby minimizing infiltration when a door is opened.

The CRHA remains habitable during emergency conditions. To make this possible, potential sources of danger such as steam lines, pressure vessels, CO_2 fire fighting containers, etc. are located outside of the CRHA.

6.4.4 System Operation Procedures

The CRHA emergency habitability portion of the CRHAVS is not required to operate during normal conditions with the exception of the variable orifice relief device. This relief device is in service exhausting CRHA air during normal and emergency operation. The normal operation of the CRHAVS maintains the air temperature of the CRHA within a predetermined temperature range. This maintains the CRHA emergency habitability system passive heat sink at or below a predetermined temperature. The normal operation portion of the CRHAVS operates during all modes of normal power plant operation, including startup and shutdown. For a detailed description of the CRHAVS operation see Subsection 9.4.1.

The COL Applicant will verify procedures and training for control room habitability address the applicable aspects of NRC Generic Letter 2003-01 and are consistent with the intent of Generic Issue 83, Reference 6.4-3 (COL 6.4-1-A).

Emergency Mode

Operation of the emergency habitability portion of the CRHAVS is automatically initiated by either of the following conditions:

- High radioactivity in the main control room supply air duct, or
- Extended Loss of Normal AC power.

Operation can also be initiated by manual actuation. Upon receipt of a high radiation level in the main control room supply air duct, the normal outside air intake and restroom exhaust are isolated from the CRHA pressure boundary by automatic closure of the isolation dampers in the system ductwork. At the same time, one of the EFUs automatically starts and begins to deliver filtered air from one of the two unique safety-related outside air intake locations. A constant air flow rate is maintained and this flow rate is sufficient to pressurize the CRHA boundary to at least 31 Pa (⅛ inch w.g.) positive differential pressure with respect to the adjacent areas. Excess air is exhausted from the CRHA via the variable orifice relief device. This device is a locked in place orifice or valve set up to maintain CRHA pressure at the delivered flow. The EFU system air flow rate is also sufficient to supply the fresh air requirement of 10.5 l/s (22 cfm) per person for up to 21 occupants (Reference 6.4-4).

THE AIRFLOW IN EMERGENCY MODE IS AS FOLLOWS:

The mixing of the EFU supplied inlet air with the general CRHA air is performed via the following mechanisms:

1. Supply / Inlet registers mixing - The mixing is continuous as EFU provided outside air is delivered to the CRHA. For each cfm delivered it generates mixing with the CR air as it exits the supply registers. This is the most common type of space air diffusion called a Mixing System. The supply air jet is delivered by the air inlet registers, which create an air jet that then mixes the outside air with the room air by entrainment (induction), which helps to reduce the jet velocity and equalize the supply air temperature as it enters the occupied (CRHA) zone.
2. Displacement (Ventilation) Supply / Exhaust - As air is supplied to the CRHA, an amount is similarly exhausted from the space. This exhaust air will be designed to be at a remote location to ensure no short cycling and a properly scavenged control room.
3. Equipment and Personnel Convective Plumes due to air differential temperature / density – The higher temperature of the air surrounding operating equipment and personnel, generates convective air plumes which rise out of the occupied zone, along with any pollutants (body odors, etc.). The rising air is replaced by cooler air from below.
4. Personnel Movement – It is assumed that a certain activity level by the CRHA occupants which derived the airflow requirements. This activity generates mixing of the CRHA air.
5. Molecular Dispersion - For Contaminants, CO_2 and others, the movement of CO_2 and other molecules across a space is via molecular dispersion.

The airflow developed in the ESBWR control room during worst case (outside air temp of 117ºF) accident conditions when the CRHA is isolated and the EFU is in operation with passive cooling is as follows and is illustrated on new Figure 6.4-2, *Control Room Habitability Area Airflows Emergency Operation.*

The EFU is operating providing 466 cfm clean outside airflow into the CRHA. This is delivered to the occupied MCR area, primarily since this area has the personnel on duty and houses the active electronic equipment. This supply air exits the ductwork at supply air diffusers (4), which perform mixing mechanism 1) above. Depending upon the delivered air temperature, the combined mixed volume either rises or drops. At the worst case outside air condition of 117ºF, modeling shows this air mixture rises above the ceiling with a larger quantity of MCR heated air; the balance driven primarily by the equipment and personnel convective plumes (mechanism 3) above). The combined, rising air above the ceiling tiles draws the same quantity of air into the MCR space from the area below the raised floor volume (mechanism 2). This cooler, slow moving air slowly spreads over the raised floor and displaces the warmer, stale air toward the ceiling, where it leaves the room. The MCR with the high ceiling becomes thermally stratified, i.e., warmer stale air is concentrated above the occupied zone and cool, fresher air is concentrated in the occupied zone. When the cool air encounters a heat source, such as a person or heat generating equipment, the air heats up and buoyantly rises out of the occupied zone.

The hot air that collects above the suspended ceiling, with CO_2 and body generated odors, spills over into the adjacent rooms due to the air density difference due to differential temperature where heat is released to the cooler walls and concrete. Cooler lower temperature air in these adjacent rooms drops to the raised floor level where air continues to drop thru to the common space below the floor. Discharge flow of 466 cfm of this air, exits the main control room at a remotely opposite location from EFU supply to prevent any short cycle of the supply air and ensure a constant turnover of the CRHA air. This air then is drawn into the MCR and a circuit is complete.

A positive pressure is maintained in the CRHA. There is no buildup of any CO_2 in any of these areas since the areas are scavenged continuously by the EFU supply with exhaust airflow of 466 cfm. The exhaust is remote to the supply at one of the adjacent rooms lower common area.

With a source of AC power available, the EFU can operate and is controlled indefinitely through Q-DCIS. In the event that normal AC power is not available, the safety-related battery power supply is sized to provide the required power to the operating EFU fan for 72 hours of operation. For longer-term operation, from post 72 hrs, each EFU fan is powered via an electrical bus supplied by one (1) of two (2) ancillary diesel generators. The temperature and humidity in the CRHA pressure boundary following a loss of the normal portion of the CRHAVS remain within the limits for reliable human performance (References 6.4-1 and 6.4-2) over a 72-hour period. The CRHA isolation dampers fail closed on a loss of normal AC power or instrument air.

Backup power to the safety-related Control Room EFU fans (post 72 hours) if normal AC power is not available is provided by two (2) ancillary diesel generators. These generators are required to support operation of the Control Room EFU beyond 72 hours after an accident. For a period between 7 days and the duration of the design basis accident, the safety-related function of the EFU can be powered from either offsite power, onsite diesel generator powered Plant Investment Protection (PIP) bus, or by continued use of the ancillary diesel generators. The requirements for the ancillary generators are described in Appendix 19A.

Upon a loss of normal AC power, the initial ranges of temperature/relative humidity in the CRHA are 21.1-23.3°C (70-74°F) and 25%-60% RH. The CRHA temperature / humidity values calculated during the 72 hours following a design basis accident equate to less than 30°C (86°F) wet bulb globe temperature and psychrometric wet bulb temperature. The 30°C (86°F) value is the recommended threshold limit for instituting hot weather practices and the recommended upper limit appropriate for assessing heat stress and predicting heat strain for moderate levels of work respectively. The pyschrometric wet bulb temperature is an appropriate index for assessing heat stress and predicting heat strain under conditions where radiant temperatures and air velocity are not large factors and where increased humidity exists. National Institute for Occupational Safety and Health (NIOSH) 86-113 provides a wet bulb temperature limit of about 30°C (86°F) for unimpaired performance on sedentary tasks (moderate levels of physical work) for normally clothed individuals at low airflows (Reference 6.4-5). During the first two hours of loss of normal AC power, most of the equipment in the MCR remains powered by the nonsafety-related battery supply. Anytime during a loss of normal AC power, once either ancillary diesel is available, the environmental conditions are maintained indefinitely. This is accomplished via the continued operation of a CRHA recirculation AHU and auxiliary cooling

- Heat transfer values

This will ensure that CRHA calculations and methodologies are maintained and updated throughout the life of the plant

Preoperational Inspection and Testing

Preoperational testing of the CRHAVS is performed to verify that the minimum air flow rate of 220 l/s (466 cfm) is sufficient to maintain pressurization of the main control room envelope of at least 31 Pa (⅛ inch w.g.) with respect to the adjacent areas. The variable orifice relief device is set during this evolution to ensure an equal amount of air is exhausted from the CRHA. The positive pressure within the main control room is confirmed via the differential pressure transmitters within the control room. The installed flow meters are utilized to verify the system flow rates. The pressurization of the control room limits the ingress of radioactivity to maintain operator dose below regulatory limits. Air quality within the CRHA environment is confirmed to be within the guidelines of American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) Standard 62 requirements for continued occupancy via meeting the fresh air supply requirement of 10.5 l/s (22 cfm) per person for the type of occupancy expected in the CRHA. The capacity of the safety-related battery is verified to ensure it can power an EFU fan for a minimum of 72 hours. Heat loads within the CRHA are verified to be less than the specified values. Preoperational testing of the CRHAVS isolation dampers is performed to verify the leaktightness of the dampers. Preoperational testing for CRHA inleakage during EFU operation is conducted in accordance with ASTM E741. Testing and inspection of the radiation monitors are discussed in Section 11.5. The other tests noted above are discussed in Chapter 14.

Inservice Testing

Inservice testing of the CRHAVS includes operational testing of the EFU fans and filter unit combinations, EFU filter performance testing, automatic actuation testing of the CRHA isolation dampers and EFU fans, and unfiltered air inleakage testing of the CRHA envelope boundary. The CRHA boundary is Pressure Tested (PT) periodically to verify leak tightness on the envelope walls, doors, and boundaries. Testing to demonstrate the integrity of the CRHA envelope is performed in accordance with RG 1.197 and ASTM E741.

The Control Room EFU supplies air with a design flow rate of 220 l/s (466 cfm), and it is designed to maintain the control room envelope at a positive pressure with respect to adjacent compartments during normal operation and radiological events. An intake filter efficiency of 99% is assumed for particulate, elemental, and organic iodine species. The system does not include filtered recirculation and the design incorporates leak tightness design requirements (Section 6.4.3). Although the control room is maintained at a positive pressure, the dose analysis assumes a 5.66 l/s (12.0 cfm) unfiltered inleakage. Based on the ESBWR CRHA design and ventilation system operation the acceptance criteria for inleakage associated with CRHA access and egress will be near zero during development of the CRHA Unfiltered Inleakage Test.

Nuclear Air Filtration Unit Testing

The EFU filtration components are periodically tested in accordance with ASME AG-1, Code on Nuclear Air and Gas Treatment, to meet the requirements of RG 1.52.

Periodic surveillance testing of safety-related CRHA isolation dampers and the EFU components are carried out per Institute of Electrical and Electronic Engineers (IEEE)-338. Safety-related evaluation considering the length of time and extent of the CRHA heat sink average air temperature excursion outside of limits, or by direct measurement of the CRHA heat sink area structural materials temperatures.

6.4.9 COL Information

6.4-1-A CRHA Procedures and Training

The COL Applicant will verify procedures and training for control room habitability address the applicable aspects of NRC Generic Letter 2003-01 and are consistent with the intent of Generic Issue 83, Reference 6.4-3 (Subsection 6.4.4) including statements under 6.4.7.

6.4-2-A Toxic Gas Analysis

The COL Applicant will identify potential site specific toxic or hazardous materials that may affect control room habitability in order to meet the requirements of TMI Action Plan III. D.3.4 and GDC 19. The COL Applicant will determine the protective measures to be instituted to ensure adequate protection for control room operators as recommended under RG 1.78. These protective measures include features to (1) provide capability to detect releases of toxic or hazardous materials, (2) isolate the control room if there is a release, (3) make the control room sufficiently leak tight, and (4) provide equipment and procedures for ensuring the use of breathing apparatus by the control room operators (Subsection 6.4.5).

6.4.10 References

6.4-1 MIL-HDBK-759C, Human Engineering Design Guidelines.

6.4-2 MIL-STD-1472E, Human Engineering.

6.4-3 A Prioritization of Generic Safety Issues, NUREG-0933, October 2006.

6.4-4 ASHRAE Standard 62.1/2007, Ventilation for Acceptable Indoor Air Quality.

6.4-5 NIOSH 86-113, Occupational Exposure to Hot Environments.

9.4.1.1 Design Bases

Safety Design Bases

Only the CRHAVS performs safety-related design basis functions in support of CRHA habitability. The habitability requirements for the CRHA are discussed and described in Section 6.4.

The CRHAVS provides the following safety-related design basis functions:

- Monitors the CRHA air supply for radioactive particulate and/or iodine concentrations; and
- Isolates the normal CRHA air supply and restroom exhaust, starts an EFU fan, and aligns the air supply through an EFU, upon a high radiation detection signal in the CRHA normal air supply, or upon an extended loss of AC power.

The portions of the CRHAVS which penetrate the CRHA envelope are safety-related and designed as Seismic Category I to provide isolation of the CRHA envelope from the outside and surrounding areas in the event of a design basis accident (DBA). The EFU portion of the subsystem is safety-related and designed and supported as Seismic Category I including the air intakes, ductwork, dampers, fans, instrumentation and controls. The remaining CRHAVS functions are nonsafety-related. The penetrations contain safety-related isolation dampers or valves that fail closed upon a loss of control signal, power, or instrument air. An EFU is automatically actuated upon radiological isolation of the CRHA envelope or an extended loss of AC power. If the initial EFU fails to start or is othewise unavailable, the second standby EFU automatically actuates.

CBVS equipment and ductwork whose failure could affect the operability of safety-related systems or components are designed as Seismic Category II. The remaining portion of the system is nonsafety-related and nonseismic.

The following CRHA components are safety-related and Seismic Category I:

- CRHA Boundary envelope including structures, doors, and components (including Variable Orifice Relief Device);
- EFUs including High Efficiency Particulate Air (HEPA) and carbon filters and related system components;
- Ductwork from the CRHA boundary envelope up to and including the CRHA isolation dampers;
- Tornado dampers provided on EFU air intake openings. These dampers are designed to withstand the full negative pressure drop;
- Tornado and tornado missile protection provided on all CRHA ventilation penetrations for outside air intake and exhaust openings; and.
- Tornado and tornado missile protection provided or the CBVS outside air intake and return/exhaust openings.

The CBVS provides a safety-related means to passively maintain habitable conditions in the CRHA following a design basis accident (radiological event concurrent with loss of normal AC power).

Radiation detected in the CRHA outside air inlet causes the following actions:

- The normally closed isolation dampers downstream of the operating EFU fan to open;
- The normal outside air inlet and restroom exhaust dampers to close; and
- An EFU fan to automatically start.

The CRHA is isolated during loss of normal AC power conditions and a safety-related EFU provides pressurization and breathing quality air. An EFU is powered from the safety-related battery supply for a 72 hour duration. For longer-term operation, (post 72 hrs) either of two (2) ancillary diesel generators can power either EFU fan system. The EFU delivery and discharge system is optimized to ensure that there is adequate fresh air delivered and mixed in the CRHA. This is accomplished by using multiple supply registers, which distribute the incoming supply air with the Control Room air volume, and a remote exhaust (Variable Orifice Relief Device) to prevent any short cycling. The EFU operation results in turning over the Control Room volume approximately 7-9 times per day. This diffusion design (mixing and displacement) in conjunction with the known convective air currents (due to heat loads/sinks) and personnel movement ensures that occupied zone temperature is within acceptable limits, buildup of contaminants (e.g., CO_2) minimal, and a freshness of air is maintained. Additional details on the above discussion are elaborated upon in DCD section 6.4.

The CBVS provides the capability to maintain the integrity of the CRHA with redundant safety-related isolation dampers in all ductwork penetrating the CRHA envelope. The active safety-related components (CRHA isolation dampers and EFUs), that ensure habitability in the CRHA envelope, are redundant. Two trains of safety-related EFUs, including HEPA and carbon filters, serve the CRHA envelop. Redundant fans are provided for each EFU to allow continued operability during maintenance of electrical power supplies. Therefore a single active failure cannot result in a loss of the system design function.

During normal modes of operation and emergency modes with electrical power available, the CRHA is maintained within the temperature and relative humidity ranges noted in Table 9.4-1 by the nonsafety-related CRHAVS Recirculation AHU. During emergency operation, with a loss of normal AC power, a nonsafety-related CRHA recirculation air handling unit (AHU), powered from the nonsafety-related Uninterruptible AC Power Supply System, maintains the CRHA within the normal operating temperature range for two hours. This allows the continued operation of certain high heat producing nonsafety-related MCR DCIS electric loads.

Anytime during a loss of normal AC power, once either ancillary diesel generator is available, the power for either Recirculation AHU fan with auxiliary cooling unit can be provided via the ancillary diesel-powered generator. Thus, a Recirculation AHU can operate indefinitely during a CRHA isolation event. If the Recirculation AHUs are not available during the loss of normal AC power, safety-related temperature sensors with two-out-of-four logic automatically trip the power to selected N-DCIS components in the MCR, thus removing the heat load due to these sources. In the event the loss of normal AC power duration extends beyond two hours, the reduced CRHA heat load is passively cooled by the CRHA heat sink. The CRHA heat sinks

- Two 100% capacity safety-related EFU fans; and
- Redundant set of safety-related CRHA isolation dampers.

The CRHAVS is configured as a recirculation system that contains the entire supply and return AHU air flow inside the CRHA, and incorporates a common supply duct for introducing outside air to the CRHA. The normal and EFU outside air intake flows are adjusted as required to maintain a minimum flow, and in conjunction with a controlled leak path, maintain a 31 PaG (1/8" w.g.) minimum positive pressure in the CRHA. Backflow prevention through the controlled leak path, the variable orifice relief device, is not required since the CRHA is at a positive pressure during normal and emergency operation.

The intake design and location are in accordance with RG 1.194. Intake design, location and control also include considerations that minimize the introduction of radiological material, toxic gases, hazardous chemicals, smoke, dust and other foreign material. Ductwork, housings, access openings, etc. are constructed in such a manner as to minimize inleakage of potentially contaminated air into the CRHAVS air stream.

During normal operation, air is conditioned and distributed by a recirculation AHU and particulates are removed from the air by medium efficiency filters. Heat is transferred between the air and the heating elements and cooling coils inside the Recirculation AHU. Moisture is added to the air stream, if required, to maintain minimum humidity levels in the CRHA by the automatically controlled humidifier. The heating and cooling processes inherently remove moisture from the air stream and maintain the humidity below the maximum specified level. The Recirculation AHU distributes conditioned air beneath the CRHA raised floor to the CRHA rooms via registers in the raised floor. The Recirculation AHU intake is ducted from a location above the suspended ceiling and return air is returned to the Recirculation AHU via registers in the suspended ceiling.

Exhaust air from the restroom is ducted to the exhaust fan and exhausted to the outside atmosphere.

The CRHA Recirculation AHUs provide cooling to the CRHA whenever offsite or onsite AC power is available. The nonsafety-related Uninterruptible AC Power Supply System provides power for the CRHA Recirculation AHUs. Each Recirculation AHU is equipped with an auxiliary cooling unit with a cooling coil in the AHU.

The Recirculation AHU fans and associated auxiliary cooling units are battery powered during the first two hours of a loss of normal AC power from the nonsafety-related battery supply. Anytime during a loss of normal AC power, once either ancillary diesel generator is available, the power for either Recirculation AHU fan with auxiliary cooling unit can be provided via an ancillary diesel-powered generator. Thus, a Recirculation AHU can operate indefinitely during a CRHA isolation event. If the Recirculation AHUs are not available during the loss of normal AC power, safety-related temperature sensors with two-out-of-four logic automatically trip the power to selected N-DCIS components in the MCR, thus removing the heat load due to these sources.

Each EFU consists of a medium efficiency filter (40% minimum), a high efficiency particulate air (HEPA) filter (99.97%), a carbon adsorption filter (99% credited efficiency), and a post-filter downstream of the carbon filter (95%). The EFUs operate only during a radiological emergency

(11) The Reactor Building HVAC Online Purge Exhaust Filters are tested to meet RG 1.140 and ASME AG-1 requirements for HEPA and carbon filter efficiency.

(12) a. The Reactor Building HVAC Accident Exhaust Filters maintains the CONAVS served areas of the reactor building at a minimum negative pressure of 62 Pa (-1/4 inch W.G.) relative to surrounding clean areas when operating.

b. The Reactor Building HVAC Accident Exhaust Filters meet RG 1.140 and ASME AG-1 requirements for HEPA and carbon filter efficiency.

Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.16.2-2 provides the design commitments, inspections, tests, analyses and acceptance criteria for the RBVS system.

2.16.2.2 Control Building HVAC System

Design Description

The Control Building HVAC consists of two independent subsystems. The Control Room Habitability Area HVAC Subsystem (CRHAVS) serves the MCR and associated areas bounded by the Control Room Habitability Area (CRHA) envelope. The Control Building General Area HVAC Subsystem (CBGAVS) serves the areas inside the Control Building but outside the CRHA. Table 2.16.2-3 lists the major Control Building HVAC system safety-related components.

Both of these subsystems are nonsafety-related except for that portion of the CRHAVS that forms the CRHA boundary envelope, and the CRHAVS Emergency Filter Units (EFU) and associated components, which are safety-related. This safety-related CRHA boundary envelope consists of the CRHA structure, doors, penetrations, redundant boundary isolation dampers, valves, and that portion of transition ductwork, piping, or tubing that is located between the CRHA boundary structure and the redundant CRHA isolation dampers or valves. The CRHA isolation dampers are the major components discussed in this Subsection. Additional systems, structures, and components (such as EFUs) that are necessary for habitability are discussed in other subsections.

The mechanical cooling of the Control Building General Areas and the CRHA is not provided as a safety-related function during a CRHA boundary isolation. Passive means of limiting CRHA and general area temperature rise to acceptable levels have been provided by the ESBWR design for the first 72 hours following a design basis accident.

The CRHAVS serves the MCR and associated support areas during normal plant operations, plant start-up and plant shutdown and is shown in Figure 2.16.2-4. The CBGAVS serves the areas outside the CRHA and is shown in Figures 2.16.2-5a and 2.16.2-5b.

CRHAVS software that controls the safety-related CRHAVS components is developed in accordance with the software development program described in Section 3.2.

(1) The functional arrangement of the CRHAVS is as described in the Design Description of this Subsection 2.16.2.2 and is as shown in Figure 2.16.2-4.

(2) The CRHA isolation dampers automatically close upon receipt of any of the following signals:

- high radiation in the CRHAVS intake;
- high radiation downstream of an Emergency Filter Unit (EFU) during emergency operation;
- low airflow through an EFU during emergency operation;
- loss of AC power.

(3) The equipment identified in Table 2.16.2-3 as Seismic Category I can withstand Seismic Category I loads without loss of safety function.

(4) The CRHAVS heat sink passively maintains the temperature of the CRHA within an acceptable range for the first 72 hours following a design basis accident.

(5) Independence is provided between safety-related divisions, and between safety-related divisions and nonsafety-related equipment.

(6) CRHA isolation damper and EFU operational status (Open/Closed) indication is provided in the MCR.

(7) The free air volume of the control room envelope is greater than or equal to the volume assumed in safety analyses.

(8) Normal operation intake flow rate is greater than or equal to the flow rate assumed in the safety analyses.

(9) (Deleted)

(10) CRHAVS Air Handling Units and Auxiliary Cooling Units support post-72 hour control room habitability cooling and cooling for post-accident monitoring heat loads.

(11) The CRHA is provided with differential pressure indication for monitoring under normal and emergency operation.

Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.16.2-4 provides definitions of the inspections, test and analyses, together with associated acceptance criteria for the Control Building HVAC.

2.16.2.3 Emergency Filter Units

Design Descriptions

The Emergency Filter Units (EFU) supply pressurized breathing air to the Control Room Habitability Area (CRHA) during isolation of the CRHA boundary envelope. The EFUs are safety-related and maintain habitable conditions in the CRHA to ensure the safety of the control room operators. An EFU is automatically initiated upon CRHA isolation to provide breathing air and pressurization of the CRHA to minimize infiltration. There are two independent, redundant EFU trains capable of supplying sufficient air and CRHA pressurization. The EFUs are part of the CRHAVS, and a simplified system diagram is provided in Figure 2.16.2-4. Design information on safety-related equipment is provided in Table 2.16.2-5.

EFU software that controls the safety-related EFU components is developed in accordance with the software development program described in Section 3.2.

Table 2.16.2-3

Control Building HVAC System Safety-Related Equipment

Equipment	Seismic Category	ASME Code Classification	Notes
CRHA supply air isolation dampers	I	AG-1	Fail Closed
CRHA Restroom Exhaust isolation dampers	I	AG-1	Fail Closed
CRHA Smoke Exhaust intake isolation dampers	I	AG-1	Fail Closed
CRHA Smoke Exhaust output isolation dampers	I	AG-1	Fail Closed
CRHA Variable Orifice Relief Device	I	AG-1	Locked in place

Table 2.16.2-4

ITAAC For The Control Building Habitability HVAC Subsystem

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
	ii. Testing will be performed to show that the operational status indication in the MCR accurately depicts the operational status of the CRHA isolation dampers and EFUs.	ii. The operational status indication accurately depicts the operational status of the as-built CRHA isolation dampers and EFUs.
7. The free air volume of the control room envelope is greater than or equal to the volume assumed in safety analyses.	Analyses to be performed based on the as-built control room envelope to determine the free air volume (total volume minus equipment and walls).	The free air volume of the control room envelop is ≥ 2,200 m^3 (78,000 ft^3).
8. Normal operation intake flow rate is greater than or equal to the flow rate assumed in the safety analyses.	Inspections will be performed to verify the normal operation intake flow rate.	The flow rate is ≥ 220 l/s (466 cfm).
9. (Deleted)		
10. CRHAVS Air Handling Units and Auxiliary Cooling Units support post-72 hour control room habitability cooling and cooling for post-accident monitoring heat loads.	Testing of the integrated system will be performed to demonstrate the air-flow capability of the CRHAVS to support post-72 hour cooling for CRHA and Q-DCIS heat loads.	The integrated system test demonstrates the air-flow capability to support post-72 hour cooling for CRHA and Q-DCIS heat loads.
11. The CRHA is provided with differential pressure indication for monitoring under normal and emergency operation.	Testing will be performed to verify that the CRHA MCR pressure indication operates as designed.	The as-built CRHA pressure indication is provided in the MCR.