Westinghouse

Westinghouse Electric Company
Nuclear Power Plants
P.O. Box 355
Pittsburgh, Pennsylvania 15230-0355
USA

U.S. Nuclear Regulatory Commission
ATTENTION: Document Control Desk
Washington, D.C. 20555

Direct tel: 412-374-6206
Direct fax: 724-940-8505
e-mail: sisk1rb@westinghouse.com

Your ref: Docket No. 52-006
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May 24, 2010

Subject: AP1000 Response to Request for Additional Information (SRP 6)

Westinghouse is submitting a response to the NRC request for additional information (RAI) on SRP Section 6. This RAI response is submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in this response is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification and the AP1000 Design Certification Amendment Application.

Enclosure 1 provides the response for the following RAI(s):

RAI-SRP6.4-SPCV-15 R1

Questions or requests for additional information related to the content and preparation of this response should be directed to Westinghouse. Please send copies of such questions or requests to the prospective applicants for combined licenses referencing the AP1000 Design Certification. A representative for each applicant is included on the cc: list of this letter.

Very truly yours,

Robert Sisk, Manager
Licensing and Customer Interface
Regulatory Affairs and Strategy

/Enclosure

1. Response to Request for Additional Information on SRP Section 6

DD63
NRO

cc:	D. Jaffe	-	U.S. NRC	1E
	E. McKenna	-	U.S. NRC	1E
	P. Donnnelly	-	U.S. NRC	1E
	T. Spink	-	TVA	1E
	P. Hastings	-	Duke Power	1E
	R. Kitchen	-	Progress Energy	1E
	A. Monroe	-	SCANA	1E
	P. Jacobs	-	Florida Power & Light	1E
	C. Pierce	-	Southern Company	1E
	E. Schmiech	-	Westinghouse	1E
	G. Zinke	-	NuStart/Entergy	1E
	R. Grumbir	-	NuStart	1E
	D. Lindgren	-	Westinghouse	1E
	D. Behnke	-	Westinghouse	1E

ENCLOSURE 1

Response to Request for Additional Information on SRP Section 6

RAI Response Number: RAI-SRP6.4-SPCV-15
Revision: 1

Question:

Provide all the DCD changes included in RAI-SRP6.4-SPCV-01 through RAI-SRP6.4-SPCV-14 as well as any changes in prior DCD revisions in redline strikeout form as they will appear in Rev 18 of the DCD. Use Rev 15 of the DCD as the base document.

Westinghouse Response:

On 4/14/10 a phone call was held with the NRC staff to discuss Revision 0 of the Westinghouse response to RAI-SRP 6.4-SPCV-15. The issues listed below were discussed on the phone call along with the Westinghouse response to these issues that are listed after each issue description. Westinghouse committed to revise the response to the RAI-SRP 6.4-SPCV-15 to address these issues.

Exception to Regulatory Position C.6.1

To the extent applicable the filtration line is designed in accordance with Regulatory Guide 1.52 Revision 3. A conformance assessment has been added to Appendix 1A of the DCD to compare the passive filtration line to the requirements defined in Regulatory Guide 1.52 Revision 3, and Regulatory Guide 1.52 has been added to DCD Table 1.9-1. In the conformance assessment, the applicant takes an exception to Regulatory Position C.6.1. The applicant did not explain why an exception was needed to this regulatory position. The staff requests an explanation why the exception is acceptable.

Westinghouse Response:

Westinghouse has determined that the filtration line design is in conformance with Regulatory Position C.6.1 of Regulatory Guide 1.52 Revision 3 and an exception is not needed. Appendix 1A of the DCD, SR 3.7.6.1 and SR 3.7.6.1 Bases were updated to reflect this conformance.

HEPA Filter Penetration Testing

In RAI-SRP 6.4-SPCV-10 R2, Westinghouse Responded as follows: Westinghouse intends to comply with Section 6.3 of Regulatory Guide 1.52, Revision 3 as indicated in the markup of Appendix 1A in RAI-SRP 6.4-SPCV-06 (Reference 0). The markup of the Technical Specifications that indicates combined penetration and leakage of less than 0.5% is an editorial error. Technical Specification 5.5.13 will be corrected as indicated below to indicate a leakage value of less than 0.05%.

However, in RAI Response RAI-SRP 6.4-SPCV-15 R0, dated February 25, 2010 (page 118) indicates that its "Ventilation Filter Testing Program" is using 0.5% as the HEPA filters penetration and system bypass testing criteria. TS section 5.5.13 was not updated as described in RAI-10 R2.

Westinghouse Response:

This was an error in that the correction to the editorial error was not included in the DCD markups in the response to RAI-SRP 6.4-SPCV-15, Revision 0. The DCD markups below correct this error.

Charcoal Design, Construction and Qualification

The staff noted in DCD Section 6.4.2.3 the applicant references RG 1.140 for the design, construction and qualification of the charcoal adsorber. The staff notes that RG 1.52 Rev 3 was cited for all other aspects of the design. The staff is unclear why the applicant would use RG 1.140 for this specific aspect of the application rather than RG 1.52, Rev 3. The staff needs a basis for using RG 1.140 in this application.

Westinghouse Response:

Westinghouse agrees that Regulatory Guide 1.52, Revision 3 is the correct reference. The DCD markups below reflect this change.

SCBA's for Control Room Occupants

The applicant reduced the number of self-contained breathing apparatus in the control room from 11 to 5, as listed in DCD Revision #3 on page 4 of RAI-15. RAI-03 R1 was given as the driver behind the change. RAI-03 R1 incorrectly specifies a change to section 6.4.2.2 for the number and location of the SCBA's. It should be 6.4.2.3. The applicant did not provide a basis for this change or a rational for acceptability. The applicant needs to provide a basis for acceptability.

Westinghouse Response:

Westinghouse has removed the proposed change that was found in RAI-SRP6.4-SPCV-03, R1 involving the number of self-contained breathing apparatus in the main control room from 11 to 5. The DCD markups below reflect 11 self-contained breathing apparatus in the main control room. This description is included in section 6.4.2.3, not in 6.4.2.2.

Editorial Issues

- In RAI-SRP6.4-SPCV-15, at the bottom of Page 70&71 the RAI listed is -06 and from page 72-on it's listed as RAI-03 R1.
- The changes to RAI-14 R1 should be included in the next revision to RAI-15.

Westinghouse Response:

The footers are corrected in this Revision 1 to the response to RAI-SRP6.4-SPCV-15

The changes from the Revision 1 to the Westinghouse response to RAI-SRP6.4-SPCV-14 are included in the DCD markups below.

See attached the DCD Changes associated with RAI-SRP6.4-SPCV-01 through RAI-SRP6.4-SPCV-14. The changes for Chapter 6.4 are color coded. Blue changes are changes from DCD Rev. 16, Green changes are from TR-134 Rev 5, Pink changes are from DCD Rev. 17 and anything in Red will be incorporated as DCD Rev. 18.

For any other sections changed in RAI-SRP6.4-SPCV-01 through RAI-SRP6.4-SPCV-14, the sections are from DCD Rev. 17 and the changes that will be incorporated into DCD Rev. 18 are highlighted in Red. The changes on pages other than section 6.4 are from the following RAI's. When DCD Rev. 18 is issued there may be more changes to the same pages than what is presented here. Those changes are from other RAI's not related directly to Chapter 6.4.

The DCD markups are presented with Chapter 6.4 first followed by Tier 1 changes and then other Tier 2 changes.

For ease of review please see the following table for DCD sections that were affected by each RAI.

RAI Number	DCD Changes	Comments
RAI-SRP6.4-SPCV-01 R0	None	
RAI-SRP6.4-SPCV-01 R1	None	DCD Changes provided in response to RAI-SRP6.4-SPCV-06.
RAI-SRP6.4-SPCV-02 R0	None	DCD Changes provided in response to RAI-SRP6.4-SPCV-06.
RAI-SRP6.4-SPCV-03 R0	Section 6.4.2.1 Section 6.4.2.4 Figure 6.4-1 Figure 9.4.1-1 (Sheet 5 of 7)	
RAI-SRP6.4-SPCV-03 R1	Tier 1 Table 2.7.1-1 Figure 2.7.1-1 (Sheet 1 of 2) Tier 2 Table 3.2-3 Table 3.9-16 Table 3.11-1 Table 3I.6-2 Table 3I.6-3 Section 6.4.2.3 Section 6.4.2.4 Table 8.3.2-1	These changes are in addition to the ones made in RAI-SRP6.4-SPCV-03 R0.

	Table 8.3.2-3 Section 9.4 Figure 9.4.1-1 (Sheets 1, 2, 3, 4, 5 of 7) Table 9.5.1-1	
RAI-SRP6.4-SPCV-03 R2	Tier 1 Section 2.7.1 Table2.7.1-1 Table 2.7.1-2 Tier 2 Table 3.2-3 Table 3.9-12 Table 3.9-16 Table 3.11-1 Table 3I.6-2 Section 9.2.5 Section 9.2.6 Section 9.2.9 Tech Spec 3.7.6 Tech Spec Bases 3.7.6	These changes are in addition to the ones made in RAI-SRP6.4-SPCV-03 R1.
RAI-SRP6.4-SPCV-04 R0	None	DCD Changes provided in response to RAI-SRP6.4-SPCV-06.
RAI-SRP6.4-SPCV-05 R0	Section 14.2.9.1.6	
RAI-SRP6.4-SPCV-06 R0	Tier 1 Section 2.2.5 Table 2.2.5-1 Table 2.2.5-5 Figure 2.2.5-1 Tier 2 Section 1.9 (B-36) Table 1.9-1 (Sheet 4 of 15) Appendix 1A Table 3.2-3 Table 3.11-1 Section 6.4 Table 6.4-1 Table 6.4-2 Table 6.4-3 Figure 6.4-1 (Shts 1 & 2 of 2) Section 7.3.1.2.17 Table 7.3-1 Table 7.3-2 Figure 7.2-1 (Shts 11 & 13 of 20) Section 9.4 Table 9.5.1-1 Table 9A-3	Figure 6.4-1 was in RAI as affected section 6.4 but there was no difference in Figure 6.4-1 from RAI-SRP6.4-SPCV-03 R0.

	Section 14.2.9.1.6 Section 15.6.5.3.5 Table 15.6.5-2 Table 15.6.5-3 Tech Spec 3.3.2 (Table 3.3.2-1, Function 20.b) Tech Spec Bases 3.3.2 (Function 20.b) Tech Spec 3.7.6 Tech Spec Bases 3.7.6 Tech Spec 5.5	
RAI-SRP6.4-SPCV-06 R1	Section 6.4.4 Table 15.6.5-3	Replaces the changes made in R0 of the response. All other changes in R0 of the response are still the same.
RAI-SRP6.4-SPCV-07 R0	None	
RAI-SRP6.4-SPCV-08 R0	Section 6.4.4	
RAI-SRP6.4-SPCV-09 R0	None	
RAI-SRP6.4-SPCV-10 R0	Tech Spec 5.5.13	Same response as RAI-SRP6.4-SPCV-11 R0.
RAI-SRP6.4-SPCV-10 R1	Tech Spec 5.5.13	No additional DCD change beyond Rev 0.
RAI-SRP6.4-SPCV-10 R2	None	Incorporated by RAI-SRP6.4-SPCV-11 R2.
RAI-SRP6.4-SPCV-11 R0	Tech Spec 5.5.13	
RAI-SRP6.4-SPCV-11 R1	Tech Spec 5.5.13	No additional DCD change beyond Rev 0.
RAI-SRP6.4-SPCV-11 R2	Appendix 1A Tech Spec 5.5.13	
RAI-SRP6.4-SPCV-12 R0	Table 7.5-1 Table 7.5-8	
RAI-SRP6.4-SPCV-13 R0	Section 6.4.2.2 Section 6.4.4 Section 6.4.8	
RAI-SRP6.4-SPCV-13 R1	Tier 1 Table 2.2.5-1 (Update table) Figure 2.2.5-1 (replace figure) Tier 2 Table 3.2-3 (Update table) Table 3.9-12 (Update table) Table 3.9-16 (Update table) Table 3.11-1 (Update table) Section 6.4.2.2 Section 6.4.2.3 Section 6.4.4 Section 6.4.8 Figure 6.4-2 (Sheet 2 of 2) (replace	

	figure)	
RAI-SRP6.4-SPCV-13 R2	Section 6.4.4	Verified dose values included
RAI-SRP6.4-SPCV-14 R0	Tech Spec Bases 3.7.6	Change in addition to changes made for RAI-SRP6.4-SPCV-06 R0.
RAI-SRP6.4-SPCV-14 R1	Tech Spec 3.7.6 Tech Spec Bases 3.7.6	

Design Control Document (DCD) Revision:

There are some minor differences administrative differences in this RAI with previously submitted RAIs.

1. On pg 119 and 120 in Tech Spec Bases section 3.7.6, there was reference made to Main Control Room Occupants controlling the plant. That change was made in RAI-SRP6.4-SPCV-06, R0 in error. The term occupants was replaced with operators in paragraph 1 and 3 of Tech Spec Bases 3.7.6. The term occupants is left in other sections to talk about more than just operators in the control room but when reference control of the plant the term occupants is misleading and could lead to the misinterpretation that personnel other than licensed operators are performing control functions in the plant.

2. Corrected Reference numbers throughout Section 6.4. There were RAI's that deleted and created difference references in Section 6.4. Various reference numbers were updated to ensure that they reference the correct document in Section 6.4.

3. ~~In RAI-SRP6.4-SPCV-03, R1 the number of breathing apparatus stored in the main control room was changed from 11 to "at least 5." The number 11 is still referenced in Section 6.4.4. That number has been changed to align with RAI-SRP6.4-SPCV-03, R1.~~ Westinghouse is removing this change and returning to 11 SCBAs inside the main control room (for Revision 1 of this RAI).

4. CN-01 in Westinghouse Letter DCP NRC 002850 subsequently revised the proposed change to DCD Section 9.2.5.1.1. This revised proposed change is included in the DCD markups below.

All listed DCD changes are from RAI-SRP6.4-SPCV-01 to RAI-SRP6.4-SPCV-14 R1.

PRA Revision:

None

Technical Report (TR) Revision:

None

6.4 Habitability Systems

The habitability systems are a set of individual systems that collectively provide the habitability functions for the plant. The systems that make up the habitability systems are the:

- Nuclear island nonradioactive ventilation system (VBS)
- Main control room emergency habitability system (VES)
- Radiation monitoring system (RMS)
- Plant lighting system (ELS)
- Fire Protection System (FPS)

When a source of ac power is available, the nuclear island nonradioactive ventilation system (VBS) provides normal and abnormal HVAC service to the main control room (MCR), control support area (CSA), instrumentation and control rooms, dc equipment rooms, battery rooms, and the nuclear island nonradioactive ventilation system equipment room as described in subsection 9.4.1.

If ac power is unavailable for more than 10 minutes or if "high-high" particulate or iodine radioactivity is detected in the main control room supply air duct, which would lead to exceeding General Design Criteria 19 operator dose limits, the protection and safety monitoring system automatically isolates the main control room and operator habitability requirements are then met by the main control room emergency habitability system (VES). The main control room emergency habitability system is capable of providing emergency ventilation and pressurization for the main control room. The main control room emergency habitability system also provides emergency passive heat sinks for the main control room, instrumentation and control rooms, and dc equipment rooms.

Radiation monitoring of the main control room environment is provided by the radiation monitoring system. Smoke detection is provided in the VBS system. Emergency lighting is provided by the plant lighting system. Storage capacity is provided in the main control room for personnel support equipment. Manual hose stations outside the MCR and portable fire extinguishers are provided to fight MCR fires.

6.4.1 Safety Design Basis

The safety design bases discussed here apply only to the portion of the individual system providing the specified function. The range of applicability is discussed in subsection 6.4.4.

6.4.1.1 Main Control Room Design Basis

The habitability systems provide coverage for the main control room pressure boundary as defined in subsection 6.4.2.1. The following discussion summarizes the safety design bases with respect to the main control room:

- The habitability systems are capable of maintaining the main control room environment suitable for prolonged occupancy throughout the duration of the postulated accidents discussed in Chapter 15 that require protection from the release of radioactivity. Refer to Section 3.1 and subsections 6.4.4 and 15.6.5.3 for a discussion on conformance with General Design Criterion 19 and to Section 1.9 for a discussion on conformance with Generic Issue B-66.

- The main control room is designed to withstand the effects of an SSE and a design-basis tornado.

- A maximum main control room occupancy of up to 11 persons can be accommodated.

- The radiation exposure of main control room personnel throughout the duration of the postulated limiting faults discussed in Chapter 15 does not exceed the limits set by General Design Criterion 19.

- The emergency habitability system maintains CO_2 concentration to less than 0.5 percent for up to 11 main control room occupants.

- The habitability systems provide the capability to detect and protect main control room personnel from external fire, smoke, and airborne radioactivity.

- Automatic actuation of the individual systems that perform a habitability systems function is provided. Smoke detectors, radiation detectors, and associated control equipment are installed at various plant locations as necessary to provide the appropriate operation of the systems.

- The habitability system provides the capability to provide passive air filtration for the main control room during VES operation. The filtration portion of the systems meets the intent of Regulatory Guide 1.52 (Reference 9).

6.4.1.2 Instrumentation and Control Room/DC Equipment Rooms Design Basis

The habitability systems are also designed to service the instrumentation and control rooms and dc equipment rooms. The habitability systems are capable of maintaining the temperature in the instrumentation and control rooms and dc equipment rooms below the equipment qualification temperature limit throughout the duration of the postulated accidents discussed in Chapter 15, an SSE, or design-basis tornado.

6.4.2 System Description

Only the main control room emergency habitability system is discussed in this subsection. The remaining systems are described only as necessary to define their functions in meeting the safety-related design bases of the habitability systems. Descriptions of the nuclear island nonradioactive ventilation system, fire protection system, plant lighting system, and radiation monitoring system are found in subsections 9.4.1, 9.5.1, 9.5.3, and Section 11.5, respectively.

6.4.2.1 Definition of the Main Control Room Pressure Boundary

The main control room pressure boundary is located on elevation 117′-6″ in the auxiliary building, on the nuclear island. As shown in Figure 6.4-1, the pressure boundary encompasses the main control area, operations work area, operations break room, shift supervisor's office, kitchen, and toilet facilities. The pressure boundary is represented by the line around the periphery of the boundary in the figure. The stairwell leading down to elevation 100′ and the area within the vestibule areis specifically excluded from the boundary.

The areas, equipment, and materials to which the main control room operator requires access during a postulated accident are shown in Figure 6.4-1. This figure is a subset of Figure 1.2-8. Areas adjacent to the main control room are shown in Figures 1.2-25 and 1.2-31. The layout, size, and ergonomics of the operator workstations and wall panel information system depicted in Figure 6.4-1 do not reflect the results of the design process described in Chapter 18. The actual size, shape, ergonomics, and layout of the operator workstations and wall panel information system is an output of the design process in Chapter 18.

6.4.2.2 General Description

The main control room emergency habitability system air storage tanks are sized to deliver the required air flow to the main control room and induce sufficient air flow through the passive filtration line to meet the ventilation and pressurization requirements for 72 hours based on the performance requirements of subsection 6.4.1.1. Normal system makeup is provided by a connection to the breathable quality air compressor in the compressed and instrument air system (CAS). See subsection 9.3.1 for a description of the CAS. A connection for refilling operation is provided in the CAS.

Flow from the air storage tanks induces a filtration flow of at least 600 cfm. Testing was conducted to validate that the passive filtration line is capable of inducing a filtration flow of at least 600 cfm greater than the design flow rate from the VES emergency air storage tanks. The testing is documented in TR-SEE-III-09-03 (Reference 11). The filtration flow passes through a series of silencers to maintain acceptable main control room noise levels. The passive filtration portion of the system includes a HEPA filter, a charcoal adsorber, and a downstream postfilter. The filters are configured to satisfy the guidelines of Regulatory Guide 1.52 (Reference 9). The air intake to the passive filtration ductwork is located near the operations work area. The ductwork is routed behind the main control area through the operations break room to reduce the overall noise level in the main control area. The filtered air supply is then distributed to three supply locations that are sufficiently separated from the air intake to avoid short circuiting of the air flow. Two of the supply locations are located inside the main control area. Flow dampers ensure the filtered air is properly distributed throughout the main control room envelope.

The function of providing passive heat sinks for the main control room, instrumentation and control rooms, and dc equipment rooms is part of the main control room emergency habitability system. The heat sinks for each room are designed to limit the temperature rise inside each room during the 72-hour period following a loss of nuclear island nonradioactive ventilation system operation. The heat sinks consist primarily of the thermal mass of the concrete that makes up the ceilings and walls of these rooms.

To enhance the heat-absorbing capability of the ceilings, a metal form is attached to the interior surface of the concrete at selected locations. Metallic plates are attached perpendicular to the form. These plates extend into the room and act as thermal fins to enhance the heat transfer from the room air to the concrete. The specifics of the fin construction for the main control room and I&C room ceilings are described in subsection 3.8.4.1.2.

The normal operating temperatures in the main control room, instrumentation and control rooms, dc equipment rooms, and adjacent rooms are kept within a specified range by the nuclear island nonradioactive ventilation system in order to maintain a design basis initial heat sink capacity of each room. See subsection 9.4.1 for a description of the nuclear island nonradioactive ventilation system.

In the unlikely event that power to the nuclear island nonradioactive ventilation system is unavailable for more than 72 hours, MCR habitability is maintained by operating one of the two MCR ancillary fans to supply outside air to the MCR. See subsection 9.4.1 for a description of this cooling mode of operation. Doors and ducts may be opened to provide a supply pathway and an exhaust pathway. Likewise, outside air is supplied to division B and C instrumentation and control rooms in order to maintain the ambient temperature below the qualification temperature of the equipment.

The main control room emergency habitability system piping and instrumentation diagram is shown in Figure 6.4-2.

6.4.2.3 Component Description

The main control room emergency habitability system compressed air supply contains a set of storage tanks connected to a main and an alternate air delivery line. Components common to both lines include a manual isolation valve and~~,~~ a pressure regulating valve~~, and a flow metering orifice~~. Single active failure protection is provided by the use of redundant, remotely operated isolation valves, which are located within the MCR pressure boundary. In the event of insufficient or excessive flow in the main delivery line, the main delivery line is isolated and the alternate delivery line is manually actuated. The alternate delivery line contains the same components as the main delivery line with the exception of the remotely operated isolation valves, and thus is capable of supplying compressed air to the MCR pressure boundary at the required air flowrate. The VES piping and penetrations for the MCR envelope are designated as equipment Class C. Additional details on Class C designation are provided in subsection 3.2.2.5. The classification of VES components is provided in Table 3.2-3, as appropriate.

- Emergency Air Storage Tanks

  There are a total of 32 air storage tanks. The air storage tanks are constructed of forged, seamless pipe, with no welds, and conform to Section VIII and Appendix 22 of the ASME Code. The design pressure of the air storage tanks is 4000 psi. The storage tanks collectively contain a minimum storage capacity of 314,132 scf of air at a minimum pressure of 3400 psig.

- Pressure Regulating Valve

  Each compressed air supply line contains a pressure regulating valve located downstream of the common header. The pressure at the outlet of the valve is controlled via a two-staged self-contained pressure control operator. A failure of either stage of the pressure regulating valve will not cause the valve to fail completely open. A failure of the second stage of the pressure regulating valve will increase flow from the emergency air storage tanks. There is adequate margin in the emergency air storage tanks such that an operator has time to isolate the line and manually actuate the alternate delivery line.~~The downstream pressure is set to approximately 100 psig so that the flow rate can be controlled by an orifice downstream of the valve.~~

- Flow Metering Orifice

  The flow rate of air delivered to the main control room pressure boundary is limited by an orifice located downstream of the pressure regulating valve in the eductor and in the eductor bypass line. The orifice is sized to provide the required air flowrate to the main control room pressure boundary~~, with an upstream pressure of approximately 100 psig~~.

- Air Delivery Main Isolation Valve

  The pressure boundary of the compressed air storage tanks is maintained by normally closed remotely operated isolation valves in the main supply line. These valves are located within MCR pressure boundary downstream of the pressure regulating valve and automatically initiate air flow upon receipt of a signal to open (see subsection 6.4.3.2).

- Pressure Relief Isolation Valve

  To limit the pressure increase within the main control room, isolation valves are provided, one in each of redundant flowpaths, which open on a time delay after receipt of an emergency habitability system actuation signal. The valves provide a leak tight seal to protect the integrity of the main control room pressure boundary during normal operation, and are normally closed to prevent interference with the operation of the nonradioactive ventilation system.

- Main Air Flowpath Isolation Valve

  The main air flowpath contains a normally open, manually operated valve located within the MCR pressure boundary, downstream~~upstream~~ of the remotely operated air delivery main isolation valves. The valve is provided as a means of isolating and preserving the air storage tank's contents in the event of a pressure regulating valve malfunction.

- Air Delivery Alternate Isolation Valve

  The alternate air delivery flowpath contains a normally closed, manually operated valve, located within the MCR pressure boundary. The valve is provided as a means of manually activating the alternate air delivery flowpath in the event the main air delivery flowpath is inoperable.

- Pressure Relief Damper

  Pressure relief dampers are located downstream of the butterfly isolation valves, and are set to open on a differential pressure of at least 1/8-inch water gauge with respect to the surrounding areas. The differential pressure between the control room and the surrounding area location is monitored to ensure that a positive pressure is maintained in the control room with respect to its surroundings.

  The pressure relief dampers discharge through the MCR vestibule in order to reduce the amount of radioactivity that can be transported into the MCR when operators enter. Two vestibule discharge openings provide a purge flow path from the vestibule to the corridor.

- Eductor

  An eductor is connected to the discharge of the VES makeup line from the emergency air storage tanks and to ductwork located inside the main control room envelope that comprises the passive filtration portion of the VES. The eductor works by directing compressed air from the VES storage tanks through a specially designed nozzle to create a powerful vacuum that draws air from the main control room through the surrounding ductwork into the passive air filtration line. The eductor is designed to create a vacuum capable of drawing at least 600 scfm of flow into the passive air filtration system. This flow rate is based on a VES makeup flow of 65 ± 5 scfm at an approximate pressure of 50 psig at the discharge of the bottled air supply to the eductor. The eductor has no electrical power requirements, contains no moving parts, and requires no maintenance such as adjusting setpoints or lubricating bearings.

- High-Efficiency Particulate (HEPA) Filter, Charcoal Adsorber, and Postfilter

  The main control room passive filtration flowpath contains a HEPA filter in series with a charcoal adsorber and a postfilter. They work to remove particulate and iodine from the air to reduce potential control room dose during VES operation.

  HEPA filters are constructed, qualified, and tested in accordance with UL-586 (Reference 8) and ASME AG-1 (Reference 13), Section FC. Each HEPA filter cell is individually shop tested to verify an efficiency of at least 99.97 percent using a monodisperse 0.3-μm aerosol in accordance with ASME AG-1 (Reference 13), Section TA.

  The charcoal adsorber is designed, constructed, qualified, and tested in accordance with ASME AG-1 (Reference 13), Section FD; and Regulatory Guide 1.~~140~~52. Each charcoal adsorber is an assembly with 2-inch deep Type II adsorber cells, conforming to IE Bulletin 80-03 (Reference 7).

  Postfilters downstream of the charcoal filters have a minimum DOP efficiency of 95 percent. The filters meet UL 900 (Reference 10) Class I construction criteria.

- Silencers

  Two silencers are located in the passive air filtration line. One silencer is located downstream of the eductor, and the other silencer is located upstream of the eductor. The silencers are designed to reduce the noise created by the passive air filtration line.

- Control Room Access Doors

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

- Breathing Apparatus

  Self-contained portable breathing equipment with air bottles is stored inside the main control room pressure boundary. The amount of stored air is sufficient to provide a 6-hour supply of breathable air for up to 11 main control room occupants. This is backup protection to the permanently installed habitability systems.~~Self-contained portable breathing equipment with air bottles for at least five main control occupants is stored on hand inside the main control room pressure boundary in accordance with NUREG-0800, Section 6.4. Additional self-contained portable breathing equipment is maintained nearby in the annex building for an additional six people. The amount of stored air is sufficient to provide at least a 6-hour supply of breathable air for up to 11 main control room occupants. This is backup protection to the permanently installed habitability systems.~~

6.4.2.4 Leaktightness

The main control room pressure boundary is designed for low leakage. It consists of cast-in-place reinforced concrete walls and slabs, and is constructed to minimize leakage through construction joints and penetrations. The following features are applied as needed in order to achieve this objective:

- The outside surface of penetrations sleeves in contact with concrete are sealed with epoxy crack sealer. The piping and electrical cable penetrations are sealed with qualified pressure-resistant material compatible with penetration materials and/or cable jacketing.

- The interior or exterior surfaces of the main control room envelope (walls, floor, and ceiling) are coated with low permeability paint/epoxy sealant.

- Inside surfaces of penetrations and sleeves in contact with commodities (i.e., pipes and conduits, etc.) are sealed. Main control room pressure boundary HVAC isolation valves are qualified to shut tight against control room pressure.

- Penetration sealing materials are designed to withstand at least 1/4-inch water gauge pressure differential in an air pressure barrier. Penetration sealing material is a silicone-based material~~gypsum cement~~ or equivalent.

- There is no HVAC duct that penetrates the main control room pressure boundary. The portions of the nuclear island nonradioactive ventilation system (VBS) that penetrate the main control room pressure boundary are safety-related piping that include redundant safety-related seismic Category I isolation valves that are physically located within the main control room envelope.

The piping, conduits, and electrical cable trays penetrating through any combination of main control room pressure boundary are sealed with seal assembly compatible with the materials of penetration commodities. Penetration sealing materials are selected to meet barrier design requirements and are designed to withstand specific area environmental design requirements and remain functional and undamaged during and following an SSE. ~~No silicone sealant or other patching material is used on VES piping, valves, dampers, or penetrations forming the MCR pressure boundary.~~ There are no adverse environmental effects on the MCR sealant materials resulting from postulated spent fuel pool boiling events.

The main control room pressure boundary main entrance is designed with a~~n airlock type~~ double-door vestibule, which is purged by the pressure relief damper discharge flow during main control room emergency habitability system operation. The emergency exit door (stairs to elevation 100′) is normally closed, and remains closed under design basis source term conditions. Administrative controls prohibit the emergency exit door to the remote shutdown workstation from being used for normal ingress and egress during VES operation.

When the main control room pressure boundary is isolated in an accident situation, there is no direct communication with the outside atmosphere, nor is there communication with the normal ventilation system. Leakage from the main control room pressure boundary is the result of an internal pressure of at least 1/8-inch water gauge provided by emergency habitability system operation.

The exfiltration and infiltration analysis for nuclear island nonradioactive ventilation system operation is discussed in subsection 9.4.1.

6.4.2.5 Interaction with Other Zones and Pressurized Equipment

The main control room emergency habitability system is a self-contained system. There is no interaction between other zones and pressurized equipment.

For a discussion of the nuclear island nonradioactive ventilation system, refer to subsection 9.4.1.

6.4.2.6 Shielding Design

The design basis loss-of-coolant accident (LOCA) dictates the shielding requirements for the main control room. 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 15.6.

The main control room and its location in the plant are shown in Figure 12.3-1.

6.4.3 System Operation

This subsection discusses the operation of the main control room emergency habitability system.

6.4.3.1 Normal Mode

The main control room emergency habitability system is not required to operate during normal conditions. The nuclear island nonradioactive ventilation system maintains the air temperature of a number of rooms within a predetermined temperature range. The rooms with this requirement include the rooms with a main control room emergency habitability system passive heat sink design and their adjacent rooms.

6.4.3.2 Emergency Mode

Operation of the main control room emergency habitability system is automatically initiated by either of the following conditions:

- "High-high" particulate or iodine radioactivity in the main control room supply air duct
- ~~Low pressurizer pressure~~
- Loss of ac power for more than 10 minutes

Operation can also be initiated by manual actuation.

The nuclear island nonradioactive ventilation system is isolated from the main control room pressure boundary by automatic closure of the isolation devices located in the nuclear island nonradioactive ventilation system ductwork if radiation levels in the main control room supply air duct exceed the "high-high" setpoint~~, pressurizer pressure exceeds the low setpoint,~~ or if ac power is lost for more than 10 minutes. At the same time, the main control room emergency habitability system begins to deliver air from the emergency air storage tanks to the main control room by automatically opening the isolation valves located in the supply line. The relief damper isolation valves also open allowing the pressure relief dampers to function and discharge the damper flow to purge the vestibule.

After the main control room emergency habitability system isolation valves are opened, the air supply pressure is regulated by a self-contained regulating valve. This valve maintains a constant downstream pressure regardless of the upstream pressure. A constant air flow rate is maintained by the flow metering orifice downstream of the pressure regulating valve. This flow rate is sufficient to maintain the main control room pressure boundary at least 1/8-inch water gauge positive differential pressure with respect to the surroundings and induce a flow rate of at least 600 cfm into the passive air filtration line. The main control room emergency habitability system air flow rate is also sufficient to maintain the carbon dioxide levels below 0.5 percent concentration for 11 occupants and to maintain air quality within the guidelines of Table 1 and Appendix C, Table C-1, of Reference 1.

The emergency air storage tanks are sized to provide the required air flow to the main control room pressure boundary for 72 hours. After 72 hours, the main control room is cooled by drawing in outside air and circulating it through the room, as discussed in subsection 6.4.2.2.

The temperature and humidity in the main control room pressure boundary following a loss of the nuclear island nonradioactive ventilation system remain within limits for reliable human performance (References 2 and 3) over a 72-hour period. The initial values of temperature/relative humidity in the MCR are 75°F/60 percent. At 3 hours, when the non-1E battery heat loads are exhausted, the conditions are 87.2°F/41 percent. At 24 hours, when the 24 hour battery heat loads are terminated, the conditions are 84.4°F/45 percent. At 72 hours, the conditions are 85.8°F/ 39 percent.

Sufficient thermal mass is provided in the walls and ceiling of the main control room to absorb the heat generated by the equipment, lights, and occupants. The temperature in the instrumentation and control rooms and dc equipment rooms following a loss of the nuclear island nonradioactive ventilation system remains below acceptable limits as discussed in subsection 6.4.4. As in the main control room, sufficient thermal mass is provided surrounding these rooms to absorb the heat generated by the equipment. After 72 hours, the instrumentation and control rooms will be cooled by drawing in outside air and circulating it through the room, as discussed in subsection 6.4.2.2.

In the event of a loss of ac power, the nuclear island nonradioactive ventilation system isolation valves automatically close and the main control room emergency habitability system isolation valves automatically open. These actions protect the main control room occupants from a potential radiation release. In instances in which there is no radiological source term present, the compressed air storage tanks are refilled via a connection to the breathable quality air compressor in the compressed and instrument air system (CAS). The compressed air storage tanks can also be refilled from portable supplies by an installed connection in the CAS.

6.4.4 System Safety Evaluation

In the event of an accident involving the release of radioactivity to the environment~~ except for a LOCA~~, the nuclear island nonradioactive ventilation system (VBS) is expected to switch from the normal operating mode to the supplemental air filtration mode to protect the main control room personnel. ~~Following a LOCA, the VBS is isolated and the VES is actuated on low pressurizer pressure. ~~Although the VBS is not a safety-related system, it is expected to be available to provide the necessary protection for realistic events. However, the design basis accident doses reported in Chapter 15 utilize ~~highly ~~conservative assumptions, and the main control room doses are~~were~~ calculated based on operation of the safety-related emergency habitability system (VES) since this is the system that is relied upon to limit the amount of activity the personnel are exposed to. The analyses assume that the VBS is initially in operation, but fails to enter the supplemental air filtration mode on a High-1 radioactivity indication in the main control room atmosphere. VES operation is then assumed to be initiated once the High-2 level for control room atmosphere activity is reached~~ except for a LOCA. As stated above, following a LOCA, the VBS is isolated and the VES is actuated on low pressurizer pressure~~.

Doses are~~were~~ also calculated assuming that the VBS does operate in the supplemental air filtration mode as designed, but with no switchover to VES operation~~, despite the fact that the High-2 radioactivity level would be exceeded for the design basis accidents~~. This VBS operating case demonstrates the defense-in-depth that is provided by the system and also shows that, in the event of an accident with ~~more ~~realistic assumptions, the VBS is~~would be more than~~ adequate to protect the control room operators without depending on VES operation.

Doses were determined for the following design basis:

	VES Operating	VBS Operating
Large Break LOCA	4.41~~3.85~~ rem TEDE	4.73~~4.71~~ rem TEDE
Fuel Handling Accident	2.5~~3.1~~ rem TEDE	1.6 rem TEDE
Steam Generator Tube Rupture		
(Pre-existing iodine spike)	4.3~~4.8~~ rem TEDE	3.1~~3.4~~ rem TEDE
(Accident-initiated iodine spike)	1.2~~2.1~~ rem TEDE	1.7~~1.8~~ rem TEDE
Steam Line Break		
(Pre-existing iodine spike)	3.9~~3.4~~ rem TEDE	2.1 rem TEDE
(Accident-initiated iodine spike)	4.0~~3.7~~ rem TEDE	4.9 rem TEDE
Rod Ejection Accident	1.8~~2.5~~ rem TEDE	2.2~~1.8~~ rem TEDE
Locked Rotor Accident		
(Accident without feedwater available)	0.7~~0.9~~ rem TEDE	0.5~~0.9~~ rem TEDE
(Accident with feedwater available)	0.5~~0.7~~ rem TEDE	1.5~~1.6~~ rem TEDE
Small Line Break Outside Containment	0.8~~1.4~~ rem TEDE	0.3 rem TEDE

For all events the doses are within the dose acceptance limit of 5.0 rem TEDE. The details of analysis assumptions for modeling the doses to the main control room personnel are delineated in the LOCA dose analysis discussion in subsection 15.6.5.3 for VES operating cases. The analysis assumptions are provided in subsection 9.4.1.2.3.1 for the VBS operating case. ~~The dose is reported for the case with VBS operating following a large beak LOCA for informational purposes only since following a LOCA, the VBS will be isolated on low pressurizer pressure and the VES will be actuated.~~

No radioactive materials are stored or transported near the main control room pressure boundary.

As discussed and evaluated in subsection 9.5.1, the use of noncombustible construction and heat and flame resistant materials throughout the plant reduces the likelihood of fire and consequential impact on the main control room atmosphere. Operation of the nuclear island nonradioactive ventilation system in the event of a fire is discussed in subsection 9.4.1.

The exhaust stacks of the onsite standby power diesel generators are located in excess of 150 feet away from the fresh air intakes of the main control room. The onsite standby power system fuel oil storage tanks are located in excess of 300 feet from the main control room fresh air intakes. These separation distances reduce the possibility that combustion fumes or smoke from an oil fire would be drawn into the main control room.

The protection of the operators in the main control room from offsite toxic gas releases is discussed in Section 2.2. The sources of onsite chemicals are described in Table 6.4-1, and their locations are shown on Figure 1.2-2. Analysis of these sources is in accordance with Regulatory Guide 1.78 (Reference 5) and the methodology in NUREG-0570, "Toxic Vapor Concentrations in the Control Room Following a Postulated Accidental Release" (Reference 6), and the analysis shows that these sources do not represent a toxic hazard to control room personnel.

A supply of protective clothing, respirators, and self-contained breathing apparatus adequate for ~~11~~ 11 persons is stored within the main control room pressure boundary.

The main control room emergency habitability system components discussed in subsection 6.4.2.3 are arranged as shown in Figure 6.4-2. The location of components and piping within the main control room pressure boundary provides the required supply of compressed air to the main control room pressure boundary, as shown in Figure 6.4-1.

During emergency operation, the main control room emergency habitability system passive heat sinks are designed to limit the temperature inside the main control room to remain within limits for reliable human performance (References 2 and 3) over 72 hours. The passive heat sinks limit the air temperature inside the instrumentation and control rooms to 120°F and dc equipment rooms to 120°F. The walls and ceilings that act as the passive heat sinks contain sufficient thermal mass to accommodate the heat sources from equipment, personnel, and lighting for 72 hours.

The main control room emergency habitability system nominally provides 65 scfm of ventilation air to the main control room from the compressed air storage tanks. Sixty scfm of supplied ventilation flow is sufficient to induce a filtration flow of at least 600 cfm into the passive air filtration line located inside the main control room envelope. This ventilation flow is also sufficient to pressurize the control room to at least positive 1/8-inch water gauge differential pressure with respect to the surrounding areas in addition to limiting the carbon dioxide concentration below one-half percent by volume for a maximum occupancy of 11 persons and maintaining air quality within the guidelines of Table 1 and Appendix C, Table C-1, of Reference 1.

Automatic transfer of habitability system functions from the main control room/control support area HVAC subsystem of the nuclear island nonradioactive ventilation system to the main control room emergency habitability system is initiated by either the following conditions:

- "High-high" particulate or iodine radioactivity in MCR air supply duct
- ~~Low pressurizer pressure~~
- Loss of ac power for more than 10 minutes

The airborne fission product source term in the reactor containment following the postulated LOCA is assumed to leak from the containment and airborne fission products are assumed to result from spent fuel pool steaming. The concentration of radioactivity, which is assumed to surround the main control room, after the postulated accident, is evaluated as a function of the fission product decay constants, the containment leak rate, and the meteorological conditions assumed. The assessment of the amount of radioactivity within the main control room takes into consideration the radiological decay of fission products and the infiltration/exfiltration rates to and from the main control room pressure boundary.

A single active failure of a component of the main control room emergency habitability system or nuclear island nonradioactive ventilation system does not impair the capability of the systems to accomplish their intended functions. The Class 1E components of the main control room emergency habitability system are connected to independent Class 1E power supplies. Both the main control room emergency habitability system and the portions of the nuclear island nonradioactive ventilation system which isolates the main control room are designed to remain functional during an SSE or design-basis tornado.

In accordance with SECY-77-439 (Reference 12), a single passive failure of a component in the passive filtration line in the main control room emergency habitability system does not impair the capability of the system to accomplish its intended function. There is no source that could create line blockage in the VES line from the air bottles to the eductor. Thus potential blockage in the filtration line does not preclude breathable air from the emergency air storage tanks from being delivered to the main control room envelope for 72 hours during VES operation. Passive filtration using the main control room habitability system is not required to maintain operator dose rates below the acceptance limit of 5.0 rem TEDE 24 hours after the initiation of a design basis event. The dose rates for the following limiting cases were determined to demonstrate that passive filtration is not required 24 hours after the initiation of a design basis event. The following cases are evaluated since they involve releases that extend beyond 24 hours after the initiation of the event.

Large Break LOCA	4.5 rem TEDE
Steam Line Break	
(Pre-existing iodine spike)	4.0 rem TEDE
(Accident-initiated iodine spike)	4.5 rem TEDE

For all events the doses are within the dose acceptance limit of 5.0 rem TEDE. The details of analysis assumptions for modeling the doses to the main control room personnel are the same as those delineated in the LOCA dose analysis discussion in subsection 15.6.5.3 assuming a passive failure disables the passive filtration flow path after 24 hours. Potential blockage in the filtration line does not preclude breathable air from the emergency air storage tanks from being delivered to the main control room envelope for 72 hours during VES operation. An eductor bypass line with flow control orifice provides the operators with the ability to ensure that the breathable air from the emergency air storage tanks is delivered to the MCR.

6.4.5 Inservice Inspection/Inservice Testing

A program of preoperational and inservice testing requirements is implemented to confirm initial and continued system capability. The VES system is tested and inspected at appropriate intervals, as defined by the technical specifications. Emphasis is placed on tests and inspections of the safety-related portions of the habitability systems.

6.4.5.1 Preoperational Inspection and Testing

Preoperational testing of the main control room emergency habitability system is performed to verify that the air flow rate of 65 ± 5 scfm is sufficient to induce a flow rate of at least 600 cfm into the passive air filtration line and maintain pressurization of the main control room envelope of at least 1/8-inch water gauge with respect to the adjacent areas. 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 preoperational testing also verifies that the VES ~~flow~~ pressure regulating valves are capable of maintaining the VES flow rate of 65 ± 5 scfm over the operating range of expected valve inlet pressures. The pressurization of the control room ~~limits~~ limits the ingress of radioactivity~~, which limits ingress of radioactivity~~ and the recirculation through the passive air filtration line ~~to~~ maintains operator dose limits below regulatory limits. Air quality within the MCR environment is confirmed to be within the guidelines of Table 1 and Appendix C, Table C-1, of Reference 1 by analyzing air samples taken during the pressurization test.

The storage capacity of the compressed air storage tanks is verified to be in excess of 314,132 scf of compressed air at a minimum pressure of 3400 psig. This amount of compressed air will assure 72 hours of air supply to the main control room.

An inspection will verify that the heat loads within the rooms identified in Table 6.4-3 are less than the specified values.

Preoperational testing of the main control room isolation valves in the nuclear island nonradioactive ventilation system is performed to verify the leaktightness of the valves.

Preoperational testing for main control room envelope habitability during VES operation will be conducted in accordance with ASTM E741 (Reference 4). Where possible, inleakage testing is performed in conjunction with the VES system level operability testing since the VES must be in operation to perform the inleakage testing. See Note 7 of Table 3.9-17 for additional information on the VES system level operability test.

Testing and inspection of the radiation monitors is discussed in Section 11.5. The other tests noted above are discussed in Chapter 14.

6.4.5.2 Inservice Testing

Inservice testing of the main control room emergency habitability system and nuclear island nonradioactive ventilation system is conducted in accordance with the surveillance requirements specified in the technical specifications in Chapter 16.

A~~T~~SSTM E741~~Leaktightness~~ testing of the main control room pressure boundary is conducted in accordance with the frequency specified in the technical specifications.

6.4.5.3 Air Quality Testing

Connections are provided for sampling the air supplied from the compressed and instrument air system and for periodic sampling of the air stored in the storage tanks. Air samples of the compressed air storage tanks are taken quarterly and analyzed for acceptable air quality within the guidelines of Table 1 and Appendix C, Table C-1, of Reference 1.

6.4.5.4 Main Control Room Envelope Habitability

Testing for main control room envelope habitability during VES operation will be conducted in accordance with ASTM E741 (Reference 4).

The main control room envelope must undergo an analysis of inleakage into the control room envelope to determine the integrity of the control room envelope boundary during a design basis accident, hazardous chemical release, or smoke event. Baseline control room envelope habitability testing will be performed as discussed in subsection 6.4.5.1, followed by a self-assessment at three (3) years after successful baseline testing, and a periodic test at six (6) years in conjunction with other ASME inservice testing requirements. The self-assessment of the ability to maintain main control room habitability includes a review of procedures, boundaries, design changes, maintenance activities, safety analyses, and other related determinations.

If periodic testing is successful, then the assessment/testing cycle continues with a self-assessment three (3) years later and periodic testing three (3) years after the self-assessment. If a periodic testing is unsuccessful, then a periodic test is required three (3) years after repair and successful re-testing, following the unsuccessful periodic testing, to ensure there is no accelerated degradation of the main control room boundary or discrepancies in control of the main control room habitability.

In addition to periodic tests, control room envelope testing will also be performed when changes are made to structures, systems, and components that could impact control room envelope integrity, including systems internal and external to the control room envelope. The tests must be commensurate with the types and degrees of modifications and repairs and the potential impact upon integrity. Additional control room envelope testing will also be performed if a new limiting condition or alignment arises for which no inleakage data is available ~~(e.g., a hazardous chemical source appears where previously there was none)~~. Test failure is considered to be inleakage in excess of the licensing basis value for the particular challenge to control room envelope integrity.

Where possible, inleakage testing is performed in conjunction with the VES system level operability testing since the VES must be in operation to perform the inleakage testing. See Note 7 of Table 3.9-17 for additional information on the VES system level operability test.

6.4.6 Instrumentation Requirements

The indications in the main control room used to monitor the main control room emergency habitability system and nuclear island nonradioactive ventilation system are listed in Table 6.4-2.

Instrumentation required for actuation of the main control room emergency habitability system and nuclear island nonradioactive ventilation system are discussed in subsection 7.3.1.

Details of the radiation monitors used to provide the main control room indication of actuation of the nuclear island nonradioactive ventilation system supplemental filtration mode of operation and actuation of main control room emergency habitability system operation are given in Section 11.5.

A description of initiating circuits, logic, periodic testing requirements, and redundancy of instrumentation relating to the habitability systems is provided in Section 7.3.

6.4.7 Combined License Information

Combined License applicants referencing the AP1000 certified design are responsible for the amount and location of possible sources of hazardous chemicals in or near the plant and for seismic Category I Class 1E hazardous chemical monitoring, as required. Regulatory Guide 1.78 (Reference 5) addresses control room protection for hazardous chemicals and evaluation of offsite hazardous chemical releases (including the potential for hazardous chemical releases beyond 72 hours) in order to meet the requirements of TMI Action Plan Item III.D.3.4 and GDC 19.

Combined License applicants referencing the AP1000 certified design are responsible for verifying that procedures and training for control room envelope habitability are consistent with the intent of Generic Issue 83 (see Section 1.9).

The Combined License applicant testing frequency for the main control room envelope habitability is discussed in subsection 6.4.5.4.

6.4.8 References

1. "Ventilation for Acceptable Indoor Air Quality," ASHRAE Standard 62 - 1989.
2. "Human Engineering Design Guidelines," MIL-HDBK-759C, 31 July 1995.
3. "Human Engineering," MIL-STD-1472E, 31 October 1996.
4. "Standard Test Methods for Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution," ASTM E741, 2000.
5. "Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release," Regulatory Guide 1.78, Revision 1, December 2001.
6. NUREG-0570, "Toxic Vapor Concentrations in the Control Room Following a Postulated Accidental Release," June 1979.
7. "Loss of Charcoal Adsorber Cells," IE Bulletin 80-03, 1980.
8. "High-Efficiency, Particular, Air-Filter Units," UL-586, 1996.
9. "Design, Testing, and Maintenance Criteria for Post Accident Engineered-Safety-Feature Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants," Regulatory Guide 1.52 Revision 3, 2001.

10. "Test Performance of Air-Filter Units," UL-900, 1994.

11. "AP1000 VES Air Filtration System Test Report," TR-SEE-III-09-03

12. "Single Failure Criterion," SECY-77-439

13. "Code on Nuclear Air and Gas Treatment," ASME/ANSI AG-1-1997

Table 6.4-1

ONSITE CHEMICALS

Material	State	Location
Hydrogen	Liquid/Gas	Gas storage
Nitrogen	Liquid	Gas storage
CO_2	Liquid	Gas storage
Oxygen Scavenger	Liquid	Turbine building
pH Addition	Liquid	Turbine building, CWS area(a)
Sulfuric Acid	Liquid	Turbine building, CWS area(a)
Sodium Hydroxide	Liquid	Turbine building, CWS area(a)
Dispersant(a)	Liquid	Turbine building, CWS area(a)
Fuel Oil	Liquid	DG fuel oil storage tank/DG building/Annex
Corrosion Inhibitor	Liquid	Turbine building, CWS area(a)
Scale Inhibitor	Liquid	Turbine building, CWS area(a)
Biocide/Disinfectant	Liquid	Turbine building, CWS area(a)
Algicide	Liquid	Turbine building, CWS area(a)

Note:
a. Site-specific

Table 6.4-2 **MAIN CONTROL ROOM HABITABILITY INDICATIONS AND ALARMS**
VES emergency air storage tank pressure (indication and low and low-low alarms)
VES MCR pressure boundary differential pressure (indication and high and low alarms)
VES air delivery line flowrate (indication and high and low alarms)
VES passive filtration flow rate (indication and high and low alarms)
VBS main control room supply air radiation level (high-high alarms)
VBS outside air intake smoke level (high alarm)
VBS isolation valve position
VBS MCR pressure boundary differential pressure

Note:

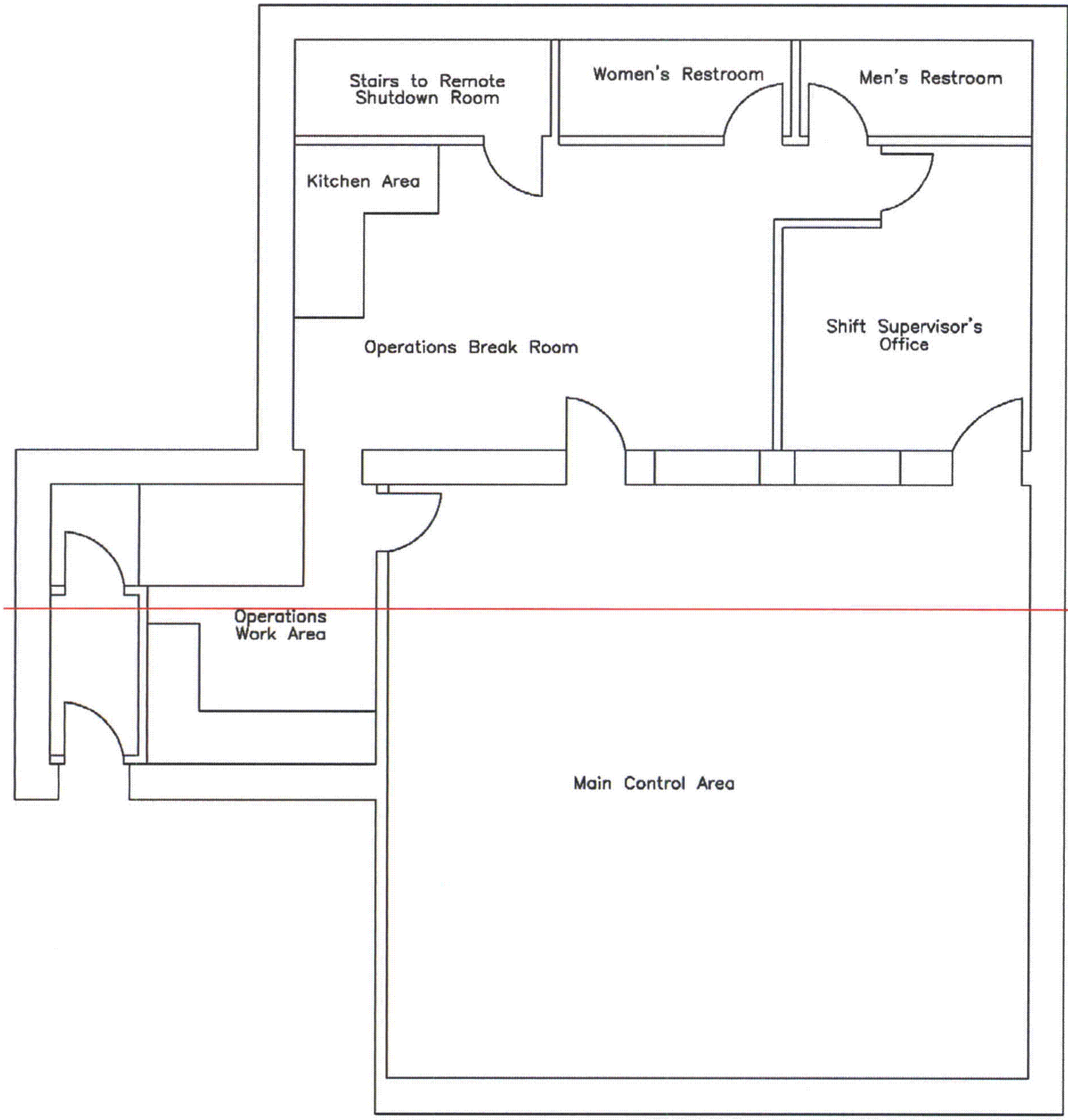
KEY: VES = Main control room emergency habitability system
VBS = Nuclear island nonradioactive ventilation system
MCR = Main control room

Table 6.4-3

LOSS OF AC POWER HEAT LOAD LIMITS

Room Name	Room Numbers	Heat Load 0 to 24 Hours (Btu/sec)	Heat Load 24 to 72 Hours (Btu/sec)
MCR Envelope	12401~~12~~	12.823 (Hour 0 through 3) 5.133 (Hour 4 through 24)	3.928
I&C Rooms	12301, 12305	8.854	0
I&C Rooms	12302, 12304	13.07	4.22
dc Equipment Rooms	12201, 12205	3.792 (Hour 0 through 1) 2.465 (Hour 2 through 24)	0
dc Equipment Rooms	12203, 12207	5.84 (Hour 0 through 1) 4.51 (Hour 2 through 24)	2.05

Security-Related Information, Withhold Under 10 CFR 2.390d



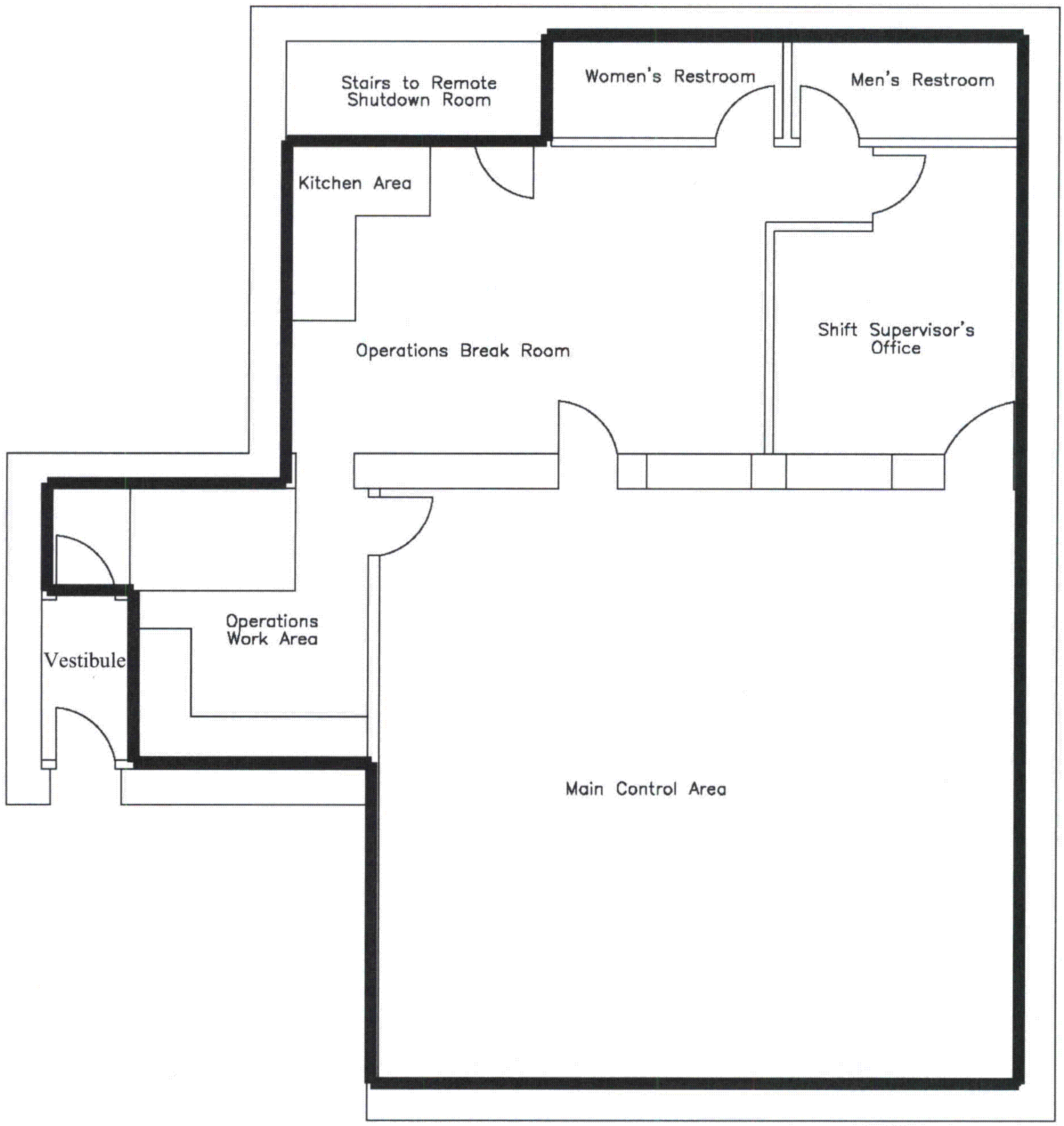
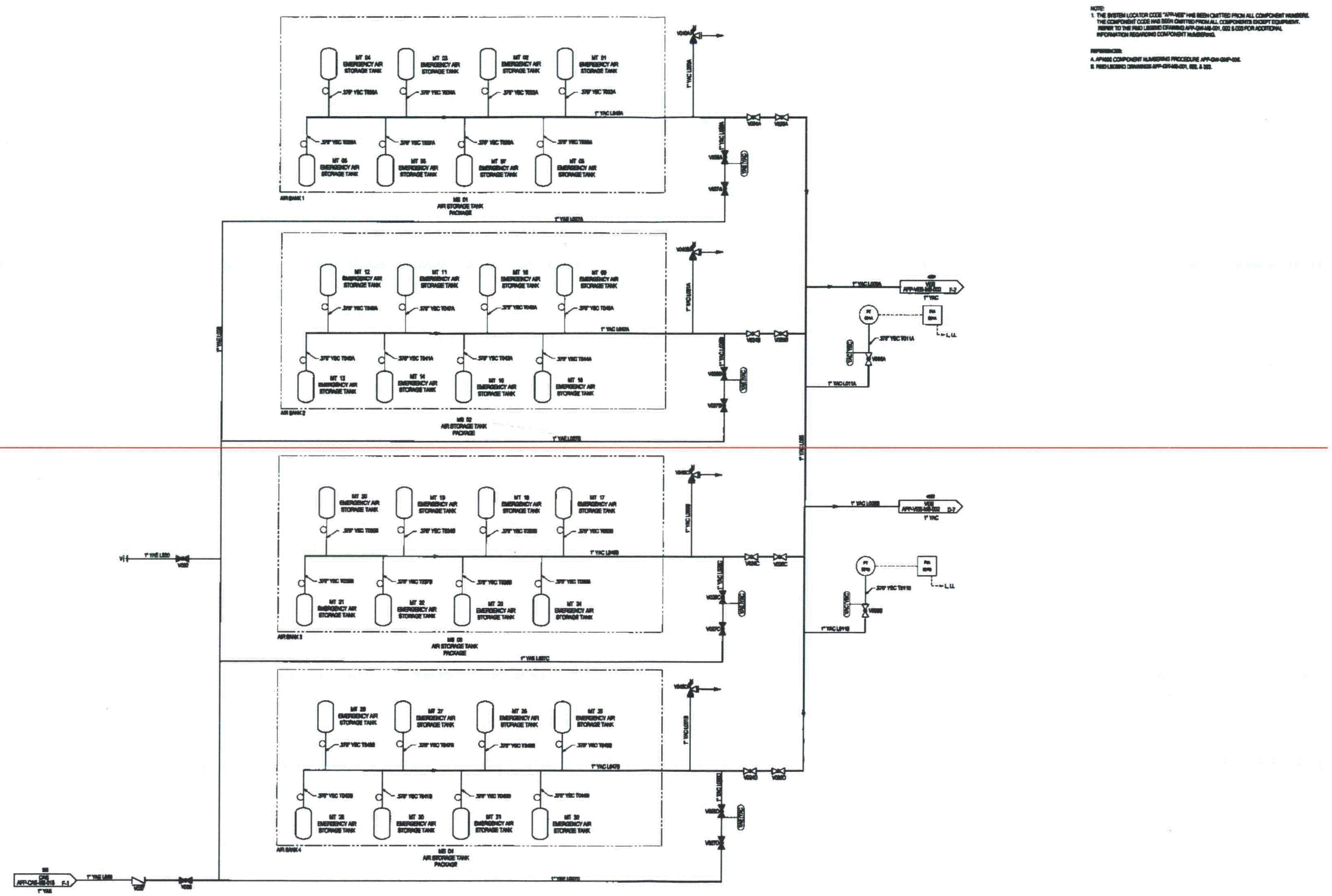


Figure 6.4-1

Main Control Room Envelope



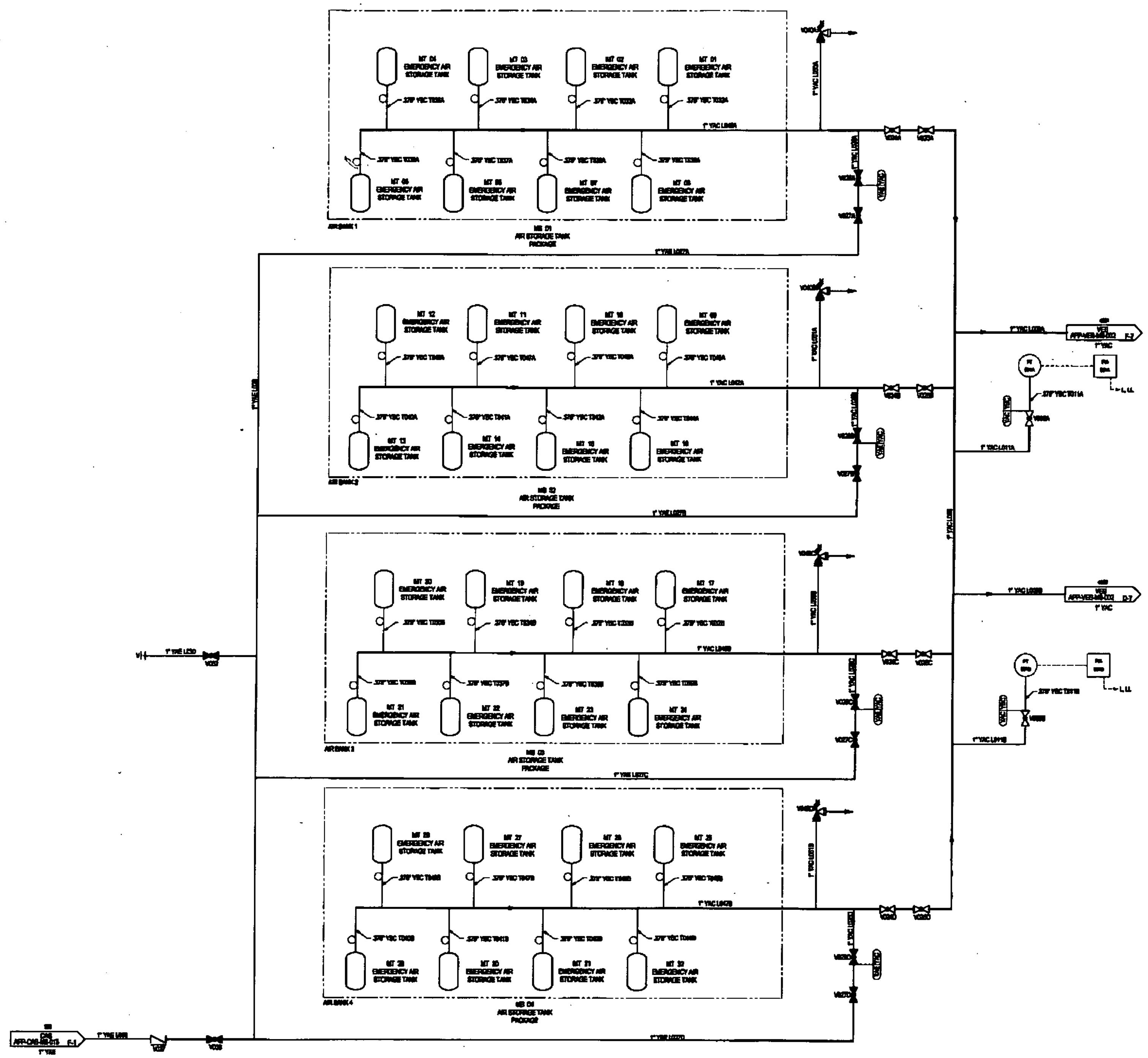
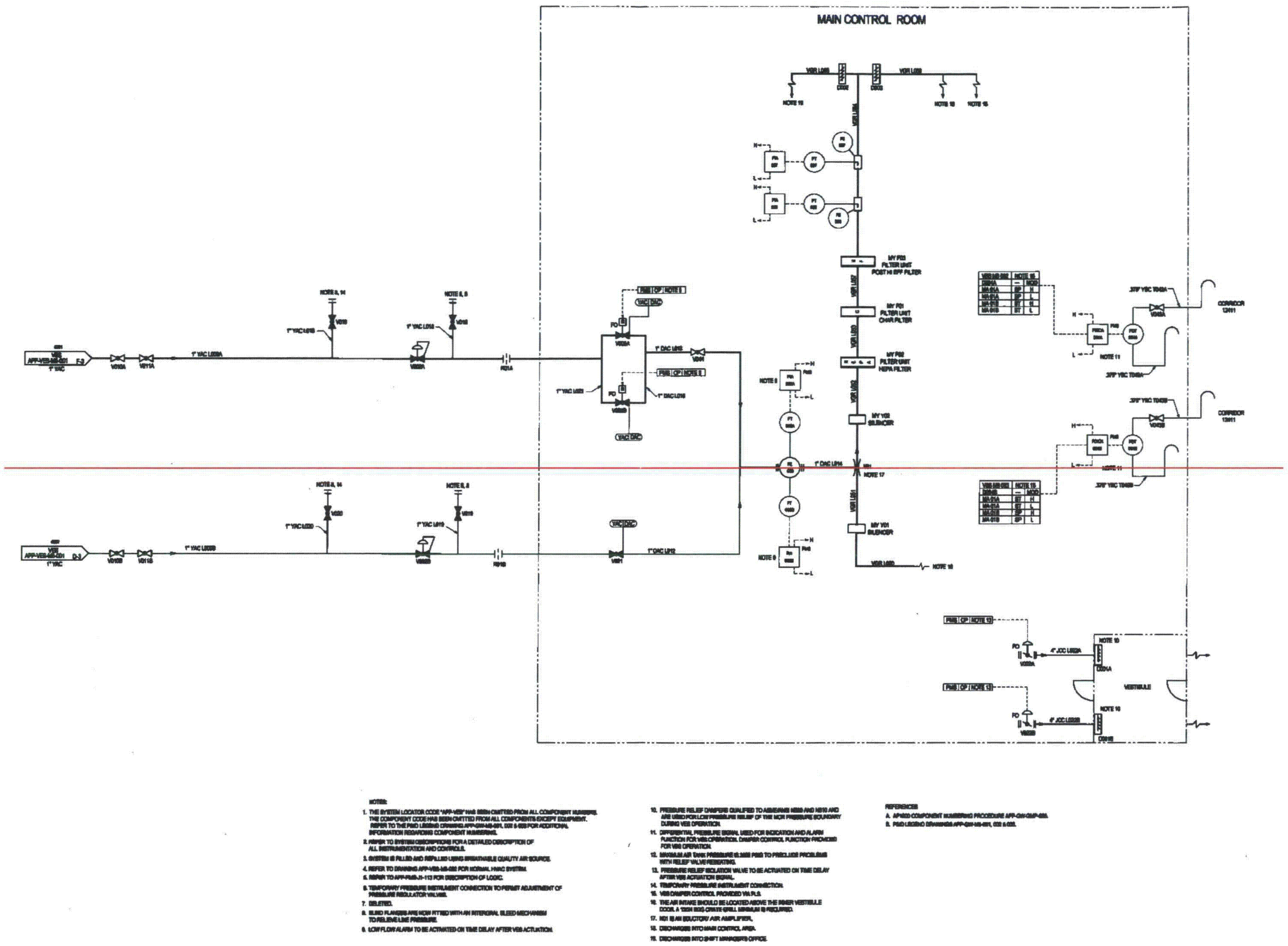


Figure 6.4-2 (Sheet 1 of 2)

Main Control Room Habitability System
Piping and Instrumentation Diagram


MAIN CONTROL ROOM

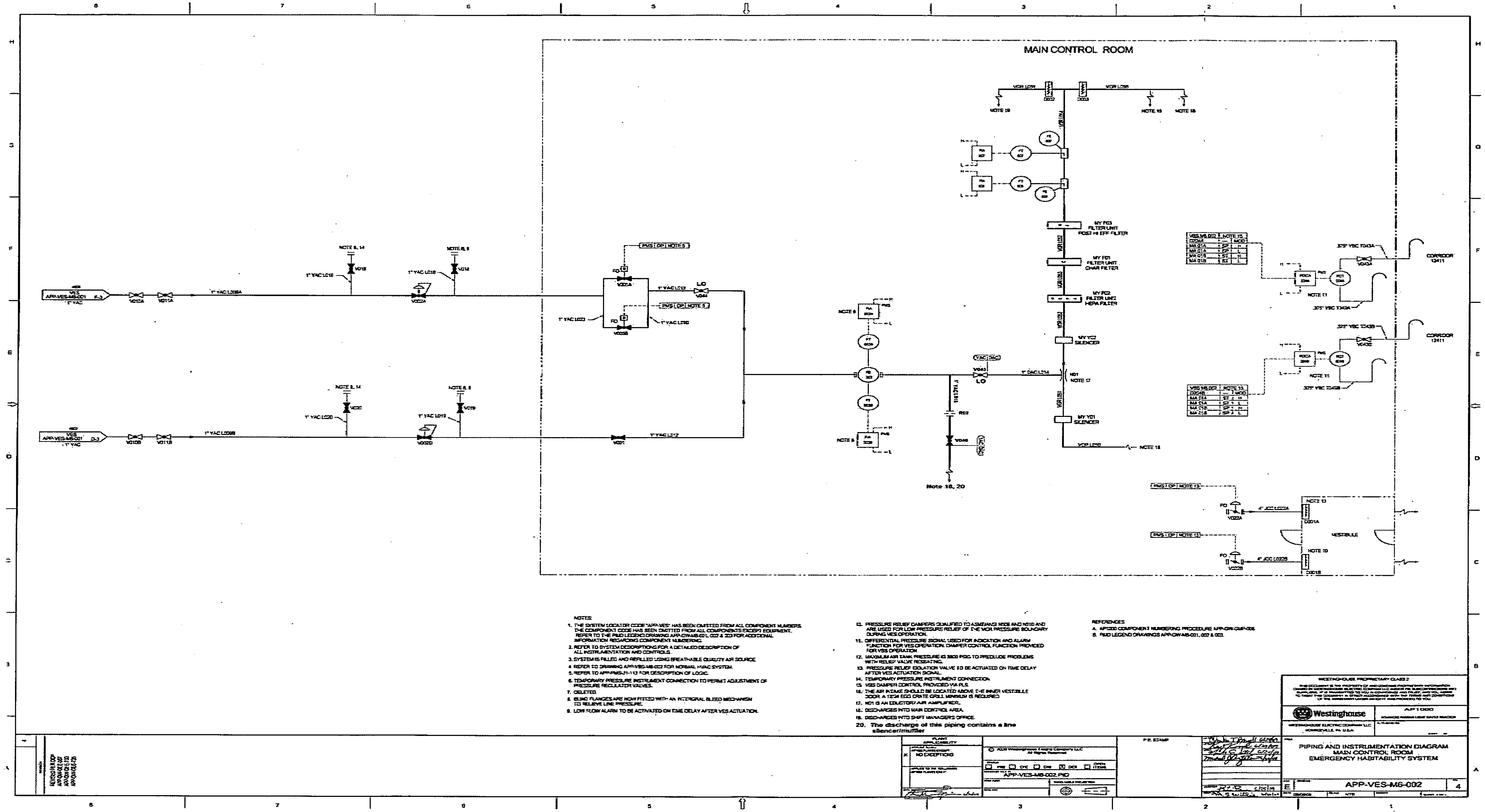


Figure 6.4-2 (Sheet 2 of 2)

Main Control Room Habitability System

Piping and Instrumentation Diagram

Tier 1 DCD Markups

2.2.5 Main Control Room Emergency Habitability System

Design Description

The main control room emergency habitability system (VES) provides a supply of breathable air for the main control room (MCR) occupants and maintains the MCR at a positive pressure with respect to the surrounding areas whenever ac power is not available to operate the nuclear island nonradioactive ventilation system (VBS) or high radioactivity is detected in the MCR air supply. (See Tier 1 material, Section 3.5 for Radiation Monitoring). The VES also limits the heatup of the MCR, the 1E instrumentation and control (I&C) equipment rooms, and the Class 1E dc equipment rooms by using the heat capacity of surrounding structures.

The VES is as shown in Figure 2.2.5-1 and the component locations of the VES are as shown in Table 2.2.5-6.

1. The functional arrangement of the VES is as described in the Design Description of this Section 2.2.5.

2. a) The components identified in Table 2.2.5-1 as ASME Code Section III are designed and constructed in accordance with ASME Code Section III requirements.

   b) The piping identified in Table 2.2.5-2 as ASME Code Section III is designed and constructed in accordance with ASME Code Section III requirements.

3. a) Pressure boundary welds in components identified in Table 2.2.5-1 as ASME Code Section III meet ASME Code Section III requirements.

   b) Pressure boundary welds in piping identified in Table 2.2.5-2 as ASME Code Section III meet ASME Code Section III requirements.

4. a) The components identified in Table 2.2.5-1 as ASME Code Section III retain their pressure boundary integrity at their design pressure.

   b) The piping identified in Table 2.2.5-2 as ASME Code Section III retains its pressure boundary integrity at its design pressure.

5. a) The seismic Category I equipment identified in Table 2.2.5-1 can withstand seismic design basis loads without loss of safety function.

   b) Each of the lines identified in Table 2.2.5-2 for which functional capability is required is designed to withstand combined normal and seismic design basis loads without a loss of its functional capability.

6. a) The Class 1E components identified in Table 2.2.5-1 are powered from their respective Class 1E division.

   b) Separation is provided between VES Class 1E divisions, and between Class 1E divisions and non-Class 1E cable.

7. The VES provides the following safety-related functions:

a) The VES provides a 72-hour supply of breathable quality air for the occupants of the MCR.

b) The VES maintains the MCR pressure boundary at a positive pressure with respect to the surrounding areas. There is a discharge of air through the MCR vestibule.

c) The heat loads within the MCR, the I&C equipment rooms, and the Class 1E dc equipment rooms are within design basis assumptions to limit the heatup of the rooms identified in Table 2.2.5-4.

d) The system provides a passive recirculation flow of MCR air to maintain main control room dose rates below an acceptable level during VES operation.

8. Safety-related displays identified in Table 2.2.5-1 can be retrieved in the MCR.

9. a) Controls exist in the MCR to cause those remotely operated valves identified in Table 2.2.5-1 to perform their active functions.

   b) The valves identified in Table 2.2.5-1 as having protection and safety monitoring system (PMS) control perform their active safety function after receiving a signal from the PMS.

10. After loss of motive power, the remotely operated valves identified in Table 2.2.5-1 assume the indicated loss of motive power position.

11. Displays of the parameters identified in Table 2.2.5-3 can be retrieved in the MCR.

12. The background noise level in the MCR does not exceed 65 dB(A) at the operator work stations when the VES is operating.

Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.2.5-4 specifies the inspections, tests, analyses, and associated acceptance criteria for the VES.

TABLE 2.2.5-1 (CONT.)

Equipment Name	Tag No.	ASME Code Section III	Seismic Cat. I	Remotely Operated Valve	Class 1E/ Qual. for Harsh Envir.	Safety-Related Display	Control PMS	Active Function	Loss of Motive Power Position
Emergency Air Storage Tank 31	VES-MT-31	No	Yes	-	-/-	-	-	-	-
Emergency Air Storage Tank 32	VES-MT-32	No	Yes	-	-/-	-	-	-	-
Air Delivery Alternate Isolation Valve	VES-PL-V001	Yes	Yes	No	-/-	No	-	Transfer Open	-
Eductor Flowpath Isolation Valve	VES-PL-V045	Yes	Yes	No	-/-	No	-	Transfer Close	-
Eductor Bypass Isolation Valve	VES-PL-V046	Yes	Yes	No	-/-	No	-	Transfer Open	-
Pressure Regulating Valve A	VES-PL-V002A	Yes	Yes	No	-/-	No	-	Throttle Flow	-
Pressure Regulating Valve B	VES-PL-V002B	Yes	Yes	No	-/-	No	-	Throttle Flow	-
MCR Air Delivery Isolation Valve A	VES-PL-V005A	Yes	Yes	Yes	Yes/No	No	Yes	Transfer Open	Open
MCR Air Delivery Isolation Valve B	VES-PL-V005B	Yes	Yes	Yes	Yes/No	No	Yes	Transfer Open	Open
MCR Pressure Relief Isolation Valve A	VES-PL-V022A	Yes	Yes	Yes	Yes/No	No	Yes	Transfer Open	Open
MCR Pressure Relief Isolation Valve B	VES-PL-V022B	Yes	Yes	Yes	Yes/No	No	Yes	Transfer Open	Open

Air Tank Safety Relief Valve A	VES-PL-V040A	Yes	Yes	No	-/-	No	-	Transfer Open	-
Air Tank Safety Relief Valve B	VES-PL-V040B	Yes	Yes	No	-/-	No	-	Transfer Open	-

TABLE 2.2.5-1 (CONT.)

Equipment Name	Tag No.	ASME Code Section III	Seismic Cat. I	Remotely Operated Valve	Class 1E/ Qual. for Harsh Envir.	Safety-Related Display	Control PMS	Active Function	Loss of Motive Power Position
Air Tank Safety Relief Valve ~~A~~C	VES-PL-~~V041A~~V040C	Yes	Yes	No	-/-	No	-	Transfer Open	-
Air Tank Safety Relief Valve ~~B~~D	VES-PL-~~V041B~~V040D	Yes	Yes	No	-/-	No	-	Transfer Open	-
Main Air Flow Path Isolation Valve	VES-PL-V044	Yes	Yes	No	-/-	No	-	Transfer Close	-
MCR Air Filtration Line Eductor	VES-PY-N01	Yes	Yes	-	-	-	-	-	-
MCR Air Filtration Line Charcoal Filter	VES-MY-F01	No	Yes	-	-	-	-	-	-
MCR Air Filtration Line HEPA Filter	VES-MY-F02	No	Yes	-	-	-	-	-	-
MCR Air Filtration Line Postfilter	VES-MY-F03	No	Yes	-	-	-	-	-	-
MCR Gravity Relief Dampers	VES-MD-D001A	No	Yes	-	-	-	-	-	-
MCR Gravity Relief Dampers	VES-MD-D001B	No	Yes	-	-	-	-	-	-

MCR Air Filtration Line Supply Damper	VES-MD-D002	No	Yes	-	-	-	-	-	-
MCR Air Filtration Line Supply Damper	VES-MD-D003	No	Yes	-	-	-	-	-	-
MCR Air Filtration Line Silencer	VES-MY-Y01	No	Yes	-	-	-	-	-	-
MCR Air Filtration Line Silencer	VES-MY-Y02	No	Yes	-	-	-	-	-	-
MCR Air Delivery Line Flow Sensor	VES-003A	No	Yes	-	Yes/No	Yes	-	-	-
MCR Air Delivery Line Flow Sensor	VES-003B	No	Yes	-	Yes/No	Yes	-	-	-
MCR Differential Pressure Sensor A	VES-004A	No	Yes	-	Yes/No	Yes	-	-	-
MCR Differential Pressure Sensor B	VES-004B	No	Yes	-	Yes/No	Yes	-	-	-

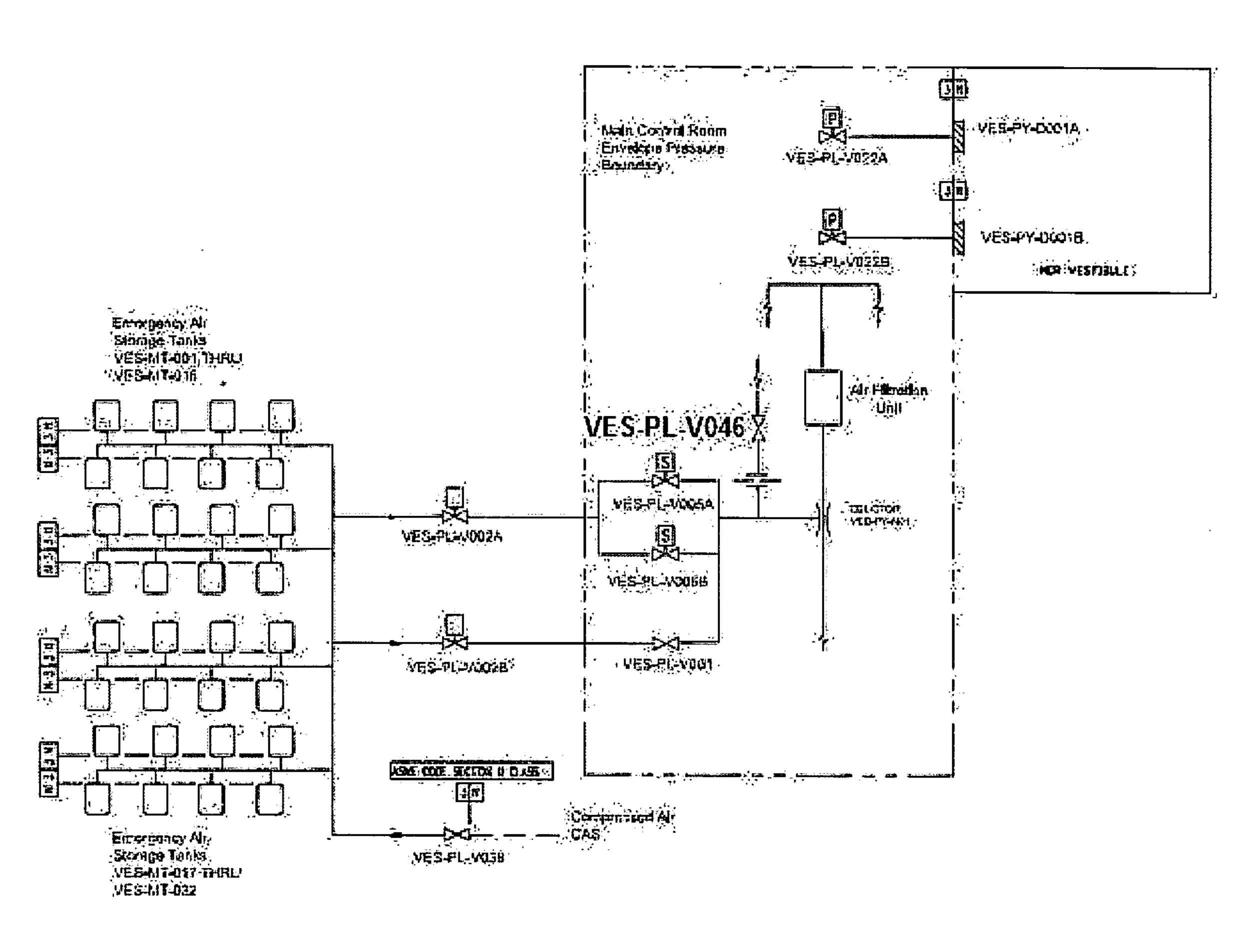


Figure 2.2.5-1
Main Control Room Emergency Habitability System

TABLE 2.2.5-5 (CONT.)
INSPECTIONS, TESTS, ANALYSES, AND ACCEPTANCE CRITERIA

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
7.a) The VES provides a 72-hour supply of breathable quality air for the occupants of the MCR.	i) Testing will be performed to confirm that the required amount of air flow is delivered to the MCR.	i) The air flow rate from the VES is at least 60 scfm and not more than 70 scfm.
	ii) Analysis of storage capacity will be performed based on as-built manufacturers data.	ii) The calculated storage capacity is greater than or equal to 314,132 scf.
	iii) MCR air samples will be taken during VES testing and analyzed for quality.	iii) The MCR air is of breathable quality.
7.b) The VES maintains the MCR pressure boundary at a positive pressure with respect to the surrounding areas.	i) Testing will be performed with VES flow rate between 60 and 70 scfm to confirm that the MCR is capable of maintaining the required pressurization of the pressure boundary.	i) The MCR pressure boundary is pressurized to greater than or equal to 1/8-in. water gauge with respect to the surrounding area.
	ii) Air leakage into the MCR will be measured during VES testing using a tracer gas.	ii) ~~Analysis of air leakage measurements indicate that VES operation limits MCR air infiltration consistent with operator dose analysis.~~Air leakage into the MCR is less than or equal to 10 cfm.
7.c) The heat loads within the MCR, the I&C equipment rooms, and the Class 1E dc equipment rooms are within design basis assumptions to limit the heatup of the rooms identified in Table 2.2.5-4.	An analysis will be performed to determine that the heat loads from as-built equipment within the rooms identified in Table 2.2.5-4 are less than or equal to the design basis assumptions.	A report exists and concludes that: the heat loads within rooms identified in Table 2.2.5-4 are less than or equal to the specified values or that an analysis report exists that concludes: – The temperature and humidity in the MCR remain within limits for reliable human performance for the 72-hour period. – The maximum temperature for the 72-hour period for the I&C rooms is less than or equal to 120°F. – The maximum temperature for the 72-hour period for the Class 1E dc equipment rooms is less than or equal to 120°F.

TABLE 2.2.5-5 (CONT.) INSPECTIONS, TESTS, ANALYSES, AND ACCEPTANCE CRITERIA		
Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
7d) The system provides a passive recirculation flow of MCR air to maintain main control room dose rates below an acceptable level during VES operation.	Testing will be performed to confirm that the required amount of air flow circulates through the MCR passive filtration system	The air flow rate at the outlet of the MCR passive filtration system is at least 600 cfm greater than the flow measured by VES-FT003A/B.

TABLE 2.2.5-5 (CONT.) INSPECTIONS, TESTS, ANALYSES, AND ACCEPTANCE CRITERIA		
Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
8. Safety-related displays identified in Table 2.2.5-1 can be retrieved in the MCR.	Inspection will be performed for retrievability of the safety-related displays in the MCR.	Safety-related displays identified in Table 2.2.5-1 can be retrieved in the MCR.
9.a) Controls exist in the MCR to cause remotely operated valves identified in Table 2.2.5-1 to perform their active functions.	Stroke testing will be performed on remotely operated valves identified in Table 2.2.5-1 using the controls in the MCR.	Controls in the MCR operate to cause remotely operated valves identified in Table 2.2.5-1 to perform their active safety functions.
9.b) The valves identified in Table 2.2.5-1 as having PMS control perform their active safety function after receiving a signal from the PMS.	Testing will be performed on remotely operated valves listed in Table 2.2.5-1 using real or simulated signals into the PMS.	The remotely operated valves identified in Table 2.2.5-1 as having PMS control perform the active safety function identified in the table after receiving a signal from the PMS.
10. After loss of motive power, the remotely operated valves identified in Table 2.2.5-1 assume the indicated loss of motive power position.	Testing of the installed valves will be performed under the conditions of loss of motive power.	After loss of motive power, each remotely operated valve identified in Table 2.2.5-1 assumes the indicated loss of motive power position.
11. Displays of the parameters identified in Table 2.2.5-3 can be retrieved in the MCR.	Inspection will be performed for retrievability of the parameters in the MCR.	The displays identified in Table 2.2.5-3 can be retrieved in the MCR.
12. The background noise level in the MCR does not exceed 65 dB(A) at the operator work stations when VES is operating.	The as-built VES will be operated, and background noise levels in the MRC will be measured at the operator work stations with the plant not operating.	The background noise level in the MCR does not exceed 65 dB(A) at the operator work stations when the VES is operating.

2.7.1 Nuclear Island Nonradioactive Ventilation System

Design Description

The nuclear island nonradioactive ventilation system (VBS) serves the main control room (MCR), control support area (CSA), Class 1E dc equipment rooms, Class 1E instrumentation and control (I&C) rooms, Class 1E electrical penetration rooms, Class 1E battery rooms, remote shutdown room (RSR), reactor coolant pump trip switchgear rooms, adjacent corridors, and passive containment cooling system (PCS) valve room during normal plant operation. The VBS consists of the following independent subsystems: the main control room/control support area HVAC subsystem, the class 1E electrical room HVAC subsystem, and the passive containment cooling system valve room heating and ventilation subsystem. The VBS provides heating, ventilation, and cooling to the areas served when ac power is available. The system provides breathable air to the control room and maintains the main control room and control support area areas at a slightly positive pressure with respect to the adjacent rooms and outside environment during normal operations. The VBS monitors the main control room supply air for radioactive particulate and iodine concentrations and provides filtration of main control room/control support area air during conditions of abnormal (high) airborne radioactivity. In addition, the VBS isolates the HVAC penetrations in the main control room boundary on "high-high" particulate or iodine radioactivity in the main control room supply air duct or on a loss of ac power for more than 10 minutes. The Sanitary Drain System (SDS) also isolates a penetration in the main control room boundary on "high-high" particulate or iodine radioactivity in the main control room supply air duct or on a loss of ac power for more than 10 minutes. Additional penetrations from the SDS and Potable Water System (PWS) into the main control room boundary are maintained leak tight using a loop seal in the piping, and the Waste Water System (WWS) is isolated using a normally closed safety related manual isolation valve. Theses features support operation of the main control room emergency habitability system (VES) and have been included in Table 2.7.1-1 and Table 2.7.1-2.

TABLE 2.7.1-1									
Equipment Name	**Tag No.**	**ASME Code Section III**	**Seismic Cat. I**	**Remotely Operated Valve**	**Class 1E/ Qual. for Harsh Envir.**	**Safety-Related Display**	**Control PMS/DAS[(1)]**	**Active Function**	**Loss of Motive Power Position**
MCR Supply Air Isolation Valve	VBS-PL-V186	Yes	Yes	Yes	Yes/No	Yes (Valve Position)	Yes/No	Transfer Closed	~~Closed~~ As Is
MCR Supply Air Isolation Valve	VBS-PL-V187	Yes	Yes	Yes	Yes/No	Yes (Valve Position)	Yes/No	Transfer Closed	~~Closed~~ As Is
MCR Return Air Isolation Valve	VBS-PL-V188	Yes	Yes	Yes	Yes/No	Yes (Valve Position)	Yes/No	Transfer Closed	~~Closed~~ As Is
MCR Return Air Isolation Valve	VBS-PL-V189	Yes	Yes	Yes	Yes/No	Yes (Valve Position)	Yes/No	Transfer Closed	~~Closed~~ As Is
MCR Exhaust Air Isolation Valve	VBS-PL-V190	Yes	Yes	Yes	Yes/No	Yes (Valve Position)	Yes/No	Transfer Closed	~~Closed~~ As Is
MCR Exhaust Air Isolation Valve	VBS-PL-V191	Yes	Yes	Yes	Yes/No	Yes (Valve Position)	Yes/No	Transfer Closed	~~Closed~~ As Is

TABLE 2.7.1-1									
Equipment Name	**Tag No.**	**ASME Code Section III**	**Seismic Cat. I**	**Remotely Operated Valve**	**Class 1E/ Qual. for Harsh Envir.**	**Safety-Related Display**	**Control PMS/DAS(1)**	**Active Function**	**Loss of Motive Power Position**
MCR SDS (Vent) Isolation Valve	SDS-PL-V001	Yes	Yes	Yes	Yes/No	Yes (Valve Position)	Yes/No	Transfer Closed	As Is
MCR SDS (Vent) Isolation Valve	SDS-PL-V002	Yes	Yes	Yes	Yes/No	Yes (Valve Position)	Yes/No	Transfer Closed	As Is
MCR WWS Isolation Valve	WWS-PL-V506	Yes	Yes	No			No		

TABLE 2.7.1-2				
Line Name	**Line Number**	**ASME Code Section III**	**Leak Before Break**	**Functional Capability Required**
Main Control Room Supply	VBS-L311	Yes	No	No
Main Control Room Exhaust	VBS-L312	Yes	No	No
Main Control Room Toilet Exhaust	VBS-L313	Yes	No	No
Main Control Room Sanitary Vent Line	SDS-L035	Yes	No	No
Main Control Room Sanitary Drain Line	SDS-L030	Yes	No	No
Main Control Room Potable Water Line	PWS-L319	Yes	No	No
Main Control Room Waste Water Drain Line	WWS-L808	Yes	No	No
Main Control Room Waste Water Drain Line	WWS-L851	Yes	No	No

DCD Tier 1 Figure 2.7-1 Sheet 1 of 2)