



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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December 11, 2009

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-SRP 6.4-SPCV-12  
RAI-SRP 6.4-SPCV-13

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,

A handwritten signature in black ink, appearing to read 'Robert Sisk'.

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

/Enclosure

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

DO63  
NRC

cc: D. Jaffe - U.S. NRC 1E  
E. McKenna - U.S. NRC 1E  
P. Donnelly - 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

ENCLOSURE 1

Response to Request for Additional Information on SRP Section 6

# AP1000 TECHNICAL REPORT REVIEW

## Response to Request For Additional Information (RAI)

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RAI Response Number: RAI-SRP 6.4-SPCV-12

Revision: 0

### **Question:**

ANSI/ANS-51.1-1983 subsection 3.3.1.3 states that "safety class 3 (SC-3) shall apply to equipment, not included in SC-1 or -2, that is designed and relied upon to accomplish the following nuclear safety functions:

- k. Ensure nuclear safety functions provided by SC-1, -2, or -3 equipment
- m. Provide information or controls to ensure capability for manual or automatic actuation of nuclear safety functions required of SC-1, -2, or -3 equipment.

The two flow instruments in the filtration line provide information to ensure the capability of the eductor to draw at least of 600 cfm so the VES system safety function (MCR habitability during radiological accidents) can be achieved. The existing VES safety flow instrumentation to indicate whether there is sufficient flow (65 cfm) coming from the compressed air tanks to induce the passive filtration is not a direct indication of the performance of the eductor. The operators will rely on this instrumentation during an accident to ensure the safety-related filtration train is functioning. Based on ANSI/ANS-51.1-1983, at least one flow instrument in the passive air filtration line should be safety related.

The applicant needs to provide additional justification that the operators will not rely on this instrumentation during an accident or make one of the instruments safety-related.

### **Westinghouse Response:**

VES flow instruments VES-FT006 and VES-FT007 are appropriately classified as nonsafety related equipment in accordance with the post accident monitoring criteria detailed in Section 7.5 of the DCD and the AP1000 safety classification guidelines. The instruments provide no automatic actuation or control of safety related components that ensure the safety function provided by an AP1000 Class A, B, or C component is performed. The instruments are also not required to ensure the nuclear safety functions are provided by SC-1, -2, or -3 equipment. The instruments are located in the passive filtration line in the VES downstream of the eductor. Due to the passive design of the VES filtration line, no credible failure in the line is assumed for the first 24 hours following a design basis accident. RAI-SRP 6.4-SPCV-13 (Reference 1) demonstrates passive filtration in the line is not required 24 hours after the initiation of a design basis event. Therefore, these instruments are not required to verify there is adequate filtration flow. There is safety related instrumentation in each of the VES air delivery lines from the emergency air storage tanks that alerts an operator if the expected bottle air flow is not being delivered.

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## Response to Request For Additional Information (RAI)

The flow instruments should be defined as a Type E post accident monitoring variables. Section 7.5.2.1 of the DCD defines equipment that monitors the main control room habitability as Type E variables. The flow instruments are defined as Category 3 instruments in accordance with DCD Section 7.5.2.2.3 and Table 7.5-2. The flow instruments are not the primary indication for determining the magnitude of release of radioactive materials. The instruments provide backup information in determining the potential exposure to a control room operator.

DCD Table 7.5-3 provides the summary of qualifications, design, and interface requirements for the different categories of post accident monitoring instrumentation. Based on the classification as an E3 instrument, the flow instruments in the passive filtration line are non-seismic and require non-class 1E power and are therefore non-safety related.

The instruments will be added to Section 7.5 of the DCD as shown below.

### References:

1. RAI-SRP 6.4-SPCV-13 Revision 0

### Design Control Document (DCD) Revision:

Table 7.5-1 (Sheet 12 of 12)								
POST-ACCIDENT MONITORING SYSTEM								
Variable	Range/ Status	Type/ Category	Qualification		Number of Instruments Required	Power Supply	QDPS Indication (Note 2)	Remarks
			Environmental	Seismic				
Main steam line radiation level	10 <sup>-1</sup> - 10 <sup>3</sup> μCi/cc	C2, E2	Mild	None	1/line	Non-1E	No	
Control support area radiation	10 <sup>-1</sup> - 10 <sup>4</sup> mR/hr	E3	None	None	1	Non-1E	No	
Meteorological parameters	N/A	E3	None	None	N/A	Non-1E	No	Site specific
Primary sampling station area radiation level	10 <sup>-1</sup> - 10 <sup>7</sup> mR/hr	E3	None	None	1	Non-1E	No	
VES Passive Air Filtration Flow	0-2000 cfm	E3	None	None	1	Non-1E	No	

# AP1000 TECHNICAL REPORT REVIEW

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Table 7.5-8

### SUMMARY OF TYPE E VARIABLES

Function Monitored	Variable	Type/Category
Containment Radiation	Containment area high range radiation level	E2
Area Radiation	Control support area radiation level	E3
	Primary sampling station area radiation level	E3
Airborne Radioactivity Released from Plant	Turbine island vent discharge radiation level	E2
	Plant vent radiation level	E2
	Plant vent air flow	E2
	Main steam line radiation level	E2
	Boundary environs radiation	E3
	Main control room supply air radiation level	E3
Environs Radiation and Radioactivity	Site specific	E3
Meteorology	Site specific	E3
Accident Sampling	Primary coolant	E3
	Containment air	E3
<u>MCR Filtration Flow</u>	<u>MCR passive filtration induced flow rate</u>	<u>E3</u>

**PRA Revision:** None

**Technical Report (TR) Revision:** None

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## Response to Request For Additional Information (RAI)

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RAI Response Number: RAI-SRP 6.4-SPCV-13  
Revision: 0

### **Question:**

ANSI/ANS-51.1-1983 subsection 3.2.1.c states that "fluid systems required to support, directly or indirectly, the three nuclear safety functions stated above shall be capable of performing their nuclear safety functions as provided in American National Standard Single Failure Criteria for Light Water Reactor Safety-Related Fluid Systems, ANSI/ANS-58.9-1981.

ANSI/ANS-58.9-1981 defines passive failure as "a failure of a component to maintain its structural integrity or the blockage of a process flow path". In this standard the term refers to a random failure and its consequential effects assumed in addition to an initiating event and its consequential effects for the purpose of safety-related fluid system design and analysis. This standard defines rules for application of the Single Failure Criteria as:

During short term, the single failure considered may be limited to an active failure.

During long term, assuming no prior failure during short term, the limiting single failure considered can be either active or passive.

Long term is defined as that period of safety-related fluid system operation following the short term, during which the safety function of the system is required. Short term is defined as that period of operation up to 24 hours following an initiating event.

Additionally, TSTF-448 Revision 3 both "MCREC system" Technical Specifications section and "CRFA system" Technical Specifications section have the following statement:

"No single active or passive failure will cause the loss of outside or re-circulated air from the CRE."

The VES passive filtration line is required to meet single failure criteria. The single active or passive failure of a component in the VES passive filtration line, assuming a loss of outside power, shall not impair the ability of the system to perform its design function. If the present passive filtration design proposed by applicant has a passive failure, e.g., the nozzle section of the eductor fails to induce the minimum 600 cfm, the safety function of the filtration may not be achievable. The proposed VES passive filtration line does not have independent, redundant trains to re-circulate and filter the CRE. Therefore, it does not appear to meet the single failure criteria.

The applicant needs to provide a justification that the described system meets the single failure criteria or to provide a redundant filter train.

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### Westinghouse Response:

The primary components that comprise the main control room habitability system (VES) passive filtration line are duct work, two silencers, an eductor, and a filtration unit. The passive filtration line has no active components. The only active components in the VES are in the air delivery portion of the system that provides the motive flow to induce to the filtration flow. The air delivery portion of the system also provides breathable air for main control room occupants during abnormal scenarios. In the air delivery portion of the system, there are redundant flow paths. The redundant flow paths prevent a single active or passive failure from impairing the ability of the system to perform its design function. Based on the guidance in SECY-77-439 (Reference 1), the passive filtration portion of the system must be evaluated for a credible passive failure 24 hours after the start of an event. SECY-77-439 defines a passive failure as events such as a line blockage or structural failure of a static component that limits the effectiveness of the component. Though a passive failure in the passive filtration portion of the VES is highly unlikely, it would not impair main control room habitability. Dose analysis for the AP1000 main control room was performed to verify that in the event of a passive failure in the passive filtration portion of the VES 24 hours after the initiation of the event operator doses would remain below 5 rem TEDE. The limiting AP1000 main control room dose scenarios were evaluated for a loss of filtration flow 24 hours into an accident. These scenarios are limiting since they involve a release 24 hours after the initiation of the event. The analysis showed the following acceptable increases in dose rates compared to the scenarios when filtration is available for 72 hours. Therefore, the passive filtration portion of the VES can sustain a single passive failure without impairing main control room habitability for the first 72 hours following a design basis accident.

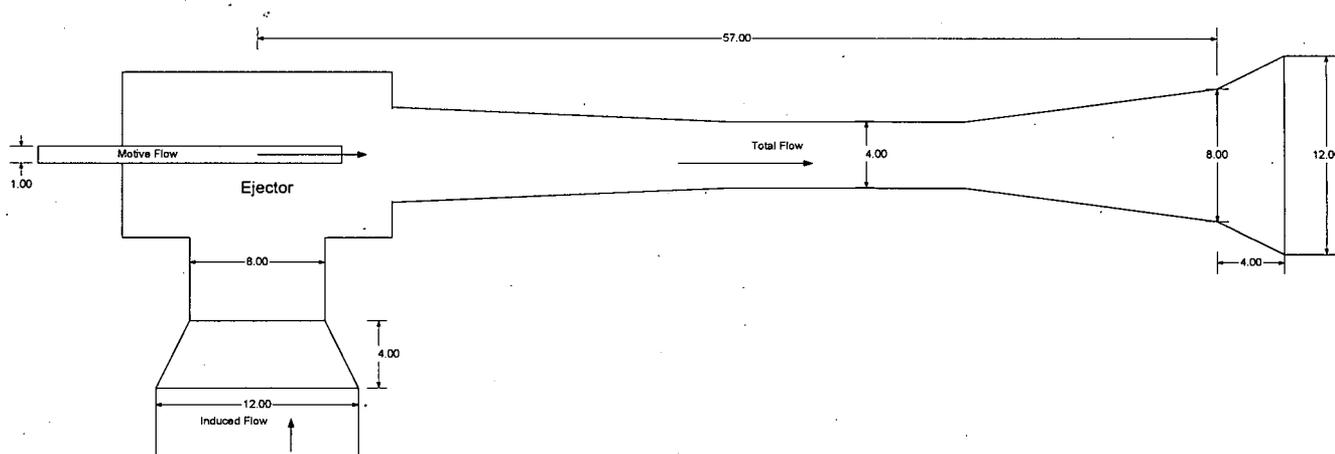
Comparison of Limiting VES Operating Cases		
Scenario	VES Filtration Operating for 72 Hours	VES Filtration Operating for 24 Hours
Large Break LOCA	4.41 rem TEDE	4.41 rem TEDE
Steam Line Break (pre-existing iodine spike)	3.9 rem TEDE	3.91 rem TEDE
Steam Line Break (Accident initiated iodine spike)	4.0 rem TEDE	4.41 rem TEDE

A markup of Section 6.4.4 of the AP1000 DCD is provided below to reflect that the passive filtration line can sustain a single failure in accordance with SECY-77-439 without impairing main control room habitability for the first 72 hours following a design basis accident. The finalized supporting calculations for the dose rates identified above and in the markup to Section 6.4.4 of the DCD are still in the process of being formally updated. The dose rates listed above are the results of detailed scoping analysis. If the results in the final calculations are different, Westinghouse will revise this response to identify the change. No significant change is expected from the formalized calculations.

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## Response to Request For Additional Information (RAI)

The VES emergency air storage tanks are still required to provide 65 +/- 5 cfm of breathable air to the main control room envelope for 72 hours during a design basis accident when VES is in operation. There are redundant active components in the flow path that are capable of providing the breathable air from the emergency air storage tanks to the main control room envelope. The two air delivery lines converge inside the main control room envelope and connect to the eductor to provide the motive flow to induce the filtration flow. A safety related instrument monitors the air flow from the emergency air storage tanks to verify that adequate air flow is being delivered to the main control room envelope. The configuration of this portion of the system is identical to the VES design certified in Revision 15 of the AP1000 DCD. The air in the VES emergency air storage tanks is provided through the high pressure air portion of the Compressed Air System (CAS). The compressor package that provides the air to the emergency air storage tanks contains a filtration package and an air purifier/dryer to maintain moisture free breathable air meeting the requirements of ANSI/CGA G7.1 commodity specification for Air Class E. There is no source that could create line blockage in the VES line from the air bottles to the eductor. A simplified schematic of the AP1000 eductor is shown below. If blockage were to occur downstream of the eductor in the filtration line after 24 hours, it would be expected that complete blockage of the filtration line would not occur. In this scenario, the blockage would increase the backpressure in the filtration line, which would reduce the total filtration flow. However, if by some mechanism, complete line blockage were to occur, the breathable air from the VES emergency air storage tanks would still be delivered to the main control room envelope. The breathable air would flow through the intake of the filtration line into the main control room envelope.



In addition to the DCD markup to address passive failures, reference to the Westinghouse test report for the passive filtration line has been added to the DCD as discussed on the conference call with the NRC on December 8, 2009. The reference to the test report was added to the system general description in Section 6.4.2.2 of the DCD.

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## Response to Request For Additional Information (RAI)

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### References:

1. SECY-77-439

### Design Control Document (DCD) Revision:

#### 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 12). 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 10). 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.

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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.

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### 6.4.4 System Safety Evaluation

In the event of an accident involving the release of radioactivity to the environment, 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. 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 conservative assumptions, and the main control room doses are 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.

Doses 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 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 rem TEDE	4.73 rem TEDE
Fuel Handling Accident	2.5 rem TEDE	1.6 rem TEDE
Steam Generator Tube Rupture (Pre-existing iodine spike)	4.3 rem TEDE	3.1 rem TEDE
(Accident-initiated iodine spike)	1.2 rem TEDE	1.7 rem TEDE
Steam Line Break (Pre-existing iodine spike)	3.9 rem TEDE	2.1 rem TEDE
(Accident-initiated iodine spike)	4.0 rem TEDE	4.9 rem TEDE
Rod Ejection Accident	1.8 rem TEDE	2.2 rem TEDE
Locked Rotor Accident (Accident without feedwater available)	0.7 rem TEDE	0.5 rem TEDE
(Accident with feedwater available)	0.5 rem TEDE	1.5 rem TEDE
Small Line Break Outside Containment	0.8 rem TEDE	0.3 rem TEDE

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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.

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 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. 60 scfm of

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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  
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 13), 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

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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.

<u>Large Break LOCA</u>	<u>4.41 rem TEDE</u>
<u>Steam Line Break</u>	
<u>(Pre-existing iodine spike)</u>	<u>3.91 rem TEDE</u>
<u>(Accident-initiated iodine spike)</u>	<u>4.41 rem TEDE</u>

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.

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### 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. "Code on Nuclear Air and Gas Treatment," ASME/ANSI AG-1-1997
8. "Loss of Charcoal Adsorber Cells," IE Bulletin 80-03, 1980
9. "High-Efficiency, Particular, Air-Filter Units," UL-586, 1996
10. "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
11. "Test Performance of Air-Filter Units," UL-900, 1994
12. "AP1000 VES Air Filtration System Test Report," TR-SEE-III-09-03
13. "Single Failure Criterion," SECY-77-439