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Subject: **Revised Response to Portion of NRC Request for Additional Information Letter No. 355 Related to ESBWR Design Certification Application – Auxiliary Systems – RAI Number 9.4-53 S01**

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) revised response to the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) 9.4-53 S01 sent by NRC Letter No. 355, Reference 1. The original response was previously submitted via Reference 2.

The response to RAI Number 9.4-53 (Reference 3) was submitted to the NRC via Reference 4.

GEH response to RAI Number 9.4-53 S01 is addressed in Enclosure 1. An analysis supporting this response is provided in Enclosure 2. Enclosure 3 contains the DCD markups associated with this response.

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

Sincerely,

Richard E. Kingston

Richard E. Kingston
Vice President, ESBWR Licensing

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NRO

References:

1. MFN 09-600, Letter from U.S. Nuclear Regulatory Commission to Jerald G. Head, *Request for Additional Information Letter No. 355 Related to ESBWR Design Certification Application*, September 16, 2009
2. MFN 09-627, Response to Portion of NRC Request for Additional Information Letter No. 355 Related to ESBWR Design Certification Application – Auxiliary Systems – RAI Number 9.4-53 S01, October 28, 2009
3. MFN 08-550, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request for Additional Information Letter No. 215 Related to ESBWR Design Certification Application*, June 23, 2008
4. MFN 08-791, Response to Portion of NRC Request for Additional Information Letter Number No. 215, Related to ESBWR Design Certification Application – Auxiliary Systems – RAI Number 9.4-53, October 20, 2008

Enclosures:

1. Revised Response to Portion of NRC Request for Additional Information Letter No. 355 Related to ESBWR Design Certification Application - Auxiliary Systems - RAI Number 9.4-53 S01
2. Revised Response to Portion of NRC Request for Additional Information Letter No. 355 Related to ESBWR Design Certification Application - Auxiliary Systems - RAI Number 9.4-53 S01 – Supporting Analysis – GENE 0000-0112-2778 R0
3. Revised Response to Portion of NRC Request for Additional Information Letter No. 355 Related to ESBWR Design Certification Application - Auxiliary Systems - RAI Number 9.4-53 S01 – DCD Markups

cc:	AE Cubbage	USNRC (with enclosures)
	JG Head	GEH/Wilmington (with enclosures)
	DH Hinds	GEH/Wilmington (with enclosures)
	TL Enfinger	GEH/Wilmington (with enclosures)
	eDRF Section	0000-0089-7042, Rev. 2 (response, markups)
		0000-0112-2778 (supporting analysis)

Enclosure 1

MFN 09-627, Rev. 1

Revised Response to Portion of NRC Request for Additional Information Letter No. 355 Related to ESBWR Design Certification Application

Auxiliary Systems

RAI Number 9.4-53 S01

NRC RAI 9.4-53 S01

1. In the response to RAI 9.4-53, it was stated that the Reactor Building (RB) accident clean up system draws the contaminated portion (CONAVS area) down to a negative pressure of ¼ in. w.g. Is any credit taken for this negative pressure in terms of a reduction of exfiltration flow in the RADTRAD dose evaluations which were performed for the 72 hour case and the 168 hour case?

2. Operating the RB accident dose clean up system provides a direct release to the environment through the stack. With a 95% efficient filter, 5% of the release would be considered unfiltered and impact the dose consequence analysis results. The staff is concerned that the testing program for filter efficiency base on RG 1.140 does not provide the level of confidence in filter efficiency to justify its use in the dose consequence analysis for the operation of the RB accident clean up system prior to the end of the 30 day accident evaluation period. Maintaining filter efficiency is an important protection to the public and operators during accident scenarios. Change the test program for filter efficiency to be based on RG 1.52, including test frequency in order to provide additional assurance that the filters have not degraded.

3. In ITAAC Table 2.16-2-2 item 12b, change the RG 1.140 to RG 1.52. Clarify that the RB accident clean up system must meet the requirements for filter efficiency as tested in the laboratory and meet the in place by pass leakage test which is done in the field. These are two separate tests.

GEH Revised Response

1. In the response to RAI 9.4-53, it was stated that the Reactor Building (RB) accident clean up system draws the contaminated portion (CONAVS area) down to a negative pressure of ¼ in. w.g. Is any credit taken for this negative pressure in terms of a reduction of exfiltration flow in the RADTRAD dose evaluations which were performed for the 72 hour case and the 168 hour case?

No credit has been taken for the negative pressure that would result in a reduction of exfiltration flow in any of the DCD Chapter 15 DBA dose evaluations which model releases from the Reactor Building (RB). Further, none of the post accident dose evaluations credit use of the RB HVAC accident exhaust filter units for mitigating dose consequences. The RB HVAC accident exhaust filter units are defense-in-depth units only, with no requirements to run them post-accident.

2. Operating the RB accident dose clean up system provides a direct release to the environment through the stack. With a 95% efficient filter, 5% of the release

would be considered unfiltered and impact the dose consequence analysis results. The staff is concerned that the testing program for filter efficiency base on RG 1.140 does not provide the level of confidence in filter efficiency to justify its use in the dose consequence analysis for the operation of the RB accident clean up system prior to the end of the 30 day accident evaluation period. Maintaining filter efficiency is an important protection to the public and operators during accident scenarios. Change the test program for filter efficiency to be based on RG 1.52, including test frequency in order to provide additional assurance that the filters have not degraded.

Under accident conditions, the RB (CONAVS and REPAVS areas) automatically isolate on high radiation to provide a hold up volume for fission products. When isolated, the RB (CONAVS areas) can be serviced by the RB HVAC accident exhaust filter units (ref: DCD Tier 2, Subsection 9.4.6). **No credit is taken for the filters** in dose consequence analyses (DCD Tier 2, Subsection 15.4.4) as noted in DCD Tier 2, Subsection 6.2.3. Operating the RB HVAC accident exhaust filter units as a defense-in-depth function during a LOCA:

1. Is not credited in the dose consequence analysis; and
2. Would not cause an increase in dose above that assumed in the design basis LOCA analysis for operation of the system after 8 hours following a DBA.

The ESBWR Reactor Building HVAC Accident Exhaust Filter Unit Dose Consequence Parametric Study, provided as Enclosure 2 of this RAI response, demonstrates that operation of the RB HVAC accident exhaust filter unit(s) will not result in an increase in dose upon operation of the system after 8 hours following a DBA given that the RTNSS function is maintained (ref: DCD Tier 2, Subsection 19A.8.4.11, "The reactor building contaminated area ventilation system filters (Reactor Building HVAC Accident Exhaust Filters only) must maintain the required filtering efficiency to ensure that theoretical control room doses are not exceeded for certain beyond design basis LOCAs").

The parametric study was executed by adding the filter unit release pathway to the ESBWR DBA LOCA model (modeled in RADTRAD v3.03) over a range of filter flows between 50 cfm and 1000 cfm and starting the filter unit at various times in the LOCA event.

The parametric study results indicate the following:

1. Use of an RB HVAC accident exhaust filter unit will always reduce the dose to the Control Room (CR) and the Low Population Zone (LPZ).
2. Use of an RB HVAC accident exhaust filter unit in post LOCA conditions assuming the "worst failure" could drive the dose at the Exclusion Area Boundary (EAB) to exceed the DBA LOCA dose results by a negligible amount (by less than 1 rem). At no time under any condition could use of the filter unit result in a dose at the EAB to be over the Regulatory Limit set forth in 10 CFR 52.47(a)(2).

3. A non-failure case was run to demonstrate the benefit of using the filter unit while still assuming a failure of the unit to draw the RB to a negative pressure. The results show that if the filter unit is started at the beginning of the DBA LOCA event, dose consequences at all offsite and onsite locations are decreased significantly.

The study performed in this evaluation demonstrates that although the DBA LOCA dose at the EAB could be exceeded by use of the filter unit if the "worst case" failure mode were to occur; the EAB would remain below the regulatory limit, and would only exceed the LOCA EAB dose by 0.6 TEDE rem maximum while decreasing the CR and LPZ doses by more than 50%. Because the risk involved with using the filter units is very small, it is recommended that the filter unit be used without restriction for any period following a DBA. In addition, not using the system as early as practical to mitigate a LOCA would not apply available "defense in depth" capabilities from a safety perspective.

The following assumptions have been applied to the DBA LOCA RB model pathway to the environment during operation of the RB HVAC accident exhaust filter unit in this evaluation:

1. It has been conservatively assumed that the RB HVAC accident exhaust filter unit does not create a negative pressure in the RB contaminated areas.
    a. The unfiltered RB leakage (300 cfm) to the environment is assumed to continue for the duration of the event. (ref: DCD Tier 2, Table 9.4-11).
    b. The RB HVAC accident exhaust filter unit is assumed to draw from the RB Contaminated Area HVAC Subsystem (CONAVS area) and exhaust via the RB/FB stack.
    c. The maximum adjustable rated flow of the RB HVAC accident exhaust filter unit is 1000 cfm. The parametric study has been executed over a range of filter flows between 50 cfm and 1000 cfm to envelope the maximum rated range of the filter units.
2. It is conservatively assumed that an inflow equal to the flow out of the RB/FB stack is coming from the environment to the CONAVS area. The scenario modeled for this evaluation is assumed to be credible only for this evaluation. It is recognized that if the RB is not drawn down to a negative pressure by the operation of the RB HVAC accident exhaust filter unit then a failure in the HVAC ducting for the system would have had to occur where the filter unit is drawing flow from one of the areas it traverses. The only possible areas from which that flow could be drawn are the environment, a clean area of the RB (CLAVS), or a contaminated area.
    a. The filter unit is inside the RB and has no boundary with the environment so it is not possible for it to ever draw air directly from the environment.

b. If the flow through the filter unit were being drawn from a clean area of the RB then there would be no impact in venting clean air to the environment. There would be no release via the RB/FB stack pathway.

c. If the flow through the filter unit were being drawn from a CONAVS area of the RB then there would have to be a leakage pathway into the CONAVS area from either a clean area of the RB or the environment. However, the CONAVS area in the RB will be leak tested to the leakage rate credited in the DBA LOCA, which ensures that this event is not possible. This is a beyond design basis scenario.

d. Under accident conditions, the RB (CONAVS and REPAVS areas) automatically isolates on high radiation. The RB HVAC accident exhaust filter units will be providing the only RB contaminated area pathway.

3. It is assumed that operation of the RB HVAC accident exhaust filter unit will have no effect on the FW, MSIV, and PCCS release pathways.
4. Consistent with ESBWR DCD Tier 2, Table 9.4-11, the filter units are assumed to have 99% filter efficiency for particulates and 95% filter efficiency for Iodine.
5. The RB/FB stack is assumed to have the same X/Q value as the Reactor Building release. The effluent released through the RB/FB stack is at a location much further away from the Control Room than the RB release currently modeled for the DCD dose analyses. While the X/Q values that could be associated with the RB/FB stack have not been added to the DCD, site specific analyses for North Anna Power Station and Grand Gulf Nuclear Station show that the X/Q value from the RB/FB stack is expected to be an order of magnitude lower than the X/Q value currently used for the RB release. The RB/FB stack X/Q would generate significantly lower CR doses in the RADTRAD model.

While assumptions applied to the ESBWR Reactor Building HVAC Exhaust Filter Unit Dose Consequence Parametric Study are beyond design basis they illustrate that the RB HVAC accident exhaust filter units will provide a defense in depth function. Operating a filter unit would draw the RB (CONAVS) down to at least –0.25” w.g. Emergency procedures will ensure proper flow and negative pressure is maintained by the RB HVAC accident exhaust filter unit during operation. This negative pressure would reduce the assumed unfiltered RB leakage compared to that resulting from the positive RB (CONAVS area) pressure developed under accident conditions. The amount of equivalent unfiltered exfiltration would therefore be less than the assumed 141.6 l/s (300 cfm) (ref: DCD Tier 2, Subsection 6.2.3).

Assurance that the RB HVAC accident exhaust filter units will maintain the required filtering efficiency is provided as follows:

- The RB HVAC accident exhaust filters maintain the CONAVS served areas of the reactor building at a minimum negative pressure of 62 Pa (-1/4 inch w.g.) relative to surrounding clean areas when operating (ref: DCD Tier 1, Table 2.16.2-2, Item 12a);

- The RB HVAC accident exhaust filters meet RG 1.140 and ASME AG-1 requirements for HEPA and carbon filter efficiency (ref: DCD Tier 1, Table 2.16.2-2, Item 12b);
- Preoperational testing of the RTNSS RB HVAC accident exhaust filter units will be performed to validate the ability to maintain the specified negative pressure in the designated rooms and areas and to direct local and total air flow, including any potential leakage relative to the anticipated contamination levels (ref: DCD Tier 2, Subsection 14.2.8.1.25);
- The RTNSS RB HVAC accident exhaust filter units will additionally be operationally tested each month by running each filter unit for 15 minutes as is recommended in RG 1.52 Rev. 3 (ref: DCD Tier 2, Subsection 9.4.6.4);
- Each required Reactor Building HVAC accident exhaust filtration train will be verified to start on a manual signal and operate for ≥ 15 continuous minutes (ref: DCD Tier 2, Chapter 19, ACSR 3.7.5.1);
- RB HVAC accident exhaust filter unit testing will be performed in accordance with DCD Tier 2, Subsection 9.4.6.4 (ref: DCD Tier 2, Chapter 19, ACSR 3.7.5.2).

The testing for filter efficiency based upon RG 1.140 or RG 1.52 both provide a level of confidence against filter degradation. As shown in this response, Table 1, Comparison of RG 1.140 and RG 1.52 Requirements, the methodology, testing, and filter efficiencies tested to, are prescriptive in both Regulatory Guides. Both Regulatory Guides ensure required laboratory test efficiency to 99% HEPA and 95% charcoal. Both Regulatory Guides specify the identical standards acceptable to the NRC staff for design and testing of atmospheric cleanup systems (filter units). Testing to RG 1.140 ensures protection to the public and operators during system operation.

The testing frequency for the RB HVAC accident exhaust filter units is revised from 1440 hours of operation to 720 hours of operation to align the RB HVAC accident exhaust filter unit testing frequency requirements to conform with testing requirements of RG 1.52.

3. In ITAAC Table 2.16-2-2 item 12b, change the RG 1.140 to RG 1.52. Clarify that the RB accident clean up system must meet the requirements for filter efficiency as tested in the laboratory and meet the in place by pass leakage test which is done in the field. These are two separate tests.

DCD Tier 1, Subsection 2.16.2.1 Reactor Building HVAC and ITAAC Table 2.16.2-2 correctly specify the RB HVAC accident exhaust filters meet RG 1.140 and ASME AG-1 requirements for HEPA and carbon filter efficiency. These filter units are not assumed to operate post-accident in the licensing bases and are not credited in the design basis accident analysis. As such, they are not safety-related RG 1.52 ESF Credited Filter Units. They are “atmospheric cleanup systems designed to collect airborne radioactive materials during normal plant operation, including anticipated operational occurrences" which fall under RG 1.140 scope, as specified in RG 1.52.

The filter efficiency requirements for both RGs are specifically delineated in the RGs as stated above. Testing will ensure the filtration requirements are met. Stating that the RB HVAC accident exhaust filters meet RG 1.140, with additional guidance in DCD Tier 2, Subsection 9.4.6.4, ensures that the filter efficiency meets the laboratory and in place testing per the Regulatory Guide. Committing to RG 1.52 in lieu of RG 1.140 for the RB HVAC accident exhaust filter units places additional unnecessary safety related requirements on these RTNSS components (e.g., Seismic Cat I, 1E electrical power supply). Table 1 of this response is provided to illustrate the filter testing similarities between RG 1.52 and RG 1.140.

DCD clarification/change is needed to DCD Tier 2, Subsection 9.4.6.4 to ensure testing is performed on the RB HVAC accident exhaust filter units after each 720 hours of operation versus the 1440 hours currently specified. This will align the RB HVAC accident exhaust filter unit testing frequency requirements in DCD Tier 2, Subsection 9.4.6.4 with identical testing requirements of RG 1.52.

GEH agrees that both in-place filter bypass leakage testing and laboratory filter efficiency testing is required for the RB HVAC accident exhaust filter units. DCD Tier 1, Table 2.16.2-2, ITAAC for the Reactor Building HVAC will be revised to clarify that these separate tests will be performed.

DCD Impact

DCD Tier 1, Table 2.16.2-2, ITAAC for the Reactor Building HVAC will be changed to clarify that in place by-pass leakage testing and requirements for filter efficiency as tested in the laboratory are performed to ensure RB HVAC accident exhaust filter units performance.

DCD Tier 2, Subsection 6.2.3 will be changed to provide a description of the RB HVAC accident exhaust filter unit dose consequence analysis performed in response to this RAI.

DCD Tier 2, Subsection 9.4.6 will be changed to clarify that the RB HVAC accident exhaust filter units, in addition to the RB HVAC online purge exhaust filter unit, meet GDC 60 by suitably controlling the release of gaseous radioactive effluents to the environment during periods of high radioactivity.

DCD Tier 2, Subsections 9.4.6.1 and 9.4.6.3 will be changed to reflect that the manually started RB HVAC accident exhaust filter units provide the ability to draw a negative pressure on the contaminated ventilation served areas of the RB and exhaust the filtered air to the RB/FB stack at any time after 8 hours post accident (> 8 hours) operation.

DCD Tier 2, Subsection 9.4.6.2 will be changed to reflect that the RB HVAC accident exhaust filter units are used for mitigating and controlling particulate in addition to gaseous effluents.

DCD Tier 2, Subsection 9.4.6.4 will be changed to ensure testing is performed on the RB HVAC accident exhaust filter units after each 720 hours of operation versus the 1440 hours currently specified.

DCD Tier 2, Appendix 19A, Availability Control Manual Basis B3.7.5 will be changed to reflect that the RB HVAC accident exhaust filter units are used for mitigating and controlling particulate in addition to gaseous effluents and exhaust the space air in the CONAVS area without recirculation.

TABLE 1 - COMPARISION OF RG 1.140 and RG 1.52 REQUIREMENTS

Subject / Criterion	Reg Guide 1.140, Rev. 2	Reg Guide 1.52, Rev. 3	Notes
Title	Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of **Normal Atmosphere Cleanup Systems** in Light-Water-Cooled Nuclear Power Plants	Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of **Post-Accident Engineered-Safety-Feature Atmosphere Cleanup Systems** in Light-Water-Cooled Nuclear Power Plants	RG 1.140 is for nonsafety-related. RG 1.52 is for safety-related.
Discussion Standards acceptable to NRC for Design and Testing	Standards acceptable to the NRC staff for the design and testing of normal atmosphere cleanup systems include those portions of ASME N509-1989, "Nuclear Power Plant Air-Cleaning Units and Components" (Ref. 1), ASME N510-1989, "Testing of Nuclear Air-Treatment Systems" (Ref. 2), and ASME AG-1-1997, "Code on Nuclear Air and Gas Treatment" (Ref. 3) that are referenced in this guide and ASTM D3803-1989, "Standard Test Methods for Nuclear-Grade Activated Carbon" (Ref. 4).	Standards acceptable to the NRC staff for the design and testing of ESF atmosphere cleanup systems include those portions of ASME N509-1989, "Nuclear Power Plant Air-Cleaning Units and Components" (Ref. 7); ASME N510-1989, "Testing of Nuclear Air-Treatment Systems" (Ref. 8); and ASME AG-1-1997, "Code on Nuclear Air and Gas Treatment" (Ref. 9) that are referenced in this guide, and ASTM D3803-1989, "Standard Test Methods for Nuclear-Grade Activated Carbon" (Ref. 10).	Both RGs call out identical Standards.
General Design and Testing Criteria	C. Regulatory Position; 1. General Design and Testing Criteria Invokes ASME AG-1-1997 and ASME N509-1989 as guidance.	C. Regulatory Position; 1. General Design and Testing Criteria Invokes ASME AG-1-1997 and ASME N509-1989 as **criteria**.	Both RGs call out ASME N510-1989 for testing.

Subject / Criterion	Reg Guide 1.140, Rev. 2	Reg Guide 1.52, Rev. 3	Notes
HEPA Filters	C. Regulatory Position; 4. Component Design Criteria and Qualification Testing; 4.3 The HEPA filters should be designed, constructed, and tested in accordance with Section FC of ASME AG-1-1997. Each HEPA filter should be tested for penetration of a challenge aerosol such as dioctyl phthalate (DOP) in accordance with Section TA of ASME AG-1-1997.	C. Regulatory Position; 4. Component Design Criteria and Qualification Testing; 4.4 HEPA filters used in ESF atmosphere cleanup systems should be designed, constructed, and tested in accordance with Section FC of ASME AG-1-1997. HEPA filters should be compatible with the chemical composition and physical conditions of the air stream. Each HEPA filter should be tested by the manufacturer (or by a qualified filter test facility) for penetration of a challenge aerosol such as dioctyl phthalate (DOP) in accordance with the procedures of Section TA of ASME AG-1-1997. Testing and documentation should be in accordance with a quality assurance program consistent with Appendix B to 10 CFR Part 50.	RG 1.140 is for nonsafety-related. RG 1.52 is for safety-related (10 CFR 50 , Appendix B).
In-Place Testing Codes	C. Regulatory Position; 6. In-place Testing Criteria; Introduction Initial in-place testing of normal atmosphere cleanup systems should be performed in accordance with Section TA of ASME AG-1-1997. Periodic, in-place testing of normal atmosphere cleanup systems and components should be performed in accordance with ASME N510-1989 as modified and supplemented by the following:	C. Regulatory Position; 6. In-place Testing Criteria; Introduction Initial in-place acceptance testing of ESF atmosphere cleanup systems and components should be performed in accordance with Section TA of ASME AG-1-1997. Periodic, in-place testing of ESF atmosphere cleanup systems and components should be performed in accordance with ASME N510-1989 as modified and supplemented by the following:	Same.

Subject / Criterion	Reg Guide 1.140, Rev. 2	Reg Guide 1.52, Rev. 3	Notes
Required Intermittent Operation	N/A.	C. Regulatory Position; 6. In-place Testing Criteria; 6.1 Each ESF atmosphere cleanup train should be operated continuously for at least 15 minutes each month, with the heaters on (if so equipped), to justify the operability of the system and all its components.	ESBWR DCD Tier 2 Section 9.4.6.4 Testing and Inspection Requirements states: The RTNSS RB HVAC Accident Exhaust Filter Units will additionally be operationally tested each month by running each filter unit for 15 minutes as is recommended in RG 1.52 Rev. 3.
Leak Tests for HEPA Filters	C. Regulatory Position; 6. In-place Testing Criteria; 6.2 In-place aerosol leak tests for HEPA filters upstream from the carbon adsorbers in normal atmosphere cleanup systems should be performed (1) initially, (2) at least once each 24 months, (3) after each partial or complete replacement of a HEPA filter bank, (4) following detection of, or evidence of, penetration or intrusion of water or other material into any portion of a normal atmosphere cleanup system that may have an adverse effect on the functional capability of the filters, and (5) following painting, fire, or chemical release in any ventilation zone communicating with the system that may have an adverse effect on the functional capability of the system. The test should be	C. Regulatory Position; 6. In-place Testing Criteria; 6.3 In-place aerosol leak tests for HEPA filters upstream from the carbon adsorbers in ESF atmosphere cleanup systems should be performed (1) initially, (2) at least once each 24 months, (3) after each partial or complete replacement of a HEPA filter bank, (4) following detection of, or evidence of, penetration or intrusion of water or other material into any portion of an ESF atmosphere cleanup system that may have an adverse effect on the functional capability of the filters, and (5) following painting, fire, or chemical release in any ventilation zone communicating with the system that may have an adverse effect on the functional capability of the system. The test should be performed in accordance with Section 10 of ASME N510-1989.	Criterion 6.2 of RG 1.140 corresponds to Criterion 6.3 of RG 1.52.

Subject / Criterion	Reg Guide 1.140, Rev. 2	Reg Guide 1.52, Rev. 3	Notes
	performed in accordance with Section 10 of ASME N510-1989. The leak test should confirm a combined penetration and leakage (or bypass) of the normal atmosphere cleanup system of less than 0.05% of the challenge aerosol at rated flow ±10%. A filtration system satisfying this condition can be considered to warrant a 99% removal efficiency for particulates. HEPA filter sections in normal atmosphere cleanup systems that fail to satisfy the appropriate leak-test conditions should be examined to determine the location and cause of leaks. Repairs, such as alignment of filter frames and tightening of filter hold-down bolts, may be made; however, repair of defective, damaged, or torn filter media by patching or using caulking materials is not recommended in normal atmosphere cleanup systems, and such filters should be replaced and not repaired. HEPA filters that fail to satisfy test conditions should be replaced with filters qualified pursuant to Regulatory Position 4.3 of this guide. After repairs or filter replacement, the normal atmosphere cleanup system should be retested as described above in this Regulatory Position.	The leak test should confirm a combined penetration and leakage (or bypass) of the ESF atmosphere cleanup system of less than 0.05% of the challenge aerosol at rated flow ±10%. To be credited with a 99% removal efficiency for particulate matter in accident dose evaluations, a HEPA filter bank in an ESF atmosphere cleanup system should demonstrate an aerosol leak test result of less than 0.05% of the challenge aerosol at rated flow ±10%. HEPA filter sections in ESF atmosphere cleanup systems that fail to satisfy the appropriate leak-test conditions should be examined to determine the location and cause of leaks. Repairs, such as alignment of filter frames and tightening of filter hold-down bolts, may be made; however, patching or caulking materials should not be used in the repair of defective, damaged, or torn filter media in ESF atmosphere cleanup systems; such filters should be replaced and not repaired. HEPA filters that fail to satisfy test conditions should be replaced with filters qualified pursuant to Regulatory Position 4.4 of this guide. After repairs or filter replacement, the ESF atmosphere cleanup system should be retested as described above in this Regulatory Position. The above process should be repeated as	

Subject / Criterion	Reg Guide 1.140, Rev. 2	Reg Guide 1.52, Rev. 3	Notes
	In accordance with ASME N510-1989 and Article TA-1000 of ASME AG-1-1997, the standard challenge aerosol used in the in-place leak testing of HEPA filters is polydisperse droplets of dioctyl phthalate (DOP), also known as di-2-ethylhexyl-phthalate (DEHP). The 0.3 micrometer monodisperse DOP aerosol is used for efficiency testing of individual HEPA filters by manufacturers. Alternative challenge agents7 may be used to perform in-place leak testing of HEPA filters when their selection is based on the following: 1. The challenge aerosol has the approximate light scattering droplet size specified in Article TA-1130 of ASME AG-1-1997 2. The challenge aerosol has the same in-place leak test results as DOP. 3. The challenge aerosol has similar lower detection limit, sensitivity, and precision as DOP. 4. The challenge aerosol causes no degradation of the HEPA filter or the other normal air cleaning system components under test conditions. 5. The challenge aerosol is listed in the Environmental Protection Agency's "Toxic Substance Control Act" (TSCA) inventory for commercial	necessary until combined penetration and leakage (bypass) of the system is less than the acceptance criteria described above in this Regulatory Position. In accordance with ASME N510-1989 and Article TA-1000 of ASME AG-1-1997, the standard challenge aerosol used in the in-place leak testing of HEPA filters is polydisperse droplets of dioctyl phthalate (DOP), also known as di-2-ethylhexyl-phthalate (DEHP). The 0.3 micrometer monodisperse DOP aerosol is used for efficiency testing of individual HEPA filters by manufacturers and Filter Test stations. Alternative challenge agents may be used to perform in-place leak-testing of HEPA filters when their selection is based on the following. 1. The challenge aerosol has the approximate light scattering droplet size specified in Article TA-1130 of ASME AG-1-1997. 2. The challenge aerosol has the same in-place leak test results as DOP. 3. The challenge aerosol has a similar lower detection limit, sensitivity, and precision as DOP. 4. The challenge aerosol causes no degradation of the HEPA filter or the other ESF air cleaning system components under test conditions. 5. The challenge aerosol is listed in the	

Subject / Criterion	Reg Guide 1.140, Rev. 2	Reg Guide 1.52, Rev. 3	Notes
	use.	Environmental Protection Agency's "Toxic Substance Control Act" (TSCA) inventory for commercial use.	
Leak Tests for Adsorbers	C. Regulatory Position; 6. In-place Testing Criteria; 6.3 In-place leak testing for adsorbers should be performed (1) initially, (2) at least once each 24 months, (3) following removal of an adsorber sample for laboratory testing if the integrity of the adsorber section is affected, (4) after each partial or complete replacement of carbon adsorber in an adsorber section, (5) following detection of, or evidence of, penetration or intrusion of water or other material into any portion of a normal atmosphere cleanup system that may have an adverse effect on the functional capability of the adsorbers, and (6) following painting, fire, or chemical release in any ventilation zone communicating with the system that may have an adverse effect on the functional capability of the system. The test should be performed in accordance with Section 11 of ASME N510-1989. The leak test should confirm a combined penetration and leakage (or bypass) of the adsorber section of 0.05% or less of the challenge gas at rated flow±10%.	C. Regulatory Position; 6. In-place Testing Criteria; 6.4 In-place leak testing for adsorbers should be performed (1) initially, (2) at least once each 24 months, (3) following removal of an adsorber sample for laboratory testing if the integrity of the adsorber section is affected, (4) after each partial or complete replacement of carbon adsorber in an adsorber section, (5) following detection of, or evidence of, penetration or intrusion of water or other material into any portion of an ESF atmosphere cleanup system that may have an adverse effect on the functional capability of the adsorber, and (6) following painting, fire, or chemical release in any ventilation zone communicating with the system that may have an adverse effect on the functional capability of the system. The test should be performed in accordance with Section 11 of ASME N510-1989. The leak test should confirm a combined penetration and leakage (or bypass) of the adsorber section of 0.05% or less of the challenge gas at rated flow ±10%. Adsorber sections that fail to satisfy the	Criterion 6.3 of RG 1.140 corresponds to Criterion 6.4 of RG 1.52.

Subject / Criterion	Reg Guide 1.140, Rev. 2	Reg Guide 1.52, Rev. 3	Notes
	Adsorber sections that fail to satisfy the appropriate leak-test conditions should be examined to determine the location and cause of leaks. Repairs, such as alignment of adsorber cells, tightening of adsorber cell hold-down bolts, or tightening of test canister fixtures, may be made; however, the use of temporary patching material on adsorbers, filters, housings, mounting frames, or ducts should not be allowed. After repairs or adjustments have been made, the adsorber sections should be retested as described above in this Regulatory Position. In accordance with ASME N510-1989 and Section TA of ASME AG-1-1997, the standard challenge gas used in the in-place leak testing of adsorbers is Refrigerant-11 (trichloromonofluoro-methane). Alternative challenge gases may be used to perform in-place leak testing of adsorbers when their selection is based on meeting the characteristics specified in Appendix TA-C of ASME AG-1-1997.	appropriate leak-test conditions should be examined to determine the location and cause of leaks. Repairs, such as alignment of adsorber cells, tightening of adsorber cell holddown bolts, or tightening of test canister fixtures, may be made; however, the use of temporary patching material on adsorbers, filters, housings, mounting frames, or ducts should not be allowed. After repairs or adjustments have been made, the adsorber sections should be retested as described above in this Regulatory Position. The above process should be repeated as necessary until the combined penetration and leakage (bypass) of the adsorber section is less than the acceptance criteria described above in this Regulatory Position. In accordance with ASME N510-1989 and Section TA of ASME AG-1-1997, the standard challenge gas used in the in-place leak testing of adsorbers is Refrigerant-11 (trichloromonofluoromethane). Alternative challenge gases may be used to perform in-place leak testing of adsorbers, when their selection is based on meeting the characteristics specified in Appendix TA-C of ASME AG-1-1997.	

Subject / Criterion	Reg Guide 1.140, Rev. 2	Reg Guide 1.52, Rev. 3	Notes
Laboratory Testing Standard	N/A.	C. Regulatory Position; 7. Laboratory Testing Criteria for Activated Carbon; Intro. Laboratory testing of samples of activated carbon adsorber material from ESF atmosphere cleanup systems should be performed in accordance with ASTM D3803-1989 and Table 1 of this guide as supplemented by the following:	
Decontamination Efficiencies	C. Regulatory Position; 7. Laboratory Testing Criteria for Activated Carbon; 7.1 The activated carbon adsorber section of the normal atmosphere cleanup system should be assigned the decontamination efficiencies given in Table 1 for radioiodine if the following conditions are met: 1. The adsorber section meets the conditions given in Regulatory Position 6.3 of this guide, 2. New activated carbon meets the physical property specifications given in Regulatory Position 4.9 of this guide, and 3. Representative samples of used activated carbon pass the laboratory tests given in Table 1 of this guide. If the activated carbon fails to meet any of the above conditions, it should not be used in adsorption units.	C. Regulatory Position; 7. Laboratory Testing Criteria for Activated Carbon; 7.3 For accident dose evaluation purposes, the activated carbon adsorber section of an ESF atmosphere cleanup system should be assigned the appropriate decontamination efficiency given in Table 1 for elemental iodine and organic iodides if the following conditions are met: 1. The adsorber section meets the leak-test conditions given in Regulatory Position 6.4 of this guide. 2. New activated carbon meets the performance and physical property specifications given in Regulatory Position 4.11 of this guide, and 3. Representative samples of new or used activated carbon pass the applicable laboratory tests specified in Table 1 of this guide.	Criterion 7.1 of RG 1.140 corresponds to Criterion 7.3 of RG 1.52.

Subject / Criterion	Reg Guide 1.140, Rev. 2	Reg Guide 1.52, Rev. 3	Notes
		If the activated carbon fails to meet any of the above conditions, it should not be used in adsorbers in ESF atmosphere cleanup systems.	
Analysis of Unused Activated Carbon	N/A	C. Regulatory Position; 7. Laboratory Testing Criteria for Activated Carbon; 7.1 If an analysis of unused activated carbon has not been conducted within the past 5 years, representative samples of the unused activated carbon should be collected at the time of installation or replacement of adsorber material and submitted for analysis. The analysis should be performed in accordance with Regulatory Position 4.11 or Table 1 of this guide, whichever is more restrictive. Carbon that is stored for future use should be stored in its original unopened and undamaged container and stored in a storage area that meets the specifications provided in Subpart 2.2 of ASME NQA-1-1997. Carbon that does not meet these specifications should not be used without performing an analysis demonstrating its current capability.	
Determination of Efficiency of Activated Carbon Adsorber	C. Regulatory Position; 7. Laboratory Testing Criteria for Activated Carbon; 7.2 The efficiency of the activated carbon adsorber section should be	N/A	

Subject / Criterion	Reg Guide 1.140, Rev. 2	Reg Guide 1.52, Rev. 3	Notes
	determined by laboratory testing of representative samples of the activated carbon exposed simultaneously to the same service conditions as the adsorber section. Each representative sample should be not less than 2 inches in both length and diameter, and each sample should have the same qualification and batch test characteristics as the system adsorbent. There should be a sufficient number of representative samples located in parallel with the adsorber section to estimate the amount of penetration of the system adsorbent throughout its service life. The design of the samples should be in accordance with Appendix A to ASME N509-1989. Where system activated carbon is greater than 2 inches deep, each representative sampling station should consist of enough 2-inch samples in series to equal the thickness of the system adsorbent. Once representative samples are removed for laboratory testing, their positions in the sampling array should be blocked off. Sampling and analysis should be performed (1) initially, (2) at intervals of approximately 24 months, (3) following painting, fire, or chemical release in any ventilation zone		

Subject / Criterion	Reg Guide 1.140, Rev. 2	Reg Guide 1.52, Rev. 3	Notes
	communicating with the system that may have an adverse effect on the functional capability of the carbon media, and (4) following detection of, or evidence of, penetration of water or other material into any portion of the filter system that may have an adverse effect on the functional capability of the carbon media. Laboratory tests of representative samples should be conducted, as indicated in Table 1 of this guide, with the test gas flow in the same direction as the flow during service conditions. Similar laboratory tests should be performed on an adsorbent sample before loading into the adsorbers to establish an initial point for comparison of future test results. The activated carbon adsorber section should be replaced with new unused activated carbon meeting the physical property specifications given in Regulatory Position 4.9 of this guide if (1) testing in accordance with Table 1 results in a representative sample that fails to pass the acceptance criterion or (2) no representative sample is available for testing.		

Subject / Criterion	Reg Guide 1.140, Rev. 2	Reg Guide 1.52, Rev. 3	Notes
Sampling and Analysis Schedule	N/A	C. Regulatory Position; 7. Laboratory Testing Criteria for Activated Carbon; 7.2 Sampling and analysis should be performed (1) after each 720 hours of system operation, or at least once each 24 months, whichever comes first, (2) following painting, fire, or chemical release in any ventilation zone communicating with the system that may have an adverse effect on the functional capability of the carbon media, and (3) following detection of, or evidence of, penetration or intrusion of water or other material into any portion of an ESF atmosphere cleanup system that may have an adverse effect on the functional capability of the carbon media.	Sampling and Analysis Schedule Criterion 7.2 of RG 1.140 corresponds to Criterion 7.2 of RG 1.52 with the following ESBWR added requirement: ESBWR DCD Tier 2 Section 9.4.6.4 Testing and Inspection Requirements states: There is an additional requirement that charcoal laboratory testing will be performed on the RB HVAC Accident Exhaust Filter Unit after each 720 hours of operation as recommended by RG 1.52 Rev. 3 for the time based charcoal testing frequency.

Subject / Criterion	Reg Guide 1.140, Rev. 2	Reg Guide 1.52, Rev. 3	Notes
Replacement of Activated Carbon Adsorber	N/A	C. Regulatory Position; 7. Laboratory Testing Criteria for Activated Carbon; 7.4 The activated carbon adsorber section should be replaced with new unused activated carbon that meets the performance and physical property specifications of Regulatory Position 4.11 of this guide if (1) testing in accordance with Regulatory Positions 7.1 and 7.2 results in a representative sample that fails to pass the applicable test in Table 1 of this guide or if (2) no representative sample is available for testing.	
Table 1: Laboratory Tests for Activated Carbon	See Notes	See Notes	The Methyl Iodide Penetration Acceptance Criterion is more strict for RG 1.52 than 1.140. Otherwise, same.

Enclosure 2

MFN 09-627, Rev. 1

Revised Response to Portion of NRC Request for Additional Information Letter No. 355 Related to ESBWR Design Certification Application

Auxiliary Systems

RAI Number 9.4-53 S01

Supporting Analysis – GENE 0000-0112-2778 R0

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EXECUTIVE SUMMARY

A parametric study was performed in order to determine the impact of the "worst failure" of the ESBWR Reactor Building Ventilation System (RBVS) nonsafety-related Reactor Building (RB) HVAC accident exhaust filter unit. The RB accident filter unit is intended for use in post-accident accident conditions after seven days following an ESBWR design basis accident (DBA) LOCA to create a negative pressure in the RB contaminated areas (CONAVS). The parametric study was executed by adding the filter unit release pathway to the ESBWR DBA LOCA model (modeled in RADTRAD v3.03) over a range of filter flows between 50 cfm and 1000 cfm and starting the filter unit at various times in the LOCA event, under the following conditions (which are conservative and do not describe a physically credible failure).

- It was assumed that the filter unit does not create a negative pressure in the RB (its primary function). Therefore, the filter unit is assumed to ***not*** mitigate RB leakage.
- Use of the filter creates an additional release pathway to the environment through the RB/FB stack.
- Unfiltered contaminated inflow equal to the flow out of the RB/FB stack is assumed to be entering the CONAVS area from the environment.

The parametric study results indicate the following:

1. Use of the RB accident filter unit will always reduce the dose to the Control Room (CR) and the Low Population Zone (LPZ).
2. Use of the RB accident filter unit in post LOCA conditions assuming the "worst failure" could drive the dose at the Exclusion Area Boundary (EAB) to exceed the DBA LOCA dose results ***by a negligible amount*** (by less than 1 rem). At no time under any condition could use of the filter unit result in a dose at the EAB to be over the Regulatory Limit set forth in 10 CFR 52.47(a)(2) [1].
3. A non-failure case was run to demonstrate the benefit of using the filter unit while still assuming a failure of the unit to draw the RB to a negative pressure. The results show that if the filter unit is started at the beginning of the DBA LOCA event, dose consequences at all offsite and onsite locations are decreased significantly.

The study performed in this evaluation demonstrates that ***although*** the DBA LOCA dose at the EAB could be exceeded by use of the filter unit if the "worst case" failure mode were to occur; the EAB would remain below the regulatory limit [1], and would only exceed the LOCA EAB dose by 0.6 TEDE rem maximum while decreasing the CR and LPZ doses by more than 50% (see Table 3). Because the risk involved with using the filter units is very small, it is recommended that the filter unit be used without restriction for any period following a DBA. In addition, not using the system as early as practical to mitigate a LOCA would not apply available "defense in depth" capabilities from a safety perspective.

1. PURPOSE AND SCOPE

The purpose of this evaluation is to support the response to RAI 9.4-53 S01, Revised Response-Item 2 that includes the following statement (concerning the post LOCA dose consequences during operation of the RB HVAC accident exhaust filter units):

> ***"The ESBWR Reactor Building Accident Exhaust Filter Unit Dose Consequence Parametric Study, provided as Enclosure 1 of this RAI response, demonstrate that operation of the Reactor Building Accident Exhaust Filter Unit will not result in an increase in dose for operation of the system after 8 hours following a DBA given that the RTNSS function is maintained (ref: DCD 19A.8.4.11- "The reactor building contaminated area ventilation system filters must maintain the required filtering efficiency to ensure that theoretical control room doses are not exceeded for certain beyond design basis LOCAs".***

The ESBWR Reactor Building Ventilation System (RBVS) has two nonsafety-related Reactor Building (RB) HVAC accident exhaust filter unit trains for use post-accident (>seven days) to create a negative pressure in the RB contaminated areas (CONAVS) and exhaust the filtered air to the RB/FB stack [2].

The design basis LOCA dose analysis supporting the ESBWR DCD Rev.6 Section 15.4.4, does not credit the Reactor Building (RB) HVAC system for accident mitigation [3]. This analysis will demonstrate that the assumptions associated with that "passive analysis" (i.e., no credit for RB filter units) bound any conditions that could occur during the potential use of the RB HVAC accident exhaust filter unit, 8 hours post accident, and that the aforementioned assertion in RAI 9.4-53 S01 Revised Response is correct.

2. METHODOLOGY

To determine the impact of the RB HVAC accident exhaust filter unit operation, a release pathway modeling the HVAC accident exhaust filter unit has been added to the RADTRAD model that generated the LOCA results presented in Table 15.4-9 of DCD Revision 6, and a parametric study of the filter flow was performed using RADTRAD v3.03. The modified model was executed at various flow rates over the operational range of the RB HVAC accident exhaust filter unit with the results compared to the LOCA results presented in Table 15.4-9 of DCD Revision 6.

For this parametric study, it is assumed that the filter unit does not create a negative pressure in the RB CONAVS area but still draws flow from CONAVS and exhausts to the RB/FB stack. Therefore, it is assumed that the filter does not mitigate the RB leakage modeled in the ESBWR DBA LOCA, and it creates another release pathway from the RB contaminated areas to the environment. In addition, it is conservatively assumed that an unfiltered contaminated inflow equal to the flow out of the RB/FB stack is coming from the environment to the CONAVS area. These assumptions describe a condition, which is the "worst failure" of the RB accident exhaust filter unit, however, because the failure may not be physically possible it is not considered a credible event.

3. ASSUMPTIONS, INPUTS, AND ANALYSIS

3.1 Assumptions

The following assumptions have been applied to the DBA LOCA RB model pathway to the environment during operation of the RB HVAC accident exhaust filter unit in this evaluation.

1. It has been conservatively assumed that the RB HVAC accident exhaust filter unit does not create a negative pressure in the RB contaminated areas.
   a. The unfiltered RB leakage (300 cfm) to the environment is assumed to continue for the duration of the event.
   b. The RB HVAC accident exhaust filter unit is assumed to draw from the RB Contaminated Area HVAC Subsystem (CONAVS area) and exhaust via the RB/FB stack.
   c. The maximum adjustable rated flow of the RB HVAC accident exhaust filter unit is 1000 cfm (ft^3/min) [4]. The parametric study has been executed over a range of filter flows between 50 cfm and 1000 cfm to envelope the maximum rated range of the filter units.
2. It is conservatively assumed that an inflow equal to the flow out of the RB/FB stack is coming from the environment to the CONAVS area. The scenario modeled for this evaluation is ***assumed*** to be credible ***only*** for this evaluation. It is recognized that if the RB is not drawn down to a negative pressure by the operation of the RB HVAC accident exhaust filter unit then a failure in the HVAC ducting for the system would have had to occur where the filter unit is drawing flow from one of the areas it traverses. The only possible areas which that flow could be drawn from are the environment, a clean area of the RB (CLAVS), or a contaminated area.
   a. The filter unit is inside the RB and has no boundary with the environment so it is not possible for it to ever draw air directly from the environment.
   b. If the flow through the filter unit were being drawn from a clean area of the RB then there would be no impact in venting clean air to the environment. There would be no release via the RB/FB stack pathway.
   c. If the flow through the filter unit were being drawn from a CONAVS area of the RB then there would have to be a leakage pathway into the CONAVS area from either a clean area of the RB or the environment. However, the CONAVS area in the RB will be leak tested to the leakage rate credited in the

DBA LOCA, which ensures that this event is not possible. This is a beyond design basis scenario.

d. Under accident conditions, the RB (CONAVS and REPAVS areas) automatically isolates on high radiation. The RB Accident Exhaust Filter units will be providing the only RB contaminated area pathway.

3. It is assumed that operation of the RB HVAC accident exhaust filter unit will have no effect on the FW, MSIV, and PCCS release pathways.

4. Consistent with ESBWR DCD Tier 2 Table 9.4-11, the filter units are assumed to have 99% filter efficiency for particulates and 95% filter efficiency for Iodine [4].

5. The RB/FB stack is assumed to have the same X/Q values as the Reactor Building release. The effluent released through the RB/FB stack is at a location much further away from the Control Room than the RB release currently modeled for the DCD dose analyses. While the X/Q values that could be associated with the RB/FB stack have not been added to the DCD, site specific analyses for North Anna Power Station [5] and Grand Gulf Nuclear Station [6] show that the X/Q value from the RB/FB stack is expected to be an order of magnitude lower than the X/Q value currently used for the RB release. The RB/FB stack X/Q would generate significantly lower CR doses in the RADTRAD model.

3.2 Inputs

Typically, one bounding dose calculation is performed to determine the dose consequences due to a LOCA. However, GE committed to the NRC to review three accident scenarios (AS-1, AS-2, and AS-3) that were deemed appropriate. Since the dose consequences for Accident Scenario 1 (AS-1) were bounding for all receptor locations, that scenario is the base case for this study.

For each AS (including AS-1), there are four leakage pathways from the primary containment that were modeled using RADTRAD.

- Feedwater (FW) line leakage assumed to leak past feedwater containment isolation valves to the Turbine Building.
- Leakage from the Main Steam Isolation Valves (MSIVs) is released from the main condenser into the Turbine Building.
- Containment leakage through the Passive Containment Cooling System (PCCS) heat exchangers.
- Leakage from containment into the RB that is then leaked to the environment.

The RADTRAD model was taken from the ESBWR LOCA radiological analysis supporting NEDE-33279P Rev. 3 [7]. The following RADTRAD input files were used in this parametric study.

- DCD R6 LOCA AS-1 RB.psf
- BWR_DBA.RFT
- ESBWR LOCA.nif
- Fgr11&12.inp

3.3 Analysis

The following table summarizes LOCA results reported in Table 15.4-9 of DCD Revision 6. The only pathway impacted by use of the RB HVAC accident exhaust filter is the RB leakage pathway.

Table 1 - ESBWR LOCA Inside Containment Accident Scenario 1 Analysis Results

Contributor	EAB TEDE[1]	LPZ TEDE	CR TEDE
Reactor Building Leakage, rem	**17.20[1]**	**16.90**	**3.74**
MSIV Leakage, rem	0.37	2.15	0.33
PCCS Leakage, rem	2.85	1.05	0.49
FW Leakage, rem	1.94	0.68	0.12
Total Dose, rem	**22.4**	**20.78**	**4.69**
Acceptance Criterion, rem	25	25	5

1. The worst two-hour dose occurred beginning at 2.3 hours.

For the comparison performed, the Low Population Zone (LPZ) and Control Room (CR) dose consequence values are generated for the RB leakage model which has been modified to include the RB accident exhaust filter unit pathway and then added to the DBA LOCA PCCS, MSIV, and FW pathway dose contributions to obtain the total doses at the LPZ and CR associated with using the filter unit. The parametric study LPZ and CR results are then directly compared to the total doses reported from DCD Revision 6 Table 15.4-9.

The peak dose interval at the Exclusion Area Boundary (EAB) is determined by calculating the postulated dose for a series of small time increments and performing a "sliding" sum over the increments for successive two-hour periods. Because the peak dose at the EAB occurs early in the event, for all cases evaluated where the filter units are engaged prior to 8 hours in the event, a sliding two-hour sum has been calculated for each LOCA release source, and results for all sources summed to obtain a total dose for each time increment considered. The RADTRAD input files for this analysis used the "RADTRAD Output Control Options" to produce results for supplemental time steps for each Accident Scenario. The case-specific ".psf" input files were setup to provide results every 0.1 hours over the first 8 hours of each event sequence. The "maximum two-hour TEDE" peak dose interval was then extracted from the results for each of those time steps. The 0.1 hour supplemental time step results for the first 8 hours of each event were transferred to a Excel worksheets in the spreadsheet entitled "*RB HVAC Accident Filter Results.xls* " for analysis of "sliding two-hour" EAB dose totals from all contributing sources. The results were then compared to the DBA LOCA EAB results and plotted along with the LPZ and CR doses.

3.3.1 Initiation of the RB filters at 7 days into the event (7 Day Study)

Because the RB HVAC accident exhaust filter unit is intended for use post-accident (>seven days), the first parametric study was performed assuming initiation of the filter unit at 7 days into the event (as it is described in DCD Section 9.4.6.1). The RADTRAD file "DCD R6 LOCA AS-1 RB.psf" includes 8 transfer pathways. The file was renamed "7 Day Study 50 cfm.psf" and two transfer pathways were added using the following RADTRAD parameters.

Pathway 9: Reactor Building to Environment (RB HVAC Accident Filter Unit via the RB/FB stack)

"Filter" flow

Flow Rate 1 = 0 cfm for time 0 hours to 168 hours.
Flow Rate 2 = 50 cfm for 168 hours to 720 hours.
Filter Efficiencies: 99%/95%/95% for Aerosol, Elemental, and Organic, respectively.

Pathway 10: Environment to Reactor Building (Added to Balance the RB/FB stack Flow Path)

"Filter" flow

Flow Rate 1 = 0 cfm for time 0 hours to 168 hours.
Flow Rate 2 = 50 cfm for 168 hours to 720 hours.
Filter Efficiencies: 0%/0%/0% for Aerosol, Elemental, and Organic, respectively.

The file was then executed and the dose results at the Low Population Zone (LPZ), EAB, and the CR were recorded. The file was then renamed using the same naming convention and re-run using flow rates of 250 cfm, 500 cfm, 750 cfm, and 1000 cfm for the period of 0 hours to 720 hours into the event. *However, since the filter unit was not initiated until 7 days in the model and the maximum dose at the EAB in the DCD LOCA dose calculation occurred at 2.3 hours into the event, this case is bounded by the EAB dose reported in DCD Table 15.4-9.*

3.3.2 Initiation of the RB filters at 0 days into the event (0 Day Study)

While the RB HVAC accident exhaust filter unit is intended for use post-accident (>seven days), the most bounding release scenario is initiation of the unit at time t = 0 days. A second parametric study was performed assuming that the RB HVAC accident exhaust filter unit is engaged at 0 days into the LOCA event. For this study, the file was renamed "0 Day Study 50 cfm.psf" and two transfer pathways were added to the model which used the following RADTRAD parameters.

Pathway 9: Reactor Building to Environment (RB HVAC Accident Filter Unit via the RB/FB stack)
"Filter" flow
Flow Rate = 50 cfm for time 0 hours to 720 hours.
Filter Efficiencies: 99%/95%/95% for Aerosol, Elemental, and Organic, respectively.

Pathway 10: Environment to Reactor Building (Added to Balance the RB/FB stack Flow Path)
"Filter" flow
Flow Rate = 50 cfm for time 0 hours to 720 hours.
Filter Efficiencies: 0%/0%/0% for Aerosol, Elemental, and Organic, respectively.

The "0 day" study was performed in the same manner as the t = 7 day case.

3.3.3 Initiation of the RB filters at 8 hours into the event (8 hour Study)

The results of the 0 day study (see Section 4.2) drove the necessity for a third parametric study which was performed assuming that the RB HVAC accident exhaust filter unit is engaged at 8 hours into the LOCA event. Again the file was renamed "8 Hour Study 50 cfm.psf" and two transfer pathways were added with the following RADTRAD parameters.

Pathway 9: Reactor Building to Environment (RB HVAC Accident Filter Unit via the RB/FB stack)
"Filter" flow
Flow Rate 1 = 0 cfm for time 0 hours to 8 hours.
Flow Rate 2 = 50 cfm for 8 hours to 720 hours.
Filter Efficiencies: 99%/95%/95% for Aerosol, Elemental, and Organic, respectively.

Pathway 10: Environment to Reactor Building (Added to Balance the RB/FB stack Flow Path)
"Filter" flow
Flow Rate 1 = 0 cfm for time 0 hours to 8 hours.
Flow Rate 2 = 50 cfm for 8 hours to 720 hours.
Filter Efficiencies: 0%/0%/0% for Aerosol, Elemental, and Organic, respectively.

3.3.4 The Non-failure Study

Because the aforementioned scenarios may not be credible, a fourth parametric study was performed to conservatively demonstrate the impact of the RB HVAC accident exhaust filter unit as used for defense in depth. The most likely failure mode of the filter unit is a failure to start altogether, however, for this study a wind loading condition that could cause the RB to not draw down completely while the filter unit is running has been assumed. The following assumptions have been applied.

1. The RB accident filter unit is assumed to create a negative pressure in the RB. Since the drawdown could typically take on the order of 30 seconds, it is conservatively assumed that it takes 5 minutes (a factor of ten higher).
2. The RB exfiltration pathway from the DBA LOCA is assumed to remain at 300 cfm for the entire drawdown period (5 minutes).
3. It is assumed that the filter unit fails to maintain the negative pressure in the RB due to wind loading on the outside of the RB that causes the doors of the RB to fail in maintaining a seal to the environment. While the type wind gusting associated with the assumed wind-loading event could potentially cause intermittent leakage from the RB doors, it is conservatively assumed here that the leakage from the wind loading is constant rate of 50 cfm for the duration of the LOCA (30 days).
4. The X/Q value for the RB/FB stack is assumed to be the same as the X/Q value for the Reactor Building releases.

For the non-failure study, the RADTRAD file "DCD R6 LOCA AS-1 RB.psf" was renamed "NF Study 50 cfm.psf" and a transfer pathway was added using the following RADTRAD parameters.

Pathway 9: Reactor Building to Environment (RB HVAC Accident Filter Unit via the RB/FB stack)
"Filter" flow

Flow Rate 1 = 50 cfm for time 0 hours to 720 hours.
Filter Efficiencies: 99%/95%/95% for Aerosol, Elemental, and Organic, respectively.

Also the RB exfiltration pathway (pathway 4 in DCD R6 LOCA AS-1 RB.psf) was modified as shown below.

Pathway 4: Reactor Building to Environment (RB Exfiltration)
"Filter" flow

Flow Rate 1 = 300 cfm for time t = 0 hours to 0.0833 hours (5 minutes).
Flow Rate 2 = 50 cfm for 0.0833 hours to 720 hours.
Filter Efficiency: 0% (all species).

The "non-failure" study was performed in the same manner as the other parametric studies.

4. RESULTS

4.1 7 Day Study

The results of the 7-day study indicate that the ESBWR DBA LOCA doses bound all dose consequences that could be generated using the RB HVAC accident exhaust filter even assuming the worst possible failure of the system. Use of the filter unit could assist in accident mitigation for all periods after 7 days into the LOCA event.

Table 2 summarizes the results from the parametric study performed for the case where the filters are engaged at time t = 7 days (the 7-day study).

Table 2 – LOCA Dose Consequences Engaging Exhaust Filters at 7 Days

RB HVAC Accident Filter Flow Rate (cfm)	LPZ Dose TEDE rem	CR Dose TEDE rem	RADTRAD Output Filename
50	20.45	4.60	7 Day Study 50 cfm.o0
250	19.82	4.41	7 Day Study 250 cfm.o0
500	19.46	4.31	7 Day Study 500 cfm.o0
750	19.27	4.25	7 Day Study 750 cfm.o0
1000	19.16	4.22	7 Day Study 1000 cfm.o0
DBA LOCA	***20.78***	***4.69***	***DCD R6 LOCA AS-1 RB.o0***

Those values have been plotted and compared to the DBA LOCA as shown in Figure 1. It was noted that all dose locations are bounded by the DBA LOCA analysis when the filter unit is engaged at 7 days as described in DCD Revision 6.

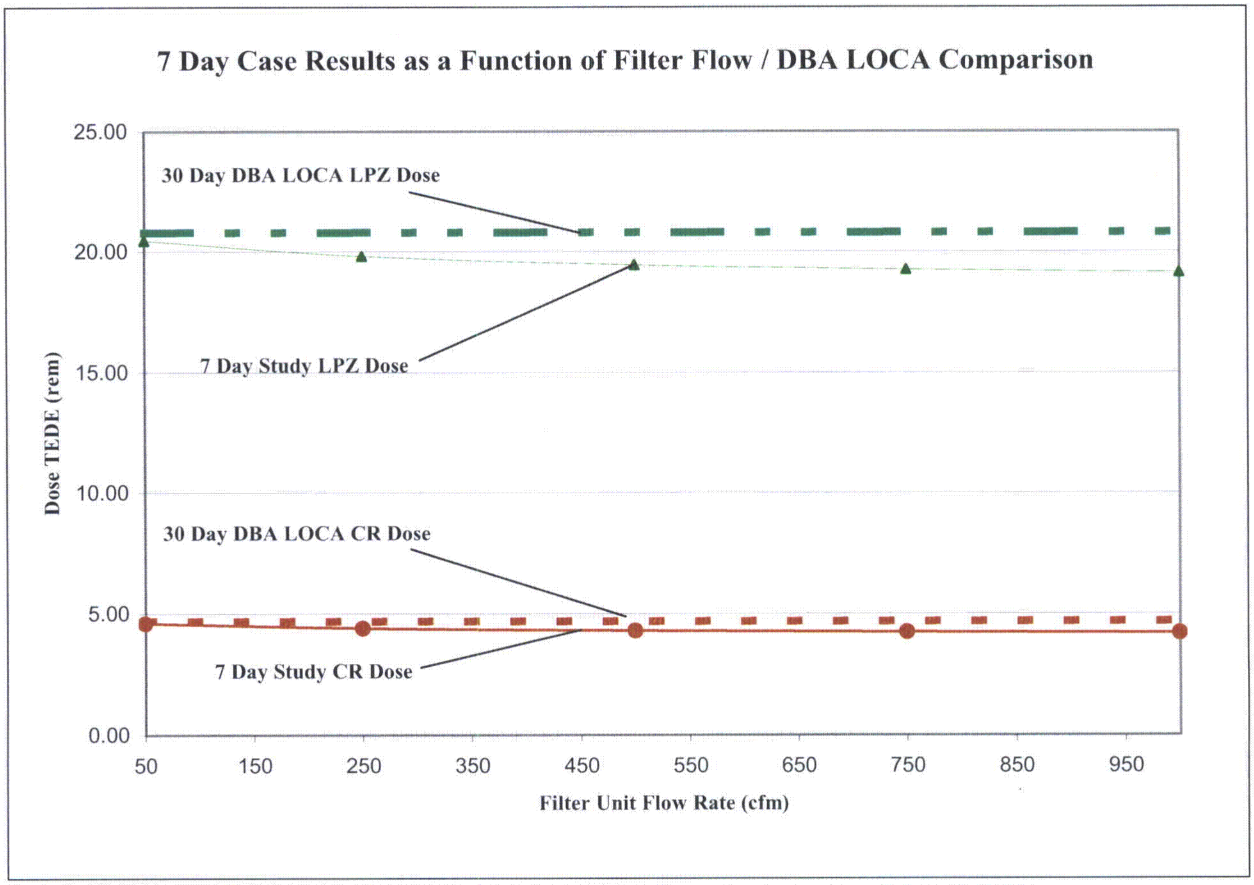

Figure 1 – Comparison of the 7-day study to the DBA LOCA

4.2 0 Day Study

The results of the 0 day study indicate that the dose at the EAB could exceed the DBA LOCA results reported in DCD Revision 6 Table 15.4-9 at that location by 0.6 rem if the RB HVAC accident exhaust filter was initiated at the beginning of the event, and the LPZ and CR doses are bounded by the DBA LOCA (Figure 2). It should be recognized that the EAB dose would remain below the regulatory dose limit of (25 TEDE rem) even assuming the worst failure and allowing the filter unit to run at the maximum design flow rate for the duration of the event.

Table 3 summarizes the results from the parametric study performed for the case where the filters are engaged at time t = 0 days (the 0-day study). In addition to the EAB dose increasing with the initiation of the filter unit at the beginning of the event, the 2-hour window of the worst dose at the EAB moved forward in the event as the filter flow was increased.

Table 3 – LOCA Dose Consequences Engaging Exhaust Filters at 0 Days

RB HVAC Accident Filter Flow Rate (cfm)	LPZ Dose (TEDE rem)	CR Dose (TEDE rem)	EAB Dose (TEDE rem)	EAB Worst 2-hour Period (hr)	Output Filename
50	19.50	4.38	22.4	2.3	0 Day Study 50 cfm.o0
250	16.60	3.65	22.5	2.2	0 Day Study 250 cfm.o0
500	14.86	3.20	22.7	2.1	0 Day Study 500 cfm.o0
750	13.90	2.94	22.9	2.1	0 Day Study 750 cfm.o0
1000	13.28	2.77	23.0	2.0	0 Day Study 1000 cfm.o0
DBA LOCA	***20.78***	***4.69***	***22.4***	***2.3***	***DCD R6 LOCA AS-1 RB.o0***

Those values have been plotted and compared to the DBA LOCA as shown in Figure 2.

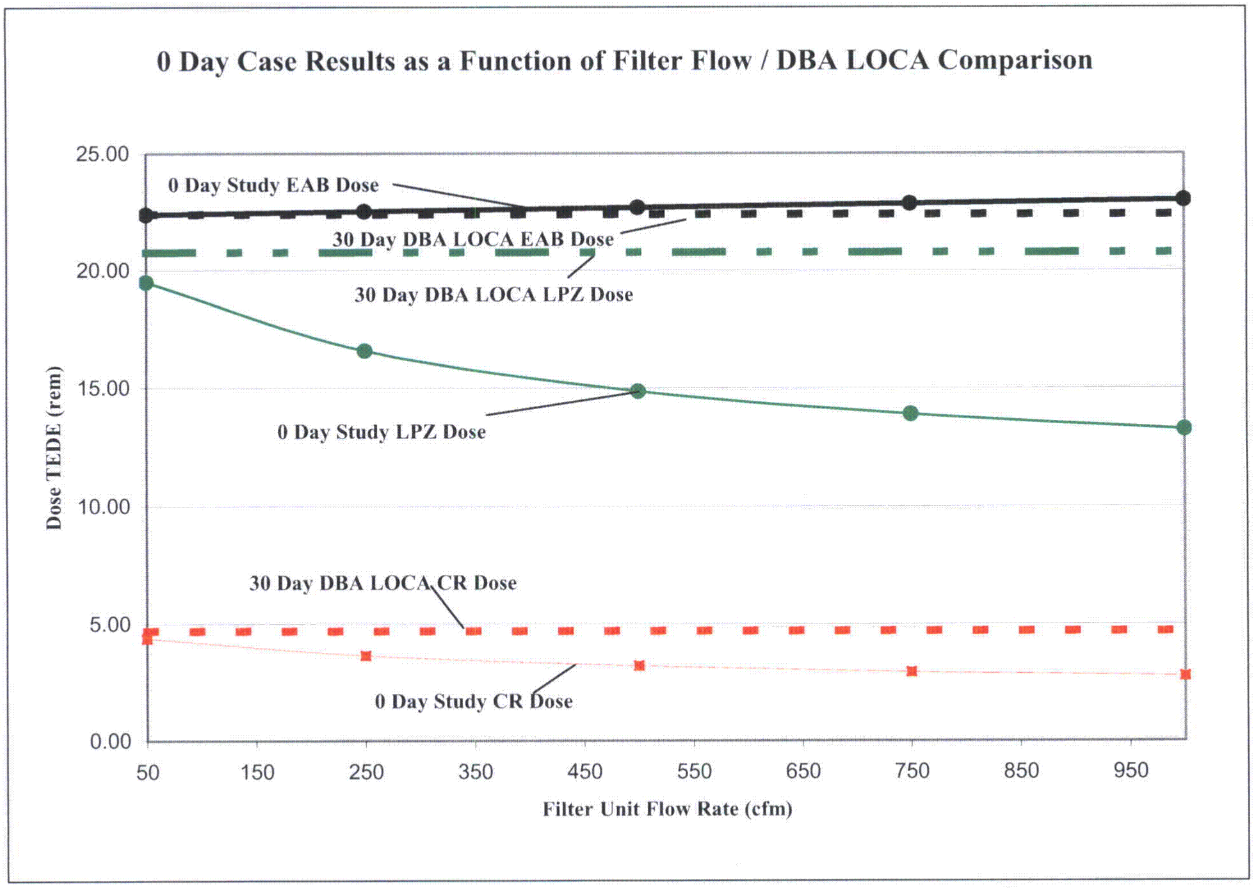

Figure 2 – Comparison of the 0 day study to the DBA LOCA

4.3 8 Hour Study

Because the results of the 0 day study indicated the EAB was not always bounded by the DBA LOCA, another parametric study was performed for the intermediate time period of 8 hours into the LOCA event. The EAB dose for the 8-hour study was identical to the DBA LOCA EAB dose (not impacted by the use of the filters). In addition, the DBA LOCA bounded the LPZ and CR dose.

Table 4 summarizes the results from the parametric study performed for the case where the filters are engaged at time t = 8 hours (the 8-Hour study).

Table 4 – LOCA Dose Consequences Engaging Exhaust Filters at 8 hours

RB HVAC Accident Filter Flow Rate (cfm)	LPZ Dose (TEDE rem)	CR Dose (TEDE rem)	EAB Dose (TEDE rem)	Worst 2-hour Period	Output Filename
50	19.72	4.43	22.4	2.3	8 Hour Study 50 cfm.o0
250	17.40	3.85	22.4	2.3	8 Hour Study 250 cfm.o0
500	16.07	3.50	22.4	2.3	8 Hour Study 500 cfm.o0
750	15.36	3.31	22.4	2.3	8 Hour Study 750 cfm.o0
1000	14.92	3.18	22.4	2.3	8 Hour Study 1000 cfm.o0
DBA LOCA	***20.78***	***4.69***	***22.4***	***2.3***	***DCD R6 LOCA AS-1 RB.o0***

Those values have been plotted and compared to the DBA LOCA as shown in Figure 3.

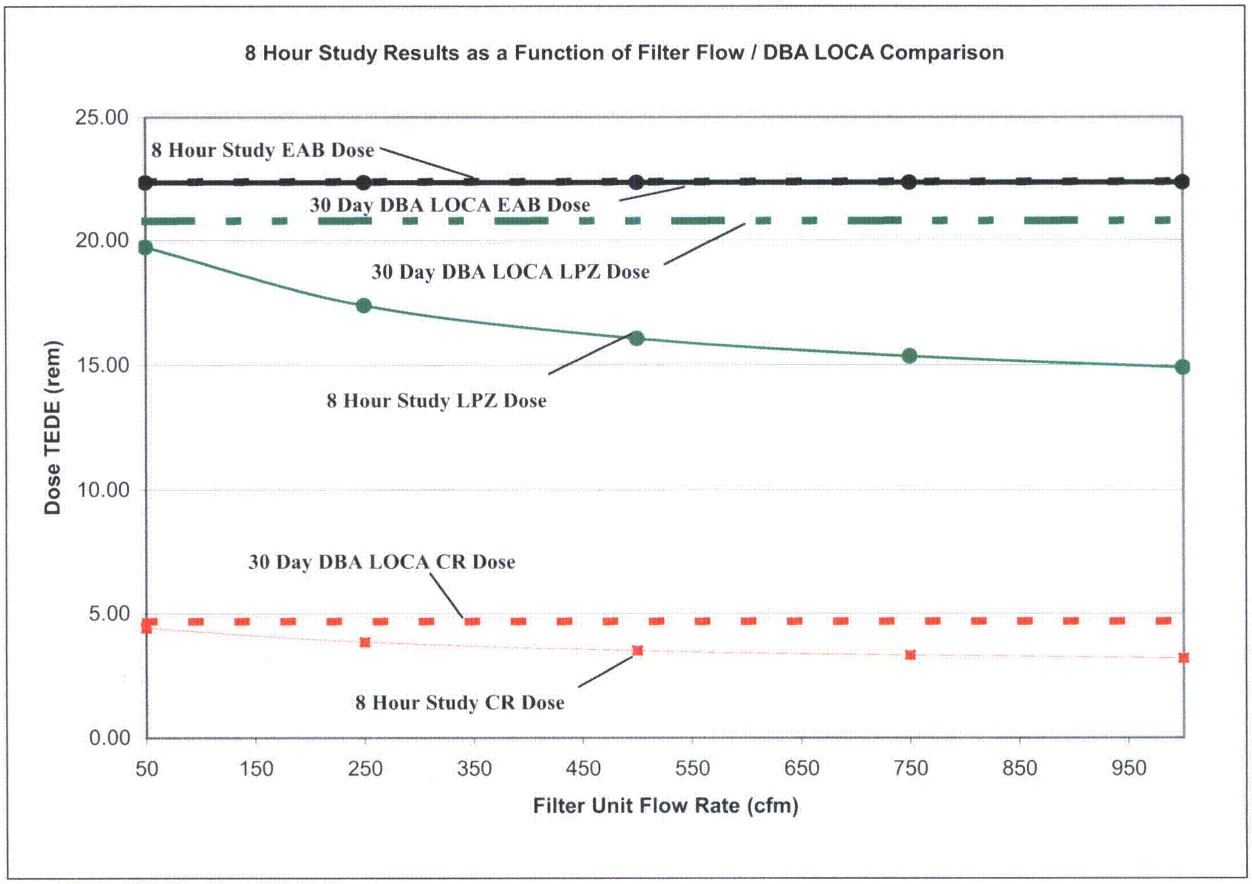

Figure 3 – Comparison of the 8-hour study to the DBA LOCA

4.4 Non-failure study

The non-failure study results are summarized in Table 5. While the non-failure study did assume the filter unit functioned, it did apply several conservative assumptions (Section 3.3.4) to model a severe wind-loading event. That event represents a more likely failure of the system than the one presented for the parametric studies where flow is leaking into the CONAVS area of the RB at a rate greater than the DCD LOCA RB exfiltration rate to which the RB (CONAVS) is tested. The results demonstrate that even if the RB HVAC accident filter unit fails to completely drawdown the RB for the entire event, if started at the beginning of the LOCA event it could reduce the consequences of the bounding ESBWR DBA LOCA scenario by at least 50%.

Table 5 – LOCA Dose Consequences for the Non-Failure Study

RB HVAC Accident Filter Flow Rate (cfm)	LPZ Dose (TEDE rem)	CR Dose (TEDE rem)	EAB Dose (TEDE rem)	Worst 2-hour Period	Output Filename
50	10.17	2.32	10.80	1.2	Non-Failure Study 50 cfm.o0
250	8.75	1.87	11.53	1.3	Non-Failure Study 250 cfm.o0
500	8.61	1.77	12.46	1.4	Non-Failure Study 500 cfm.o0
750	8.69	1.75	13.37	1.5	Non-Failure Study 750 cfm.o0
1000	8.80	1.75	14.24	1.5	Non-Failure Study 1000 cfm.o0
DBA LOCA	***20.78***	***4.69***	***22.4***	***2.3***	***DCD R6 LOCA AS-1 RB.o0***

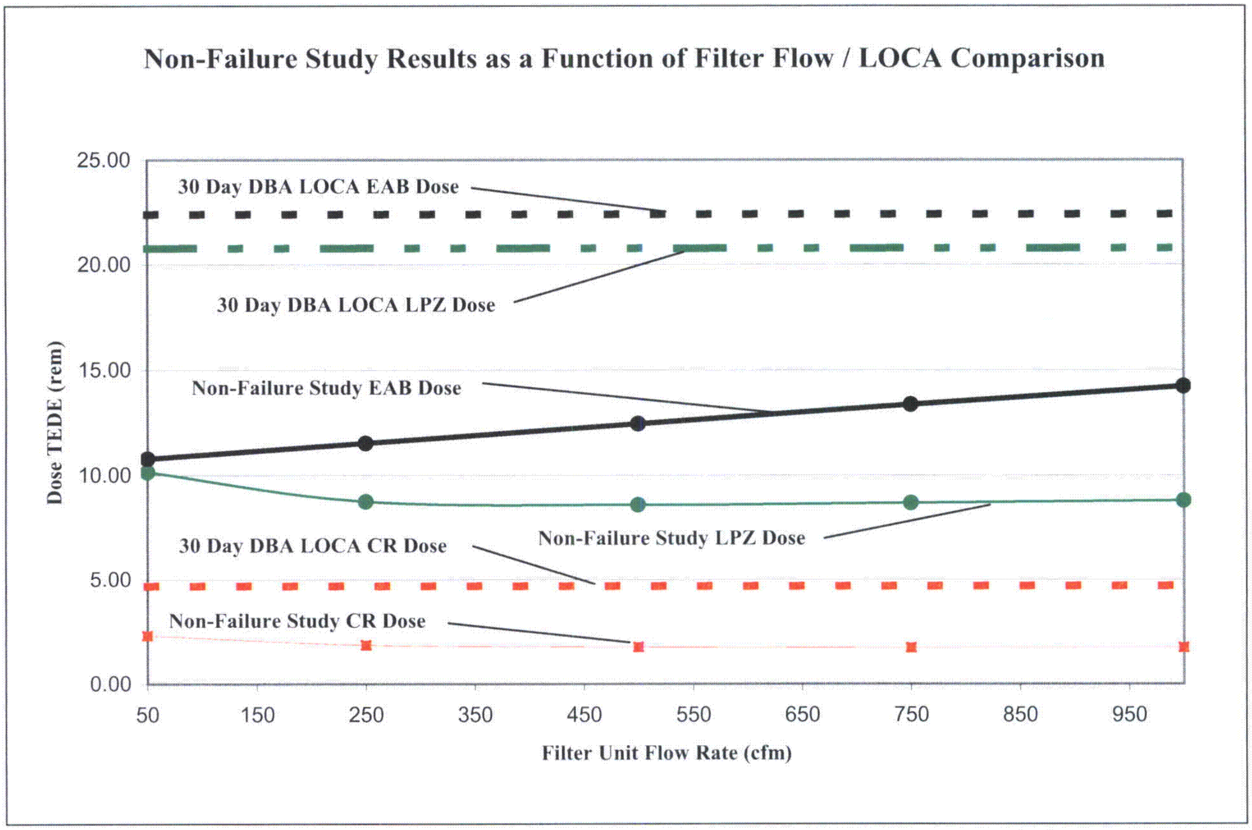

Figure 4 – Comparison of the non-failure study to the DBA LOCA

REFERENCES

1 Title 10 to the Code of Federal Regulations,
   a. Part 50, Appendix A, "General Design Criterion 19."
   b. Part 52, Section 47, "Contents of applications; technical information."

2 ESBWR Design Control Document [DCD], Revision 6, Section 9.4.6.

3 ESBWR Design Control Document [DCD], Revision 6, Section 15.4.4.

4 ESBWR Design Control Document [DCD], Revision 6, Table 9.4-11.

5 GEH Report, GENE-0000-0086-5382-R2, *ESBWR Onsite Atmospheric Dispersion Factor Review and Evaluation for the North Anna Power Station*, September 2009.

6 GEH Report, GENE-0000-0086-5404-R0, *ESBWR Onsite Atmospheric Dispersion Factor Review and Evaluation for the Grand Gulf Nuclear Station*, October 2008.

7 NEDE-33279P, "ESBWR Containment Fission Product Removal Evaluation Model," Revision 3.

Enclosure 3

MFN 09-627, Rev. 1

Revised Response to Portion of NRC Request for Additional Information Letter No. 355 Related to ESBWR Design Certification Application

Auxiliary Systems

RAI Number 9.4-53 S01

DCD Markups

Table 2.16.2-2

ITAAC For The Reactor Building HVAC

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
7. The RBVS provides post 72-hour cooling for DCIS , CRD and RWCU pump rooms, electrical cabinet cooling and CRD / RWCU motor cooling.	Testing of the integrated system will be performed to demonstrate the air flow capability of the RBVS to support post-72 hour cooling for DCIS, CRD and RWCU pump rooms, electrical cabinet cooling and CRD / RWCU motor cooling.	The integrated system test demonstrates the air flow capability to support post-72 hour cooling for DCIS, CRD and RWCU pump rooms, electrical cabinet cooling and CRD / RWCU motor cooling.
8. Indications and controls for safety-related components of the RBVS as indicated in Table 2.16.2-1 are available in the MCR.	Inspection of the MCR will be performed to verify that the safety-related system functions of the RBVS are available.	Indications and controls for the safety-related components of the RBVS as indicated in Table 2.16.2-1 are available in the MCR.
9. Independence is provided between safety-related divisions, and between safety-related divisions and nonsafety-related equipment.	i. Tests will be performed on the RBVS dampers by providing a test signal in only one safety-related division at a time. ii. Inspection of the as-built safety-related divisions in the system will be performed.	i. The test signal exists only in the safety-related division under test in the as-built RBVS damper. ii. Physical separation and electrical isolation exists between as-built RBVS dampers. Physical separation or electrical isolation exists between safety-related divisions and nonsafety-related equipment.
10. (Deleted)		
11. The Reactor Building HVAC Online Purge Exhaust Filters meet RG 1.140 and ASME AG-1 requirements for HEPA and carbon filter efficiency	Each charcoal adsorber will be tested in accordance with RG 1.140. HEPA filters will be tested in accordance with ASME AG-1, Section FC.	The as-built Reactor Building HVAC Online Purge Exhaust filter efficiency meet the acceptance criteria for laboratory and in place testing in accordance with RG 1.140 and ASME AG-1.

Table 2.16.2-2

ITAAC For The Reactor Building HVAC

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
12a. The Reactor Building HVAC Accident Exhaust Filters maintains the CONAVS served areas of the reactor building at a minimum negative pressure of 62 Pa (-1/4 inch W.G.) relative to surrounding clean areas when operating.	Testing will be performed to confirm that the Reactor Building HVAC Accident Exhaust Filters maintain the CONAVS area at a minimum negative pressure of 62 Pa (-1/4 inch W.G.) relative to surrounding clean areas when operating each filter train.	The time average pressure differential in the as-built CONAVS served areas of the reactor building as measured by pressure differential indicators is minimum negative pressure of 62 Pa (-1/4 inch W.G.).
12b. The Reactor Building HVAC Accident Exhaust Filters meet RG 1.140 and ASME AG-1 requirements for HEPA and carbon filter efficiency.	The Reactor Building HVAC Accident Exhaust Filters meet RG 1.140 and ASME AG-1 requirements for HEPA and carbon filter efficiency.	The as-built RB HVAC Accident Exhaust filter efficiencies meet the acceptance criteria for laboratory and in place testing in accordance with RG 1.140 and ASME AG-1.

The PCCS condenser cannot fail in a manner that damages the safety-related IC/PCCS pool because it is designed to withstand induced dynamic loads, which are caused by combined seismic, DPV/ SRV or LOCA conditions in addition to PCCS operating loads.

In conjunction with the pressure suppression containment (Subsection 6.2.1.1), the PCCS is designed to remove heat from the containment to comply with 10 CFR 50, Appendix A, Criterion 38. Provisions for inspection and testing of the PCCS are in accordance with Criteria 39, 52 & 53. Criterion 51 is satisfied by using nonferritic stainless steel in the design of the PCCS.

The intent of Criterion 40, testing of containment heat removal system is satisfied as follows:

- The structural and leak-tight integrity can be tested by periodic pressure testing;
- Functional and operability testing is not needed because there are no active components of the system; and
- Performance testing during in-plant service is not feasible; however, the performance capability of the PCCS was proven by full-scale PCCS condenser prototype tests at a test facility before their application to the plant containment system design. Performance is established for the range of in-containment environmental conditions following a LOCA. Integrated containment cooling tests have been completed on a full-height reduced-section test facility, and the results have been correlated with TRACG computer program analytical predictions; this computer program is used to show acceptable containment performance (Reference 6.2-10 Section 5.3, and Reference 6.2-11, Section 13), which is reported in Subsection 6.2.1.1 and Section 15.4.

6.2.2.4 Testing and Inspection Requirements

The PCCS is an integral part of the containment, and it is periodically pressure tested as part of overall containment pressure testing (Subsection 6.2.6). Also, the PCCS condensers can be isolated using spectacle flanges for individual pressure testing during maintenance.

If additional inservice inspection becomes necessary, it is unnecessary to remove the PCCS condenser because ultrasonic (UT) testing of tube-to-drum welds and eddy current testing of tubes can be done with the PCCS condensers in place during refueling outages.

6.2.2.5 Instrumentation Requirements

The PCCS does not have instrumentation. Control logic is not needed for it's functioning. There are no sensing and power actuated devices except for the vent fans. Containment System instrumentation is described in Subsection 6.2.1.7.

6.2.3 Reactor Building Functional Design

Relevant to the function of a secondary containment design, this subsection addresses (or references to other DCD locations that address) the applicable requirements of GDC 4, 16, and 43 and Appendix J to 10 CFR 50 discussed in SRP 6.2.3 R2. The plant meets the relevant and applicable requirements of:

- GDC 4 as it relates to safety-related structures, systems and components being designed to accommodate the effects of normal operation, maintenance, testing and postulated accidents, and being protected against dynamic effects (for example, the effects of missiles, pipe whipping, and discharging fluids) that may result from equipment failures;

- GDC 16 as it relates to reactor containment and associated systems being provided to establish an essentially leak-tight barriers against the uncontrolled release of radioactive material to the environment;
- GDC 43 as it relates to atmosphere cleanup systems having the design capability to permit periodic functional testing to ensure system integrity, the operability of active components, and the operability of the system as a whole and the performance of the operational sequence that brings the system into operation; and
- 10 CFR 50, Appendix J as it relates to the secondary containment being designed to permit preoperational and periodic leakage rate testing so that bypass leakage paths are identified.

This subsection applies to the ESBWR RB design. The RB structure encloses penetrations through the containment (except for those of the main steam tunnel and IC/PCCS pools). The RB:

- Provides an added barrier to fission product released from the containment in case of an accident;
- Contains, dilutes, and holds up any leakage from the containment; and
- Houses safety-related systems.

The RB consists of rooms/compartments, which are served by one of the three ventilation subsystems; Contaminated Area Ventilation Subsystem (CONAVS), Refueling and Pool Area HVAC Subsystem (REPAVS), and Clean Area Ventilation Subsystem (CLAVS). None of these compartmentalized areas communicate with each other.

Under accident conditions, the RB (CONAVS and REPAVS areas) automatically isolate on high radiation to provide a hold up volume for fission products. When isolated, the RB (CONAVS and REPAVS areas) can be serviced by the RB HVAC On-Line Purge Exhaust Filter units (CONAVS and REPAVS areas) and the RB HVAC Accident Exhaust Filter units (CONAVS areas) (Subsection 9.4.6). No credit is taken for the filters in dose consequence analyses (Subsection 15.4.4). While the RB HVAC Accident Exhaust Filter units are a defense in depth feature, operation of the system for a period of 30 days following a design basis accident was evaluated using the design basis LOCA RADTRAD model described in chapter 15 (subsection 15.4.4) to ensure the design basis LOCA analysis results remain bounding. The RB HVAC Accident Exhaust Filter dose consequence analysis was conservative in that no credit was taken for CONAVS area drawdown while operating the RB HVAC Accident Exhaust Filter unit over the design flowrate range in parallel with the RB design exfiltration. Credit of cleanup of the CONAVS area from operation of RB HVAC Accident Exhaust Filter units (95% carbon filter efficiency) was assumed. The radiological consequences presented in Chapter 15 for the design basis LOCA are bounding as long as operation of the RB HVAC Accident Exhaust Filter units is delayed at least eight hours post accident. Operation of the filter units at an earlier post accident time requires site specific radiological consequence evaluation.

- Supply airflow indicator and controls, alarms and trips for supply fans; and
- Airflow failure signals, alarm and trip for each exhaust fan.

This instrumentation conforms to GDC 13. Refer to Subsection 3.1.2.4 for a general discussion of the GDC.

9.4.4.6 COL Information

None

9.4.4.7 References

The applicable HVAC codes and standards are shown in Table 9.4-17.

9.4.5 Engineered Safety Feature Ventilation System

The Emergency Filter Unit (EFU) portion of the CRHAVS supplies the engineered safety feature for CRHA radiological protection as described in Section 6.4 and Subsection 9.4.1.

9.4.6 Reactor Building HVAC System

The RB HVAC System (RBVS) serves the following areas of the RB:

- The potentially contaminated areas (CONAVS);
- The refueling area (REPAVS);
- The non-radiologically controlled areas (CLAVS); and
- Containment during inerting and de-inerting operations.

Relative to the RBVS, this subsection addresses applicable requirements of General Design Criteria (GDC) 2, 5 and 60. These GDCs are discussed in Standard Review Plan (SRP) 9.4.3. The ESBWR:

- Meets GDC 2 via compliance to the guidance of RG 1.29, Position C.2 for nonsafety-related portions. The RBVS is nonsafety-related except for the building isolation dampers. The RBVS components are designed as Seismic Category II except for the safety-related building isolation dampers and associated controls that are Seismic Category I. The RB is a Seismic Category I structure. The FB penthouse that houses the RBVS equipment is Seismic Category II.
- Meets GDC 5 for shared systems and components important to safety for the RB isolation dampers. The RBVS is not shared among other operating units.
- Meets GDC 60 by suitably controlling the release of gaseous radioactive effluents to the environment. The system may direct its exhaust air to the RB HVAC Online Purge Exhaust Filter Unit during periods of high radioactivity. The nonsafety-related RB HVAC Accident Exhaust Filter Units provide the ability to draw a negative pressure on the potentially contaminated ventilation served areas (CONAVS) of the RB. The RB HVAC Online Purge Exhaust Filter Units and RB HVAC Accident Exhaust Filter Units are ~~is~~ designed, tested and maintained in accordance with RG 1.140. Additional testing requirements are described in subsection 9.4.6.4. The RBVS (CONAVS and REPAVS) exhaust subsystems are equipped with control systems to automatically isolate the

effluent on indication of a high radiation level. The RB boundary isolation dampers (CONAVS and REPAVS) close on receipt of a high radiation signal, or on a loss of AC power.

9.4.6.1 Design Bases

Safety Design Bases

With the following exception, the RBVS is nonsafety-related. The isolation dampers and ducting penetrating the RB boundary and associated controls that provide the isolation signal are safety-related. The RBVS performs no safety-related function except for automatic isolation of the RB boundary (CONAVS and REPAVS subsystems) during accidents. The RBVS has nonsafety-related RB HVAC Online Purge Exhaust Filter Units for mitigating and controlling gaseous effluents from the RB. The RBVS has nonsafety-related RB HVAC Accident Exhaust Filter Units for use post accident (>8 hours)~~for use post accident (>seven days)~~ to create a negative pressure in the RB contaminated areas and exhaust~~ing~~ the filtered air to the RB/FB stack. The filtering efficiency ensures that control room doses are not exceeded for certain beyond design basis LOCAs.

The RBVS has RTNSS functions as described in Appendix 19A, which provides the level of oversight and additional requirements to meet the RTNSS functions. Performance of RTNSS functions is assured by applying the defense-in-depth principles of redundancy and physical separation to ensure adequate reliability and availability. In addition, augmented design standards are applied as described in Subsection 19A.8.3.

Power Generation Design Bases

The RBVS:

- Provides a controlled environment for personnel comfort and safety, and for proper operation and integrity of equipment. See Table 9.4-8 for area temperatures maintained.
- Maintains potentially contaminated areas at a negative pressure to minimize exfiltration of potentially contaminated air. See Table 9.4-8 for area pressurization.
- Maintains clean areas of the building, except for the battery rooms, at a positive pressure to minimize infiltration of outside air. See Table 9.4-8 for area pressurization.
- Maintains airflow from areas of lower potential for contamination to areas of greater potential for contamination. The pressure in these areas hereafter called "Slightly Negative Pressure" is a range from less than zero to –124 PaG (-0.50" w.g.).
- Is provided with redundant active components to increase the reliability, availability, and maintainability of the systems.
- Is capable of exhausting smoke, heat and gaseous combustion products in the event of a fire.
- Prevents smoke and hot gases from migrating into other fire areas by automatically closing smoke dampers upon detection of smoke.

- Provides the ability to draw a negative pressure and exhaust the contaminated ventilation served areas of the RB through the RB HVAC Accident Exhaust Filter Units.
- Provides the capability to manually divert exhaust air for processing through the RB HVAC On-line Purge Exhaust Filter Units.
- Reactor Building HVAC On-line Purge Exhaust Filter Units can be energized to re-circulate the CONAVS area air space.
- Provides pool sweep ventilation air over the refueling area pool surface.
- Maintains its structural integrity after a safe shutdown earthquake.
- Is designed such that failure of the system does not compromise or otherwise damage safety-related equipment.
- Is provided with shutoff dampers on the inlet and outlet of fans and AHUs to allow for maintenance as required.
- Is provided with shutoff valves at the inlet and outlet of cooling coils to allow for maintenance as required.
- Is provided with access doors for AHUs, fans, filter sections, and duct mounted dampers to allow for maintenance as required.
- Is provided with capability for manual control of system fans to facilitate testing and maintenance.
- Maintains the hydrogen concentration levels in the battery rooms below 2% by volume in accordance with RG 1.128.
- Replaces the containment inerted atmosphere with conditioned air during a refueling operation.
- Provides local recirculation AHUs for cooling of the Hydraulic Control Unit area.
- RBVS maintains SLC accumulator room environmental conditions within temperature limits including employing two backup heaters per room. PIP A and PIP B busses provide power for these heaters.
- Provides cooling for CRD and RWCU/SDC pump motors, rooms, and/or electrical/instrument panels designed to limit the room/equipment to within its temperature environmental qualification when the building is isolated. The motor cooler heat sink is the RCCW, while Chilled Water or Direct Expansion Units are provided for electrical cabinet cooling.
- Maintains Battery room temperatures within a range to maximize output and equipment life.

9.4.6.2 System Description

Summary Description

The RBVS maintains space design temperature, quality of air, and pressure control in the RB. The system consists of three subsystems. The RB Contaminated Area HVAC Subsystem

(CONAVS) serves the potentially contaminated areas of the RB. The Refueling and Pool Area HVAC Subsystem (REPAVS) serves the refueling area of the RB. The RB Clean Area HVAC Subsystem (CLAVS) serves the clean (non-radiological controlled) areas of the RB.

Detailed System Description

CONAVS

Figure 9.4-10 shows a simplified system diagram for the CONAVS. Table 9.4-11 shows the major equipment for the CONAVS and Subsection 9.4.10 describes component information.

The CONAVS is a two train, once-through ventilation system with each train consisting of an AHU, redundant exhaust fans, and building isolation dampers. It includes a containment purge exhaust fan, recirculation AHUs and unit heaters. The AHU includes filters, heating and cooling coils and redundant supply fans. Outside air is filtered and heated or cooled prior to distribution by the AHU in service. The Chilled Water System provides cooling for the CONAVS AHUs. The Instrument Air System provides instrument air for the pneumatic actuators. A common supply air duct distributes conditioned air to the potentially contaminated areas of the RB. Air is exhausted from the potentially contaminated areas of the RB by the operating exhaust fan and discharged to the Reactor Building/Fuel Building (RB/FB) vent stack. During containment de-inerting operations the supply airflow rate of the AHU supply fan is increased. At the same time the airflow rate of the exhaust fan is increased an equal amount. In the event of a fire, fire dampers close to isolate the fire area. In the event smoke is detected in the air duct, the system is shut down. After the fire is completely extinguished, the exhaust fans are then used for smoke removal with the exhaust air being monitored for radiological contamination. If contaminated, temporary portable filters may be used to exhaust the contaminated air. The building isolation dampers close and the supply and exhaust fans stop due to high radiation in the exhaust ducts. CONAVS also includes redundant RB HVAC Exhaust Filter Units ("Accident" and "Online Purge" Filter Assemblies) and exhaust fans. During radiological events, exhaust air from contaminated areas may be manually diverted through the RB HVAC Online Purge Exhaust Filter Units. The RB Exhaust Filter Units are equipped with pre-filters, HEPA filters, high efficiency filters and carbon filters for mitigating and controlling particulate and gaseous effluents from the RB. The RB HVAC Online Purge Exhaust Filter Units can be used to re-circulate the CONAVS area air and thereby clean up the contaminated environments in the RB.

After a LOCA, one RB HVAC Accident Exhaust Filter Unit (the redundant one is in standby) can be energized to create a negative pressure by exhausting the air in the CONAVS area.

The supply AHU and normal exhaust fan may be shut down during filtered purge exhaust. Recirculation AHUs provide supplementary cooling for selected rooms. Cooling is provided for CRD and RWCU/SDC pump motor coolers from RCCW, and electrical/instrument panels are provided with either Chilled Water or Direct Expansion Units designed to limit the room and associated equipment to within its temperature environmental qualification when the building is isolated. Electric unit heaters provide supplementary heating.

9.4.6.3 Safety Evaluation

The RBVS is nonsafety-related, except for the building isolation dampers. The safety-related isolation dampers fail closed upon a loss of control signal, power, or instrument air.

The RBVS components are designed as Seismic Category II, except for the safety-related building isolation dampers and associated controls. The building isolation dampers and associated controls are designed as Seismic Category I.

The RBVS does not perform any safety-related functions, except for the CONAVS and REPAVS subsystem boundary isolation dampers closing in the event of radiological events. The CLAVS subsystems is also provided with safety-related building isolation dampers, which close upon Loss of Power or Loss of Instrument Air. Redundant dampers and controls are provided so the RB can be isolated even if one of the dampers or controls fail.

Rooms containing safety-related equipment have passive cooling features designed to limit the room temperature to the equipment's environmental qualification temperature.

RBVS maintains SLC accumulator room environmental conditions within temperature limits.

The nNon-safety-related Related, RB HVAC Accident Exhaust Filter Units provide the ability to draw a negative pressure on the contaminated ventilation served areas of the RB (post accident >8 hours). post accident (>seven days). These accident units are RTNSS components.

The nNon-safety rRelated, RB HVAC Online Purge Exhaust Filter Units provide online cleanup of contaminated areas within the CONAVS or REPAVS subsystems. These online units are not RTNSS components.

9.4.6.4 Testing and Inspection Requirements

Routine testing of the RBVS is conducted in accordance with normal power plant requirements for demonstrating system and component operability. Periodic surveillance testing of safety-related building isolation dampers is carried out per IEEE-338.

The RB HVAC ("Accident" and "Online" Purge) Exhaust Filter components are periodically tested in accordance with RG 1.140, Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Normal Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants. There is an additional requirement that charcoal laboratory testing will be performed on the RB HVAC Accident Exhaust Filter Unit after each 1440720 hours of operation as recommended by RG 1.52 Rev. 3 for the, because RG 1.140 does not specify a time based charcoal testing frequency. The RB HVAC Online Purge Exhaust Filter Units will be tested on a 4-year frequency. The RTNSS RB HVAC Accident Exhaust Filter Units will additionally be operationally tested each month by running each filter unit for 15 minutes as is recommended in RG 1.52 Rev. 3.

9.4.6.5 Instrumentation Requirements

The RBVS is operated from the MCR. A local run/stop control switch is provided for each fan for maintenance and testing purposes. The RBVS is manually controlled, except for certain automatic operations described below:

ACM B 3.7 PLANT SYSTEMS

AC B 3.7.5 Reactor Building HVAC Accident Exhaust Filtration

BASES

Contaminated Area HVAC Subsystem (CONAVS) includes redundant Reactor Building HVAC Accident and Online Purge Exhaust Filtration units and exhaust fans (i.e., trains). During radiological events, exhaust air from contaminated areas may be manually diverted through the Reactor Building HVAC Accident or Online Purge Exhaust Filtration units. The Reactor Building Accident and Online Purge Exhaust Filtration units are equipped with pre-filters, high efficiency particulate air (HEPA) filters, high efficiency filters and carbon filters for mitigating and controlling particulate and gaseous effluents from the Reactor Building. After LOCA, one Reactor Building HVAC Accident Exhaust Filtration Unit (the redundant one is in standby) can be energized to ~~partial recirculate and partial~~ exhaust the space air in the CONAVS area.

This accident function is a nonsafety-related function that provides building negative pressure control and exhaust filtering efficiency to ensure that theoretical control room doses are not exceeded for certain beyond design basis LOCAs. Failure to provide adequate filtration is considered to be an adverse system interaction satisfying the criteria for Regulatory Treatment of Non-Safety Systems, and therefore enhanced regulatory oversight is provided. The short-term availability controls for this function, which are specified as Completion Times, are acceptable to ensure that the availability of this function is consistent with the functional unavailability in the ESBWR PRA. The surveillance requirements also provide an adequate level of support to ensure that component performance is consistent with the functional reliability in the ESBWR PRA.

Enclosure 4

MFN 09-627, Rev. 1

Revised Response to Portion of NRC Request for Additional Information Letter No. 355 Related to ESBWR Design Certification Application

Auxiliary Systems

RAI Number 9.4-53 S01

Affidavit

GE-Hitachi Nuclear Energy Americas LLC

AFFIDAVIT

I, **Larry J. Tucker,** state as follows:

(1) I am Manager, ESBWR Engineering, GE Hitachi Nuclear Energy ("GEH"), and have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is contained in enclosure 2 of GEH's letter, MFN 09-627, Rev. 1, Mr. Richard E. Kingston to U.S. Nuclear Regulatory Commission, entitled "Revised Response to Portion of NRC Request for Additional Information Letter No. 355 Related to Design Certification Application – Auxiliary Systems – RAI Number 9.4-53 S01" dated February 10, 2010. Enclosure 2, entitled "*Revised Response to Portion of NRC Request for Additional Information Letter No. 355 Related to ESBWR Design Certification Application - Auxiliary Systems - RAI Number 9.4-53 S01 – Supporting Analysis – GENE 0000-0112-2778 R0 – GEH Proprietary Information,*" is considered proprietary in its entirety. Figures and large equation objects are identified with double square brackets before and after the object. In each case, the superscript notation {3} refers to Paragraph (3) of this affidavit, which provides the basis for the proprietary determination.

(3) In making this application for withholding of proprietary information of which it is the owner or licensee, GEH relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC Sec. 552(b)(4), and the Trade Secrets Act, 18 USC Sec. 1905, and NRC regulations 10 CFR 9.17(a)(4), and 2.390(a)(4) for "trade secrets" (Exemption 4). The material for which exemption from disclosure is here sought also qualify under the narrower definition of "trade secret", within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975F2d871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704F2d1280 (DC Cir. 1983).

(4) Some examples of categories of information which fit into the definition of proprietary information are:

a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by GEH's competitors without license from GEH constitutes a competitive economic advantage over other companies;

b. Information which, if used by a competitor, would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;

c. Information which reveals aspects of past, present, or future GEH customer-funded development plans and programs, resulting in potential products to GEH;

d. Information which discloses patentable subject matter for which it may be desirable to obtain patent protection.

The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a. and (4)b. above.

(5) To address 10 CFR 2.390(b)(4), the information sought to be withheld is being submitted to NRC in confidence. The information is of a sort customarily held in confidence by GEH, and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by GEH, no public disclosure has been made, and it is not available in public sources. All disclosures to third parties, including any required transmittals to NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary agreements which provide for maintenance of the information in confidence. Its initial designation as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in paragraphs (6) and (7) following.

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge, or subject to the terms under which it was licensed to GEH. Access to such documents within GEH is limited on a "need to know" basis.

(7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist, or other equivalent authority for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GEH are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary agreements.

(8) The information identified in paragraph (2) is classified as proprietary because it contains details of GEH's design and licensing methodology. The development of the methods used in these analyses, along with the testing, development and approval of the supporting methodology was achieved at a significant cost to GEH.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GEH's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GEH's comprehensive BWR safety and technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and

includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

The research, development, engineering, analytical and NRC review costs comprise a substantial investment of time and money by GEH.

The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial.

GEH's competitive advantage will be lost if its competitors are able to use the results of the GEH experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GEH would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive GEH of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing and obtaining these very valuable analytical tools.

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information, and belief.

Executed on this 10th day of February 2010.

Larry J. Tucker
GE-Hitachi Nuclear Energy Americas LLC