energy harbor

Energy Harbor Nuclear Corp.
Beaver Valley Power Station
P. O. Box 4
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Matt J. Enos
General Plant Manager, Beaver Valley Nuclear

724-682-7773

June 9, 2020
L-20-161

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT:
Beaver Valley Power Station, Unit Nos. 1 and 2
Docket No. 50-334, License No. DPR-66
Docket No. 50-412, License No. NPF-73
Response to Request for Additional Information Regarding License Amendment Request to Modify Technical Specifications 3.4.16, "RCS Specific Activity," 3.7.13 "Secondary Specific Activity," 5.5.7, "Ventilation Filter Testing Program (VFTP)," and 5.5.14, "Control Room Envelope Habitability Program" (EPID L-2019-LLA-0223)

By letter dated October 20, 2019 (Accession No. ML19293A367), an amendment was submitted to revise the Beaver Valley Power Station Unit Nos. 1 and 2 Technical Specifications (TS). The requested changes revise TS 3.4.16, "RCS Specific Activity," 3.7.13," Secondary Specific Activity," 5.5.7, "Ventilation Filter Testing Program (VFTP)," and 5.5.14, "Control Room Envelope Habitability Program." The proposed changes to TSs 3.4.16 and 3.7.13 would reduce the allowed reactor coolant system and secondary coolant specific activities for Unit 2 and make administrative changes to the Unit 1 TS. The proposed changes to TS 5.5.7 for the control room emergency ventilation system (CREVS) change the acceptance criteria for the CREVS penetration and system bypass requirement and CREVS charcoal adsorber removal efficiency. The proposed change to the Control Room Envelope Habitability Program in TS 5.5.14 would add a note allowing a one-time extension of three years to the unfiltered air inleakage test frequency.

On March 12, 2020, the Nuclear Regulatory Commission (NRC) staff requested additional information to complete its review. The Energy Harbor Nuclear Corp. response dated April 14, 2020 (Accession No. ML20105A347) provided part of the requested information and stated that calculation packages would be provided at a later date. In response to the NRC staffs' sixth question, those calculations are provided in the enclosures to this letter.

An application for withholding proprietary information from public disclosure and accompanying affidavit are provided in Enclosure A. The last four enclosures contain information proprietary to Westinghouse Electric Company LLC ("Westinghouse"), and are supported by an affidavit signed by Westinghouse, the owner of the information. The affidavit sets forth the basis on which the information may be withheld from public disclosure by the Nuclear Regulatory Commission and addresses with specificity the considerations listed in paragraph (b)(4) of 10 CFR Section 2.390. Accordingly, it is respectfully requested that the information that is proprietary to Westinghouse be withheld from public disclosure in accordance with 10 CFR Section 2.390.

Correspondence with respect to the copyright or proprietary aspects of the enclosures or the supporting Westinghouse affidavit should reference CAW-20-5023 and be addressed to:

Mr. Zachary S. Harper
Westinghouse Electric Company
1000 Westinghouse Drive, Suite 165
Cranberry Township, Pennsylvania 16066

The information provided by this submittal does not invalidate the significant hazards consideration analysis provided in the October 20, 2019 submittal.

There are no regulatory commitments contained in this submittal. If there are any questions, or if additional information is required, please contact Mr. Thomas A. Lentz, Manager, Nuclear Licensing and Regulatory Affairs, at (440) 280-5567.

I declare under penalty of perjury that the foregoing is true and correct. Executed on June 9, 2020.

Sincerely,

Matt J. Enos

Enclosures:

A. Application for Withholding Proprietary Information From Public Disclosure
B. L-SHW-BV2-000240 NP-Attachment 1 Calculation 8700-UR(B)-219, Revision 3, "Site Boundary and Control Room Doses following a Steam Generator Tube Rupture (SGTR) based on Core Uprate and Alternative Source Term" (Nonproprietary Version)

C. L-SHW-BV2-000240 NP-Attachment 2 Calculation 10080-UR(B)-487, Revision 3, "Site Boundary, Control Room and Emergency Response Facility Doses following a Loss-of-Coolant Accident based on Core Uprate, an Atmospheric Containment and Alternative Source Terms" (Nonproprietary Version)

D. L-SHW-BV2-000240 NP-Attachment 3 Calculation 10080-UR(B)-493, Revision 1, "Site Boundary and Control Room Doses based on Core Uprate and Alternative Source Term Methodology following a) a Locked Rotor Accident b) a Loss of AC Power Accident" (Nonproprietary Version)

E. L-SHW-BV2-000240 NP-Attachment 4 Calculation 10080-UR(B)-496, Revision 3, "Site Boundary and Control Room Doses following a Steam Generator Tube Rupture based on Core Uprate and Alternative Source Term Methodology" (Nonproprietary Version)

F. L-SHW-BV2-000240 P-Attachment 1 Calculation 8700-UR(B)-219, Revision 3, "Site Boundary and Control Room Doses following a Steam Generator Tube Rupture (SGTR) based on Core Uprate and Alternative Source Term" (Proprietary Version)

G. L-SHW-BV2-000240 P-Attachment 2 Calculation 10080-UR(B)-487, Revision 3, "Site Boundary, Control Room and Emergency Response Facility Doses following a Loss-of-Coolant Accident based on Core Uprate, an Atmospheric Containment and Alternative Source Terms" (Proprietary Version)

H. L-SHW-BV2-000240 P-Attachment 3 Calculation 10080-UR(B)-493, Revision 1, "Site Boundary and Control Room Doses based on Core Uprate and Alternative Source Term Methodology following a) a Locked Rotor Accident b) a Loss of AC Power Accident" (Proprietary Version)

I. L-SHW-BV2-000240 P-Attachment 4 Calculation 10080-UR(B)-496, Revision 3, "Site Boundary and Control Room Doses following a Steam Generator Tube Rupture based on Core Uprate and Alternative Source Term Methodology" (Proprietary Version)

cc: NRC Region I Administrator
NRC Resident Inspector
NRC Project Manager
Director BRP/DEP
Site BRP/DEP Representative

Enclosure A
L-20-161

Application for Withholding Proprietary Information From Public Disclosure
(3 pages follow)

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:
COUNTY OF BUTLER:

(1) I, Zachary S. Harper, have been specifically delegated and authorized to apply for withholding and execute this Affidavit on behalf of Westinghouse Electric Company LLC (Westinghouse).

(2) I am requesting the proprietary portions of L-SHW-BV2-000240 marked as L-SHW-BV2-000240 P-Attachment 1, L-SHW-BV2-000240 P-Attachment 2, L-SHW-BV2-000240 P-Attachment 3 and L-SHW-BV2-000240 P-Attachment 4 be withheld from public disclosure under 10 CFR 2.390.

(3) I have personal knowledge of the criteria and procedures utilized by Westinghouse in designating information as a trade secret, privileged, or as confidential commercial or financial information.

(4) Pursuant to 10 CFR 2.390, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

(i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse and is not customarily disclosed to the public.

(ii) Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar technical evaluation justifications and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

AFFIDAVIT

(5) Westinghouse has policies in place to identify proprietary information. Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage (e.g., by optimization or improved marketability).

(c) Its use 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 a similar product.

(d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.

(e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

(f) It contains patentable ideas, for which patent protection may be desirable.

(6) The attached documents are bracketed and marked to indicate the bases for withholding. The justification for withholding is indicated in both versions by means of lower case letters (a) through (f) located as a superscript immediately following the brackets enclosing each item of information being identified as proprietary or in the margin opposite such information. These

AFFIDAVIT

lower case letters refer to the types of information Westinghouse customarily holds in confidence identified in Sections (5)(a) through (f) of this Affidavit.

I declare that the averments of fact set forth in this Affidavit are true and correct to the best of my knowledge, information, and belief.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on: 5/14/2020

Zachary S. Harper, Manager
Licensing Engineering

Enclosure B
L-20-161

L-SHW-BV2-000240 NP-Attachment 1 Calculation 8700-UR(B)-219, Revision 3, “Site Boundary and Control Room Doses following a Steam Generator Tube Rupture (SGTR) based on Core Uprate and Alternative Source Term”
(Nonproprietary Version)

(93 pages follow)

FirstEnergy

CALCULATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.	VENDOR CALCULATION NO.
8700-UR(B)-219	**N/A**

☒ BV1 ☐ BV2 ☐ BV1/2 ☐ BV3 ☐ BVSWT ☐ DB ☐ PY

Title/Subject: Site Boundary and Control Room Doses following a Steam Generator Tube Rupture (SGTR) based on Core Uprate and Alternative Source Term

Category:	☒ Active ☐ Historical ☐ Study — **Vendor Calc Summary:** Yes ☐ No ☒
Classification:	☒ Tier 1 Calculation ☒ Safety-Related/Augmented Quality ☐ Non-safety-Related
Open Assumptions?:	☐ Yes ☒ No If Yes, Enter Tracking Number
System Number:	N/A
Functional Location :	N/A
Commitments:	None
Initiating Documents:	CR-2017-10857
(PY) Calculation Type:	
(PY) Referenced In USAR Validation Database ☐ Yes ☐ No	(PY) Referenced In Atlas? ☐ Yes ☐ No

Computer Program(s)

Program Name	Version / Revision	Category	Status	Description
PERC2	V00 / L02	B	Active	Activity Transport and Consequence

Revision Record

Rev.	Affected Pages	Originator *(Print, Sign & Date)*	Reviewer/Design Verifier *(Print, Sign & Date)*	Approver *(Print, Sign & Date)*
3	N/A	Keith Ferguson [signature] 02/04/2019	Joseph Baron [signature] 02/04/2019	Sreela Ferguson [signature] 02/04/2019
	Description of Change: As part of a Long Term Objective, the dose consequences at the Site Boundary and Control Room following a Steam Generator Tube Rupture has been updated to facilitate relaxation of operational limits that currently affect plant operation; specifically to allow an increase in the allowable unfiltered inleakage into the Control room Envelope. Also included is a review / update of all design input parameter values / references to reflect current plant design.			
	Describe where the calculation will be evaluated for 10CFR50.59 and/or 10CFR72.48 applicability. Regulatory Applicability Determination and 10CFR50.59 Screen 18-01778 is attached to this calculation			

Rev.	Affected Pages	Originator *(Print, Sign & Date)*	Reviewer/Design Verifier *(Print, Sign & Date)*	Approver *(Print, Sign & Date)*
2	N/A	W.H .Peng 01/06/05	K.P. Ferguson 01/06/05	Sreela Ferguson 01/06/05
	Description of Change:			
	Describe where the calculation will be evaluated for 10CFR50.59 and/or 10CFR72.48 applicability.			

~~PROPRIETARY~~

FirstEnergy	CALCULATION NOP-CC-3002-01 Rev. 05
CALCULATION NO. **8700-UR(B)-219, Revision 3**	**[ ] VENDOR CALC SUMMARY** **VENDOR CALCULATION NO. N/A**

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CALCULATION NO. **8700-UR(B)-219, Revision 3**	**[ ] VENDOR CALC SUMMARY** **VENDOR CALCULATION NO. N/A**	

OBJECTIVE OR PURPOSE:

The objective of this calculation is to determine the airborne dose at the Exclusion Area Boundary (EAB), Low Population Zone (LPZ) and Control Room (CR) at Beaver Valley Power Station (BVPS) Unit 1 following a postulated Steam Generator Tube Rupture (SGTR) Accident. The analysis is based on a core power level of 2918 MWt (i.e., the uprated core thermal power level with margin for power uncertainty).

The calculated dose is based on "Alternative Source Terms" per Regulatory Guide (RG) 1.183, Revision 0, increased allowable unfiltered inleakage into the Control Room Envelope (CRE), and current design input parameter values as provided by First Energy Nuclear Operating Company (FENOC) via DIN# 1 and 11, and included as Attachments 1 and 2 of this calculation.

SCOPE OF CALCULATION:

As part of a Long Term Objective, and with the intent of providing operational margin, the BVPS design basis site boundary and control room dose consequence analyses are being updated to facilitate relaxation of certain operational limits that have significant effect on plant operation. To that end, Revision 3 herein investigates the impact of a proposed increase in the allowable unfiltered inleakage into the Control Room Envelope (CRE) on the dose consequences following a SGTR accident at Unit 1.

The objective of Revision 3 is to demonstrate continued compliance with the dose acceptance criteria of 10CFR50.67 (as modified by Table 6 of RG 1.183 R0) after taking into consideration the following:

a) An increase in allowable unfiltered inleakage into the CRE (inclusive of that associated with ingress /egress) from 30 cfm to 165 cfm.

b) Review / Update (as needed) of all design input parameter values / references to reflect current plant design.

SUMMARY OF RESULTS/CONCLUSIONS:

The BVPS Site Boundary and Control Room doses due to airborne radioactive material released following a SGTR at Unit 1 (U1) will remain within the regulatory limits set by 10CFR50.67 and Regulatory Guide 1.183, R0.

In accordance with regulatory guidance, two scenarios were evaluated, i.e., a Pre-accident Iodine Spike and a Concurrent Iodine spike. As noted in Section 8, the pre-accident iodine spike scenario is bounding.

Control Room

The limiting 30-day integrated dose to the Control Room (CR) operator is 2.6 rem TEDE. This value is below the regulatory limit of 5 rem TEDE.

Note: In accordance with current licensing basis, the CR dose estimates following a SGTR at Unit 1 is based on the assumption that the CR ventilation system remains in normal operation mode, and that the CR is purged at a minimum flow rate of 16,200 cfm between t=8 hrs and t=8.5 hrs after which it reverts to the normal operation mode.

Site Boundary

The limiting integrated dose to an individual located at any point on the boundary of the exclusion area (EAB) for any 2-hour period following the onset of the event is 2.3 rem TEDE (t=0 hr to t=2 hour time window). This dose is less than the regulatory limit of 25 rem TEDE for the pre-accident iodine spike.

The limiting integrated dose to an individual located at LPZ following the onset of the event is 0.2 rem TEDE, which is less than the regulatory limit of 25 rem TEDE for the pre-accident iodine spike.

It is noted however that although the estimated doses at the EAB and LPZ due to a concurrent iodine spike are bounded by the estimated doses reported above due to the pre-accident iodine spike, the margin to the regulatory limit for the concurrent iodine spike (i.e., 2.5 rem TEDE), is less. (See Section 8 for detail).

LIMITATIONS OR RESTRICTIONS ON CALCULATION APPLICABILITY:

NRC approval of the increase in the maximum allowable unfiltered inleakage into the CRE (inclusive of that associated with ingress /egress) from 30 cfm to 165 cfm.

IMPACT ON OUTPUT DOCUMENTS:

Unit 1 UFSAR Section 14.2.4 and associated tables, as needed.

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NOP-CC-3002-01 Rev. 05

CALCULATION

CALCULATION NO. **8700-UR(B)-219, Revision 3**	**[ ] VENDOR CALC SUMMARY** **VENDOR CALCULATION NO. N/A**

DESIGN VERIFICATION FORM

Project Name:	**BVPS Control Room Dose Consequence Analyses Update**	**Job Number:**	**7001041**
Verified Document No.:	**8700-UR(B)-219**	**Revision:**	**3**
Verified Document Title:	**Site Boundary and Control Room Doses following a Steam Generator Tube Rupture (SGTR) based on Core Uprate and Alternative Source Term**	**Date Verified:**	**02/04/2019**
Verifier's Name/Signature:	**Joseph S Baron** [signature]	**02/04/2019**	
Lead Engr. Concurrence Name/Signature/ Date	**Sreela Ferguson** [signature]	**02/04/2019**	

Extent of Review: (entire document or not)	Full ☒ Partial ☐ If partial, specify what was reviewed:
Method of Review	Design Review ☒ Alternate Calculation/Analysis ☐ Qualification Testing ☐
Incomplete or unverified portions of design:	NA
Consideration of known problems affecting the standard or previously proven design document:	NA

THE FOLLOWING QUESTIONS ARE SUMMARIZED. REFER TO NEPP 4-43 FOR COMPLETE REVIEW REQUIREMENTS. ADDRESS ADDITIONAL APPLICABLE REVIEWS IN COMMENT/JUSTIFICATION BLOCK AS NECESSARY.

Design Reviews	Inputs have been properly selected?	Yes ☒ No ☐
	Assumptions are adequately described and reasonable?	Yes ☒ No ☐
	Methodology, including computer programs, to assure the appropriateness of the overall approach, its implementation, and the correctness of the specific information and correlations utilized?	Yes ☒ No ☐
	Inputs are correctly used in the document, including validity of references identified?	Yes ☒ No ☐
	Design Output is reasonable compared to the inputs used?	Yes ☒ No ☐
	Design Input and Verification Requirements for interfacing organizations are specified in design documents or in supporting procedures?	Yes ☒ No ☐
Administrative Check Of Format And Content		Yes ☒ No ☐

Comments/Justification (Identify comment subject and associated response.)
The results of this calculation are based on the design input provided by FENOC

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DOCUMENT INDEX

DIN No.	Document Number/Title	Revision, Edition, Date	Reference	Input	Output
1	FENOC Letter ND1MDE:0730: BV1 Complete Reanalysis of Dose Consequences for CRE Tracer Gas Testing and other Acceptance Criteria Changes - Design Input Transmittal DIT-BVDM-0111-00 for Steam Generator Tube Rupture	August 16, 2018	☒	☒	☐
2	Reg. Guide 1.183, “Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power reactors”, July 2000	July 2000	☒	☐	☐
3	10CFR50.67, “Accident Source Term”	N/A	☒	☐	☐
4	Radiological Engineering & Waste Management Generic Library Data Volume I, Average β/γEnergies and Inhalation Dose Conversion Factors	September 26 1996	☒	☐	☐
5	EPA-520/1-88-020, Federal Guidance Report No.11, “Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion and Ingestion.”	September 1988	☐	☒	☐
6	WECTEC Calculation 10080-UR(B)-484, “Primary and Secondary Coolant Design/Technical Specification Activity Concentrations including Pre-Accident Iodine Spike concentrations and Equilibrium Iodine Appearance Rates”	Rev.1	☐	☒	☐
7	ANSI/ANS 6.1.1-1991, “Neutron and Gamma-ray Fluence-to-dose Factors”	Published 1991	☒	☐	☐
8	DOE/TIC-11026, “Radioactive Decay Data Tables - A handbook of Decay Data for Application to Radiation Dosimetry and Radiological Assessments”,	Kocher, 1981	☒	☐	☐
9	WECTEC Calculation 8700-EN-ME-105, “Atmospheric Dispersion Factors (χ/Qs) at Control Room and ERF Receptors for Unit 1 Accident Releases Using the ARCON96 Methodology”	Rev.0	☒	☒	☐
10	WECTEC Computer Program NU-226, Ver. 00, Lev. 02, PERC2, “Passive/Evolutionary Regulatory Consequence Code”	September 22, 2006	☒	☒	☐

CALCULATION NO. 8700-UR(B)-219, Revision 3	[ ] VENDOR CALC SUMMARY VENDOR CALCULATION NO. N/A

DIN No.	Document Number/Title	Revision, Edition, Date	Reference	Input	Output
11	FENOC Letter ND1MDE:0738, BV1 & BV2 Complete Reanalysis of Dose Consequences for CRE Tracer Gas Testing and Other Acceptance Criteria Changes - Design input Transmittal DIT-BVDM-0103-03 for Control Room Dose	January 29, 2019	☒	☒	☐
12	Lawrence Berkeley Laboratory, University of California, Berkeley, “Table of Isotopes”	7th Edition	☒	☐	☐
13	TID-24190, Air Resources Laboratories, “Meteorology and Atomic Energy”	July 1968	☒	☐	☐
14	BV Condition Report CR-2017-10857, 3BVT1.44.5 testing 1VS-D-40-1D Component Test Results	October 28, 2017	☒	☐	☐
15	WECTEC Calculation 10080-UR(B)-514, “Confirm Continued Validity of the Current Licensing Basis 4-hour Duration of the BVPS Post-Accident Concurrent Iodine Spike assuming Alternate Source Terms and Gap Fractions based on Draft Guide 1199”	Revision 0	☐	☒	☐

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REVISION STATUS

Revision **Number**	**Affected** **Sections**	**Description of Revision**
0	N/A	Original Issue
1	Sect. 3, 4, 5, 9, &10, and Attach. 1 through 6. The entire calculation is re-issued and marked as Rev.1.	The design input no. 11, 12, 14, 16, 17, 20, and 21 were changed and documented in the Rev.1 Attachment 1. These revised inputs reflect the complete model 54F replacement SGs. Revision 1 closed out the confirmation required status of Assumption 1 in Rev.0, which was tracked by CR 02-07984. The entire calculation was re-issued and marked as Rev.1.
2	Appendix A was added to the calculation	Rev.1 is based on thermal-hydraulic data listed in Ref.1, which provides conservative break flows and steam releases with an assumed termination time of 30 minutes for the break flow and releases from the ruptured SG (current Unit 1 licensing basis). As part of the EPU/RSG project, Westinghouse has performed an operational assessment for the Unit 1 SGTR transient with LOFTR2 computer modeling and calculated a break flow termination time of 44 minutes. The offsite and control room doses are calculated with this operational assessment release data and compared to the Rev.1 values in Appendix A. The comparison shows that the doses based on the current licensing basis (i.e., the Rev.1values) are conservative. Appendix A is new in Rev.2; the rest of Rev.2 is the same as Rev.1.
2, Addendum 1	Appendix A of Revision 2 is revised.	Westinghouse has revised the thermal-hydraulic input data supporting the operational response analysis evaluated in Rev 2 Appendix A, to address *single failure including margin for steam generator overfill.* The updated thermal-hydraulic input data is used in Addendum 1 to update Appendix A.
Rev 2, Addendum 2	See Description of Revision	This addendum provides a technical basis for the 4 hour duration assumed for the concurrent iodine spike per Ref.1 of the Rev.2 calculation. The 4-hr spike duration is listed as Input No.8 and Assumption No. 2 in the Rev. 2 calculation.
Rev 2, Addendum 3	Addendum 1 is revised.	Westinghouse revised the thermal-hydraulic input data supporting the operational response analysis evaluated in Rev 2 Addendum 1, to address *an operator action time of 10 minutes to locally isolate a failed open ADV.* The updated thermal-hydraulic input data was used in Addendum 3 to update Addendum 1.
Rev 2, Addendum 4	The results of Rev.2 and Rev.2	The dose consequences of the SGTR are being updated to reflect additional steam releases from the intact steam generators due to the recently identified reduced capacity of the Atmospheric Dump Valves.

	Addendum 3 are revised.	Based on the above valve capacity limitation, environmental releases are expected beyond the 8-hour plant cool down period previously required to reach RHR cut-in pressure and temperature. Consequently, the licensing basis SGTR model documented in Calc 8700-UR(B)-219, Rev 2, and the SGTR operations assessment documented in Addendum 3 of Rev.2, are updated herein to address additional steam releases from the intact steam generators during the T= 8 hr to the T= 24 hr period.
3	All	Complete update of the "licensing basis" SGTR model to address: 1) An increase in allowable unfiltered inleakage into the Control Room Envelope from 30 cfm to 165 cfm. 2) Review / Update (as needed) of all design input parameter values / references to reflect current plant design. Note: The intent of the "operations response analysis" evaluated in Revision 2 was to demonstrate that the licensing basis model is bounding. Per FENOC direction, the operational response analysis documented in Revision 2, Addendum 4, will not be re-assessed since the SGTR thermal-hydraulic data utilized in that assessment remain unchanged - thus the conclusion that the dose consequences of the licensing basis model is bounding, remains unaffected.

1.0 BACKGROUND / APPROACH

1.1 Background

Beaver Valley Power Station (BVPS) has implemented Alternative Source terms (AST) in accordance with Regulatory Guide (RG) 1.183, Revision 0. The dose consequences at the Exclusion Area Boundary (EAB), Low Population Zone (LPZ) and Control Room (CR) for a postulated Steam Generator Tube Rupture (SGTR), at BVPS Unit 1, based on AST methodology and Extended Power Uprate (EPU) is currently documented in Revision 2.

The *current licensing basis thermal hydraulic analysis model* used to determine the dose consequences at the site boundary and control room for the BVPS-1 SGTR following the EPU is a simplified transient model which, per Westinghouse, was the common industry standard prior to 1980. The model uses a hand calculation method which provides conservative break flows and releases, and utilizes an assumed termination time of 30 minutes for the break flow and releases from the ruptured SG.

To confirm that the dose estimates using the *licensing basis thermal hydraulic analysis model* discussed above are bounding, an *operational response analysis* was included in Revision 2 and its addendums, which addressed a more realistic SGTR transient analysis that takes into account realistic operator action times, single failure modeling, margin for steam generator overfill, and a 10-minutes stuck-open ADV.

Summarized below is the revision history of the AST based SGTR dose consequence analysis developed in support of the power uprate:

- The dose consequences following a SGTR based on the *current licensing basis thermal hydraulic analysis model* were originally documented in Calculation 8700-UR(B)-219, Revision 1. The thermal-hydraulic input data reflected *replacement steam generators,* and was summarized in FENOC letter ND1MLM:0383.

- Revision 2 of Calculation 8700-UR(B)-219 was developed to include Appendix A - specifically, to document the dose consequences based on thermal-hydraulic input data developed by Westinghouse (provided via FENOC letter ND1MLM:0439) with LOFTR2 computer modeling for an “*operational response analysis*” that reflected a more realistic SGTR transient analysis and utilized a calculated break flow termination time of *44 minutes* (as opposed to the *30 min licensing basis model)*. Appendix A of Calculation 8700-UR(B)-219, Rev 2 concluded that the Control Room, EAB, and LPZ doses using the licensing basis thermal hydraulic data was bounding.

- In January 2005, Westinghouse revised the thermal-hydraulic input data supporting the “*operational response analysis*” to address single failure including margin for steam generator overfill. The revised thermal-hydraulic input data was provided via FENOC letter ND1MLM:0447. Addendum 1 to Calculation 8700-UR(B)-219, Rev 2 (totally replaced Appendix A) was prepared to reflect this updated thermal-hydraulic input data from Westinghouse. The major differences were a) the revised break flow termination time was 3652 seconds (60.9 mins) vs. 44 minutes and b) the break flow flashing terminated prior to break flow termination time. The operational response break flow, flashing fractions, and steam releases were also revised. Addendum 1 to

Calculation 8700-UR(B)-219, Rev 2 concluded that the Control Room, EAB, and LPZ doses using the licensing basis thermal hydraulic data remained bounding.

- Addendum 2 to Calculation 8700-UR(B)-219, Rev 2 was prepared to provide a technical basis for the 4 hour duration assumed for the concurrent iodine spike used in the calculation.

- In November 2005, Westinghouse revised the *operational response analysis* thermal-hydraulic data to address an increase of operator action time to locally isolate a failed open Atmospheric Dump Valve (ADV) to the ruptured steam generator from 6.5 min to 10 min. The revised thermal-hydraulic input data was provided via FENOC letter ND1MDE:0325. Addendum 3 was prepared to reflect the updated o*perational response analysis* data with a 10 minutes stuck-open ADV. The calculation approach in Addendum 3 was the same as that in Addendum 1. Addendum 3 to Rev.2 replaced Addendum 1 in its entirety and concluded that the Control Room, EAB, and LPZ doses using the licensing basis thermal hydraulic data remained bounding.

- Addendum 4 to Calculation 8700-UR(B)-219, Rev 2 was prepared in January 2007 to update the dose consequences of the SGTR to reflect additional steam releases from the intact steam generators due to the reduced capacity of the Atmospheric Dump Valves. Based on the above valve capacity limitation, environmental releases were expected beyond the 8-hour plant cool down period previously required to reach RHR cut-in pressure and temperature. The impact on dose consequences was evaluated for the two scenarios previously analyzed, i.e.: the:
  - *licensing basis thermal hydraulic / environmental release model* assessed for dose consequences and documented in the main body of Calc 8700-UR(B)-219, Rev 2.
  - *operational response thermal hydraulic / environmental release model* (takes into account realistic operator action times, single failure modeling, margin for steam generator overfill, and a 10-minutes stuck-open ADV) assessed for dose consequences and documented in Calc 8700-UR(B)-219, Rev 2 Addendum 3.

  Addendum 4 concluded that the Control Room, EAB, and LPZ doses using the licensing basis thermal hydraulic data remained bounding.

As part of a Long Term Objective, and with the intent of providing operational margin, the BVPS design basis site boundary and control room dose consequence analyses are being updated to facilitate relaxation of certain operational limits that have significant effect on plant operation. To that end, Revision 3 investigates the impact of a proposed increase in the allowable unfiltered inleakage into the Control Room Envelope (CRE), on the dose consequences following a Steam Generator Tube Rupture (SGTR) at Unit 1.

In addition, per FENOC direction, the *operational response analysis* documented in Revision 2, Addendum 4, *will not be re-assessed* since the SGTR thermal-hydraulic data utilized in that assessment remain unchanged - thus the conclusion that the dose consequences of the licensing basis model is bounding, remains unaffected. Should any of the SGTR thermal-hydraulic data utilized in the operational response analysis as documented in Revision 2, Addendum 4 be affected at some future date, an assessment may need to be made to demonstrate the continued validity of the conclusion that the dose consequences of the "licensing basis" model is bounding.

In summary, the objective of Revision 3 is to demonstrate continued compliance of the SGTR *licensing basis model* with the dose acceptance criteria of 10CFR50.67, as modified by Table 6 of RG 1.183 R0, based on the following:

a) An increase in allowable unfiltered inleakage into the CRE (inclusive of that associated with ingress/egress) from 30 cfm to 165 cfm. This is intended to address the fact that recent CRE Tracer Gas Tests indicate unfiltered CRE inleakage that are in excess of the values used in the design basis dose consequence analyses.

b) Review / Update (as needed) of all design input parameter values / references to reflect current plant design.

1.2 Approach

This event assumes the instantaneous rupture of a steam generator (SG) tube with a resultant release of primary coolant into the lower pressure secondary system. Based on an assumption of a Loss of Offsite Power (simultaneous with reactor trip), the condenser is assumed to be unavailable, and environmental steam releases via the Main Steam Safety Valves (MSSVs) and Atmospheric Dump Valves (ADVs) of the intact steam generators are used to cool down the reactor until initiation of shutdown cooling via the RHR system. A portion of the primary coolant break flow into the ruptured SG flashes and is released a) to the condenser before reactor trip and b) directly to the environment after reactor trip, via the MSSVs / ADVs. The remaining break flow mixes with the secondary side liquid, and is released to the environment via steam releases through MSSVs and ADVs. The activity in the RCS also leaks into the intact steam generators via SG tube leakage and is released to the environment from the MSSVs / ADVs.

Regulatory guidance provided in Regulatory Guide 1.183 Appendix F (DIN# 2) is used to develop the dose consequence model. The key assumptions / parameters utilized to develop the radiological consequences following a SGTR are listed in DIN# 1.

Per DIN# 1, no melt or clad breach is postulated for the U1 BVPS SGTR event. Thus, and in accordance with RG 1.183, the activity released is based on the maximum coolant activity allowed by the plant Technical Specifications. In addition, and per RG 1.183, two scenarios are addressed, i.e., a) a pre-accident iodine spike which reflects the maximum allowable iodine spike activity level per the Plant Technical Specifications and b) an accident-initiated iodine spike (also called a concurrent iodine spike) which results in an increase in the iodine appearance rate from the fuel to the RCS by 335 times.

Activity Transport

WECTEC computer program PERC2 (DIN# 10) is used to calculate the Committed Effective Dose Equivalent (CEDE) from inhalation and the Deep Dose Equivalent (DDE) from submersion due to halogens and noble gases at the offsite locations and in the control room. PERC2 is a multiple compartment activity transport code with the dose model consistent with the regulatory guidance. The decay and daughter build-up during the activity transport among compartments and the various cleanup mechanisms are included.

The BVPS design input parameters utilized in the Unit 1 SGTR analysis are provided via DIT # 1 and 11.

The “licensing basis” thermo-hydraulic transient analysis of a postulated SGTR was performed by Westinghouse to determine the mass/energy release and the system response to the accident. The thermo-hydraulic data from the Westinghouse analysis, and other input parameters that are required to determine the dose consequences at the control room and offsite locations, are summarized in DIN# 1.

Based on DIN# 1 the radiological model used for the SGTR analysis conservatively assumes, reactor trip occurs at ~225 seconds (224.72) after the tube rupture. Due to the tube rupture the primary coolant with elevated iodine concentrations (pre-accident or concurrent iodine spike) flows to the ruptured steam generator and the associated activities are released to the environment due to secondary side steam releases. Before the reactor trip, the activities are released from the air ejector. After the reactor trip the steam release is from both the ruptured and intact SGs via the MSSVs/ADVs. The primary coolant activities due to the iodine spike is leaked into the intact steam generator at the maximum allowable primary-to-secondary leakage value and are also released to the environment via secondary steam releases.

The steam releases from the intact SGs, continue until shutdown cooling is initiated via operation of the RHR system at T= 24 hrs, resulting in the termination of environmental releases via this pathway. Releases from the ruptured SG are assumed to stop when the SG is isolated. The ruptured SG break flow termination time is 1800 seconds.

EAB Worst Case 2-hr Window

AST methodology requires that the worst case dose to an individual located at any point on the boundary at the EAB, for any 2-hr period following the onset of the accident be reported as the EAB dose. It is noted that regardless of the starting point of the worst 2 hr window, the 0-2 hr EAB χ/Q (limiting) is utilized.

The major source of radioactivity release following a SGTR, and thus dose consequences, is the flashed portion of the RCS break flow, which is released from condenser/air ejector before reactor trip and from MSSVs/ ADVs after reactor trip. The break flow release is terminated at T = 30 minutes when the ruptured SG is isolated. Therefore, the worst 2-hr window dose occurs during T = 0 to 2 hours after the accident.

Source Terms

Since there is no fuel damage during the course of the accident, the main source of release of radioactivity are the primary and secondary coolant systems. For the primary coolant, two spiking cases are addressed: a pre-accident iodine spike and a concurrent iodine spike. The resultant RCS activity leaks into the ruptured and intact SGs via SG tube leakage, and is released to the environment from the break point, and from the MSSVs / ADVs, respectively.

a) Pre-accident iodine spike - the initial primary coolant iodine activity is based on a maximum allowable pre-accident iodine spike activity level per the Plant Technical Specifications of 60 times the equilibrium Technical Specification iodine activity concentration of 0.35 µCi/gm DE I-131 (DIN# 1) or 21 µCi/gm of DE I-131 (transient Technical Specification limit for full power operation). The initial primary coolant noble gas activity is consistent with the design basis relative mix and activity levels associated with the Tech Spec iodine concentrations in the coolant.

b) Concurrent iodine spike - the initial primary coolant iodine activity is assumed to be at the equilibrium Technical Specification iodine activity concentration of 0.35 µCi/gm DE I-131. Immediately following the accident the iodine appearance rate from the fuel to the primary coolant is assumed to increase to 335 times (per DIN# 2) the equilibrium appearance rate corresponding to the 0.35 µCi/gm DE I-131 coolant concentration allowed by the plant Technical Specifications. The duration of the assumed spike is 4 hours (DIN# 1). The initial primary coolant noble gas activity is assumed to be at Tech Spec levels. (See discussion under item a).

The secondary coolant iodine activity, just prior to the accident, is also assumed to be at the Technical Specification limit of 0.1 µCi/gm DE I-131.

Activity Release Model

Following a Main Steam Line Break Accident the primary and secondary reactor coolant activity is released to the environment via two pathways.

Ruptured SG Release

A postulated SGTR will result in a large amount of primary coolant being released to the ruptured steam generator via the ruptured tube with a significant portion of it flashed to the steam space. The noble gases in the entire break flow and the iodine in the flashed flow are assumed to be immediately available for release from the steam generator. The iodine in the non-flashed portion of the break flow mixes uniformly with the steam generator liquid mass and is released into the steam space in proportion to the steaming rate and partition factor. To maximize the calculated offsite doses it is assumed that offsite power is lost (LOOP) so that the main condensers are not available. Before the reactor trip, the radioactivity in the steam is released to the environment from air ejector. The noble gases and organic iodine in the steam are released directly to the environment. Only a portion of the elemental iodine carried with the steam is partitioned to the air ejector and released to the environment. The rest is partitioned to the condensate, returned to all three steam generators and assumed to be available for future steaming release. After the reactor trip, the break flow continues until the primary system is fully depressurized. The steam is released from the MSSVs/ADVs. All activity releases from the ruptured steam generator cease when it is isolated at 30 mins after the accident.

Intact SG release

The activity release from the intact steam generators are due to normal primary-to-secondary leakage and steam release from the secondary side. The Primary-to-Secondary system leak rate is assumed to be at the maximum Tech Spec allowable value. All leaked primary coolant iodine activities are assumed to mix uniformly with the steam generator liquid and are released in proportion to the steaming rate and the partition factor. Before the reactor trip, the main steam is released from the air ejector/ condenser. After the reactor trip, the steam is released from the MSSVs/ADVs. The reactor coolant noble gases that enter the intact steam generator are released directly to the environment without holdup. Because the intact steam generators are used to cool down the reactor until the shutdown cooling starts, the steam release from intact steam generators continues until the RHR system is initiated at 24 hours after the accident.

Per DIN# 1, the effect of SG tube uncovery in intact SGs (for SGTR and non-SGTR events), has been evaluated for potential impact on dose consequences as part of a Westinghouse Owners Group (WOG) Program and demonstrated to be insignificant; therefore, and per RG 1.183, R0, the iodines are assumed to have a partition coefficient of 100 in the SG and released to the environment in proportion to the steaming rate and the partition coefficient. In accordance with RG 1.183, R0, the iodine releases to the environment from the SG are assumed to be 97% elemental and 3% organic. The noble gases are released freely to the environment without retention in the SG.

Release of Initial SG Liquid Activity

The initial iodine inventory in the steam generator liquid at Tech. Spec. level (0.1μ Ci/gm DE I-131) is released to the environment due to steam releases, via the condenser/air ejector before reactor trip and via MSSVs/ADVs after reactor trip. The release from the ruptured SG stops when the SG is isolated at T=30 mins. The release from intact steam generators continues until the RHR system is initiated at 24 hours after the accident.

Control Room Design/Operation/Transport Modeling

Control Room Design / Operation

Beaver Valley Power Station is served by a single control room that supports both Units. The joint control room is serviced by two ventilation intakes, one assigned to BVPS-1 and the other to BVPS-2. These air intakes are utilized for both the normal as well as the accident mode.

During normal plant operation, both ventilation intakes are operable providing a total supply of 1250 cfm of unfiltered outside air makeup which includes all potential inleakage and uncertainties (Note: this value is the total for both U1 and U2 intakes with margin; it includes the intake flow and all unfiltered inleakage (including that associated with ingress / egress and all potential inleakage) with uncertainties). (DIN# 11)

The containment high-high pressure signal (CIB) signals from either unit initiate the BVPS-2 control room emergency ventilation system. In the event one of the BVPS-2 trains is out of service, and the second train fails to start, operator action will be utilized to initiate the BVPS-1 control room emergency pressurization system.

The CR emergency pressurization intake filter has an efficiency of 99% for particulates, and 98% for elemental and organic iodine (DIN# 11).

Filtration of the Control Room ventilation recirculation flows during all modes of operation, by particulate air filters (intended for dust removal) in the CRVS recirculation air-conditioning system, is not credited.

The control room emergency filtered ventilation intake flow varies between 800 to 1000 cfm, which includes allowance for measurement uncertainties (DIN# 11). The control room unfiltered inleakage during the emergency pressurization mode is conservatively assumed to be 165 cfm (includes 10 cfm unfiltered inleakage due to ingress / egress) to reflect the results of tracer gas testing in the pressurized mode, and to also accommodate margin for potential future deterioration.

Control Room Transport Model

Since the BVPS control rooms (CR) are contained in a single control room envelope, they are modeled as a single region. Isotopic concentrations in areas outside the control room envelope are assumed to be comparable to the isotopic concentrations at the control room intake locations. To support development of bounding control room doses, the most limiting χ/Q associated with the release point / receptor, is utilized.

The control room post-accident ventilation model utilized in the dose analysis corresponds to an assumed "single intake" which utilizes the worst case atmospheric dispersion factor (χ/Q) from release points to the limiting control room intake. The atmospheric dispersion factors are provided in Section 2.

Based on DIN# 11, the atmospheric dispersion factors associated with control room inleakage are assumed to be the same as those utilized for the control room intake. (Also, see Assumption 5)

To provide operational margin, and in accordance with DIN# 11, the analysis herein assumes that during normal plant operation, the BVPS-1 & BVPS-2 unfiltered intake plus inleakage is a maximum of 1250 cfm (total for both Units). This maximum normal operation unfiltered inflow to the CR is an analytical upper bound value that is intended to include a) the CR intake flow rate (including test measurements uncertainties), b) all unfiltered inleakage and c) a 10 cfm allowance for ingress / egress. The above value bounds the test results of BV1/2 Procedure 3BVT 1.44.05 via Order 200699902. See Section 3, Assumption 4 for additional details.

Based on DIN# 1, the control room emergency ventilation is not automatically initiated, and the unfiltered intake flow into the control room remains at the normal operation flow of 1250 cfm. Eight (8) hours after a postulated SGTR at BVPS Unit 1, the CR free volume is purged at 16,200 cfm for 30 minutes. After purging the vent system is returned to the normal mode of operation.

Dose Calculation Model

WECTEC radiological consequence program PERC2 is used to calculate the Committed Effective Dose Equivalent (CEDE) from inhalation and the Deep Dose Equivalent (DDE) from submersion due to halogens and noble gases transported to offsite locations and in the control room. The CEDE is calculated with dose conversion factors from DIN# 5, which uses the methodology provided in ICRP-30. The committed doses to other organs due to inhalation of halogens, particulates and noble gas daughters are also calculated. PERC2 is a multiple compartment activity transport code with the dose model consistent with the regulatory guidance. The decay and daughter build-up during the activity transport among compartments and the various cleanup mechanisms are included.

The PERC2 activity transport model, first calculates the integrated activity (using a closed form integration solution) at the offsite locations and in the control room air region, and then calculates the cumulative doses as described below:

Committed Effective Dose Equivalent (CEDE) Inhalation Dose - The dose conversion factors by isotope and internal organ type are applied to the activity in the air space of the control room, or at the EAB/LPZ.

The exposure is adjusted by the appropriate respiration rate and occupancy factors for the CR dose at each integration interval as follows:

$$Dh(j) = A(j) \times h(j) \times C2 \times C3 \times CB \times CO$$

Where:
Dh(j) = Committed Effective Dose Equivalent (rem) from isotope j
A(j) = Integrated Activity (Ci-s/m^3)
h(j) = Isotope j Committed Effective Dose Equivalent (CEDE) dose conversion factor (mrem/pCi) based on Fed. Guidance Report No.11, Sept. 1988 (DIN# 5)
C2 = Unit conversion of 1×10^{12} pCi/Ci
C3 = Unit conversion of 1×10^{-3} rem/mrem
CB = Breathing rate (m^3/s)
CO = Occupancy factor

Deep Dose Equivalent (DDE) from External Exposure - According to the guidance provided in Section 4.1.4 and Section 4.2.7 of RG 1.1.83, R0 (DIN# 2), the Effective Dose Equivalent (EDE) may be used in lieu of DDE in determining the contribution of external dose to the TEDE if the whole body is irradiated uniformly. The EDE in the control room is based on a finite cloud model that addresses buildup and attenuation in air. The dose equation is based on the assumption that the dose point is at the center of a hemisphere of the same volume as the control room. The dose rate at that point is calculated as the sum of typical differential shell elements at a radius R. The equation utilizes, the integrated activity in the control room air space, the photon energy release rates per energy group from activity airborne in the control room based on using the isotopic gamma energy library data developed in DIN# 4 based on DIN#s 12 and 8, and the ANSI/ANS 6.1.1-1991 "Neutron and Gamma-ray Fluence-to-dose Factors", DIN# 7.

The Deep Dose Equivalent at the EAB and LPZ locations is very conservatively calculated using the semi-infinite cloud model outlined in TID-24190 (DIN# 13), Section 7-5.2, Equation 7.36, where 1 rad is assumed to be equal to 1 rem.

γD_∞ (x,y,0) rad = 0.25 $E\gamma_{BAR}$ ψ (x,y,0)
$E\gamma_{BAR}$ = average gamma energy released per disintegration (Mev/dis) is based on the isotopic gamma energy data developed in DIN# 4
ψ (x,y,0) = concentration time integral (Ci-sec/m^3)
0.25 = $[1.11 \bullet 1.6 \times 10^{-6} \bullet 3.7 \times 10^{10}] / [1293 \bullet 100 \bullet 2]$

Where:
1.11 = ratio of electron densities per gm of tissue to per gm of air
1.6×10^{-6} (erg/Mev) = number of ergs per Mev
3.7×10^{10} (dis/sec-Ci) = disintegration rate per curie
1293 (g/m^3) = density of air at S.T.P.
100 = ergs per gram per rad
2 = factor for converting an infinite to a semi-infinite cloud

2.0 DESIGN INPUTS

All input parameters values associated with BVPS design used in this analysis including identification of the source documents from which the parameter values were obtained, have been verified / approved for use by FENOC and provided to WECTEC via DIN# 1 and 11 (included herein as Attachments 1 and 2). Comments / explanations associated with the parameter values presented below are provided in DIN# 1 and 11 under the "Comment" column, and provide additional information that may be useful to the user.

General Comment (Per DIN# 1 & 11)
The equipment / parameter values presented below as approved design input reflect safety related components that can be credited in design bases dose consequence analyses; i.e., the components have the appropriate redundancy, environmental qualification, pedigree, seismic support etc. applicable to safety related equipment, and the parameter values reflect single failure criteria.

Design Input Parameter / Value **DIN#**

1. Reactor Core thermal power – 2918 MW (100.6% of uprate power level of 2900 MW) [1]
2. Failed Fuel Percentage – 0% [1]
3. Melted fuel percentage – 0% [1]
4. Primary Coolant and Secondary Side Halogen and Noble Gas Concentrations at Technical Spec Limits (0.35 μCi/gm DE I-131 for primary coolant, 0.1 μCi/gm DE I-131 for the secondary side) [1] [6]

Nuclide		Reactor Coolant (μCi/gm)		Secondary Liquid (μCi/gm)
KR 83M		4.09E-02		
KR 85M		1.48E-01		
KR 85		1.30E+01		
KR 87		9.68E-02		
KR 88		2.74E-01		
KR 89		7.80E-03		
XE131M		5.54E-01		
XE133M		4.59E-01		
XE133		3.34E+01		
XE135M		9.87E-02		
XE135		1.02E+00		
XE137		2.03E-02		
XE138		6.86E-02		

Nuclide		Reactor Coolant (µCi/gm)		Secondary Liquid (µCi/gm)
BR83		7.64E-03		
BR84		3.84E-03		
BR85		4.07E-04		
BR87		2.11E-04		
I129		1.04E-08		3.34E-09
I130		4.52E-03		8.38E-04
I131		2.73E-01		8.34E-02
I132		1.13E-01		1.39E-02
I133		4.17E-01		9.32E-02
I134		6.47E-02		1.90E-03
I135		2.46E-01		3.34E-02
I136		7.07E-04		5.79E-07

5. Primary Coolant Iodine Concentrations with Pre-accident Spike (21 µCi/gm DE I-131) [1] [6]

Nuclide			
I131		1.64E+01	µCi/gm
I132		6.77E+00	µCi/gm
I133		2.50E+01	µCi/gm
I134		3.88E+00	µCi/gm
I135		1.48E+01	µCi/gm

6. Iodine Appearance Rate at Equilibrium Technical Spec Concentrations (0.35 µCi/gm DE I-131) [1] [6]

Nuclide			
I131		2.27E+03	µCi/sec
I132		2.83E+03	µCi/sec
I133		4.17E+03	µCi/sec
I134		3.39E+03	µCi/sec
I135		3.44E+03	µCi/sec

7. Iodine Appearance Rate with Concurrent Spike = 335 x Datum 6 values [1] [2]
8. Duration of Iodine Concurrent Spike = 4 hours [1]

9. Chemical form of halogens released via steam generators [1] [2]

   97% elemental, 3% organic

10. Primary to Secondary Coolant leakage rate in Intact SGs [1]

    150 gpd @ STP per SG, leakage density 1g/cc

11. Initial & Minimum post-accident reactor coolant mass [1]

    373,100 lbm

12. Time Till Reactor Trip – 224.72 seconds (rounded to 225) [1]
    See Assumption 6

13. Activity Release Path [1][2]

    Before reactor trip – Condenser/ air ejector effluent

    After reactor trip – MSSV/ADV

14. Break Flow from RCS to ruptured SG and the Flash Fraction [1]

Time (sec)	Break Flow (lbs)	Flash Fraction (-)
0 – 225	21,900	0.2227
225 - 1800	128,000	0.1645

15. Maximum main steam flow to condenser before reactor trip [1]

    1207.407 lbs/sec per steam generator

16. Maximum Steam Releases from ruptured SG via MSSVs/ADVs [1]

Time (sec)	MSSVs/ADVs Release (lbm)
225 - 1800	68,900

17. Maximum Steam Releases from intact SGs via MSSVs/ADVs [1]

Time	MSSVs/ADVs Release (lbm)
225 sec – 7200 sec	417,100
2 hr– 8 hr	979,500
8 hr – 16 hr	658,400
16 hr – 24 hr	546,700

18. Time period of tube uncovery - negligible [1]

19. Partition Coefficient in Steam Generators [1][2]

Flashed portion of the rupture flow:

Noble Gas & iodine – released freely with no retention

Non-flashed portion of the rupture flow and leakage flow in intact SG:

Noble Gas – released freely with no retention

Iodine – 100

Partition Coefficient = $\frac{\text{mass of iodine per unit mass of liquid}}{\text{mass of iodine per unit mass of gas}}$

20. Partition Factor in Condenser/ Air Ejector [1]

Noble Gas – 1 (all released)

Organic iodine – 1 (all released)

Elemental iodine – 100 (1/100th released)

21. Minimum post-accident Steam Generator Liquid Mass [1]

91,000 lbm for each SG (ruptured and intact SGs)

22. Initial Steam Generator Liquid Mass [1]

96,000 lbm for each SG

23. Control Room Breathing Rate [2][11]

0-30 day - 3.5E-04 m3/sec

24. Control Room Occupancy Factors [2][11]

0-1 day	1.0
1-4 day	0.6
4-30 day	0.4

25. Minimum Control Room Envelope Free Volume [11]

173,000 ft^3

26. Maximum normal operation ventilation air intake / inleakage into the CR [11]

1250 cfm

(Total for both U1 and U2 intakes with margin, includes intake and all unfiltered inleakage, including that associated with ingress / egress)

This is an assumed value intended to provide operational margin – see Assumption 4.

27. Post-accident control room purge [1]

16,200 cfm from 8 hr to 8.5 hr

28. Dispersion factor from MSSV/ADV and Air Ejector (T.B. SE corner) to the control room [1] [9]

(Unit 1 CR intake value is more limiting)

Time	MSSV/ADV	T.B. SE Corner
0-2hr	1.24E-03 s/m^3	1.05E-02 s/m^3
2-8hr	9.94E-04 s/m^3	7.72E-03 s/m^3
8-24 hr	4.08E-04 s/m^3	3.01E-03 s/m^3

29. Exclusion Area Boundary χ/Q [11]

0-2 hr - 1.04E-03 sec/m^3

30. Low Population Zone χ/Q [11]

0-8 hr – 6.04E-05 sec/m^3

8-24 hr – 4.33E-05 sec/m^3

31. Offsite Breathing Rate [2][11]

0-8 hr	3.5E-04 m^3/sec
8-24 hr	1.8E-04 m^3/sec
1-30 day	2.3E-04 m^3/sec

3.0 ASSUMPTIONS

Assumptions utilized in this assessment have been approved by FENOC and were provided to WECTEC via DIN# 1 and 11. None of these assumptions need further verification. Discussions regarding the bases of these assumptions are also included in DIN# 1 and 11. Summarized below are some of the salient assumptions, including those made by the author when developing the transport models:

1. Assumptions used in the SGTR dose consequence transport model that are listed as Design Input No. 7, 9, 13, 19, 23, 24, 31 are based on the guidance provided in RG 1.183, Revision 0. The partition factor in the condenser listed under Design Input No. 20 is based on guidance provided in NUREG 0017, R1.

2. In accordance with DIN# 15, the concurrent iodine spike is assumed to last 4 hours.

3. In accordance with DIN# 1, the analysis herein assumes manual operator action to purge the CR free volume at 16,200 cfm for 30 minutes, eight (8) hours after a postulated SGTR.

4. To provide operational margin, and in accordance with DIN# 11, the analysis herein assumes that during normal plant operation, the BVPS-1 & BVPS-2 unfiltered intake plus inleakage is a maximum of 1250 cfm (total for both Units). This maximum normal operation unfiltered inflow to the CR is an analytical upper bound value that is intended to include a) the CR intake flow rate (including test measurements uncertainties), b) all unfiltered inleakage and c) a 10 cfm allowance for ingress / egress. The above value bounds the test results of BV1/2 Procedure 3BVT 1.44.05 via Order 200699902.

5. As noted in DIN# 11, due to the following reasons, the CR air intake χ/Q values are assumed to be representative / applicable for unfiltered in-leakage (including CR ingress / egress).

   - Component tests performed as part of the 2017 CR Inleakage Tracer Gas Test indicated that a potential source of unfiltered inleakage into the Control Room are the normal operation intake dampers - which can be assigned the same χ/Q as the Control Room air intakes.

   - Regarding other potential locations of inleakage, a χ/Q value that reflects the center of the Control Room boundary at roof level as a receptor could be considered the average value applicable to Unfiltered Inleakage locations around the CRE, and thus representative for all CR unfiltered leakage locations.

     Review of dwg 8700-RY-1C, R2 indicates that since the post-accident release points are a) closer to the CR intakes and b) the directions from the release points to the CR center and CR intakes are similar, use of χ/Q values associated with the CR intakes, for CR unfiltered inleakage, would be conservative.

   - The 10 cfm allowance for ingress/egress, is assigned to the door leading into the Control Room that is considered the primary point of access. This door (S35-71) is located at grade level on the side of the building facing the BV1 Containment and between the CR air intakes. It is located close enough to the air intakes to allow the assumption that the χ/Q associated with this source of leakage would be reasonably similar to that associated with the air intakes.

6. DIN# 1 lists the calculated time of reactor trip as “224.72 seconds (rounded up to 225 seconds)”. Since the small change in rounding makes no difference in the analysis, the actual value of 274.72 seconds is used in the analysis herein.
7. Isotopes addressed herein are consistent with the AST LAR, Power Uprate analysis, and those addressed in the current analysis of record.
8. In accordance with RG 1.183 R0, the condenser is assumed unavailable due to a coincident loss of offsite power. Consequently, the radioactivity release from the intact SGs resulting from a SGTR is discharged to the environment via the MSSVs and the ADVs.

4.0 ACCEPTANCE CRITERIA

EAB and LPZ Dose Criteria for a SGTR (per 10CFR § 50.67, and Section 4.4 Table 6 of RG 1.183)

(1) An individual located at any point on the boundary of the exclusion area for any 2-hour period following the onset of the postulated accident, should not receive a radiation dose in excess of 0.25 Sv (25 rem) total effective dose equivalent (TEDE) for the Pre-incident Spike Case and 0.025 Sv (2.5 rem) TEDE for the Coincident Spike Case.

(2) An individual located at any point on the outer boundary of the low population zone, who is exposed to the radioactive cloud resulting from the postulated accident (during the entire period of its passage), should not receive a radiation dose in excess of 0.25 Sv (25 rem) TEDE for the Pre-incident Spike Case and 0.025 Sv (2.5 rem) TEDE for the Coincident Spike Case.

Control Room Dose Criteria (10 CFR Part 50 § 50.67)

Adequate radiation protection is provided to permit occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 0.05 Sv (5 rem) total effective dose equivalent (TEDE) for the duration of the accident.

5.0 LIST OF COMPUTER PROGRAMS AND OUTPUT FILES

IDENTIFICATION OF COMPUTER HARDWARE

Dell Precision T1700 PC, Intel Core i5-4570, Windows 7 Professional Version 2009, Service Pack 1, WECTEC Serial/ID number: 154LH02

IDENTIFICATION OF COMPUTER PROGRAMS

PERC2, NU-226, Ver.00, Lev.02, QA Cat. I, "PERC2 - Passive Evolutionary Regulatory Consequence Code", created September 22, 2006

There are no outstanding error releases associated with PERC2 that would affect the results of this analysis.

LIST OF COMPUTER OUTPUT FILES

File Name[(2)]	Run Date	Run Time	Description
Pre-accident Iodine Spike Source			
BV219LB01P,C	10/23/18	10:20:19	Ruptured flow, halogen source, control room & LPZ
BV219LB02P	10/23/18	10:21:30	Ruptured flow, halogen source, EAB
BV219LB03P,C	10/23/18	10:21:41	Ruptured flow, noble gas & daughters, control room & LPZ (0-30 m)
BV219LB04P,C	10/23/18	10:21:52	Ruptured flow, noble gas & daughters, control room & LPZ (>30 m)
BV219LB05P	10/23/18	10:22:02	Ruptured flow, noble gas & daughters, EAB
BV219LB06P,C	10/23/18	10:22:14	Intact SG leakage, N.G. & halogen source, control room & LPZ
BV219LB07P	10/23/18	10:22:33	Intact SG leakage, N.G. & halogen source, EAB
Iodine Inventory in Steam Generator Liquid			
BV219LB08P,C	10/23/18	10:22:53	Ruptured steam generator, control room & LPZ
BV219LB09P	10/23/18	10:23:10	Ruptured steam generator, EAB
BV219LB10P,C	10/23/18	10:23:22	Intact steam generators, control room & LPZ
BV219LB11P	10/23/18	10:23:31	Intact steam generators, EAB
Concurrent Iodine Spike Source			
BV219LB12P,C	10/23/18	10:23:52	Ruptured flow, halogen source, control room & LPZ
BV219LB13P	10/23/18	10:24:05	Ruptured flow, halogen source, EAB
BV219LB14P,C	10/23/18	10:24:37	Ruptured flow, noble gas & daughters, control room & LPZ (0-30 m)
BV219LB15P,C	10/23/18	10:24:57	Ruptured flow, noble gas & daughters, control room & LPZ (>30 m)
BV219LB16P	10/23/18	10:25:11	Ruptured flow, noble gas & daughters, EAB
BV219LB17P,C	10/23/18	10:25:22	Intact SG leakage, N.G. & halogen source, control room & LPZ
BV219LB18P	10/23/18	10:25:38	Intact SG leakage, N.G. & halogen source, EAB

Computer run files are retained in the WECTEC Offices.

6.0 COMPUTATION

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7.0 RESULTS

Presented in Table 7-1 and Table 7-2 below are the airborne doses at the EAB, LPZ and Control Room following a postulated SGTR at Unit 1 from each pathway for the pre-accident iodine spike scenario and the concurrent iodine spike scenario, respectively. As discussed earlier, the "worst" 2-hour EAB dose following a SGTR is the 0-2 hour period.

Table 7-1
Pre-Accident Iodine Spike Scenario

Site Boundary Doses (rem)

	2 hr- EAB			30 day LPZ		
CONTRIBUTOR	**CEDE**	**DDE**	**TEDE**	**CEDE**	**DDE**	**TEDE**
Ruptured SG – Halogens	2.044E+00	1.365E-01	2.18E+00	1.201E-01	7.989E-03	1.28E-01
Ruptured SG - NG & Halogen Daughters[1]	1.929E-04	1.100E-01	1.10E-01	1.120E-05	3.654E-03	3.66E-03
Intact SGs - Halogen, NG & Daughters	2.184E-04	1.572E-04	3.76E-04	4.032E-04	1.647E-04	5.68E-04
T.S. Iodine in Ruptured SG Sec. Coolant	4.617E-04	1.726E-05	4.79E-04	2.681E-05	1.003E-06	2.78E-05
T.S. Iodine in Intact SGs Sec. Coolant	2.499E-03	8.813E-05	2.59E-03	5.638E-04	1.789E-05	5.82E-04
Totals	2.047E+00	2.468E-01	**2.294**	1.211E-01	1.183E-02	**0.133**

Control Room Operator Dose (rem)

	30-day CONTROL ROOM		
CONTRIBUTOR	**CEDE**	**DDE**	**TEDE**
Ruptured SG – Halogens	2.520E+00	4.331E-03	2.52E+00
Ruptured SG - NG & Halogen Daughters[1]	7.441E-04	3.083E-03	3.83E-03
Intact SGs - Halogen, NG & Daughters	5.948E-03	2.727E-05	5.98E-03
T.S. Iodine in Ruptured SG Sec. Coolant	1.065E-03	1.131E-06	1.07E-03
T.S. Iodine in Intact SGs Sec. Coolant	9.616E-03	8.330E-06	9.62E-03
Totals	2.537E+00	7.450E-03	**2.545**

Notes:
[1] Dose is sum of output from runs 219R3-03 and 219R3-04

General notes
[2] Noble gas daughter products as particulates are included in files 219R3-03, 05, 06 and 07. They exist in the runs because the models are conservative. The model does not account for the fact that the particulates will largely remain in the secondary coolant. Even though the particulate contribution is overestimated the dose values due to the addition of these particulates is inconsequential.
[3] The control room doses are taken from output file "CNTLROOM.OUT". The EAB and LPZ doses are taken from output file "PERC.OUT".

Table 7-2
Concurrent Accident Iodine Spike Scenario

Site Boundary Doses (rem)

	2 hr- EAB			30 day LPZ		
CONTRIBUTOR	**CEDE**	**DDE**	**TEDE**	**CEDE**	**DDE**	**TEDE**
Ruptured SG – Halogens	6.550E-01	1.141E-01	7.69E-01	3.809E-02	6.629E-03	4.47E-02
Ruptured SG - NG & Halogen Daughters[1]	1.926E-04	7.104E-02	7.12E-02	1.119E-05	2.699E-03	2.71E-03
Intact SGs - Halogen, NG & Daughters	1.515E-04	1.820E-04	3.34E-04	1.229E-03	7.317E-04	1.96E-03
T.S. Iodine (0.35 uCi/g DEI-131) in RCS	3.407E-02	4.108E-03	3.61E-02	2.008E-03	1.359E-04	2.14E-03
T.S. Iodine in Ruptured SG Sec. Coolant	4.617E-04	1.726E-05	4.79E-04	2.681E-05	1.003E-06	2.78E-05
T.S. Iodine in Intact SGs Sec. Coolant	2.499E-03	8.813E-05	2.59E-03	5.638E-04	1.789E-05	5.82E-04
Totals	6.92E-01	1.88E-01	**0.880**	4.19E-02	1.02E-02	**0.052**

Control Room Operator Dose (rem)

	30-day CONTROL ROOM		
CONTRIBUTOR	**CEDE**	**DDE**	**TEDE**
Ruptured SG - Halogens	7.373E-01	2.635E-03	7.40E-01
Ruptured SG - NG & Halogen Daughters[1]	7.437E-04	2.996E-03	3.74E-03
Intact SGs - Halogen, NG & Daughters	1.829E-02	8.907E-05	1.84E-02
T.S. Iodine (0.35 uCi/g DEI-131) in RCS	4.210E-02	7.218E-05	4.22E-02
T.S. Iodine in Ruptured SG Sec. Coolant	1.065E-03	1.131E-06	1.07E-03
T.S. Iodine in Intact SGs Sec. Coolant	9.616E-03	8.330E-06	9.62E-03
Totals	8.09E-01	5.80E-03	**0.815**

Notes:
[1] Dose is sum of output from runs 219R3-14 and 219R3-15

General notes
[2] Noble gas daughter products as particulates are included in files 219R3-14, 16, 17 and 18. They exist in the runs because the models are conservative. The models do not account for the fact that the particulates will largely remain in the secondary coolant. Even though the particulate contribution is overestimated the dose values due to the addition of these particulates is inconsequential.
[3] The control room doses are taken from output file “CNTLROOM.OUT”. The EAB and LPZ doses are taken from output file “PERC.OUT”.

8.0 CONCLUSIONS

The BVPS Site Boundary and Control Room doses due to airborne radioactive material released following a SGTR at Unit 1 will remain within the regulatory limits set by 10CFR50.67 and Regulatory Guide 1.183. These doses were calculated by using Alternative Source Terms and BVPS Unit 1 design input parameter values provided by FENOC via DIN#s 1 and 11 (see Attachment 1 and 2).

In accordance with regulatory guidance, two scenarios were evaluated, i.e., a Pre-accident Iodine Spike and a Concurrent Iodine spike. As noted in Section 7, Results, the pre-accident iodine spike scenario is bounding:

Pre-accident Iodine Spike Case

Control Room (30 days)	2.6 rem	Limit 5 rem
EAB (maximum 2 hours)	2.3 rem	Limit 25 rem
LPZ (course of accident)	0.14 rem	Limit 25 rem

Concurrent Iodine Spike Case

Control Room (30 days)	0.82 rem	Limit 5 rem
EAB (maximum 2 hours)	0.88 rem	Limit 2.5 rem
LPZ (course of accident)	0.06 rem	Limit 2.5 rem

In summary:

Control Room
The limiting 30-day integrated dose to the Control Room (CR) operator is 2.6 rem TEDE. This value is below the regulatory limit of 5 rem TEDE.

Note: In accordance with current licensing basis, the CR dose estimates following a SGTR at Unit 1 is based on the assumption that the CR ventilation system remains in normal operation mode, and that the CR is purged at a minimum flow rate of 16,200 cfm between t=8 hrs and t=8.5 hrs after which it reverts to the normal operation mode.

Site Boundary
The limiting integrated dose to an individual located at any point on the boundary of the exclusion area (EAB) for any 2-hour period following the onset of the event is 2.3 rem TEDE (t=0 hr to t=2 hour time window). This dose is less than the regulatory limit of 25 rem TEDE for the pre-accident iodine spike.

The limiting integrated dose to an individual located at LPZ following the onset of the event with a concurrent iodine spike is 0.2 rem TEDE, which is less than the regulatory limit of 25 rem TEDE for the pre-accident iodine spike.

It is noted however that although the estimated doses at the EAB and LPZ due to a concurrent iodine spike are bounded by the estimated doses reported above due to the pre-accident iodine spike, the margin to the regulatory limit for the concurrent iodine spike (i.e., 2.5 rem TEDE), is less.

FirstEnergy	CALCULATION COMPUTATION NOP-CC-3002-01 Rev. 05
CALCULATION NO.: 8700-UR(B)-219	REVISION: 3

Attachment 1

FirstEnergy Design Input Transmittal

DIT-BVDM-0111-00 transmitted via FENOC Letter ND1MDE:0730

August 16, 2018

FENOC
FirstEnergy Nuclear Operating Company

Beaver Valley Power Station
P.O. Box 4
Shippingport, PA 15077

Patrick G. Pauvlinch
Manager, Design Engineering
pauvlinchp@firstenergycorp.com

Phone: 724-682-4982
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ND1MDE:0730
August 16, 2018

Sreela Ferguson
WECTEC
720 University Ave.
Norwood, MA 02062

BV1 Complete Reanalysis of Dose Consequences
For CRE Tracer Gas Testing and Other Acceptance Criteria Changes
Design Input Transmittal DIT-BVDM-0111-00 for Steam Generator Tube Rupture

Dear Ms. Ferguson:

Attached is Design Input Transmittal DIT-BVDM-0111-00 which provides information for evaluating the control room operator dose for a BV1 Steam Generator Tube Rupture Design Basis Accident.

Should you have any questions about the attached information, please contact Douglas Bloom at 724-682-5078 or Mike Ressler at 724-682-7936.

Sincerely,

Patrick G. Pauvlinch
Manager, Design Engineering

DTB/bls

Attachment

cc: D. T. Bloom
M. G. Unfried
M. S. Ressler
BVRC

FirstEnergy

CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 8700-UR(B)-219	REVISION: 3

Form 1/2-ADM-2097.F01, Rev 0

RTL# A1.105V

DESIGN INPUT TRANSMITTAL

☒ SAFETY RELATED / AUG QUAL ☐ NON-SAFETY RELATED	Originating Organization: ☒ FENOC ☐ Other (Specify)	DIT- BVDM-0111-00 Page __1__ of __1__
Beaver Valley Unit: ☒1 ☐2 ☐Both System Designation: Various Engineering Change Package: N/A		To: Sreela Ferguson Organization: WECTEC

Subject: **Design Input Transmittal for Calculating BVPS Unit 1 Steam Generator Tube Rupture (SGTR) Dose Consequences**

Status of Information: ☒Approved for Use ☐Unverified

For Unverified DITs, Notification number tracking verification: ____________________

Description of Information:

Safety Analysis Design inputs? ☒Yes ☐No
Reconciled to Current Design Basis? ☒Yes ☐N/A

This DIT provides information required for the performance of the Steam Generator Tube Rupture dose consequence design basis accident calculation. This supports a proposed License Amendment Request (LAR) involving the control room envelope tracer gas testing criteria.

Purpose of Issuance:
This DIT provides information required for the performance of design basis accident dose consequence calculation UR(B)-219.

Source of Information (Reference, Rev, Title, Location):

Engineering Judgment Used? ☐Yes ☒No

See attachment to DIT table.

Preparer: Douglas T Bloom	Preparer Signature: [signature]	Date: 8-16-18
Reviewer: K. J. Frederick	Reviewer Signature: [signature]	Date: 8-16-18
Approver: M. S. Ressler N. Walker for Ressler	Approver Signature: [signature]	Date: 8/16/18

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3A: Parameters for Calculating BVPS Unit 1 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-219, R2, A1 to A4]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**

General Notes:

1. The equipment / parameter values presented in the table below as approved design inputs to be used for the U1 SGTR analysis reflect safety related components that can be credited in design bases dose consequence analyses; i.e., the components have the appropriate redundancy, environmental qualification, pedigree, seismic support, etc., applicable to safety related equipment, and the parameter values reflect single failure criteria.
2. The critical input values are: Initial RCS T/S activity concentrations, Time of reactor trip, Maximum break flow from RCS into the ruptured SG, Maximum break flow that flashes (ruptured SG), Termination of environmental releases from the ruptured SG, Maximum time period of tubes being uncovered, Maximum steam release to atmosphere from the ruptured SG, Minimum post-accident liquid mass per SG, Minimum RCS mass, Initial SG liquid mass per SG, Control Room (CR) atmospheric dispersion factors

Parameter	AOR Value	AOR Reference	LAR Value	LAR Reference	Comment
1. Core Power Level (with power uncertainty) used to establish radiation source terms	2918 MWt	FENOC letter ND1MDE:0388, 01/15/07	2918 MWt	BV1 Renewed Operating License DPR-66 BV1 LRM B 3.3.8 BV1/2 TS 5.6.3 BV1 Calculation UR(B)-219 BV1 UFSAR Section 14.2.4.2.2 BV1 UFSAR Table 14.2-9	Rated Thermal Power shall not exceed 2900 MWt. Total power measurement uncertainty of better than +/- 0.6% of RTP at full power is achieved using the Leading Edge Flow Meter. 2900 MWt x 1.006 = 2917.4 MWt
2. Design Basis Core Activity for iodines and Noble gases	As provided in reference calculation	FENOC letter ND1MDE:0388, 01/15/07 BV1/2 Calculation UR(B)-483	As provided in Reference	BV1/2 Calculation UR(B)-483	The current design basis composite equilibrium core inventory, which is based on 2918 MWt, an 18-month burnup cycle and initial enrichments from 4.2% to 5%, is appropriate and is not being changed.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3A: Parameters for Calculating BVPS Unit 1 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-219, R2, A1 to A4]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
3. Maximum failed fuel percentage following a SGTR	None	FENOC letter ND1MDE:0388, 01/15/07 Westinghouse letter FENOC-03-139, 7/25/03	None	NRC Regulatory Guide 1.183 BV1 UFSAR Section 14.2.4.2.2 BV1 UFSAR Table 14.2-9 FENOC Letter ND1SGRP:0403 FENOC Letter ND1MDE:0388	Per NRC Regulatory Guide 1.183, Appendix F (SGTR) states, in part: "If no or minimal fuel damage is postulated for the limiting event, the activity released should be the maximum coolant activity allowed by technical specification. Two cases of iodine spiking should be assumed." UFSAR Section 14.2.4.2.2 states: "Since there is no postulated fuel damage associated with this accident, the main radiation source is the activity in the primary coolant system and the two iodine spiking cases addressed, i.e, a) a pre-accident iodine spike and, b) a concurrent iodine spike."
4. Maximum melted fuel percentage following a SGTR	None	FENOC letter ND1MDE:0388, 01/15/07 Westinghouse letter FENOC-03-139, 7/25/03	None	BV1 UFSAR Section 14.2.4.2.2 BV1 UFSAR Table 14.2-9 FENOC Letter ND1SGRP:0403 FENOC Letter ND1MDE:0388	See Parameter 3

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3A: Parameters for Calculating BVPS Unit 1 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-219, R2, A1 to A4]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
5. Activity available for release	- Technical Specification (T/S) Reactor Coolant System (RCS) concentrations - T/S secondary side concentrations - Pre-accident iodine spike activity Concurrent iodine spike activity	FENOC letter ND1MDE:0388, 01/15/07 RG 1.183 Rev.0	- Technical Specification (TS) Reactor Coolant System (RCS) concentrations - TS secondary side concentrations - Pre-accident iodine spike activity - Concurrent iodine spike activity	NRC Regulatory Guide 1.183 BV1 Calculation UR(B)-219 BV1/2 Calculation UR(B)-484 BV1 UFSAR Section 14.2.4.2.2 BV1 UFSAR Table 14.2-9	Per NRC Regulatory Guide 1.183, Appendix F (SGTR) states, in part: "If no or minimal fuel damage is postulated for the limiting event, the activity released should be the maximum coolant activity allowed by technical specification. Two cases of iodine spiking should be assumed…(i.e., a preaccident iodine spike case…concurrent iodine spike case)." RCS activity is released into the ruptured SG via the tube rupture, and into the intact SGs due to primary-to-secondary leakage; the activity is released to the environment via the MSSVs and ADVs. Secondary side activity is released due to steam release from all SGs.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3A: Parameters for Calculating BVPS Unit 1 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-219, R2, A1 to A4]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
6. Initial RCS activity concentrations (µCi/gm) T/S values	RCS activity limited to ≤ 0.35 µCi/gm Dose Equivalent (DE) I-131 ≤ 100 E_{BAR} µCi/gm Isotopic inventory obtained from referenced calculation	FENOC letter ND1MDE:0388, 01/15/07 BVPS1 TS 3.4.8 S&W calculation UR(B)-484, R0 /A1	Reactor Coolant Dose Equivalent I-131 specific activity limited to: ≤ 0.35 µCi/gm Reactor Coolant gross specific activity limited to: ≤ 100/E_{bar} µCi/gm Isotopic inventory obtained from referenced calculation	BV1/2 TS 3.7.13 BV1/2 Calculation UR(B)-484	
7. Initial T/S secondary side liquid iodine concentrations (µCi/gm),	Steam generator (SG) coolant activity limited to ≤ 0.10 µCi/gm DE I-131 Isotopic inventory obtained from referenced calculation	BVPS-1 TS Sec. 3.7.1.4 BVPS-1 TS Amendment No. 244 Calculation UR(B)-484, R0 / A1	Secondary Coolant activity limited to: ≤ 0.10 µCi/gm I-131 DE Isotopic inventory obtained from referenced calculation	BV1/2 TS 3.7.13 BV1/2 Calculation UR(B)-484	

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3A: Parameters for Calculating BVPS Unit 1 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-219, R2, A1 to A4]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
8. Concurrent iodine spike appearance rate (Ci/sec)	335 times T/S equilibrium appearance rate T/S equilibrium appearance rate provided in referenced calculation	FENOC letter ND1MDE:0388, 01/15/07 RG 1.183 Rev.0 S&W calculation UR(B)-484, R0/A1	335 times TS equilibrium appearance rate TS equilibrium appearance rate provided in referenced calculation	NRC Regulatory Guide 1.183 BV1 Calculation UR(B)-219 BV1/2 Calculation UR(B)-484 BV1 UFSAR Section 14.2.4.2.2 BV1 UFSAR Table 14.2-9	Per NRC Regulatory Guide 1.183, Appendix F (SGTR) states, in part: "The primary system transient associated with the SGTR causes an iodine spike in the primary system. The increase in primary coolant iodine concentration is estimated using a spiking model that assumes that the iodine release rate from the fuel rods to the primary coolant (expressed in curies per unit time) increases to a value 335 times greater than the release rate corresponding to the iodine concentration at the equilibrium value (typically 1.0 µCi/gm DE I-131) specified in technical specifications (i.e., concurrent iodine spike case)."

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3A: Parameters for Calculating BVPS Unit 1 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-219, R2, A1 to A4]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
9. Duration of concurrent iodine spike	4 hours	FENOC letter ND1MDE:0388, 01/15/07 Current licensing basis Calculation UR(B)-219, R2, A2	4 hours	BV1 Calculation UR(B)-219 BV1 UFSAR Section 14.2.4.2.2 BV1 UFSAR Table 14.2-9 FENOC Letter L-05-137	Per NRC Regulatory Guide 1.183, Appendix F (SGTR) states, in part: "The assumed iodine spike duration should be 8 hours. Shorter spike durations may be considered on a case-by-case basis if it can be shown that the activity released by the 8-hour spike exceeds that available for release from the fuel gap of all fuel pins." Basis for acceptability of the 4-hour duration was provided to NRC via response to Request for Additional Information. NRC acknowledged 4-hour duration in Safety Evaluation for BV1 Amendment 273.
10. Pre-accident iodine spike	21 µCi/gm DE I-131 Values provided in referenced calculation	FENOC letter ND1MDE:0388, 01/15/07 BVPS-1 & 2 T/S Figure 3.4-1 S&W calculation UR(B)-484, R0/A1/A2	21 µCi/gm DE I-131 Values provided in referenced calculation	BV1/2 TS B 3.4.16 BV1/2 Calculation UR(B)-484 BV1 UFSAR Section 14.2.4.2.2 BV1 UFSAR Table 14.2-9	Value is 60 times the 0.35 µCi/gm DE I-131 TS limit. Value is the threshold iodine concentration to shut down the plant.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3A: Parameters for Calculating BVPS Unit 1 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-219, R2, A1 to A4]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
11. Iodine species released from SGs to environment	97% elemental 3% organic	FENOC letter ND1MDE:0388, 01/15/07 RG 1.183 Rev.0	97% elemental 3% organic	NRC Regulatory Guide 1.183 BV1 Calculation UR(B)-219 BV1 UFSAR Table 14.2-9	Per NRC Regulatory Guide 1.183, Appendix F (SGTR) states, in part: "Iodine releases from the steam generators to the environment should be assumed to be 97% elemental and 3% organic."
12. Activity release path	Prior to trip, both intact and ruptured SGs release steam to the condenser; environmental release occurs from the condenser via the air ejectors. After reactor trip, due to the loss of offsite power, the main condenser is not available. Steam releases occur from both the ruptured and intact SGs via the MSSVs and ADVs.	FENOC letter ND1MDE:0388, 01/15/07, Westinghouse letter FENOC-03-139, 7/25/03 RG 1.183, Rev. 0	Prior to trip, both intact and ruptured SGs release steam to the condenser; environmental release occurs from the condenser via the air ejectors. After reactor trip, due to assumed loss of offsite power, condenser steam dump valves are not available. Steam releases occur from both the ruptured and intact SGs via the Main Steam Safety Valves and Atmospheric Dump Valves.	NRC Regulatory Guide 1.183 BV1 Calculation UR(B)-219 BV1 UFSAR Section 14.2.4.2.2	

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3A: Parameters for Calculating BVPS Unit 1 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-219, R2, A1 to A4]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
13. Time of reactor trip	224.72 seconds	FENOC letter ND1MDE:0388, 01/15/07 Westinghouse letter FENOC-03-139, 7/25/03	224.72 seconds (rounded to 225 seconds)	BV1 Calculation UR(B)-219 Westinghouse Calculation CN-CRA-01-52 BV1 UFSAR Table 14.2-9	First credited trip is low pressurizer pressure.
14. Maximum break flow from RCS into ruptured SG	0-225 sec: 21,900 lbm 225 – 1800 sec: 128,000 lbm	FENOC letter ND1MDE:0388, 01/15/07 Westinghouse letter FENOC-03-139, 7/25/03	0 to 225 seconds 21,900 lbm 225 to 1800 seconds 128,000 lbm	BV1 Calculation UR(B)-219 Westinghouse Calculation CN-CRA-01-52 BV1 UFSAR Table 14.2-9	
15. Maximum fraction of break flow that flashes in ruptured SG	0-225 sec: 0.2227 225 – 1800 sec: 0.1645	FENOC letter ND1MDE:0388, 01/15/07 Westinghouse letter FENOC-03-139, 7/25/03	0 to 225 seconds 0.2227 225 to 1800 seconds 0.1645	BV1 Calculation UR(B)-219 Westinghouse Calculation CN-CRA-01-52 BV1 UFSAR Table 14.2-9	

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3A: Parameters for Calculating BVPS Unit 1 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-219, R2, A1 to A4]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
16. Steam generator (SG) primary-to-secondary leakage rate at T/S levels in intact SG	150 gallons per day (gpd) (any one SG) Leakage density = 1.0 g/cc	FENOC letter ND1MDE:0388, 01/15/07 BVPS-1 T/S 3.4.6.2	150 gallons per day (any 1 SG) 450 gpd (all 3 SGs) Leakage density = 1.0 g/cc	BV1/2 TS B 3.4.13 NRC Regulatory Guide 1.183	Per NRC Regulatory Guide 1.183, Appendix F (SGTR) states, in part: "In most cases, the density should be assumed to be 1.0 gm/cc (62.4 lbm/ft^3)."

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3A: Parameters for Calculating BVPS Unit 1 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-219, R2, A1 to A4]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
17. Termination of environmental releases	Intact SGs: 24 hours Ruptured SG: Break flow and steam releases at 1800 sec.	FENOC letter ND1MDE:0388, 01/15/07 Westinghouse letter FENOC-07-10	Intact SGs 24 hours Ruptured SG Break flow and steam releases at 1800 seconds	NRC Regulatory Guide 1.183 BV1 Calculation UR(B)-219 Westinghouse Calculation CN-CRA-01-52	Per NRC Regulatory Guide 1.183, Appendix F (SGTR) states, in part: "The primary-to-secondary leakage should be assumed to continue until the primary system pressure is less than the secondary system pressure, or until the temperature of the leakage is less than 100ºC (212ºF). The release of radioactivity from the unaffected steam generators should be assumed to continue until shutdown cooling is in operation and releases from the steam generators have been terminated." Releases via the intact SGs are assumed to stop once the Residual Heat Removal system starts operation for shutdown cooling and there are no more releases from the MSSVs and ADVs. Releases from the ruptured SG are assumed to stop after the SG is isolated.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3A: Parameters for Calculating BVPS Unit 1 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-219, R2, A1 to A4]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
18. Maximum time period of tubes being uncovered	Negligible	FENOC letter ND1MDE:0388, 01/15/07 WCAP-13247 March, 1992 NRC letter dated 3/10/93 (Jones to Walsh)	Negligible effect	WCAP-13247 NRC letter (3/10/1993)	The scope of WCAP-13247 includes the Steam Generator Tube Rupture. The results of the Westinghouse Owners Group program indicate that steam generator tube uncovery does not increase the consequences of Steam Generator Tube Rupture and Non-SGTR events significantly. The current design basis analysis methodologies are adequate and remain valid. NRC letter (3/10/1993) expressed agreement with the position presented in WCAP-13247.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3A: Parameters for Calculating BVPS Unit 1 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-219, R2, A1 to A4]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
19. Partition coefficient in SGs when tubes are totally submerged	Flashed portion of rupture flow: Noble gases – released freely with no retention All iodines – released freely with no retention Non-flashed portion of rupture flow and TS leakage in intact SG: Noble gases – released freely with no retention All iodines – 100	FENOC letter ND1MDE:0388, 01/15/07 RG 1.183, Rev. 0	Flashed portion of rupture flow: Noble gases – released freely with no retention All iodines – released freely with no retention Non-flashed portion of rupture flow and TS leakage in intact SGs: Noble gases – released freely with no retention All iodines – 100	NRC Regulatory Guide 1.183 BV1 Calculation UR(B)-219 BV1 UFSAR Section 14.2.4.2.2 BV1 UFSAR Table 14.2-9	Per NRC Regulatory Guide 1.183, Appendix F (SGTR) states: "All noble gas radionuclides released from the primary system are assumed to be released to the environment without reduction or mitigation." No credit for scrubbing of the flashed elemental iodine is a conservative assumption. Per NRC Regulatory Guide 1.183, Appendix F (SGTR) states: "The transport model described in Regulatory Positions 5.5 and 5.6 of Appendix E should be utilized for iodine and particulates." Per NRC Regulatory Guide 1.183, Appendix E (MSLB) position 5.5.4 states, in part: "A partition coefficient for iodine of 100 may be assumed."

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3A: Parameters for Calculating BVPS Unit 1 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-219, R2, A1 to A4]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
20. Partition coefficient in the ruptured SG and intact SGs during periods when tubes are uncovered	Noble gases: released freely with no retention All iodines : released freely with no retention	FENOC letter ND1MDE:0388, 01/15/07 RG 1.183, Rev. 0	Noble gases released freely with no retention All iodines released freely with no retention	NRC Regulatory Guide 1.183 BV1 Calculation UR(B)-219 BV1 UFSAR Section 14.2.4.2.2 BV1 UFSAR Table 14.2-9	Per NRC Regulatory Guide 1.183, Appendix F (SGTR) states: "The transport model described in Regulatory Positions 5.5 and 5.6 of Appendix E should be utilized for iodine and particulates." Per NRC Regulatory Guide 1.183, Appendix E (MSLB) position 5.5.1 states, in part: "During periods of steam generator dryout, all of the primary-to-secondary leakage is assumed to flash to vapor and be released to the environment with no mitigation."
21. Partition factor in condenser/air ejector	Noble gas: 1 Organic iodine: 1 Elemental iodine: 0.01	FENOC letter ND1MDE:0388, 01/15/07 NUREG-0017, R1	Noble gas: 1 Organic iodine: 1 Elemental iodine: 0.01	NUREG-0017 BV1 Calculation UR(B)-219 BV1 UFSAR Table 14.2-9	
22. Maximum steam release from the ruptured SG via the MSSVs/ADVs	225 sec – 1800 sec: 68,900 lbm	FENOC letter ND1MDE:0388, 01/15/07 Westinghouse letter FENOC-03-138, 7/25/03	225 to 1800 seconds: 68,900 lbm	BV1 Calculation UR(B)-219 Westinghouse Calculation CN-CRA-01-52 BV1 UFSAR Table 14.2-9	

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3A: Parameters for Calculating BVPS Unit 1 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-219, R2, A1 to A4]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
23. Maximum steam release to atmosphere from intact SGs via MSSVs/ADVs	225 - 7200 sec: 417,100 lbm 2 hr - 8 hr: 979,500 lbm 8 hr - 16 hr: 658,400 lbm 16 hr - 24 hr: 546,700 lbm	FENOC letter ND1MDE:0388, 01/15/07 Westinghouse letter FENOC-07-10	225 to 7200 seconds 417,100 lbm 2 to 8 hours 979,500 lbm 8 to 16 hours 658,400 lbm 16 to 24 hours 546,700 lbm	BV1 Calculation UR(B)-219 Westinghouse Calculation CN-CRA-01-52 FENOC Letter ND1MDE:0388 Westinghouse Letter FENOC-07-10	
24. Normal full power main steam flow to the condenser before reactor trip, (lbm/s/SG)	1113.889 lbm/s @ 400 °F T-feed (min.) 1207.407 lbm/s @ 455 °F T-feed (max.)	FENOC letter ND1MDE:0388, 01/15/07 PCWG-2614	Minimum Flow 12.01×10^6 lb/hr total @ 400°F T-feed (1112.037 lbm/s/SG) Maximum Flow 13.04×10^6 lb/hr total @ 455°F T-feed (1207.407 lbm/s/SG)	BV1 Calculation UR(B)-219 Westinghouse Calculation CN-PCWG-00-17 (PCWG-2793, Rev. 1)	To obtain total steam flow from the ruptured SG, add this parameter value to the break flows in parameter 14 and multiply by the flashing fraction in parameter 15.
25. Minimum post-accident liquid mass per SG	91,000 lbm (both intact and ruptured SGs)	FENOC letter ND1MDE:0388, 01/15/07 Westinghouse letter FENOC-03-139, 7/25/03	91,000 lbm (both intact and ruptured SGs)	BV1 Calculation UR(B)-219 FENOC Letter ND1MDE:0388 BV1 UFSAR Table 14.2-9	This value is used to determine the activity release rate during the accident.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3A: Parameters for Calculating BVPS Unit 1 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-219, R2, A1 to A4]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
26. Initial and Minimum RCS mass not including pressurizer liquid and steam masses.	373,100 lbm	FENOC letter ND1MDE:0388, 01/15/07 Westinghouse letter FENOC-03-139, 7/25/03	373,100 lbm	BV1 Calculation UR(B)-219 FENOC letter ND1MDE:0388 BV1 UFSAR Table 14.2-9	RCS liquid mass will increase following a trip so the minimum is represented by the initial value.
27. Initial SG liquid mass per SG	91,000 – 96,000 lbm	FENOC letter ND1MDE:0388, 01/15/07 Westinghouse letter FENOC-03-139, 7/25/03	91,000 to 96,000 lbm	BV1 Calculation UR(B)-219 FENOC Letter ND1MDE:0388 BV1 UFSAR Table 14.2-9	This value is used to determine the total iodine activity in the SG liquid. The SG liquid mass increases following the trip, so the initial value is the minimum value.
28. Control Room (CR) atmospheric dispersion factors	<u>Release points</u>: <u>Condenser/Air ejector</u>: N3943.84 <u>MSSVs & ADVS</u>: N3799	FENOC letter ND1MDE:0388, 01/15/07 As presented in Reference Drawing 8700-RY-1C, R1 X/Qs determined in S&W calculation 8700-EN-ME-105, R0/A1	<u>Turbine Building (SE Corner)</u> N3943.84, E7732 <u>Main Steam Relief Valves (as a Single Riser)</u> N3799, E7550	BV1/2 Drawing RY-0001C BV1 Calculation EN-ME-105 BV1 UFSAR Section 14.2.4.2.2 BV1 UFSAR Table 14.2-9	The atmospheric dispersion factors at the CR intake are representative for inleakage. X/Qs are determined in BV1 Calculation EN-ME-105. Condenser and Air Ejector are located in the Turbine Building. Main Steam Relief Valves release point is for MSSVs and ADVs.

Control Room Isolation / Emergency Ventilation (following a SGTR)					
29. CR emergency ventilation initiation:	CR emergency ventilation is not automatically initiated	FENOC letter ND1MDE:0388, 01/15/07 Conservative assumption	CR emergency ventilation is not automatically initiated	BV1 Calculation UR(B)-219 FENOC Letter ND1MDE:0388 BV1 UFSAR Section 14.2.4.2.2 BV1 UFSAR Table 14.2-9	SGTR does not result in high containment pressure; no Containment Isolation Phase B signal is generated.
30. Initiation of CR purge after environmental release is terminated : time & rate	t = 8 hrs. 16,200 cfm for 30 min.	FENOC letter ND1MDE:0388, 01/15/07 1 / 2 OM-44A.4A.A, Issue 4, Rev. 13 Step 11.	<u>Maximum Time</u> 8 hours <u>Minimum Purge Rate</u> 16,200 cfm for 30 minutes	BV1 Calculation UR(B)-219 FENOC Letter ND1MDE:0388 BV1 UFSAR Section 14.2.4.2.2 BV1 UFSAR Table 14.2-9	Fans 1VS-F-40A&B are rated for 33,200 cfm per BV1 Specification BVS-430, while fans 2HVC-ACU201A&B are rated for 20,000 cfm per BV2 Specification 2BVS-179. The BV2 Fan, which is conservative compared to BV1, is credited for producing 16,200 cfm.

References

1. NRC Regulatory Guide 1.183, Rev. 0, Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors
2. BV1 Renewed Operating License DPR-66
3. BV1/2 Technical Specifications, including BV1 Amendment 302 and BV2 Amendment 191
4. BV1/2 Technical Specification Bases, Rev. 35
5. BV1 Licensing Requirements Manual (including Bases), Rev. 101
6. BV1 Updated Final Safety Analysis Report, Rev. 30
7. BV1/2 Calculation UR(B)-483, Rev. 0, Composite Reactor Core Inventory for BVPS Following Power Uprate (2918 MWth, Initial 4.2% to 5% Enrichment, 18 month Fuel Cycle)
8. BV1/2 Calculation UR(B)-484, Rev. 0 including Add. 1, Primary and Secondary Coolant Design/Technical Specification Activity Concentrations including Pre-Accident Iodine Spike Concentrations and Equilibrium Iodine Appearance Rates following Power Uprate
9. BV1 Calculation EN-ME-105, Rev. 0 including Add. 1, Atmospheric Dispersion Factors (X/Qs) at Control Room and ERF Receptors for Unit 1 Accident Releases Using the ARCON96 Methodology
10. BV1 Calculation UR(B)-219, Rev. 2 through and including Add. 4, Site Boundary and Control Room Doses following a Steam Generator Tube Rupture based on Core Uprate and Alternative Source Term
11. BV1/2 Drawing RY-0001C, Rev. 2, Site Postulated Release and Receptor Points
12. Westinghouse Owners Group Report WCAP-13247 (3/1992), Report on Methodology for Resolution of the Steam Generator Tube Uncovery Issue
13. NRC Letter (3/10/1993), Westinghouse Owners Group – Steam Generator Tube Uncovery Issue (attachment to WOG-93-066) [ML17054C235]
14. FENOC Letter ND1SGRP:0403 (8/18/2003), RSG Project Post Accident Radiological Input Parameters for Dose Analysis (includes Westinghouse Letter BV1-RSG-03-265)
15. FENOC Letter ND1MDE:0388 (1/15/2007), BV1 SGTR Dose Analysis Inputs, DIT-FPP-0047-00
16. FENOC Letter L-03-007 (1/30/2003), Response to NRC Request for Additional Information regarding Atmospheric Containment Conversion License Amendment Request
17. FENOC Letter L-05-137 (8/26/2005), Response to NRC Request for Additional Information regarding BV1 Replacement Steam Generators License Amendment Request
18. Westinghouse Calculation CN-CRA-01-52, Rev. 3, BV1 Steam Generator Tube Rupture Analysis – Mass Release for 9.4% Uprate with 54F RSG
19. Westinghouse Calculation CN-PCWG-00-17 (PCWG-2793, Rev. 1), Revision to Beaver Valley Unit 1 (DLW) Approval of Category III (for Contract) PCWG Parameters to Support the "2910 MWt/Full Replacement" Model 54F RSG Project
20. NUREG-0017, Rev. 1, Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors: PWR-GALE Code

Note: BV1/2 Calculation UR(B)-484 has been revised and submitted to FENOC for Owner Acceptance Review. The concentrations from Rev. 1 of this calculation will be used for the radiological dose consequence analyses.

FirstEnergy	CALCULATION COMPUTATION NOP-CC-3002-01 Rev. 05	Page Att1-21 of Att1-24
CALCULATION NO.: 8700-UR(B)-219		REVISION: 3

FirstEnergy

DESIGN VERIFICATION RECORD

Page 1 of 1

NOP-CC-2001-01 Rev. 00

SECTION I: TO BE COMPLETED BY DESIGN ORIGINATOR

DOCUMENT(S)/ACTIVITY TO BE VERIFIED:

DIT-BVDM-111-00

☒ SAFETY RELATED ☐ AUGMENTED QUALITY ☐ NONSAFETY RELATED

SUPPORTING/REFERENCE DOCUMENTS

DESIGN ORIGINATOR: *(Print and Sign Name)* Douglas T. Bloom [signature] DATE 8-16-18

SECTION II: TO BE COMPLETED BY VERIFIER

VERIFICATION METHOD *(Check one)*

☑ DESIGN REVIEW *(Complete Design Review Checklist or Calculation Review Checklist)* ☐ ALTERNATE CALCULATION ☐ QUALIFICATION TESTING

JUSTIFICATION FOR SUPERVISOR PERFORMING VERIFICATION:

NA

APPROVAL: *(Print and Sign Name)* NA DATE

EXTENT OF VERIFICATION:

Design Review Checklist

Checked inputs and references

COMMENTS, ERRORS OR DEFICIENCIES IDENTIFIED? ☐ YES ☑ NO

RESOLUTION: *(For Alternate Calculation or Qualification Testing only)*

NA

RESOLVED BY: *(Print and Sign Name)* NA DATE

VERIFIER: *(Print and Sign Name)* K. J. Frederick [signature] DATE 8-16-18

APPROVED BY: *(Print and Sign Name)* N. Walker [signature] DATE 8/16/18

FirstEnergy NOP-CC-2001-02 Rev. 04

DESIGN REVIEW CHECKLIST

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):

DIT-BVDM-111-00

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
1. Were the basic functions of each structure, system or component considered?		✓			
2. Have performance requirements such as capacity, rating, and system output been considered?		✓			
3. Are the applicable codes, standards and regulatory requirements including applicable issue and/or addenda properly identified and are their requirements for design and/or material been met or reconciled?		✓			
4. Have design conditions such as pressure, temperature, fluid chemistry, and voltage been specified?		✓			
5. Are loads such as seismic, wind, thermal, dynamic and fatigue factored in the design?	✓				
6. Considering the applicable loading conditions, does an adequate structural margin of safety exist for the strength of components?	✓				
7. Have environmental conditions anticipated during storage, construction and operation such as pressure, temperature, humidity, soil erosion, run-off from storm water, corrosiveness, site elevation, wind direction, nuclear radiation, electromagnetic radiation, and duration of exposure been considered?	✓				
8. Have interface requirements including definition of the functional and physical interfaces involving structures, systems and components been met?		✓			
9. Have the material requirements including such items as compatibility, electrical insulation properties, protective coating, corrosion, and fatigue resistance been considered?	✓				
10. Have mechanical requirements such as vibration, stress, shock and reaction forces been specified?	✓				
11. Have structural requirements covering such items as equipment foundations and pipe supports been identified?	✓				
12. Have hydraulic requirements such as pump net positive suction head (NPSH), allowable pressure drops, and allowable fluid velocities been specified?	✓				
13. Have chemistry requirements such as the provisions for sampling and the limitations on water chemistry been specified?	✓				
14. Have electrical requirements such as source of power, voltage, raceway requirements, electrical insulation and motor requirements been specified?	✓				
15. Have layout and arrangement requirements been considered?	✓				
16. Have operational requirements under various conditions, such as plant startup, normal plant operation, plant shutdown, plant emergency operation, special or infrequent operation, and system abnormal or emergency operation been specified?		✓			

FirstEnergy

NOP-CC-2001-02 Rev. 04

DESIGN REVIEW CHECKLIST

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):

DIT-BVDM-111-00

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
17. Have instrumentation and control requirements including instruments, controls, and alarms required for operation, testing, and maintenance been identified? Other requirements such as the type of instrument, installed spares, range of measurement, and location of indication should also be included.	✓				
18. Have adequate access and administrative controls been planned for plant security?	✓				
19. Have redundancy, diversity, and separation requirements of structures, systems, and components been considered?		✓			
20. Have the failure requirements of structures, systems, and components, including a definition of those events and accidents which they must be designated to withstand been identified?		✓			
21. Have test requirements including in-plant tests, and the conditions under which they will be performed been specified?		✓			
22. Have accessibility, maintenance, repair and in-service inspection requirements for the plant including the conditions under which they will be performed been specified?	✓				
23. Have personnel requirements and limitations including the qualification and number of personnel available for plant operation, maintenance, testing and inspection and permissible personnel radiation exposure for specified areas and conditions been considered?		✓			
24. Have transportability requirements such as size and shipping weight, limitations and Interstate Commerce Commission regulations been considered?	✓				
25. Have fire protection or resistance requirements been specified?	✓				
26. Are adequate handling, storage, cleaning and shipping requirements specified?	✓				
27. Have the safety requirements for preventing undue risk to the health and safety of the public been considered?		✓			
28. Are the specified materials, processes, parts and equipment suitable for the required application?	✓				
29. Have safety requirements for preventing personnel injury including such items as radiation hazards, restricting the use of dangerous materials, escape provisions from enclosures and grounding of electrical equipment been considered?	✓				
30. Were the inputs correctly selected and incorporated into the design?		✓			
31. Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed?		✓			
32. Are the appropriate quality and quality assurance requirements specified?		✓			

FirstEnergy NOP-CC-2001-02 Rev. 04

DESIGN REVIEW CHECKLIST

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):
DIT-BVDM-111-00

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
33. Have applicable construction and operating experience been considered?		✓			
34. Have the design interface requirements been satisfied?	✓				
35. Was an appropriate design method used?		✓			
36. Is the output reasonable compared to inputs?		✓			
37. Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?	✓				
38. Have adequate maintenance features and requirements been specified?	✓				
39. Has the design properly considered radiation exposure to the public and plant personnel?		✓			
40. Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfied?		✓			
41. Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?	✓				
42. Are adequate identification requirements specified?	✓				
43. Are requirements for record preparation, review, approval, retention, etc., adequately specified?		✓			
44. Have protective coatings qualified for Design Basis Accident (DBA) been specified to structures, equipment and components installed in the containment/drywell?	✓				
45. Are the necessary supporting calculations completed, checked and approved?		✓			
46. Have the equipment heat load changes been reviewed for impact on HVAC systems?	✓				
47. IF a computer program was used to obtain the design by analysis, **THEN** has the program been validated per NOP-SS-1001 and documented to verify the technical adequacy of the computer results contained in the design analysis?	✓				
48. Have Professional Engineer (PE) certification requirements been addressed and documented where required by ASME Code (if applicable).	✓				
49. Does the design involve the installation, removal, or revise software/firmware and have the requirements of NOP-SS-1001 been addressed?	✓				
50. Does the design involve the installation, removal, or change to a digital component(s) and have the requirements of NOP-SS-1201 been addressed?	✓				

COMPLETED BY: *(Print and Sign Name)*	DATE
K.J. Frederick [signature]	8-16-18

IF CHECKLIST IS REVIEWED BY MORE THAN ONE VERIFIER, SIGN BELOW:

ADDITIONAL VERIFIER *(Print and Sign Name)*	DATE

Attachment 2

(Partial Copy – excludes CR Shielding Data)

FirstEnergy Design Input Transmittal

DIT-BVDM-0103-03 transmitted via FENOC letter ND1MDE:0738

January 29, 2019

FirstEnergy	**CALCULATION COMPUTATION** NOP-CC-3002-01 Rev. 05
CALCULATION NO.: 8700-UR(B)-219	REVISION: 3

FENOC
FirstEnergy Nuclear Operating Company

Beaver Valley Power Station
P.O. Box 4
Shippingport, PA 15077

Patrick G. Pauvlinch
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Phone: 724-682-4982
Fax: 330-315-9717

ND1MDE:0738
January 29, 2019

Sreela Ferguson
WECTEC
720 University Ave.
Norwood, MA 02062

BV1 & BV2 Complete Reanalysis of Dose Consequences
For CRE Tracer Gas Testing and Other Acceptance Criteria Changes
Design Input Transmittal DIT-BVDM-0103-03 for Control Room Dose

Dear Ms. Ferguson:

Attached is Design Input Transmittal DIT-BVDM-0103-03 which provides information for evaluating the control room operator dose for various design-basis accidents.

Should you have any questions about the attached information, please contact Doug Bloom at 724-682-5078 or Mike Ressler at 724-682-7936.

Sincerely,

Patrick G. Pauvlinch
Manager, Design Engineering

DTB/bls

Attachment

cc: D. T. Bloom
M. G. Unfried
M. S. Ressler
BVRC

FirstEnergy	CALCULATION COMPUTATION NOP-CC-3002-01 Rev. 05
CALCULATION NO.: 8700-UR(B)-219	REVISION: 3

Form 1/2-ADM-2097.F01, Rev 0 RTL# A1.105V

DESIGN INPUT TRANSMITTAL

☒ SAFETY RELATED / AUG QUAL ☐ NON-SAFETY RELATED	Originating Organization: ☒ FENOC ☐ Other (Specify)	DIT- BVDM-0103-03 Page __1___ of __1___
Beaver Valley Unit: ☐1 ☐2 ☒Both System Designation: Various Engineering Change Package: N/A		To: Sreela Ferguson Organization: WECTEC

Subject: **Design Input Transmittal for Parameter List for Calculating Dose Consequences at the Control Room and Site Boundary**

Status of Information: ☒Approved for Use ☐Unverified

For Unverified DITs, Notification number tracking verification: ______________________

Description of Information:

Safety Analysis Design Inputs? ☒Yes ☐No
Reconciled to Current Design Basis? ☒Yes ☐N/A

This DIT provides information required for the performance of calculating dose consequences at the BV1 and BV2 Control Rooms and Site Boundary.

Purpose of Issuance:
This DIT provides information required for the performance of design basis accident dose consequence calculation UR(B)-487.

Source of Information (Reference, Rev, Title, Location): Engineering Judgment Used? ☐Yes ☒No

See attachment to DIT table.

Preparer: Douglas T Bloom	Preparer Signature: *[signature]*	Date: 1-29-19
Reviewer: M. G. Unfried	Reviewer Signature: *[signature]*	Date: 1/29/2019
Approver: M. S. Ressler	Approver Signature: *[signature]*	Date: 1/29/2019

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE E: Parameter List for Calculating Dose Consequences at the Control Room & Site Boundary

	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
General Notes: 1. As noted in Design Input transmittals provided in support of the BVPS-2 RSGs (e.g., DIT-SGR2-0046-01 for the LOCA) the CR parameters such as shielding configuration, volume, ventilation system parameters (flows, filter efficiency, signals that initiate emergency ventilation, timing of manual action, etc.) have not changed since the Containment Sump modification 2. The critical input values are: CR volume, CR ventilation flows (NOP intake, unfiltered inleakage and filtered intake during pressurization mode), CR filter efficiencies, CREVS initiation times, and atmospheric dispersion factors.					
Control Room (Inhalation / Submersion Dose)					
1. Minimum Control Room (CR) Free Volume	1.73E5 ft^3	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 DQL Calc B-74, Rev. 0. 12/8/81 DLC EM 11578 (NOT IN FILENET RECORDS) Confirmed by DLC EM 116251	1.73E5 ft^3	BV1 Calculations CR-AC-1 & DMC-3171 BV1 UFSAR Table 11.5-8 & Table 14.3-14a BV2 Calculations B-029A & B-074 BV2 Drawing RB-0039A BV2 UFSAR Table 6.4-1 & Table 6.4-1a	BV1 and BV2 share a joint control room inside a single Control Room Envelope. Dimensions used in BV2 Calculation B-074 are consistent with those derived from BV2 Drawing RB-0039A. The net free volume has historically been assumed to be approximately 75% of the gross volume for the radiological dose consequence analyses; it is noted that 30% was used for estimating the occupied volume (resulting in 70% net free volume) in BV2 Calculation B-029A involving refrigerant. The assumption of 75% is adopted here.

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TABLE E: Parameter List for Calculating Dose Consequences at the Control Room & Site Boundary

	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
2. Control Room Ventilation Intake Design	Single intake for each unit; same intake used for normal ventilation as well as emergency ventilation.	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 Drawing # 8700-RY-1C, R2 Receptors 2 and 3 for Unit-1, and Unit-2, respectively.	One intake for BV1 and one intake for BV2, which supply the common Control Room. The same intakes are used for normal ventilation as well as emergency ventilation.	BV1/2 Drawing RY-0001C BV1 Drawings RM-0003K & RM-0444A-004 BV2 Drawing RM-0444A-2	There is a single intake for each Unit; the same intake is used for normal ventilation as well as emergency ventilation. The total unfiltered normal operation air intake flow rate is usually unequally divided between the BV1 and BV2 intakes. Receptor 2 represents the BV1 intake, and receptor 3 represents the BV2 intake.
3. Maximum Normal Operation Unfiltered Inflow into Control Room (includes Ventilation Intake Flow Rate and all Unfiltered Inleakage) and postulated Location of referenced Unfiltered Inleakage	Unit 1: Unfiltered: 300 cfm Unit 2: Unfiltered: 200 cfm Total (Unfiltered): 500 cfm Filtered: 0 cfm *All NOP ventilation flowrate values include uncertainties.* *Total unfiltered flow includes 10 cfm for ingress/egress.*	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 2DBD-44A2, Rev. 8, para. 2.2, pg. 6 NDINEM:1144 EM:116251	BV1 & BV2 Unfiltered Intake / Inleakage: 1250 cfm maximum (total for both Units) This maximum normal operation ventilation intake flow rate value is an analytical upper bound value that is intended to include: a) flow rate test measurement uncertainties, b) alll unfiltered inleakage, and c) a 10 cfm ingress/ egress allowance	Assumed value - intended to provide operational margin.	Location of Unfiltered Inleakage Component tests performed as part of 2017 tracer gas testing indicated that potential sources of unfiltered inleakage into the Control Room are the normal operation intake dampers – which can be assigned the same χ/Q as the Control Room air intakes. Regarding other potential locations of inleakage, a χ/Q value that reflects the center of the Control Room boundary at roof level as a receptor could be considered the average value applicable to Unfiltered Inleakage locations around the CRE, and thus representative for

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Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
			The above value bounds the test results of BV1/2 Procedure 3BVT 1.44.05 via Order 200699902. All Unfiltered Inleakage (including that associated with ingress/egress) may be assumed to occur at same location as intakes (i.e., receptor points 2 and 3 of BV1/2 Drawing RY-0001C).	Engineering judgement – see comment column for basis BV1/2 Drawing RY-0001C BV1/2 Procedure 3BVT 1.44.05 Order 200699902 Vendor Report, NCS Corporation, Control Room Envelope Inleakage Testing at Beaver Valley Power Station 2017, Final Report	all CR unfiltered leakage locations. Review of BV1/2 Drawing RY-0001C indicates that since the post-accident release points are a) closer to the CR intakes and b) the directions from the release points to the CR center and CR intakes are similar, use of χ/Q values associated with the CR intakes, for CR Unfiltered Inleakage, would be conservative. The 10 cfm allowance for ingress/egress, is assigned to the door leading into the Control Room that is considered the primary point of access. This door (S35-71) is located at grade level on the side of the building facing the BV1 Containment and between the CR air intakes. It is located close enough to the air intakes to allow the assumption that the χ/Q associated with this source of leakage would be reasonably similar to that associated with the air intakes.

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	AOR [UR(B)-487 R1, A1 & A2]		**LAR – Increase in CR Inleakage**		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
4. CR Emergency Ventilation Intake Design	Filtered emergency intake with recirculation which pressurizes the CRE to +1/8" w.g. above outside air pressure. CREVS provides for 0.35 filtered air changes per hour	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 U-1 T/S SR 4.7.7.1.1.d.3, .2.d.4 U-2 T/S SR 4.7.7.1.1.e.4 UFSAR-2, Table 6.4-1, *Control Room Envelope Ventilation Design Parameters*	CREVS provides for 0.28 filtered air changes per hour (based on 800 cfm minimum filtered intake) and 0.35 filtered air changes per hour (based on 1000 cfm maximum filtered intake).	The number of air changes per hour is based on filtered emergency intake flow rate [parameter 8] and minimum Control Room free volume [parameter 1].	The filtered air intake flow path is normally not in service. With the adoption of tracer gas testing for the Control Room Envelope, the relative pressure comparison is no longer important from a design and licensing basis perspective. It may be used for other purposes, such as ventilation balancing.
5. CREBAPS Design Basis	CREBAPS has been eliminated	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 Amendments 257/139	The Control Room Emergency Bottled Air Pressurization System has been eliminated.	Engineering Change Packages ECP-02-0243-ID-01 through ECP-02-0243-ID-09 & ECP-02-0243-RD NRC Safety Evaluation for Amendments 257 (BV1) & 139 (BV2)	

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	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
6. Maximum control room unfiltered inleakage during CR isolation and emergency pressurization mode and postulated Location of reference Unfiltered Inleakage	<u>Isolation (recirculation) mode</u>: 300 scfm with no pressurization <u>Emergency (pressurization) mode</u>: 30 scfm o Allowance for ingress/egress 10 o Allowance for dampers: 4 o Allowance for doors & seals: 6 o Allowance for degradation: <u>10</u> TOTAL 30 All unfiltered inleakage may be assumed to occur at same location as intakes, i.e. receptor points 2 and 3. These values include measurement uncertainties	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 Control Room Envelope Inleakage Testing at Beaver Valley Power Station; Final Report; NCS Corp. (Lagus) 7/23/01, Table 20, p.69 8700-RY-1C, R2	<u>CR Isolation (recirculation) mode</u>: 450 cfm maximum <u>CR Emergency (pressurization) mode</u>: 165 cfm maximum Each maximum control room unfiltered flow rate value listed above is an upper bound analytical value that includes test measurement uncertainties and a 10 cfm allowance for ingress and egress. All Unfiltered Inleakage (including that associated with ingress/egress) may be assumed to occur at same location as intakes (i.e., receptor points 2 and 3 of BV1/2 Drawing RY-0001C).	Assumed values are intended to provide operational margin. Engineering judgment – see comment column for parameter 3 BV1/2 Drawing RY-0001C	Refer to Comment for parameter 3.

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	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
7. Allowance for Ingress/Egress (all modes)	10 scfm	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 RG 1.78, position C.10 D.G. 1087, 3.4 SRP NuReg-0800, 6.4 SRP NuReg-0800, 6.4.III.3.d.iii	10 cfm	NRC Regulatory Guide 1.197 BV1 Drawing RA-0020A BV2 Drawing RA-0006B Engineering judgment	There are multiple doors that form part of the Control Room Envelope. Door S35-71 on the south wall of the Control Room at grade elevation 735'-6", between the two Control Room air intakes, accounts for most ingress and egress. Although the door for the Control Room south entrance is protected by a vestibule, no reduction in the 10 cfm allowance is credited.
8. Filtered emergency intake flow rate	600 - 1030 cfm range includes allowance for measurement uncertainties	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 T/S-1; 4.7.7.1.2 T/S-2; 4.7.7.1.2 Control Room Envelope Inleakage Testing at BVPS; Final Report; NCS Corp. (Lagus) 7/23/01, Table 7, p.44 and Table 11, p.50	800 to 1000 cfm Control room filtered inleakage ventilation flow rate values are analytical values that include test measurement uncertainties.	BV1/2 TS 5.5.7 BV1 Specification BVS-367 BV2 Specification 2BVS-157	<u>WECTEC Note:</u> A greater filtered emergency intake flow would reduce the CR dose because the greater depletion rate of the existing airborne activity associated with the larger intake eclipses the larger filtered activity intake.

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	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
9. Margin used on all CR ventilation flows	Not required Flows are based on measurements with reported uncertainty included.	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06	CR ventilation flow rates provided in parameters 3, 6, & 8, above, are analytical values that include test measurement uncertainties.		

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	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
10. CR Intake filter iodine removal efficiency DBA analysis values:	a) 99% for particulate b) 98% for elemental and organic	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 G.L. 99-02	99% for particulate	Regulatory Position C.5.c of NRC Regulatory Guide 1.52 BV1/2 TS 5.5.7.a	The inplace dioctyl phthalate (DOP) test of the HEPA filters in accordance with ANSI N510-1980 confirming a penetration and system bypass of less than 0.05% at design flow rate can be considered to warrant a 99% removal efficiency for particulate matter in accident dose evaluations.
			98% for elemental and organic	Per NRC Generic Letter 99-02; to ensure that the efficiency assumed in the accident analysis is still valid at the end of the operating cycle, a minimum safety factor of 2 is to be applied to the laboratory test acceptance criteria. A SF of 2 is assumed. See comment and parameter 11 for additional detail.	WECTEC Notes: The penetration and bypass for the CREVS HEPA Filter per TS 5.5.7.a of < 0.05% warrants the use of an efficiency of 99% in safety analysis. Thus, the current licensing basis value of 99% remains valid. Per parameter 11, the proposed penetration and system bypass acceptance criterion for the CREVS Charcoal Filter (to be documented in updated TS 5.5.7.b) is < 0.5%. Per NRC GL 99-02, safety analyses can assume a charcoal filter efficiency of 100% - [(0.5% + 0.5%) x 2) = 98%. Thus, the current licensing basis value of 98% remains valid.

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	AOR [UR(B)-487 R1, A1 & A2]		**LAR – Increase in CR Inleakage**		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
11. a) T/S Surveillance Acceptance Criterion for CR charcoal filters	a) ≥ 99 % efficiency acceptance criterion using radioactive methyl iodide.	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 U-1 T/S 4.7.7.1.c.2, T/S 4.7.7.2.c.2 U-2 T/S 4.7.7.1.d	a) ≥ 99.5% removal efficiency acceptance criterion for the <u>charcoal adsorber</u> using methyl iodide (i.e., as demonstrated by a laboratory test of a sample)	***a) Proposed change to BV1/2 TS 5.5.7.c acceptance criteria***	Charcoal adsorber sample is tested in laboratory in accordance with ASTM D3803-1989. System Engineering requested flexibility in charcoal adsorber testing acceptance criteria.
b) T/S Surveillance Acceptance Criterion for CR charcoal filters	b) ≥ 99.95 % efficiency acceptance criterion using R-11 refrigerant.	U-1 T/S 4.7.7.1.c.1, T/S 4.7.7.2.c.1 U-2 T/S 4.7.7.1.c.1	b) < 0.5% penetration and system bypass acceptance criterion for the charcoal adsorber (i.e., as demonstrated by an inplace test)	***b) Proposed change to BV1/2 TS 5.5.7.b acceptance criteria***	Charcoal adsorber is tested inplace in accordance with ANSI N510-1980. <u>WECTEC Note:</u> An efficiency ≥ 99.5% for the charcoal adsorber using R-11 refrigerant means the penetration and system bypass is less than 0.5% for the charcoal adsorber, as demonstrated by an inplace test.
c) T/S Surveillance Acceptance Criterion for CR HEPA filters	c) ≥ 99.95% for particulate using DOP.	U-1 T/S 4.7.7.1.c.1, T/S 4.7.7.2.c.1 U-2 T/S 4.7.7.1.c.2	c) < 0.05% penetration and system bypass for the HEPA filters (i.e., as demonstrated by an inplace test)	c) BV1/2 TS 5.5.7.a	

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	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
12. CR Filtered Recirculation Rate	N/A	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06	The BV1 and BV2 ventilation air-conditioning system recirculates CR air through filters intended for dust removal. BV1 - AC fan 1VS-AC-1A and 1VS-F-40A or the B train - bag type filters - efficiency ~ 90% BV2 - AC fan 2HVC-ACU201A or B - Hi efficiency type filters - efficiency ~ 85% Minimum Flow rate: Based on that available for CR air purge, i.e., 16,200 cfm per unit or 32,400 cfm Duration: t=0 to t-30 days	Location of Recirculation filters with respect to the CR are shown in the BV1 & BV2 sketch attached to this DIT BV1 Vendor Manual 10.001-0644 BV1 Specification BVS-0431 BV2 Vendor Manual 2510.140-179-005 BV2 Stock Code 10008727 BV2 Procedure 3BVT1.44.06 BV1 UFSAR Table 14.3-14a BV2 UFSAR Table 15.6-11	BV licensing basis does not credit / address recirculation filters. Analysis should evaluate if this approach remains conservative *Since the filters are not subject to a maintenance program, the analysis should conservatively assume 50% of the rated efficiency when crediting the filters to estimate the impact of use of the filters on the inhalation / submersion dose, and 100% efficiency when estimating the dose due to direct shine.* Roll Filters have an approximate 20% efficiency based on ASHRAE 52.1 – 1992 Test Method (Reference: Flanders Filter Efficiency Guide). Also reference BV1 Drawing RM-0444A-004, BV2 Drawing RM-0444A-001 and BV2 Drawing RM-0444A-002

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	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
13. Signals that automatically initiate CR emergency Ventilation	- Control Room Area Monitors - CIB signal	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 8700-120-65D S&W 2001-409-001	Signals originate from the Control Room Area Radiation Monitors or as Containment Isolation Phase B	BV1 Drawing LSK-021-001K BV1 UFSAR Section 11.3.5 BV2 UFSAR Section 6.4.2.2	For the purposes of DBA analyses, no credit is taken for CREVS initiation by CR area radiation monitors: BV1 Radiation Monitors RM-1RM-218A & B BV2 Radiation Monitors 2RMC-RQ201 & 202
14. Power supply to safety related instrumentation (i.e., the CIB signal) that initiate CR emergency Ventilation	Uninterrupted power	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 DCP 1302, Rev. 0, Solid State Protection System AC Power	Vital Bus System supplies Class 1E Uninterruptible Power System	BV1 Drawings RE-0001U & RE-0001AA BV2 Drawings RE-0001AY & RE-0001AZ BV1 UFSAR Section 8.5.4 BV2 UFSAR Section 8.3.1.1.17	

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	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
15. CR Emergency Ventilation initiation.	Manual: Yes (see Note 1) Automatic: Yes t = 0 to t = 77 sec: time delay associated with achieving CR isolation; assume normal ventilation (unfiltered) <u>U -1 (bounding)</u> t=77 sec to t = 30 min, CR isolated but not pressurized, t = 30 min to 30 days, CR pressurized/ emergency filtered intake mode	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 Unit 1 T/S 3/4.7.7 SRP 6.4 specifies that a substantial delay be assumed where manual isolation is assumed. ANS 58.8, "Time Response Design Criteria for Safety Related Operations"	The Control Room is automatically isolated within 77 seconds of receipt of a CIB signal; for this time period, normal (unfiltered) ventilation is assumed. Following the CIB signal, the Control Room would remain isolated from 77 seconds to 30 minutes (to bound manual actuation of BV1 CREVS), while on recirculation. From 30 minutes to 30 days, the Control Room will be placed in the emergency filtered intake mode and pressurized via CREVS.	BV1/2 TS 3.7.10 including Bases BV1 LRM Table 3.3.2-1 BV2 LRM Table 3.3.2-1	A CIB from either Unit isolates the Control Room and initiates BV2 CR emergency ventilation. There are three CREVS fan pressurization systems, one at BV1 and two at BV2. Operation with the one BV1 system and one of the two BV2 systems is permitted; a single failure of the operable BV2 system would require manual start of the BV1 system. The 30 minute allowance is for performing manual operator actions outside the Control Room, such as damper manipulations, and bounds the sequencing scheme of automatically starting a BV2 CREV system. The 30 minute allowance is consistent with the current design and licensing basis. For conservatism, all delays are assumed to be sequential.

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Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
16. Radiation monitor alarm set point to initiate CR emergency ventilation (non-1E)	≤ 0.476 mR/hr	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 T/S –1 Table 3.3-6	N/A	N/A	The CREVS initiation function from CR Radiation Monitors (listed in parameter 13) is not credited.
17. Radiation monitor response delay time after CR environment has reached alarm setpoint	≤180 sec following Hi Radiation	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06	N/A	N/A	The CREVS initiation function from CR Radiation Monitors (listed in parameter 13) is not credited.
Control room ventilation isolation delay time on Hi-Hi Containment Pressure (CIB)	≤22.0 sec following CIB signal ≤ 77.0 sec. (including D.G. start and sequencer delays)	Unit -1 & -2 LRM, Table 3.2-1	≤ 22.0 seconds following CIB signal, and ≤ 77.0 seconds following CIB signal and including Emergency Diesel Generator start and EDG load sequencer delays	BV1 LRM Table 3.3.2-1 BV2 LRM Table 3.3.2-1 BV1 Procedure 1BVT1.1.2 BV2 Procedure 2BVT1.1.2	Time response testing demonstrates that the acceptance criteria are satisfied. Actuation times and delays involving the sensor, channel, slave relay, Emergency Diesel Generator (start and coming up to speed), EDG load sequencer, and damper (stroke) are included as appropriate.
18. Radiation monitor accuracy	± 22% of reading	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06	N/A	N/A	The CREVS initiation function from CR Radiation Monitors (listed in parameter 13) is not credited.

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Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
19. CIB signal processing delay time after LOCA	Assumed instantaneous	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06	Assumed instantaneous (see parameter 15)		This parameter is included within the time delay values quoted for parameter 15 (except for the manual actuation at 30 minutes).
20. CR Breathing rate	3.5E-4 m^3/s	R.G. 1.183 Rev 0	3.5E-4 m^3/s	NRC Regulatory Guide 1.183	See RG 1.183 section 4.2.6.
21. Control Room Occupancy Factors	0-24 hr 1.0 1-4 day 0.6 4-30 day 0.4	R.G. 1.183 Rev 0, 4.2.6 SRP, NuReg-0800, 6.4 Appendix A	0 to 24 hours: 1.0 1 to 4 days: 0.6 4 to 30 days: 0.4	NRC Regulatory Guide 1.183	See RG 1.183 section 4.2.6.

Control Room Shielding (General)					
22. Control Room Penetrations	All penetrations in CR walls / ceiling, including CR door have equivalent shielding	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 This will have to be listed as an assumption.	BV1 CR ventilation Intake filters and the air-conditioning recirculation filters are located in the BV1 fan room below the BV1 CR. There are no penetrations between the fan room (ceiling) and CR (floor) BV2 ventilation Intake filters and the air-conditioning recirculation filters are located in the fan room east of the CR (i.e., adjacent to the computer room). There are penetrations in the wall between the fan room and the computer room.	BV1 Drawing 8700-RM-0003M BV1 sketch attached to this DIT BV2 sketch attached to this DIT	

23. Release paths to be addressed for the LOCA analysis	<u>Direct Shine to Control Room</u>: Containment Shine, CR Penetration Shine due to Airborne Activity in the Cable spreading area under Unit 2 CR, CR Penetration Shine due to Airborne Activity in the Cable Tray Mezzanine under Unit 1 CR, Cloud shine due to Containment, ESF, and RWST Leakage, CR filter shine due to containment, ESF and RWST leakage, RWST direct shine	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 U1 UFSAR 14.3.5, U2 UFSAR 15.6.5	<u>Direct Shine to Control Room</u>: 1. Containment Shine, 2. Control Room Penetration Shine due to Airborne Activity in BV2 Cable Spreading Area under BV2 CR, 3. CR Penetration Shine due to Airborne Activity in the Cable Tray Mezzanine under BV1 CR, 4. Cloud shine due to Containment, Engineered Safety Features, and Refueling Water Storage Tank leakage, 5. CR filter shine due to Containment, ESF and RWST leakage, and 6. RWST direct shine	The current design and licensing basis is to be carried forward in BV1/2 Calculation UR(B)-487.	Release paths defined in the current design and licensing basis are applicable.

Control Room Shielding (RWST Direct Shine)					
38. LOCA dose to CR due to direct shine from the RWST	From Reference	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 S&W calc 12241/11700-UR(B)-487, R0 including Addendum 1 and 2	See parameter 24		
Site Boundary Atmospheric Dispersion Factors and Breathing Rates					
39. Offsite atmospheric dispersion factors (s/m^3)	<u>EAB</u> 0-2hrs:1.04E-3 (U1) 0-2hrs:1.25E-3 (U2) <u>LPZ</u> 0-8 hr: 6.04E-5 8-24: 4.33E-5 1-4days: 2.10E-5 4-30 days: 7.44E-6	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 ERS-SFL-96-021	<u>Exclusion Area Boundary</u> 0 to 2 hours: 1.04E-3 (BV1) 1.25E-3 (BV2) <u>Low Population Zone</u> 0 to 8 hours: 6.04E-5 8 to 24 hours: 4.33E-5 1 to 4 days: 2.10E-5 4 to 30 days: 7.44E-6	BV1/2 Calculation ERS-SFL-96-021 BV2 UFSAR Table 15.0-11	
40. Offsite Breathing rates (m^3/sec)	0-8 hrs: 3.5E-4 8-24 hr: 1.8E-4 1-30 days: 2.3E-4	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 RG 1.183 R0	0 to 8 hours: 3.5E-4 8 to 24 hours: 1.8E-4 1 to 30 days: 2.3E-4	NRC Regulatory Guide 1.183	

References for Table E

1. BV1 Updated Final Safety Analysis Report, Rev 30
2. BV1 Licensing Requirements Manual (including Bases), Rev 101
3. BV1 Calculation CR-AC-1, Rev 0, Volume of Control Room Area Air Conditioning Spaces
4. BV1 Calculation DMC-3171, Rev 0, Verification of Control Room Area Volume
5. BV1 Calculation EN-ME-105, Rev 0 including Add 1, Atmospheric Dispersion Factors (X/Qs) at Control Room and ERF Receptors for Unit 1 Accident Releases Using the ARCON96 Methodology
6. BV1 Drawing LSK-021-001K, Rev 5, Logic Diagram – Air Conditioning and Refrigeration – Control Room
7. BV1 Drawing RA-0020A, Rev 10, Floor Plans Main Entrance & Control Room
8. BV1 Drawing RB-0017J, Rev 16, Air Conditioning Plan – Control Room Service Building
9. BV1 Drawing RC-0008C, Rev 13, Slab Plan at Elevation 735'-6" Outline Service Building
10. BV1 Drawing RE-0001U, Rev 39, 120V AC Vital Bus – I One Line Diagram (Red)
11. BV1 Drawing RE-0001AA, Rev 36, 120V AC Vital Bus – II One Line Diagram (White)
12. BV1 Drawing RM-0444A-004, Rev 15, Valve Operating Number Diagram, Control Room Area – Air Conditioning System
13. BV1 Drawing 10.001-0222, Rev B, Control Room Emergency Filter
14. BV1 Procedure 1BVT1.1.2, Rev 25, Engineered Safety Features Time Response Test
15. BV1 Procedure 1CMP-44VS-FL-2-1M, Rev 2, Control Room Emergency Outside Air Filter Replacement
16. BV1 Specification BVS-0367, Rev 3 through and including Add 3, Specification for Primary Ventilation Filter Assemblies
17. BV1 Specification BVS-0431, Rev. 2, Central Station Air Handling Units and Heating and Ventilation Units
18. BV1 Vendor Manual 10.001-0644, Rev. N, Central Station Climate Changers Installation and Maintenance Manual
19. BV2 Updated Final Safety Analysis Report, Rev 23
20. BV2 Licensing Requirements Manual (including Bases), Rev 92
21. BV2 Calculation B-029A, Rev 0, Control Room Ventilation System – Freon-22 Concentration
22. BV2 Calculation B-074, Rev 0, Determination of Control Room Volume
23. BV2 Calculation EN-ME-106, Rev 0 including Add 1, Atmospheric Dispersion Factors (X/Qs) at Control Room and ERF Receptors for Unit 2 Accident Releases Using the ARCON96 Methodology
24. BV2 Drawing RA-0006B, Rev 23, Door Schedule & Details
25. BV2 Drawing RB-0039A, Rev 14, Air Conditioning & Ventilation, Control Building
26. BV2 Drawing RE-0001AY, Rev 13, 120 VAC Vital Bus I One Line Diagram (Red)
27. BV2 Drawing RE-0001AZ, Rev 13, 120 VAC Vital Bus II One Line Diagram (White)
28. BV2 Drawing RM-0444A-001, Rev 8, Valve Operating Number Diagram, Control Building Ventilation System
29. BV2 Drawing RM-0444A-002, Rev 16, Valve Operating Number Diagram, Computer and Control Room Air Conditioning
30. BV2 Drawing 2010.800-157-003, Rev G, Control Room Air Pressurization Filter
31. BV2 Vendor Manual 2510.140-179-005, Rev. F, Installation, Startup and Service Instruments for Carrier 39E Air Handling Units
32. BV2 Vendor Manual 2510.800-157-002, Rev Y, Installation, Operation and Maintenance Manual – Ventilation Filter Assemblies
33. BV2 Procedure 2BVT1.1.2, Rev 15, Safeguards Time Response Test
34. BV2 Specification 2BVS-157, Final Revision (2/2/1988), Specification for Ventilation Filter Assemblies

35. BV1/2 Calculation UR(B)-487, Rev 2 [Pending], Site Boundary, Control Room and Emergency Response Facility Doses following a Loss-Of-Coolant Accident Based on Core Uprate, an Atmospheric Containment and Alternative Source Terms
36. BV1/2 Calculation ERS-SFL-96-021, Rev 0, RG 1.145 Short-Term Accident X/Q Values for EAB and LPZ, based on 1986 – 1995 Observations
37. BV1/2 Drawing RY-0001C, Rev 2, Site Postulated Release and Receptor Points
38. BV1/2 Engineering Change Packages for CREBAPS Deletion and CREVS Modification (i.e., ECP-02-0243-ID-01 Rev 5 through ECP-02-0243-ID-09 Rev 2, plus ECP-02-0243-RD Rev 5)
39. BV1/2 Procedure 3BVT 1.44.05, Rev. 6, Control Room Envelope Air In-Leakage Test
40. BV1/2 Technical Specifications (including Bases), 6/14/2018
41. Order 200699902 (2017), Perform 3BVT-01_44_05
42. Vendor Report, NCS Corporation, Control Room Envelope Inleakage Testing at Beaver Valley Power Station 2017, Final Report (1/31/2018)
43. FENOC Stock Item 9735047, Charcoal Filter Tray
44. FENOC Stock Item 9735717, Charcoal Filter Tray
45. FENOC Stock Item 100075371, Charcoal Filter Tray
46. FENOC Stock Item 10008727, Cambridge Hi-Flo Filter
47. NRC Generic Letter 99-02, Laboratory Testing of Nuclear-Grade Activated Charcoal (6/3/1999), including Errata (8/23/1999)
48. NRC Regulatory Guide 1.52, Rev 2 (3/1978), Design, Testing, and Maintenance Criteria for Post Accident Engineered-Safety-Feature Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants
49. NRC Regulatory Guide 1.183, Rev 0 (7/2000), Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors
50. NRC Regulatory Guide 1.197, Rev 0 (5/2003), Demonstrating Control Room Envelope Integrity at Nuclear Power Reactors
51. NRC Safety Evaluation for Amendments 257 (BV1) & 139 (BV2) for selective implementation of an Alternative Source Term methodology for the Loss-Of-Coolant Accident and the Control Rod Ejection Accident, incorporation of ARCON96 methodology for release points associated with the LOCA and CREA, elimination of the Control Room Emergency Bottled Air Pressurization System changes to the Control Room Emergency Ventilation System, and a change to the BV1 CREVS filter bypass leakage acceptance test criteria

Note: Increasing the current fresh air flow rate (500 cfm) has been requested during normal operation. Unfiltered normal operation air intake flow rates are often stated in the BV1 UFSAR and BV2 UFSAR to be 300 cfm (BV1) and 200 cfm (BV2), or a total of 500 cfm. These UFSAR values are to be changed after the Amendments are received. Other documents showing analogous flow rates are likewise affected.

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CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 8700-UR(B)-219	REVISION: 3

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DESIGN VERIFICATION RECORD

Page 1 of 1

NOP-CC-2001-01 Rev. 00

SECTION I: TO BE COMPLETED BY DESIGN ORIGINATOR

DOCUMENT(S)/ACTIVITY TO BE VERIFIED:

DIT-BVDM-0103-03

☒ SAFETY RELATED ☐ AUGMENTED QUALITY ☐ NONSAFETY RELATED

SUPPORTING/REFERENCE DOCUMENTS

DESIGN ORIGINATOR: *(Print and Sign Name)* Douglas T Bloom [signature]	DATE 1-28-19

SECTION II: TO BE COMPLETED BY VERIFIER

VERIFICATION METHOD *(Check one)*

☒ DESIGN REVIEW *(Complete Design Review Checklist or Calculation Review Checklist)* ☐ ALTERNATE CALCULATION ☐ QUALIFICATION TESTING

JUSTIFICATION FOR SUPERVISOR PERFORMING VERIFICATION:

N/A

APPROVAL: *(Print and Sign Name)* N/A	DATE

EXTENT OF VERIFICATION:

Design Review Checklist completed.

COMMENTS, ERRORS OR DEFICIENCIES IDENTIFIED? ☐ YES ☒ NO

RESOLUTION: *(For Alternate Calculation or Qualification Testing only)*

N/A

RESOLVED BY: *(Print and Sign Name)* N/A	DATE
VERIFIER: *(Print and Sign Name)* Michael G. Unfried [signature]	DATE 1/28/2019
APPROVED BY: *(Print and Sign Name)* M S Ressler [signature]	DATE 1/29/2019

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DESIGN REVIEW CHECKLIST

NOP-CC-2001-02 Rev. 04

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):

DIT-BVDM-0103-03

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
1. Were the basic functions of each structure, system or component considered?		✓			
2. Have performance requirements such as capacity, rating, and system output been considered?		✓			
3. Are the applicable codes, standards and regulatory requirements including applicable issue and/or addenda properly identified and are their requirements for design and/or material been met or reconciled?		✓			
4. Have design conditions such as pressure, temperature, fluid chemistry, and voltage been specified?		✓			
5. Are loads such as seismic, wind, thermal, dynamic and fatigue factored in the design?	✓				
6. Considering the applicable loading conditions, does an adequate structural margin of safety exist for the strength of components?	✓				
7. Have environmental conditions anticipated during storage, construction and operation such as pressure, temperature, humidity, soil erosion, run-off from storm water, corrosiveness, site elevation, wind direction, nuclear radiation, electromagnetic radiation, and duration of exposure been considered?	✓				
8. Have interface requirements including definition of the functional and physical interfaces involving structures, systems and components been met?		✓			
9. Have the material requirements including such items as compatibility, electrical insulation properties, protective coating, corrosion, and fatigue resistance been considered?	✓				
10. Have mechanical requirements such as vibration, stress, shock and reaction forces been specified?	✓				
11. Have structural requirements covering such items as equipment foundations and pipe supports been identified?	✓				
12. Have hydraulic requirements such as pump net positive suction head (NPSH), allowable pressure drops, and allowable fluid velocities been specified?	✓				
13. Have chemistry requirements such as the provisions for sampling and the limitations on water chemistry been specified?	✓				
14. Have electrical requirements such as source of power, voltage, raceway requirements, electrical insulation and motor requirements been specified?	✓				
15. Have layout and arrangement requirements been considered?		✓			
16. Have operational requirements under various conditions, such as plant startup, normal plant operation, plant shutdown, plant emergency operation, special or infrequent operation, and system abnormal or emergency operation been specified?		✓			

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DESIGN REVIEW CHECKLIST

NOP-CC-2001-02 Rev. 04

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):

DIT-BVDM-0103-03

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
17. Have instrumentation and control requirements including instruments, controls, and alarms required for operation, testing, and maintenance been identified? Other requirements such as the type of instrument, installed spares, range of measurement, and location of indication should also be included.	✓				
18. Have adequate access and administrative controls been planned for plant security?	✓				
19. Have redundancy, diversity, and separation requirements of structures, systems, and components been considered?		✓			
20. Have the failure requirements of structures, systems, and components, including a definition of those events and accidents which they must be designated to withstand been identified?	✓				
21. Have test requirements including in-plant tests, and the conditions under which they will be performed been specified?	✓				
22. Have accessibility, maintenance, repair and in-service inspection requirements for the plant including the conditions under which they will be performed been specified?	✓				
23. Have personnel requirements and limitations including the qualification and number of personnel available for plant operation, maintenance, testing and inspection and permissible personnel radiation exposure for specified areas and conditions been considered?	✓				
24. Have transportability requirements such as size and shipping weight, limitations and Interstate Commerce Commission regulations been considered?	✓				
25. Have fire protection or resistance requirements been specified?	✓				
26. Are adequate handling, storage, cleaning and shipping requirements specified?	✓				
27. Have the safety requirements for preventing undue risk to the health and safety of the public been considered?		✓			
28. Are the specified materials, processes, parts and equipment suitable for the required application?	✓				
29. Have safety requirements for preventing personnel injury including such items as radiation hazards, restricting the use of dangerous materials, escape provisions from enclosures and grounding of electrical equipment been considered?	✓				
30. Were the inputs correctly selected and incorporated into the design?		✓			
31. Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed?	✓				
32. Are the appropriate quality and quality assurance requirements specified?	✓				

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NOP-CC-2001-02 Rev. 04

DESIGN REVIEW CHECKLIST

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.): OIT- BVDM- 0103-03

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
33. Have applicable construction and operating experience been considered?		✓			
34. Have the design interface requirements been satisfied?	✓				
35. Was an appropriate design method used?		✓			
36. Is the output reasonable compared to inputs?		✓			
37. Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?	✓				
38. Have adequate maintenance features and requirements been specified?	✓				
39. Has the design properly considered radiation exposure to the public and plant personnel?		✓			
40. Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfied?	✓				
41. Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?	✓				
42. Are adequate identification requirements specified?	✓				
43. Are requirements for record preparation, review, approval, retention, etc., adequately specified?	✓				
44. Have protective coatings qualified for Design Basis Accident (DBA) been specified to structures, equipment and components installed in the containment/drywell?	✓				
45. Are the necessary supporting calculations completed, checked and approved?	✓				
46. Have the equipment heat load changes been reviewed for impact on HVAC systems?	✓				
47. **IF** a computer program was used to obtain the design by analysis, **THEN** has the program been validated per NOP-SS-1001 and documented to verify the technical adequacy of the computer results contained in the design analysis?	✓				
48. Have Professional Engineer (PE) certification requirements been addressed and documented where required by ASME Code (if applicable).	✓				
49. Does the design involve the installation, removal, or revise software/firmware and have the requirements of NOP-SS-1001 been addressed?	✓				
50. Does the design involve the installation, removal, or change to a digital component(s) and have the requirements of NOP-SS-1201 been addressed?	✓				

COMPLETED BY: (*Print and Sign Name*)	DATE	ADDITIONAL VERIFIER (*Print and Sign Name*)	DATE
M. G. Unfried [signature]	1/28/2019	N/A	

IF CHECKLIST IS REVIEWED BY MORE THAN ONE VERIFIER, SIGN BELOW:

Enclosure C
L-20-161

L-SHW-BV2-000240 NP-Attachment 2 Calculation 10080-UR(B)-487, Revision 3, “Site Boundary, Control Room and Emergency Response Facility Doses following a Loss-of-Coolant Accident based on Core Uprate, an Atmospheric Containment and Alternative Source Terms”
(Nonproprietary Version)

(363 pages follow)

FirstEnergy	NOP-CC-3002-01 Rev. 05	**CALCULATION**	Page i

CALCULATION NO. 10080-UR(B)-487	**[ ] VENDOR CALC SUMMARY N/A** N/A

☒ BV1 ☒ BV2 ☐ BV1/2 ☐ BV3 ☐ BVSWT ☐ DB ☐ PY

Title/Subject: Site Boundary, Control Room and Emergency Response Facility Doses following a Loss-of-Coolant Accident based on Core Uprate, an Atmospheric Containment and Alternative Source Terms

Category:	☒ Active	☐ Historical	☐ Study	**Vendor Calc Summary:** Yes ☐ No ☒
Classification:	☒ Tier 1 Calculation	☒ Safety-Related/Augmented Quality		☐ Non-safety-Related
Open Assumptions?:	☐ Yes ☒ No If Yes, Enter Tracking Number			
System Number:	N/A			
Functional Location :	N/A			
Commitments:	None			
Initiating Documents:	CR-2017-10857			

(PY) Calculation Type:

(PY) Referenced In USAR Validation Database ☐ Yes ☐ No (PY) Referenced In Atlas? ☐ Yes ☐ No

Computer Program(s)

Program Name	Version / Revision	Category	Status	Description
PERC2	V00 / L02	B	Active	Activity Transport and Consequence
SW-QADCGGP (NU-222)	V00 / L03	B	Active	Gamma-ray Trace Shielding Program

Revision Record

Rev.	Affected Pages	Originator *(Print, Sign & Date)*	Reviewer/Design Verifier *(Print, Sign & Date)*	Approver *(Print, Sign & Date)*
3	All	Keith Ferguson 3/19/2019	Joseph Baron 3/19/2019	Sreela Ferguson 3/19/2019
	Description of Change: As part of a Long Term Objective, the dose consequences at the Site Boundary and Control Room following a Loss-of Coolant Accident (LOCA) has been updated to facilitate relaxation of operational limits that currently affect plant operation; specifically to allow an increase in the allowable unfiltered in-leakage into the Control room Envelope. Also included is a review / update of all design input parameter values / references to reflect current plant design.			
	Describe where the calculation will be evaluated for 10CFR50.59 and/or 10CFR72.48 applicability. Regulatory Applicability Determination and 10CFR50.59 Screen 18-01776 is attached to this calculation			
Rev.	Affected Pages	Originator *(Print, Sign & Date)*	Reviewer/Design Verifier *(Print, Sign & Date)*	Approver *(Print, Sign & Date)*
2	All	Keith Ferguson 12/17/2015	Wu-Hung Peng 12/17/2015	Sreela Ferguson 12/17/15
	Description of Change:			Initiating Document:
	Describe where the calculation will be evaluated for 10CFR50.59 applicability.			

~~***PROPRIETARY***~~

FirstEnergy	NOP-CC-3002-01 Rev. 05 **CALCULATION**	Page ii
CALCULATION NO. **10080-UR(B)-487, Revision 3**	**[ ] VENDOR CALC SUMMARY** **VENDOR CALCULATION NO. N/A**	

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CALCULATION NO. **10080-UR(B)-487, Revision 3**		**[ ] VENDOR CALC SUMMARY** **VENDOR CALCULATION NO. N/A**

4. FENOC Design Input DIT-BVDM-0103-03, Table E (Control Room)	36 pages
5. FENOC Design Input DIT-BVDM-0115-01 (Emergency Response Facility (ERF))	31 pages
6. FENOC Letter BV2SGRP:2014 transmitting DIT-SGR2-0046-01	12 pages
SUPPORTING DOCUMENTS (*For Records Copy Only)*	
DESIGN VERIFICATION RECORD	1 page
CALCULATION REVIEW CHECKLIST	3 pages
10CFR50.59 DOCUMENTATION	
10CFR72.48 DOCUMENTATION	N/A
DESIGN INTERFACE SUMMARY	9 pages
DESIGN INTERFACE EVALUATIONS	N/A
OTHER (Owners Comments)	4 page
TOTAL NUMBER OF PAGES IN CALCULATION (COVERSHEETS + BODY + ATTACHMENTS)	**363 Pages**

CALCULATION NO. 10080-UR(B)-487, Revision 3	[ ] VENDOR CALC SUMMARY VENDOR CALCULATION NO. N/A

OBJECTIVE OR PURPOSE:

The objective of this calculation is to determine the dose at the Exclusion Area Boundary (EAB), Low Population Zone (LPZ), Control Room (CR) and Emergency Response facility (ERF, includes the Technical Support Center (TSC)) at Beaver Valley Power Station (BVPS) following a postulated Loss of Coolant Accident (LOCA). The analysis is based on a core power level of 2918 MWt (i.e., the uprated core thermal power level with margin for power uncertainty)

The calculated dose is based on “Alternative Source Terms” per Regulatory Guide (RG) 1.183, Revision 0, increased allowable unfiltered inleakage into the Control Room Envelope (CRE), and current design input parameter values as provided by First Energy Nuclear Operating Company (FENOC) via DIN# 1, 48 and 49, and included as Attachments 1, 4 and 5 of this calculation.

SCOPE OF CALCULATION/REVISION:

As part of a Long Term Objective, and with the intent of providing operational margin, the BVPS design basis site boundary, control room and ERF dose consequence analyses are being updated to facilitate relaxation of certain operational limits that have significant effect on plant operation.

To that end, Revision 3 herein investigates the impact of a proposed *increase in the allowable unfiltered inleakage into the Control Room Envelope (CRE)*, on the dose consequences in the CR following a LOCA at Unit 1 or Unit 2. Also, included in this effort is an assessment of the impact of the presence of the following, on the CR operator dose:

a) Wall penetrations (previously not addressed) between the BVPS-2 CR Filter cubicle and the adjacent computer room which is located in the Control Room Envelope (CRE).
b) Particulate air filters (intended for dust removal) in the CRVS recirculation air-conditioning system (specifically, Revision 3 is intended to demonstrate that the current model that does not address the presence of these dust filters, is bounding).

In addition, the dose consequence to the occupant in the ERF /TSC is being updated to:

a) Reflect the use of a conservative bounding approach with respect to the ERF ventilation filters. Specifically, similar to the previous revisions, Revision 3, does not credit the ERF ventilation system when calculating the inhalation dose. However, unlike the previous revisions which addressed the stated filter efficiency when estimating the direct shine dose from the filter, Revision 3, conservatively assumes that the intake and recirculation filters are 100% (or 0%) efficient, as deemed conservative. Establishment of ERF/TSC habitability using the above approach will facilitate exemption of the ERF ventilation and filtration system from testing programs.
b) Provide worst-case 30-day integrated dose estimates in a) the ERF (i.e., Room 143, corridor adjacent to the recirculation filter cubicles), and b) the TSC (Room 119).
c) Include a dose contribution to ERF/TSC personnel due to daily passage through Room 112 (Service Dock) when accessing / exiting the ERF/TSC (expected occupation: 10 minutes per day for the 30-day duration of the accident).

In summary, the objective of Revision 3 is to demonstrate continued compliance with the dose acceptance criteria of 10CFR50.67 (as modified by Table 6 of RG 1.183 R0) after taking into consideration the following:

a) An increase in allowable unfiltered inleakage into the CRE (inclusive of that associated with ingress /egress) from 30 cfm to 165 cfm.
b) The presence of wall penetrations between the BVPS-2 CR filter cubicle and the CRE.
c) An investigation / demonstration that the current model that does not address the presence of particulate air filters (intended for dust removal) in the CRVS recirculation air-conditioning system, remains bounding.
d) A bounding approach with respect to the ERF ventilation filters (specifically, not crediting the filters when calculating the inhalation dose, but conservatively assuming 100% (or 0%) efficiency, as deemed conservative, when addressing the direct shine dose).
e) Worst-case 30-day integrated dose estimates in a) the ERF (i.e., Room 143, corridor adjacent to the recirculation filter cubicles), and b) the TSC (Room 119)
f) Include a dose contribution to ERF/TSC personnel due to daily passage through Room 112 (Service Dock) when accessing / exiting the ERF/TSC (expected occupation: 10 minutes per day for the 30-day duration of the accident)
g) Review / Update (as needed) of all design input parameter values / references to reflect current plant design.

SUMMARY OF RESULTS/CONCLUSIONS:

The BVPS Site Boundary and Control Room doses due to radioactive material released following a LOCA will remain within the regulatory limits set by 10CFR50.67 and Regulatory Guide 1.183. The ERF doses also remain within 5 Rem TEDE.

Control Room

The maximum 30-day integrated dose to the control room operator is 4.49 Rem TEDE. This value is less than the regulatory limit of 5 Rem TEDE.

Note:

1. *In accordance with current licensing basis, the CR dose estimates following a LOCA is based on the assumption that the CR a) is automatically isolated, and b) placed in emergency pressurization / filtration mode via manual operator action within 30 mins of the accident.*
2. As a result of *scatter through wall penetrations* between the BVPS-2 CR filter cubicle and the CRE, *there is a hot spot near the north stairwell of 0.11 rem due to shine from the CRVS filters (vs the current maximum dose in the general areas of the CRE of 0.0634 rem). (Refer to Table 10 and Appendix D for detail)*
3. *The current model that does not credit the presence of particulate air filters (intended for dust removal) in the CRVS recirculation air-conditioning system, is bounding.*

Emergency Response Facility

The maximum 30-day integrated dose to personnel in the ERF (bounds the estimated dose in the TSC) is 4.02 Rem TEDE. This value is less than the acceptance criteria of 5 Rem TEDE.

Note:

1. *In accordance with current licensing basis, the inhalation / submersion dose estimate following a LOCA does not credit the ERF structure / ventilation system*
2. *The estimated dose includes a dose contribution to ERF/TSC personnel due to daily passage through Room 112 (Service Dock) when accessing / exiting the ERF/TSC (expected occupation: 10 minutes per day for the 30-day duration of the accident)*
3. *A bounding approach is utilized with respect to filter efficiency when estimating the dose due to direct shine from the intake and recirculation ventilation filters, i.e., use of 100% or 0% efficiency, as deemed conservative. This approach provides a basis to eliminate the need for filter efficiency testing.*

Site Boundary

The integrated dose to an individual located at any point on the boundary of the exclusion area for any 2-hour period following the onset of the event is 16.62 Rem TEDE (t=0.5 hr to t=2.5 hr time window). This value is less than the regulatory limit of 25 Rem TEDE and remains unchanged from Revision 2.

The integrated dose to an individual located at any point on the outer boundary of the low population zone for the duration of the release is 2.9 Rem TEDE. This value is less than the regulatory limit of 25 Rem TEDE and remains unchanged from Revision 2.

LIMITATIONS OR RESTRICTIONS ON CALCULATION APPLICABILITY:

NRC approval of the increase in the maximum allowable unfiltered inleakage into the CRE (inclusive of that associated with ingress /egress) from 30 cfm to 165 cfm.

IMPACT ON OUTPUT DOCUMENTS:

Unit 1 UFSAR: Sections 6.6 and 14.3.5, and associated tables, as needed
Unit 2 UFSAR: Sections 6.4, 6.5.1, 6.5.2 and 15.6.5, , and associated tables, as needed

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CALCULATION NO. **10080-UR(B)-487, Revision 3**		**[ ] VENDOR CALC SUMMARY** **VENDOR CALCULATION NO. N/A**	

DESIGN VERIFICATION FORM

Project Name:	**BVPS Control Room Dose Consequence Analyses Update**	**Job Number:**	**7001041**
Verified Document No.:	**10080-UR(B)-487**	**Revision:**	**3**
Verified Document Title:	Site Boundary, Control Room and Emergency Response Facility Doses following a Loss-of-Coolant Accident based on Core Uprate, an Atmospheric Containment and Alternative Source terms	**Date Verified:**	**3/19/2019**
Verifier's Name/Signature:	**Joseph Baron** (signature) **3/19/2019**		
Lead Engr. Concurrence Name/Signature/ Date	**Sreela Ferguson** (signature) **3/19/2019**		
Extent of Review: (entire document or not)	Full ☒ Partial ☐ If partial, specify what was reviewed:		
Method of Review	Design Review ☒ Alternate Calculation/Analysis ☐ Qualification Testing ☐		
Incomplete or unverified portions of design:	NA		
Consideration of known problems affecting the standard or previously proven design document:	NA		

THE FOLLOWING QUESTIONS ARE SUMMARIZED. REFER TO NEPP 4-43 FOR COMPLETE REVIEW REQUIREMENTS. ADDRESS ADDITIONAL APPLICABLE REVIEWS IN COMMENT/JUSTIFICATION BLOCK AS NECESSARY.

Design Reviews	Inputs have been properly selected?	Yes ☒ No ☐
	Assumptions are adequately described and reasonable?	Yes ☒ No ☐
	Methodology, including computer programs, to assure the appropriateness of the overall approach, its implementation, and the correctness of the specific information and correlations utilized?	Yes ☒ No ☐
	Inputs are correctly used in the document, including validity of references identified?	Yes ☒ No ☐
	Design Output is reasonable compared to the inputs used?	Yes ☒ No ☐
	Design Input and Verification Requirements for interfacing organizations are specified in design documents or in supporting procedures?	Yes ☒ No ☐
Administrative Check Of Format And Content		Yes ☒ No ☐

Comments/Justification (Identify comment subject and associated response.)
The results of this calculation are based on the design input provided by FENOC

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DOCUMENT INDEX

DIN No.	Document Number/Title	Revision, Edition, Date	Reference	Input	Output
1	FENOC Letter ND1MDE:0733; BV1 & BV2 Complete Reanalysis of Dose Consequences for CRE Tracer Gas Testing and other Acceptance Criteria Changes, Design Input Transmittal DIT-BVDM-0113-00 for Loss of Coolant Accident (LOCA)	October 30, 2018	☒	☒	☐
2	Regulatory Guide 1.183, “Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors”	July 2000	☒	☒	☐
3	10CFR50.67, “Accident Source Term	N/A	☒	☐	☐
4	NUREG-0800, Standard Review Plan 15.0.1, “Radiological Consequence Analyses using Alternative Source Terms”	Rev. 0	☒	☐	☐
5	Code of Federal Regulations, Title 10, Part 100.11, “Determination of Exclusion Area, Low Population Zone, and Population Center Distance.”	N/A	☒	☐	☐
6	Ramsdell, J. V. Jr. and C. A. Simonen, "Atmospheric Relative Concentrations in Building Wakes.” Prepared by Pacific Northwest Laboratory for the U.S. Nuclear Regulatory Commission, PNL-10521, NUREG/CR-6331,	Rev. 1, May 1997.	☒	☒	☐
7	ANSI/ANS 6.1.1-1991, “Neutron and Gamma-ray Fluence-to-dose Factors”	1991	☒	☒	☐
8	TID-24190, Air Resources Laboratories, “Meteorology and Atomic Energy”	July 1968	☒	☐	☐
9	WECTEC Calculation 10080-UR(B)-483, “Composite Reactor Core Inventory for BVPS Following Power Uprate (2918 MWth, Initial 4.2% - 5% Enrichment, 18 Month Fuel Cycle)”	Rev. 0	☒	☒	☐

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DIN No.	Document Number/Title	Revision, Edition, Date	Reference	Input	Output
10	WECTEC Calculation 8700-US(B)-257, "Iodine Removal Coefficients"	Rev. 2 including Add 1	☒	☒	☐
11	WECTEC Calculations (a) Unit 1 Calc 11700-PE(B)-194, "Recirculation Spray Volume Coverage Re-Evaluation", (b) Unit 2 Calc 12241-US(B)-163, "Recirculation Spray Volume Coverage"	a) Rev. 0, Add 2 b) Rev. 0, including Add 1, 2 & 3	☒	☒	☐
12	NUREG-0800, 1988, Standard Review Plan, "Containment Spray as a Fission Product Cleanup System," Section 6.5.2	Rev. 2	☒	☒	☐
13	NUREG/CR-5732, "Iodine Chemical Forms in LWR Severe Accidents –Final Report,"	April 1992	☒	☐	☐
14	NUREG-0800, SRP 6.4, "Control Room Habitability System."	Revision 2	☒	☐	☐
15	WECTEC Computer Program NU-226, PERC2, "Passive/Evolutionary Regulatory Consequence Code", QA Cat 1	Ver. 00, Lev. 02	☒	☐	☐
16	Keenan & Keyes, Hill and Moore, "Steam Tables (English Units)"	1969	☒	☒	☐
17	WECTEC Calc 8700-US(B)-ERS-SNW-92-009, "Iodine Release from the Beaver Valley Unit 1&2 Refueling Water Storage Tank"	Rev. 6, including Add 1 and 2	☒	☒	☐
18	WECTEC Calculation 10080-UR(B)-484, "Primary and Secondary Coolant Design/Technical Specification Activity Concentrations including Pre-Accident Iodine Spike Concentrations and Equilibrium Iodine Appearance Rates"	Rev. 1	☒	☒	☐
19	WECTEC Calculations (a) 10080-UR(B)-485, and (b) 8700-UR(B)-213, "Containment Vacuum System Maximum Flowrate for Radiological Input"	a) Rev. 0 b) Rev. 0	☒	☒	☐

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20	WECTEC Calculation 8700-EN-ME-105, "Relative Atmospheric Dispersion Factors (χ/Qs) at Control Room and ERF Receptors for Unit 1 Accident Releases"	Rev. 0, including Add 1	☒	☒	☐
21	WECTEC Calculation 10080-EN-ME-106, "Relative Atmospheric Dispersion Factors (χ/Q s) at Control Room and ERF Receptors for Unit 2 Accident Releases"	Rev. 0, including Add 1	☒	☒	☐
22	DOE/TIC-11026, "Radioactive Decay Data Tables - A handbook of Decay Data for Application to Radiation Dosimetry and Radiological Assessments", Kocher	1981	☒	☒	☐
23	Lawrence Berkeley Laboratory, University of California, Berkeley, "Table of Isotopes"	7th Edition	☒	☒	☐
24	EPA-520/1-88-020, "Federal Guidance Report No.11, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion and Ingestion."	September 1988	☒	☒	☐
25	WECTEC Calculation 12241-UR(B)-390, "Control Room Dose Penetrations Shielding Requirement"	Rev. 0	☒	☒	☐
26	TID-14844, J.J. DiNunno, et. al., "Calculation of Distance Factors for Power and Test Reactor Sites", March 23, 1962	March 23, 1962	☒	☐	☐
27	WECTEC Calculation 12241/11700-UR(B)-480, "Radiological Dose Consequences at the EAB, LPZ, and in the Control Room due to a Postulated LOCA at Beaver Valley Power Station Unit 1"	Rev. 0, including Adendum1	☒	☒	☐
28	WECTEC Calculation 12241/11700-UR(B)-481, "Radiological Dose Consequences at the EAB, LPZ, and in the Control Room due to a Postulated LOCA at Beaver Valley Power Station Unit 2"	Rev. 0, including Addendum 2	☒	☒	☐

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[ ] VENDOR CALC SUMMARY
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DIN No.	Document Number/Title	Revision, Edition, Date	Reference	Input	Output
29	a) BVPS Dwg. No. 8700-RB-17J, b) Dwg. No. 8700-RB-17K	a) Rev. 15 b) Rev. 12	☒	☒	☐
30	BVPS Dwg. No. 8700-RC-8C	Rev. 13	☒	☒	☐
31	BVPS Dwg. No. 8700-10.1-222	Rev. B	☒	☒	☐
32	American National Standard, ANSI-ANS-6.1-1977, "Neutron and Gamma-Ray Flux-to-Dose Rate Factors"	1977	☒	☐	☐
33	BVPS Dwg. No. 10080-RB-39A BVPS Dwg. No. 10080-RB-39B	Rev. 13 Rev. 12	☒	☒	☐
34	BVPS Dwg. No. 8700-RM-3K	Rev. 4	☒	☒	☐
35	WECTEC Calculation 12241-UR(B)-193, "Containment Skyshine Dose Rate"	Rev. 0	☒	☒	☐
36	WECTEC Calculation 12179-UR(B)-354, "Skyshine Dose Rate from an Accident Containment (Scattered Component only)," (WECTEC Proprietary)	Rev. 0	☒	☒	☐
37	DLC Calculation ERS-SFL-83-010, "Emergency Response Facility Post- LOCA Dose"	Rev. 0	☒	☒	☐
38	BVPS Dwg. No. 8700-RM-60H	Rev. 3	☒	☒	☐
39	BVPS Dwg. No. 8700-RA-60M	Rev. 1	☒	☒	☐
40	BVPS Dwg. No. 8700-RA-60J	Rev. 1	☒	☒	☐
41	BVPS Dwg. No. 8700-9.16-388	Rev. A	☒	☒	☐
42	BVPS Dwg. No. 8700-RM-60E	Rev. 3	☒	☒	☐
43	FENOC letter ND1MLM:0189, W. R. Kline to E. A Dzenis, Westinghouse, "Containment Analysis Information, Revision 7, Units 1 & 2"	January 30, 2002	☒	☒	☐
44	WECTEC computer program NU-222, Ver.00, Lev.03, "SW-QADCGGP – A Combinatorial Geometry Version of QAD-5A"	Ver00, Lev.03	☒	☐	☐
45	Unit 1 UFSAR Section 14.3.5		☐	☐	☒
46	Unit 2 UFSAR Section 15.6.5		☐	☐	☒

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DIN No.	Document Number/Title	Revision, Edition, Date	Reference	Input	Output
47	FENOC Letter BV2SGRP:2014 transmitting DIT-SGR2-0046-01 / BVPS Unit 2 SGRP- Inputs for Calculation 10080-UR(B)-487	December 7, 2015	☒	☐	☐
48	FENOC Letter ND1MDE:0738, BV1 & BV2 Complete Reanalysis of Dose Consequences for CRE Tracer Gas Testing and Other Acceptance Criteria Changes - Design input Transmittal DIT-BVDM-0103-03 for Control Room Dose	January 29, 2019	☒	☒	☐
49	FENOC Letter ND1MDE:0739, BV1 & BV2 Complete Reanalysis of Dose Consequences for CRE Tracer Gas Testing and Other Acceptance Criteria Changes - Design input Transmittal DIT-BVDM-0115-01 for Emergency Response Facility	January 30, 2019	☒	☒	☐
50	Radiological Engineering & Waste Management Generic Library Data Volume I, Average β/γEnergies and Inhalation Dose Conversion Factors	September 26 1996	☒	☐	☐
51	FENOC letter ND1MDE:0374, “Containment Sump Modification Dose Inputs, Units 1&2– DIT-FPP-0044-00;	Sept. 20, 2006	☒	☐	☐
52	US Nuclear Regulatory Commission, NUREG 0737, "Clarification of TMI Action Plan Requirements"	November 1980	☒	☐	☐
53	BV Condition Report CR-2017-10857, 3BVT1.44.5 Testing 1VS-D-40-1D Component Test Results	October 28, 2017	☒	☐	☐
54	BV Drawing 8700-RA-60A, Emergency Response Facility Structure	Rev. 2	☒	☒	
55	Courtney, J.C., ANS/SD-76/14, A Handbook of Radiation Shielding Data	July 1976	☒	☐	
56	BV1 Drawing 8700-RM-0003M, Combined Control Room Plan & Elevation	Rev. 9	☒	☒	

HISTORY OF REVISIONS

Revision Number	Affected Sections	Description of Revision
0	N/A	Original Issue
1	ALL	Revision 1 incorporated the impact of the changes in recirculation spray system operation incorporated as part of the resolution to GSI-191 and associated containment sump strainer modification, on the dose consequences following a design basis LOCA.
2	ALL	Revision 2 evaluated the impact of the following on the dose consequences reported in Revision 1. a) BVPS-2 RSGs/RRVCH b) Westinghouse NSAL 11-5 on the post-LOCA M&Es (and the consequent effect on the containment pressure / temperature transient). Updated values of affected parameters that adversely impact the dose consequences (i.e., containment spray coverage, maximum containment spray initiation time, aerosol and elemental iodine removal rates inside containment, initiation of sump water back leakage into the RWST, initiation of RWST releases to the environment) are identified in FENOC DIT-SGR2-0046-01 (Attachment 4). In addition, Revision 2 also incorporated Addendum 1 and 2 of Revision 1 which assessed the dose consequence of changing the mechanism for adding a buffering agent to the post-LOCA sump water from chemical (NaOH) addition to the Quench spray, to use of NaTB baskets. Revision 2 also corrected a few unrelated inadvertent typos that existed in Revision 1.
3	ALL	Updated to address: a) An increase in allowable unfiltered inleakage into the CRE (inclusive of that associated with ingress /egress) from 30 cfm to 165 cfm. b) The presence of wall penetrations between the BVPS-2 CR filter cubicle and the CRE.

		c) An investigation / demonstration that the current model that does not address the presence of particulate air filters (intended for dust removal) in the CRVS recirculation air-conditioning system, remains bounding. d) A bounding approach with respect to the ERF ventilation filters (specifically, not crediting the filters when calculating the inhalation dose, but conservatively assuming 100% (or 0%) efficiency, as deemed conservative, when addressing the direct shine dose). e) Worst-case 30-day integrated dose estimates in a) the ERF (i.e., Room 143, corridor adjacent to the recirculation filter cubicles), and b) the TSC (Room 119) f) Include a dose contribution to ERF/TSC personnel due to daily passage through Room 112 (Service Dock) when accessing / exiting the ERF/TSC (expected occupation: 10 minutes per day for the 30-day duration of the accident) g) Review / Update (as needed) of all design input parameter values / references to reflect current plant design.

CALCULATION NO.: 10080-UR(B)-487	REVISION: 3

1.0 BACKGROUND / APPROACH

1.1 Background

BVPS-1 and 2 has implemented Alternative Source terms (AST) in accordance with Regulatory Guide 1.183, Revision 0. The dose consequences at the Exclusion Area Boundary (EAB), Low Population Zone (LPZ), Control Room (CR) and Emergency Response Facility (ERF) for a postulated Loss-of-Coolant Accident (LOCA) based on AST methodology, Containment Conversion to atmospheric conditions, BVPS-1 Replacement Steam Generators (RSGs) and Extended Power Uprate (EPU) was originally documented in Revision 0.

Revision 1: Subsequent to the implementation of AST, the operation of the recirculation spray system was modified as part of the resolution to GSI-191 and the associated containment sump strainer modification. The associated changes in design input that directly impacted the dose consequences following a LOCA included the following:

- Delayed initiation of recirculation sprays
- Changes in sump water volume vs time
- Sump water temperature at initiation of recirculation
- Elemental iodine and aerosol fission product removal rates as a function of time
- Fractional volumetric release from the RWST gas space as a function of time

Addenda 1 and 2 of Revision 1 assessed the dose consequence of changing the mechanism for adding a buffering agent to the post-LOCA sump water from chemical (NaOH) addition to the Quench spray, to use of NaTB baskets in BVPS-2 and 1, respectively. Since the NaTB baskets are to be filled to ensure an ultimate sump water pH of ≥ 7.0, there was no impact on the Revision 1 post-LOCA containment and ECCS leakage dose consequence models relative to iodine re-evolution. However, the change in the sump pH transient did impact the BVPS-1 & 2 bounding post-LOCA iodine releases from the RWST; thus the effect of this modification on the dose consequences from the RWST back leakage pathway was evaluated in Addenda 1 and 2. The referenced addenda concluded that the dose consequences documented in Revision 1 remain bounding.

Revision 2 evaluated the impact of the following on the dose consequences reported in Revision 1.

a) BVPS-2 Replacement Steam Generators (RSGs)/ Replacement Reactor Vessel Closure Head (RRVCH)
b) Westinghouse NSAL 11-5 on the post-LOCA BVPS-2 M&Es (and the consequent effect on the containment pressure / temperature transient)

Updated values of affected parameters that adversely impacted the dose consequences (i.e., containment spray coverage, maximum containment spray initiation time, aerosol and elemental iodine removal rates inside containment, initiation of sump water back leakage into the RWST, initiation of RWST releases to the environment) were identified in FENOC DIT-SGR2-0046-01 (DIN# 47, Attach 5).

In addition, Revision 2 also incorporated Addendum 1 and 2 of Revision 1 which assessed the dose consequence of changing the mechanism for adding a buffering agent to the post-LOCA sump water from chemical (NaOH) addition to the Quench spray, to use of NaTB baskets.

Revision 3: As part of a Long Term Objective, and with the intent of providing operational margin, the BVPS design basis site boundary and control room / ERF dose consequence analyses are being updated herein to facilitate relaxation of certain operational limits that have significant effect on plant operation. To that end, Revision 3 investigates the impact of following on the dose consequences following a LOCA:

a) An increase in allowable unfiltered inleakage into the CRE (inclusive of that associated with ingress /egress) from 30 cfm to 165 cfm. This is intended to address the fact that recent CRE Tracer Gas Tests indicate unfiltered CRE inleakage that are in excess of the values used in the design basis dose consequence analyses.

b) The presence of wall penetrations between the BVPS-2 CR filter cubicle and the CRE.

c) An investigation / demonstration that the current model that does not address the presence of particulate air filters (intended for dust removal) in the CRVS recirculation air-conditioning system, remains bounding.

d) A bounding approach with respect to the ERF ventilation filters (specifically, not crediting the filters when calculating the inhalation dose, but conservatively assuming 100% (or 0%) efficiency, as deemed conservative, when addressing the direct shine dose).

e) Worst-case 30-day integrated dose estimates in a) the ERF (i.e., Room 143, corridor adjacent to the recirculation filter cubicles), and b) the TSC (Room 119).

f) Include a dose contribution to ERF/TSC personnel due to daily passage through Room 112 (Service Dock) when accessing / exiting the ERF/TSC (expected occupation: 10 minutes per day for the 30-day duration of the accident).

g) Review / Update (as needed) of all design input parameter values / references to reflect current plant design.

1.2 Approach

Regulatory Guide (RG) 1.183 identifies the large break LOCA as the design basis case of the spectrum of break sizes for evaluating performance of release mitigation systems / containment and facility siting relative to radiological consequences.

The BVPS design input parameters utilized in the LOCA analysis are provided via DIN# 1 (LOCA parameters), DIN# 48 (Control Room parameters) and DIN# 49 (ERF parameters). The referenced DINs summarize the design input previously used in Revision 2 of this analysis, and that approved for use in Revision 3.

Per DIN# 1, BVPS has identified four activity release paths following a LOCA:

(a) Containment Pressure Relief Line Release
(b) Containment Leakage
(c) ESF System Leakage
(d) RWST back leakage

WECTEC radiological consequence program PERC2 is used to calculate the Committed Effective Dose Equivalent (CEDE) from inhalation and the Deep Dose Equivalent (DDE) from submersion due to halogens and noble gases at the offsite locations and in the control room. The models used to estimate the post-LOCA inhalation and submersion dose to the public or to the operator in the control room (CR) or the occupant in the Emergency Response Facility (ERF, includes the Technical Support Center), are described in the main body of the calculation. A bounding analysis is performed, thus the results are applicable to both Unit 1 and 2.

The dose contribution to the operator in the CR and the occupant in the ERF due to direct shine from post-LOCA external or contained sources, was originally developed in Revision 0, and documented in Appendix A and Appendix B, respectively. As part of the Revision 1 update, Appendix A and B were completely revised to reflect the updated design input parameter values / fission product progression model associated with implementation of GSI-191.

Revision 2, (developed in support of the BVPS-2 RSGs), did not update Appendix A and B. Rather, the dose impact of the updated values of affected parameters (i.e., containment spray coverage, maximum containment spray initiation time, aerosol and elemental iodine removal rates inside containment, initiation of sump water back leakage into the RWST, initiation of RWST releases to the environment) was assessed in detail in Appendix C, and the results reported in the main body of the calculation.

The methodology utilized in Revision 3 (which utilizes design inputs from DIN# 1, 48 and 49) remains the same as that used previously in Revision 2. Note:

- Review of DIN# 1, indicates that the LOCA activity release model and the plant design input values associated with the above release pathways remain unchanged for Revision 3.
- Review of DIN# 48 indicates differences in the control room design input parameter values between that used in Revision 2, and that approved for use in Revision 3. Specifically, changes include:
    - The value assumed for CR unfiltered inleakage
    - The maximum normal operation flowrate associated with unfiltered intake + inleakage
    - The value assumed for CR inleakage during it isolation/recirculation mode
    - The filtered emergency intake flow rate
    - The dimensions of the BVPS-2 HEPA filter
    - The presence of wall penetrations (previously not addressed) between the BVPS-2 CR Filter cubicle and the adjacent computer room which is located in the Control Room Envelope (CRE)

  - Information with respect to the particulate air filters (intended for dust removal, previously not provided) in the CRVS recirculation air-conditioning system
- DIN# 49 indicates differences in the ERF/TSC design input parameter values, between that used in Revision 2, and that approved for use in Revision 3. Specifically, changes include updated values for the:
  - ERF Minimum Free Volume
  - ERF Maximum Recirculation flow rate
  - ERF Intake and Recirculation Filter efficiency (specifically, the use of conservative assumptions such that testing is not required)
  - Distance between the ERF and the Containment
  - Distance between the ERF and the RWST
  - ERF Intake filter dimensions
  - ERF Recirculation filter dimensions
  - Distance between the ERF Intake filter and personnel in the TSC
  - Distance between the ERF Recirculation filter and personnel in the TSC
  - Distance between the ERF Intake filter and personnel in Room 143 (corridor adjacent to the recirculation filter cubicle, previously not provided)
  - Distance between the ERF Recirculation filter and personnel in Room 143 (previously not provided)
  - Distance between the ERF Intake filter and personnel in Room 112 (previously not provided)
  - Distance / shielding between the ERF Recirculation filter and personnel in Room 112 (previously not provided)
  - Occupancy time (previously not provided) for ERF/TSC personnel due to daily passage through Room 112 (Service Dock) when accessing / exiting the ERF/TSC

Except as noted, Revision 3 does not update Appendix A, Appendix B or Appendix C.

CR & ERF Direct Shine doses:

- The dose contribution from the BVPS-2 HEPA filters to an operator in the Control Room (originally developed in Appendix A, and updated in Appendix C), has been updated to reflect the design inputs provided by DIN# 48. The new assessment is documented in Appendix D.
- The dose contribution from the ERF ventilation filters to an occupant in the ERF/TSC (originally developed in Appendix B, and updated in Appendix C), has been updated to reflect the design inputs provided by DIN# 49. The new assessment is documented in Appendix E. In addition, the impact of shorter estimated distances between the ERF/TSC and the containment and RWST sources on the estimated doses (originally developed in Appendix A, and updated in Appendix C), is also addressed in Appendix E.

CR & ERF Inhalation / Submersion doses:

- Computer runs from Appendix C that are impacted by the changes in design input parameters provided via DIN# 48 (CR) are updated, and the results reported in the main body of the analysis.
- The dose in the ERF due to inhalation / submersion was conservatively estimated on the roof of the ERF (i.e., no credit was taken for the ERF ventilation system /structure). Consequently, the updated input provided via DIN# 49 will not impact the inhalation/submersion doses to the ERF.

EAB/LPZ Doses:

As noted earlier, since DIN# 1 does not affect the LOCA activity release model and the plant design input values associated with the release pathways, the inhalation / submersion doses at the EAB / LPZ remain unchanged from Revision 2.

Dose Calculation Methodology

1. Inhalation and Submersion Doses from Airborne Radioactivity

WECTEC radiological consequence program PERC2 is used to calculate the Committed Effective Dose Equivalent (CEDE) from inhalation and the Deep Dose Equivalent (DDE) from submersion due to halogens, noble gases and other nuclides transported to offsite locations and in the control room. The CEDE is calculated with dose conversion factors from DIN# 24, which uses the methodology provided in ICRP-30. The committed doses to other organs due to inhalation of halogens, particulates and noble gas daughters are also calculated. PERC2 is a multiple compartment activity transport code with the dose model consistent with the regulatory guidance. The decay and daughter build-up during the activity transport among compartments and the various cleanup mechanisms are included.

The PERC2 activity transport model, first calculates the integrated activity (using a closed form integration solution) at the offsite locations and in the control room air region, and then calculates the cumulative doses as described below:

Committed Effective Dose Equivalent (CEDE) Inhalation Dose - The dose conversion factors by isotope and internal organ type are applied to the activity in the air space of the control room, or at the EAB/LPZ. The exposure is adjusted by the appropriate respiration rate and occupancy factors for the CR dose at each integration interval as follows:

$$Dh(j) = A(j) \times h(j) \times C2 \times C3 \times CB \times CO$$

Where:

Dh(j) = Committed Effective Dose Equivalent (rem) from isotope j

A(j) = Integrated Activity (Ci-s/m^3)

h(j) = Isotope j Committed Effective Dose Equivalent (CEDE) dose conversion

factor (mrem/pCi) based on Fed. Guidance Report No.11, Sept. 1988 (DIN# 24)
C2 = Unit conversion of $1x10^{12}$ pCi/Ci
C3 = Unit conversion of $1x10^{-3}$ rem/mrem
CB = Breathing rate (m^3/s)
CO = Occupancy factor

Deep Dose Equivalent (DDE) from External Exposure - According to the guidance provided in Section 4.1.4 and Section 4.2.7 of RG 1.183, R0 (DIN# 2), the Effective Dose Equivalent (EDE) may be used in lieu of DDE in determining the contribution of external dose to the TEDE if the whole body is irradiated uniformly. The EDE in the control room is based on a finite cloud model that addresses buildup and attenuation in air. The dose equation is based on the assumption that the dose point is at the center of a hemisphere of the same volume as the control room. The dose rate at that point is calculated as the sum of typical differential shell elements at a radius R. The equation utilizes, the integrated activity in the control room air space, the photon energy release rates per energy group from activity airborne in the control room based on using the isotopic gamma energy library data developed in DIN# 50 based on DIN#s 23 and 22, and the ANSI/ANS 6.1.1-1991 "Neutron and Gamma-ray Fluence-to-dose Factors", DIN# 7.

The Deep Dose Equivalent at the EAB and LPZ locations is very conservatively calculated using the semi-infinite cloud model outlined in TID-24190 (DIN# 8), Section 7-5.2, Equation 7.36, where 1 rad is assumed to be equal to 1 rem.

$\gamma D_\infty (x,y,0)$ rad = $0.25\, E\gamma_{BAR}\, \psi (x,y,0)$
$E\gamma_{BAR}$ = average gamma energy released per disintegration (Mev/dis) is based on the isotopic gamma energy data developed in DIN# 50
$\psi (x,y,0)$ = concentration time integral (Ci-sec/m^3)
0.25 = $[1.11 \bullet 1.6x10^{-6} \bullet 3.7x10^{10}] / [1293 \bullet 100 \bullet 2]$

Where:

1.11	=	ratio of electron densities per gm of tissue to per gm of air
$1.6x10^{-6}$ (erg/Mev)	=	number of ergs per Mev
$3.7x10^{10}$ (dis/sec-Ci)	=	disintegration rate per curie
1293 (g/m^3)	=	density of air at S.T.P.
100	=	ergs per gram per rad
2	=	factor for converting an infinite to a semi-infinite cloud

2. Direct Shine Dose from External and Contained Sources

Point kernel shielding computer program SW-QADCGGP is used to calculate the deep dose equivalent (DDE) in the control room, ERF/TSC due to external and contained sources. The calculated DDE is added to the inhalation (CEDE) and the submersion (EDE) dose due to airborne radioactivity to develop the final TEDE. Conservative build-up factors are used and the geometry models are prepared to ensure that un-accounted streaming/scattering paths were eliminated. The dose albedo method with conservative albedo values is used to estimate the scatter dose in situations where the scattering contributions are potentially significant. ANSI/ANS 6.1.1-1977 "Neutron and gamma-ray flux-to-dose-rate factors" is used to convert the gamma flux to the dose equivalent rate. (See Appendix A, B, D and E for details)

EAB 2-hour worst case window

Similar to Revision 0, to establish the dose to an individual located at any point on the boundary of the exclusion area, for any 2-hour period following the onset of the postulated LOCA, Revision 1 utilized the following approach:

- The integrated dose at various times after a LOCA was calculated with PERC2 for each of the four release pathways (i.e., containment atmospheric vacuum relief line leakage, containment penetration leakage, ESF leakage and RWST back leakage).
- A polynomial expression was then developed to express the cumulative integrated dose, for each of the release pathways using the doses calculated with PERC2 as discussed in step above. (The equations allow the dose per pathway to be calculated at any time after the LOCA external to the Activity Transport and Dose Code PERC2)
- The cumulative integrated dose versus time for the containment leakage pathway and the combined ESF/RWST back leakage pathway was then calculated at increments of 0.1 hours post LOCA for each of the four pathways using the polynomial expressions.
- The dose from all pathways at each 0.1 hours increment was then added to establish the total dose (TEDE in units of rem) versus time after LOCA at equal 0.1 hour increments.
- The 2-hour dose at a time x (for x ≥ 2.1) was then calculated by subtracting the dose at a time (x 2 hrs) from any time x ≥ 2.1 hours after the LOCA. The worst case 2-hour window dose can then be established by comparing the moving 2-hour dose calculated at each 0.1 hour increment. For example, the two-hour window TEDE dose that ends at 2.5 hours is the TEDE dose at 2.5 hours minus the TEDE dose at 0.5 hours after LOCA.

To facilitate analysis simplification, Appendix “C” of Revision 2 demonstrated that the worst case dose window defined by Revision 1 remained valid without re-performing the above tasks to establish the worst case 2-hr window.

It is noted that the assessment documented in Appendix C for the site boundary, remains valid for Revision 3 since DIN# 1 does not affect the Revision 2 design input parameter values associated with quantity, concentration, isotopic mix, timing or location of the post-LOCA radioactivity releases / site boundary receptors.

In addition, since the direct shine dose at the EAB from contained sources such as the containment and RWST is negligible the TEDE is based solely on the CEDE and DDE from inhalation and submersion, respectively.

Containment Pressure Relief Line Release

It is assumed that the containment pressure relief line is operational at the initiation of the LOCA and that the release is terminated as part of containment isolation. In accordance with DIN# 2, 100% of the radionuclide inventory in the RCS liquid, assumed to be at Technical specification levels, is released to the containment at T = 0 hours. It is conservatively assumed that 100% of the released volatiles (i.e., the noble gases and the halogens), are instantaneously and homogeneously mixed in containment atmosphere. Containment pressurization (due to the RCS mass and energy release), combined with the relief line cross-sectional area, results in a 2200 scfm release of containment atmosphere (based on BVPS-1, equivalent release from BVPS-2 is 1600 scfm), to the environment over a period of 5 seconds (i.e., prior to containment isolation). Since the release is assumed to be isolated within 5 seconds after the LOCA, i.e., before the onset of the gap phase release assumed to be at 30 seconds, no fuel damage releases are postulated.

Per DIN# 2, the chemical form of the iodine released from the RCS is assumed to be 97% elemental and 3% organic. The containment pressure relief line is routed to the Process Vent which is located on top of the BVPS-1 Cooling Tower. However, since the associated piping is non-seismic, it is conservatively assumed that the release occurs at containment wall. See Figure 2 for activity transport diagram.

No credit is taken for processing this release via the safety related ventilation exhaust and filtration system that services the areas contiguous to containment; i.e.; the Supplementary Leak Collection System (SLCRS) filters. To ensure bounding values, the atmospheric dispersion factors utilized for this release reflects the worst value between the containment wall release point and the SLCRS release point for 0-2 hr time period.

Containment Leakage

The inventory of fission products in the reactor core available for release via containment leakage following a LOCA is based on DIN# 9 which represents a conservative equilibrium reactor core inventory of dose significant isotopes, assuming maximum full power operation at a core power level of 2918 MWt, and taking into consideration fuel enrichment and burnup.

In accordance with DIN# 2, the fission products released from the fuel are assumed to mix instantaneously and homogeneously throughout the free air volume of the primary containment as it is released from the core.

Containment sprays are utilized as one of the primary means of fission product cleanup following a LOCA. BVPS design includes a containment quench spray and a containment recirculation spray system at each of the units. Following post LOCA containment pressurization, the quench spray system is automatically initiated by the CIB signal, and injects cooling water from the refueling water storage tank (RWST), into the containment, via the quench spray system spray headers. Based on an assumption of a LOOP coincident with the LOCA, the quench spray is assumed to be initiated at 77.4 seconds (max time for either unit), and is available until depletion of the RWST inventory. Recirculation spray starts on a specified RWST level; consequently the recirculation spray initiation time is dependent on the accident scenario. For purposes of conservatism, the model is based on a scenario that maximizes the delay in start of the recirculation spray. Recirculation spray is assumed to start at 3855 secs (value based on BVPS-2, the BVPS-1 value is 2080 secs, DIN# 1, DIN# 10, pg.4 & pg. 5). The recirculation spray system takes suction from the containment sump and provides recirculation spray inside containment via the recirculation spray headers. Credit for recirculation spray is taken up to 96 hrs post-LOCA (DIN# 1, 10). Elemental iodine and aerosol spray removal lambdas are developed in DIN# 10; details of the spray system configuration / operation parameters used to develop the fission product cleanup following a LOCA are provided in DIN# 10.

Mixing of the "effectively" sprayed volume of containment with the unsprayed volume of the containment also facilitates the cleanup. In order to quantify the effectiveness of the containment spray systems, the volume fraction of containment that is effectively sprayed, and the mixing rate between the effectively sprayed and unsprayed volumes are quantified.

Fission Product Cleanup

In the effectively sprayed region, fission product cleanup is actively accomplished by the quench and recirculation spray systems and passively by transport of particulates to the spray droplets and heat sink surfaces as a result of steam condensation on these surfaces.

Aerosol deposition rates in the sprayed and unsprayed region are obtained from DIN# 10 and envelope BVPS 1 & 2.

Per DIN# 10, the elemental iodine removal rate in the sprayed region is limited to 4.1075 hr^{-1} (due to plateout) until sprays are initiated. After sprays are initiated the elemental iodine is conservatively assumed to be removed from the sprayed region at the same rate as the aerosols except the spray deposition for elemental iodine is limited to 20 hr^{-1}. The 0.5358 hr^{-1} plateout is valid during the spray period. Therefore, the maximum rate credited for elemental iodine removal in the sprayed region at any time after LOCA is 20 hr^{-1} + 0.5358 hr^{-1} = 20.5358 hr^{-1}. No credit for elemental Iodine removal is taken in the unsprayed region as the rate is insignificant.

Radiological Transport Model

As noted earlier, the fission products released from the fuel are assumed to mix instantaneously and homogeneously throughout the free air volume of the primary containment as it is released from the core. In accordance with RG 1.183 (DIN# 2), two fuel release phases are considered for DBA analyses: (a) the gap release, which begins 30 seconds after the LOCA and continues for 30 minutes and (b) the early In-Vessel release phase which begins 30 minutes into the accident and continues for 1.3 hours.

Per DIN# 2, the core inventory release fractions, by radionuclide groups, for the gap and early in-vessel damage are as follows:

TABLE 1
LOCA Core Activity Release Fraction Information (DIN# 1, TBL 1, items 4, 5 and 6)

Group	Gap Release phase	Early In-Vessel Release phase	Nuclides
Noble Gas	0.05*	0.95*	Xe, Kr, **Rn, H**
Halogens	0.05	0.35	I, Br
Alkali Metals	0.05	0.25	Cs, Rb
Tellurium Group		0.05	Te, Sb, Se, **Sn, In, Ge, Ga, Cd, As, Ag**
Barium, Strontium		0.02	Ba, Sr, **Ra**
Noble Metals		0.0025	Ru, Rh, Pd, Mo, Tc, Co
Cerium Group		0.0005	Ce, Pu, Np, **Th, U, Pa, Cf, Ac**
Lanthanides		0.0002	La, Zr, Nd, Eu, Nb, Pm, Pr, Sm, Y, Cm, Am, **Gd, Ho, Tb, Dy**

** Note that the core release fractions to the free volume of containment listed above in Table 1 apply to the core release fractions to the sump except that noble gases are excluded, i.e., noble gas fractions are zero per RG 1.183 R0 and DIN# 1, TBL 1 items 7 and 8.*

Note that the groupings above were expanded from that in RG 1.183 to address isotopes in the core with similar characteristics; the added isotopes are in bold font.

Since the BVPS long term sump pH is controlled to a value of 7 and greater (DIN# 1), the chemical form of the radioiodine released from the fuel is assumed to be 95% cesium iodide (CsI), 4.85% elemental iodine, and 0.15% organic iodine. With the exception of noble gases, elemental and organic iodine, all fission products released are assumed to be in particulate form. (DIN# 2)

In accordance with DIN# 2, the activity released from the core during each release phase is modeled as increasing in a linear fashion over the duration of the phase. The release into the containment is assumed to terminate at the end of the early in-vessel phase, approximately 1.8 hours after the LOCA.

The removal of particulate and elemental iodine in the containment is based on DIN# 10. In the “effectively” sprayed region (minimum value of 60% of containment, U2 value) the activity transport model takes credit for aerosol removal due to steam condensation and via containment recirculation and quench sprays based on spray flowrates associated with minimum ESF. It considers mixing between the effectively sprayed and unsprayed regions of the containment, reduction in airborne radioactivity in the containment by concentration dependent aerosol removal lambdas, and isotopic in-growth due to decay.

Since, using SRP 6.5.2 (DIN# 12) methodology, the calculated elemental iodine spray removal lambdas are greater than 20 hr^{-1}, it is conservatively assumed that the sprays remove the elemental iodine at the same rate as the aerosols when the aerosol removal rates are less than 20 hr^{-1}, and at 20 hr^{-1} when the aerosol removal rate is greater than 20 hr^{-1}. In the effectively sprayed region, a plateout coefficient of 0.5358 hr^{-1} is calculated for BVPS. This allows a maximum elemental iodine removal rate in the effectively sprayed region, during the spray period, of 20.5358 hr^{-1}.

In the unsprayed region, the aerosol removal lambdas reflect gravitational settling. Since the elemental iodine removal lambdas are negligible in the unsprayed region of containment the dose model conservatively neglects elemental iodine removal in the unsprayed region.

Per DIN# 2, since the spray removal coefficients are based on calculated time dependent airborne aerosol mass, there is no restriction on the DF for particulate iodine. The maximum DF for elemental iodine is based on SRP 6.5.2 and is limited to a DF of 200. For BVPS, this DF value is reached for the elemental iodine at approximately 6.31 hours after the accident.

Mixing between the “effectively” sprayed and unsprayed regions of the containment is assumed for the duration of the accident. Though higher mixing rates are expected, the dose analysis conservatively assumes a mixing rate of 2 unsprayed volumes per hour in accordance with the default value noted in SRP 6.5.2.

BVPS design includes chemical addition to the post-LOCA sump water via use of NaTB baskets to ensure a long term sump pH equal to or greater than 7.0. Long-term production of acids (HCl and HNO3), by irradiation is included in determining the long term sump pH. Long-term retention of iodine in sump liquids is strongly dependent on the sump pH. The dose analysis does not address iodine re-evolution as a sump pH of ≥ 7 is achieved within 16 hours after the LOCA and maintained for the duration of the accident. (DIN# 1) The definition of long term as it relates to sump pH and iodine re-evolution post LOCA is addressed in NUREG/CR 5732 (DIN# 13).

Radioactivity is assumed to leak from both the sprayed and unsprayed region to the environment at the containment technical specification leak rate for the first-day, and half that leakage rate for the remaining duration of the accident (i.e., 29 days). No credit is taken for processing the containment leakage via the safety related ventilation exhaust and filtration system that services the areas contiguous to containment; i.e.; the Supplementary Leak Collection System (SLCRS) filters. To ensure bounding values, the atmospheric dispersion factors utilized for the containment release path reflects the worst value between the containment wall release point and the SLCRS release point for each time period. (see Figure 3 for activity transport model diagram).

ESF and RWST Back-Leakage

Per DIN# 2, with the exception of noble gases, all the fission products released from the core in the gap and early in-vessel release phases are assumed to be instantaneously and homogeneously mixed in the primary containment sump water at the time of release from the fuel. Per DIN# 1, the minimum sump mass increases to a steady state minimum value of 2,683,700 lbm, two hours after the LOCA. In accordance with DIN# 1, three sump volume values can be utilized in the transport model. Up to the first half hour after the LOCA, the sump volume is about 42% of the final value. For the next one and a half hours the sump volume is about 56% of the final value. For the remainder of the accident the steady state minimum sump volume can be utilized. To minimize model changes (since the changes are negligible), and similar to Revision 2, Revision 3 conservatively continues to use the Revision 1 values for sump volume (i.e., a steady state minimum sump volume of 2,680,000 lbm two hours after the LOCA, with a sump volume of 40% of the final value during the first half hour, and 56% of the final value during the next one and a half hours) - see Assumption 4 for detail.

In accordance with Regulatory Guide 1.183, with the exception of halogens, all radioactive materials in the recirculating liquid are assumed to be retained in the liquid phase. The subsequent environmental radioactivity release is discussed below:

<u>ESF leakage</u>:

Equipment carrying sump fluids and located outside containment are postulated to leak at twice the surveillance limit of 5700 cc/hr (BVPS-1 value, BVPS-2 value is 2134 cc/hr) into the Auxiliary Building. Per DIN# 1, ESF leakage is expected to start at initiation of the recirculation mode which, at BVPS is conservatively assumed to be at 1200 seconds (bounding for both units). Note that due to the long term nature of this release, minor variations in the start time of this release will not significantly impact the resultant doses. Per DIN# 1, the peak sump water temperature after 20 minutes is 250°F. As noted in Regulatory Guide 1.183, the fraction of total iodine in the liquid that becomes airborne should be assumed to be equal to the fraction of the leakage that flashes to vapor. The flash fraction, (using Regulatory Guide 1.183 methodology) associated with this temperature is calculated to be less than 10%. Consequently, in accordance with Regulatory Guide 1.183, 10% of the halogens associated with this leakage is assumed to become airborne and are exhausted (without mixing and without holdup) to the environment via the SLCRS vent located on top of Containment. In accordance with DIN# 2, the chemical form of the iodine released from the sump water is 97% elemental and 3% organic. No credit is taken for the SLCRS filters. See Figure 4 for activity transport model diagram.

<u>RWST Back-leakage</u>:

Sump water back-leakage into the RWST (located in the Yard) is postulated to occur at twice the surveillance limit of 1 gpm, to be released directly to the environment via the RWST vent (DIN# 1). As discussed in DIN# 17, a significant portion of the iodine associated with the RWST back-leakage is retained within the tank due to equilibrium iodine distribution balance between the RWST gas and liquid phases (i.e., a time dependent iodine partition coefficient).

Per DIN# 1, for BVPS-1, sump water begins to leak into the RWST at 1768 seconds after the LOCA. At 3039 seconds, the iodine begins to flow out of the RWST and disperses to the environment.

The RWST iodine and noble gas release rate coefficients provided in DIN# 17 are bounding for Units 1 and 2. As discussed in the Revision 0 analysis, the iodine and noble gas releases from the RWST, were conservatively assumed to be *twice the RWST iodine release fraction vs time developed in Revision 3 of DIN# 17. These conservative iodine release fractions from DIN# 17, Revision 3 were* *considered the "design" release fractions*, and subsequent revisions of the dose consequence analyses herein have continued to use these "design" values since they are greater than the more rigorously calculated Unit 1 and 2 "bounding" release fractions developed in the subsequent revisions of DIN# 17. Appendix "C" of Revision 2 of this analysis demonstrated that retaining the "design" RWST environmental release fractions remains conservative when compared to dose consequences estimated using the Unit 1 and 2 "bounding" release fractions calculated in Revision 6, Addendum 1 of DIN# 17 (reflects BVPS-2 RSGs/RRVCH taking into consideration impact of NSAL 11-5 on BVPS-2).

It is noted that the Unit 1 data used in DIN# 17, Revision 6, Addendum 1 *but did not* address NSAL-11-5, although the Unit 2 data (was based on the RSGs) and included the methodology correction discussed in NSAL-11-5. DIN# 17, Revision 6, Addendum 2 addressed the impact of the increased BVPS-1 LOCA M&E releases due to NSAL-11-5 and the potential for continued use of Original Steam Generators at BVPS-2. It concluded that the associated impact on the "bounding" release fractions calculated in DIN# 17, Revision 6, Addendum 1, will not impact the "design" RWST noble gas and iodine release rates used in dose consequence analyses.

Consequently, this analysis will continue to use twice the RWST iodine and gaseous release fractions vs time developed in Revision 3 of DIN# 17, i.e., the "design" values. Thus, the release fractions utilized herein remain the same as used in Revision 1.

In accordance with DIN# 2, environmental airborne iodine activity resulting from RWST back-leakage is assumed to be 97% elemental and 3% organic. In the dose model, this phenomenon is modeled using a series of effective environmental release rate lambdas from the RWST vent. These release rates are provided in Table 3. See Figure 5 for the activity transport model diagram.

Control Room Design / Operation / Transport Model

<u>Control Room Design / Operation</u>

Beaver Valley Power Station is served by a single control room that supports both Units. The joint control room is serviced by two ventilation intakes, one assigned to BVPS-1 and the other to BVPS-2. These air intakes are utilized for both the normal as well as the accident mode.

During normal plant operation, both ventilation intakes are operable providing a total supply of 1250 cfm of unfiltered outside air makeup which includes all potential inleakage and uncertainties (Note: this value is the total for both U1 and U2 intakes with margin; it includes the intake flow and all unfiltered inleakage (including that associated with ingress / egress and all potential inleakage) with uncertainties). (DIN# 48)

The containment high-high pressure (CIB) signals from either unit initiate the BVPS-2 control room emergency ventilation system. In the event one of the BVPS-2 trains is out of service, and the second train fails to start, operator action will be utilized to initiate the BVPS-1 control room emergency ventilation system.

The CR emergency pressurization intake filter has an efficiency of 99% for particulates, and 98% for elemental and organic iodine (DIN# 48). Filtration of the Control Room ventilation recirculation flows during all modes of operation by particulate air filters (intended for dust removal) in the CRVS recirculation air-conditioning system, is not credited.

The control room emergency filtered ventilation intake flow varies between 800 to 1000 cfm, which includes allowance for measurement uncertainties (DIN# 48). The control room unfiltered inleakage during the emergency pressurization mode is conservatively assumed to be 165 cfm (includes 10 cfm unfiltered inleakage due to ingress / egress) to reflect the results of tracer gas testing in the pressurized mode, and to also accommodate margin for potential future deterioration.

Control Room Transport Model

Since the BVPS control rooms (CR) are contained in a single control room envelope, they are modeled as a single region. Isotopic concentrations in areas outside the control room envelope are assumed to be comparable to the isotopic concentrations at the control room intake locations. To support development of bounding control room doses, the most limiting χ/Q associated with the release point / receptor for an event in either unit, is utilized.

To provide operational margin, and in accordance with DIN# 48, the analysis herein assumes that during normal plant operation, the BVPS-1 & BVPS-2 unfiltered intake plus inleakage is a maximum of 1250 cfm (total for both Units). This maximum normal operation unfiltered inflow to the CR is an analytical upper bound value that is intended to include a) the CR intake flow rate (including test measurements uncertainties), b) all unfiltered inleakage and c) a 10 cfm allowance for ingress / egress. The above value bounds the test results of BVPS 1/2 Procedure 3BVT 1.44.05 via Order 200699902. See Section 3, Assumption 8 for additional details.

The control room post-accident ventilation model utilized in the dose analysis corresponds to an assumed "single intake" which utilizes the worst case atmospheric dispersion factor (χ/Q) from release points associated with accidents at either unit, to the limiting control room intake. The atmospheric dispersion factors for the various combinations of release point / receptor applicable for a LOCA, at BVPS-1 and BVPS-2, are provided in Table 8.

Based on DIN# 48, the atmospheric dispersion factors associated with control room inleakage are assumed to be the same as those utilized for the control room intake. (Also, see Assumption 9)

A LOCA is expected to initiate a containment high-high pressure signal (i.e., CIB). Current plant design will automatically isolate the control room and initiate control room pressurization via the BVPS-2 control room emergency ventilation system (CREVS) upon receipt of a CIB signal from either unit. The BVPS-2 CREVS is safety-related, fully automated, and fully compliant with all relevant regulatory requirements. In the unlikely event that neither of the BVPS-2 trains can be put in service, operator action may be utilized to initiate the BVPS-1 control room filtered emergency pressurization system. This unlikely scenario is utilized in accident analysis to allow flexibility in taking out a BVPS-2 CREVS train for maintenance.

Taking into account Loss of Offsite Power (LOOP), the maximum estimated delay in attaining control room isolation after receipt of a CIB signal is 77 seconds which accounts for delays due to diesel start, sequencing and damper movement/re-alignment.

CREVS Train A fan is expected to get a start signal at T=90 secs. Considering the CREVS time delay relay setting for Train B fan start, plus fan acceleration time, the total auto start delay is estimated to be 137 sec. (DIN# 1, Item 50) However, per DIN# 1, since the analysis is intended to be bounding for an event at either unit, no credit is taken for automatic initiation of the BVPS-2 control room emergency ventilation system, rather it is assumed that operator action will be necessary to initiate the control room emergency filtered pressurization system, and that a pressurized control room will be available within T=30 minutes.

Unfiltered inleakage into the control room post-LOCA while it remains isolated (and in a recirculation mode), during the time period t=77 secs to t=30 mins, is 450 cfm. (DIN# 48)

For reasons outlined below, the dose model uses the minimum filtered intake flow rate of 800 cfm in the pressurized mode as it is considered to be more limiting. Although the intake of radioisotopes is higher at the larger intake rate of 1000 cfm, it is small compared to the radioactivity entering the control room, in both cases, due to unfiltered inleakage. Consequently, the depletion of airborne activity in the control room via the higher exhaust rate of 1000 cfm make the lower intake rate of 800 cfm more limiting from a dose consequence perspective. This argument holds true because the CEDE from inhalation is far more limiting than the DDE from immersion which is principally from noble gases.

Control Room Dose due to Direct Shine from the External Cloud and Contained Sources

The dose contribution in the control room due to direct shine from the external cloud and from all contained sources (for both bulk shielding and through penetrations), was originally addressed in Appendix A. The external cloud contribution includes containment leakage, ESF leakage and RWST back-leakage. The contained sources include direct shine from the:

- Containment Structure (skyshine dose is insignificant due to associated soft photons, and the 2 ft concrete roof/walls of the control room),
- Cable spreading room airborne source below the Unit 2 portion of the combined control room through floor penetrations,
- Cable tray mezzanine airborne source below the Unit 1 portion of the combined control room through floor penetrations,
- Control room emergency ventilation intake filters, and
- Radiation source inside the RWST due to sump water back leakage.

As part of the Revision 2 update, the control room operator dose from the external cloud and contained sources previously developed in Appendix A, was adjusted for BVPS-2 RSGs/NSAL 11-5 in Appendix C.

In Revision 3, DIN# 48 updates some of the design input parameter values that could affect the direct shine dose from the CRVS filters. Specifically:

- DIN# 48 reduces the maximum filter intake rate from 1030 cfm to 1000 cfm.
- DIN# 48 updates the dimensions of the BVPS-2 emergency HEPA filters from 27-1/2" x 25-3/4" x 7-3/4" are 24" x 24" x 11.5" cm.
- DIN# 48 provides information regarding the presence of wall penetrations between the BVPS-2 CR filter cubicle and the CRE.

Revision 3, Appendix D addresses the dose impact due to *scatter through wall penetrations* between the BVPS-2 CR filter cubicle and the CRE. Appendix D also assesses the effect of filtration of the Control Room ventilation recirculation flows during all modes of operation by particulate air filters (intended for dust removal) in the CRVS recirculation air-conditioning system, and *demonstrates that the current model that does not address the presence of particulate air filters in the CRVS recirculation air-conditioning system, is bounding*. (i.e., confirms that the associated reduction in the inhalation/submersion dose compensates the for the added dose due to direct shine from the activity accumulated on the air-conditioning filters)

The maximum control room operator dose following a LOCA at either unit is presented in Section 7.

Emergency Response Facility Emergency Ventilation Design and Operation

In accordance with DIN# 49, BVPS is served by a single Emergency Response Facility (ERF) that supports both units. The ERF houses the Technical Support Center. During normal plant operation, the ERF ventilation intake flow of 3800 cfm (+/-10% for uncertainty) is processed through a HEPA filter. Unfiltered inleakage during normal operation is estimated at 2090 cfm.

Following a LOCA, the ERF is manually isolated and switched to an emergency filtered recirculation mode between T=30 mins to T=60 mins. The ERF emergency ventilation recirculation flowrate could be operating at its maximum value of 7200 cfm (+/-10%). The ERF emergency mode processes the ventilation flow through charcoal and HEPA filters. The unfiltered inleakage into the ERF during the emergency mode is estimated to be 910 cfm which includes 10 cfm for ingress and egress. (DIN# 49)

However, for the purposes of demonstrating habitability, no credit is taken for the ERF structure/normal or emergency ventilation systems when determining the inhalation or submersion dose. Because the facility is located a sufficient distance away from the BVPS-1 and 2 Containment Buildings, the atmospheric dispersion characteristics of potential activity releases following a LOCA are highly favorable, and therefore, no ventilation design features are required to ensure habitability. The habitability analysis of the ERF following a LOCA is performed by assuming that there is no ERF structure (i.e., the ERF is modeled as a point in the environment). Breathing rates and occupancy factors utilized are similar to that used for the control room.

Although no structure is accounted for the inhalation and submersion doses, direct shine from the ERF ventilation filters is calculated since their presence poses a risk from direct shine to personnel in the ERF. A bounding approach is utilized with respect to estimating the direct shine dose from the ERF intake and recirculation ventilation filters; specifically, the filters are assumed to be 100% or 0% efficient, as deemed conservative, when addressing the direct shine dose. For example, to maximize the intake filter shine when calculating the direct shine dose, a 100% efficiency is assumed. However, to maximize the direct shine dose from the recirculation filter, it is assumed that the intake filters have 0% efficiency. (See Appendix E for detail)

The ERF /TSC dose consequence analysis develops the worst-case 30-day integrated dose estimates in a) the ERF (i.e., Room 143, corridor adjacent to the recirculation filter cubicles), and b) the TSC (Room 119). Included in this estimate is a dose contribution to ERF/TSC personnel due to daily passage through Room 112 (Service Dock) when accessing / exiting the ERF/TSC (expected occupation: 10 minutes per day for the 30-day duration of the accident)

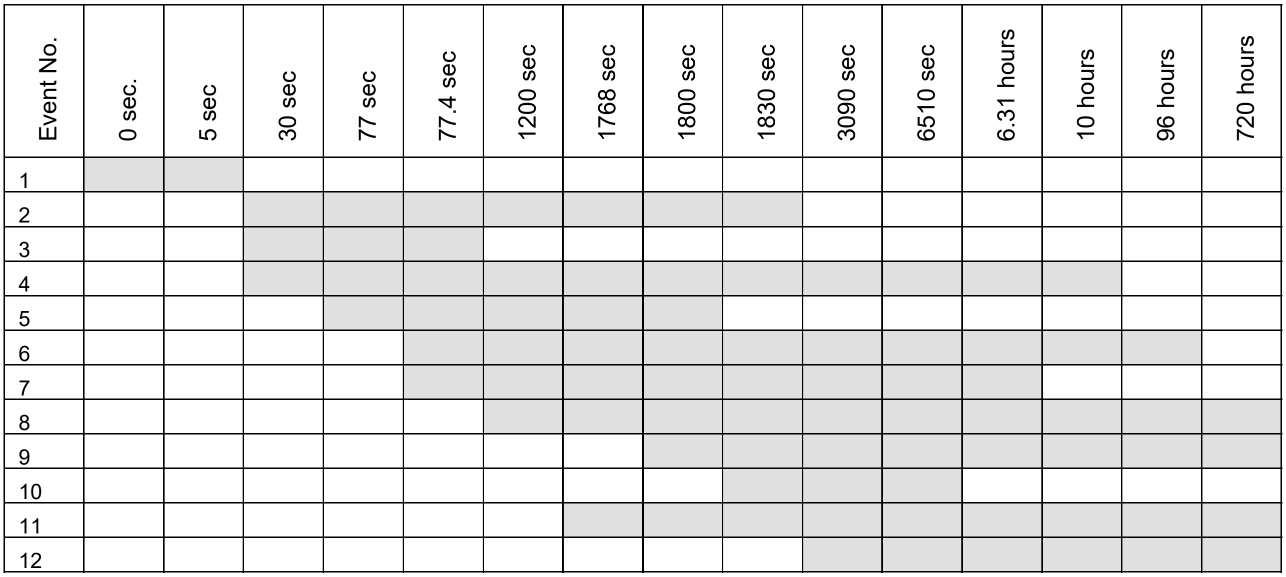
All DDE contribution to personnel in the ERF from contained sources is performed in Appendix E.

Thirty (30) Day BVPS Design Basis Accident (Bounding Large Break LOCA) Timeline

Provided below is a timeline of the events following the BVPS design basis LOCA. The events are summarized below in the Timeline chart presented in Figure 1.

FIGURE 1

Histogram of BVPS LOCA Events



<u>Events Following the BVPS U1 and U2 Bounding LOCA</u>

1. The radionuclide inventory in the RCS liquid, assumed to be at Technical specification levels, is released to the containment at T = 0 hours. It is conservatively assumed that 100% of the released volatiles (i.e., the noble gases and the halogens), are instantaneously and homogeneously mixed in the containment atmosphere. During the next 5 seconds, 0.01% of the containment atmosphere is released to the environment. (see pg 43 for detail)
2. The core “gap” activity release period begins and continues over the next 30 minutes.
3. Condensation is credited until sprays begin.
4. Settling is credited in unsprayed region until 10 hours after the accident.
5. The control room isolates and remains isolated for the next 1723 seconds.
6. Sprays are credited for (Quench then Recirculation sprays) airborne particulate deposition until 96 hours after the accident.
7. Sprays are then credited for airborne elemental activity deposition until a DF of 200 is reached 6.31 hours after the accident.
8. ESF systems that circulate the sump water begin to leak into the Aux. Bldg.
9. The control room emergency ventilation is in full operation as a result of operator action.
10. The “Early-in-Vessel” release period begins and continues for 1.3 hours.
11. Back-flow leakage from the sump begins to enter the RWST.
12. The RWST begins to vent activity to environment.

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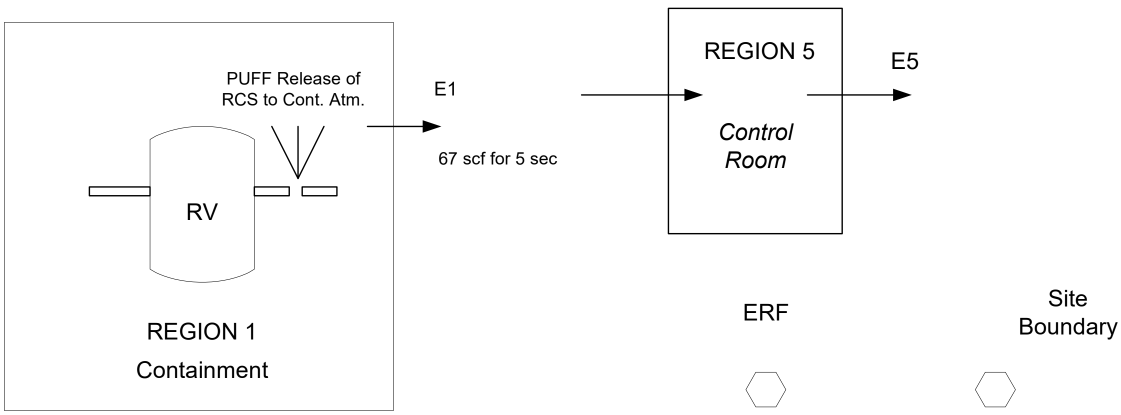
FIGURE 2

LOCA: Vacuum Relief Line Release



<u>Notes</u>

See "Computation" Section for details

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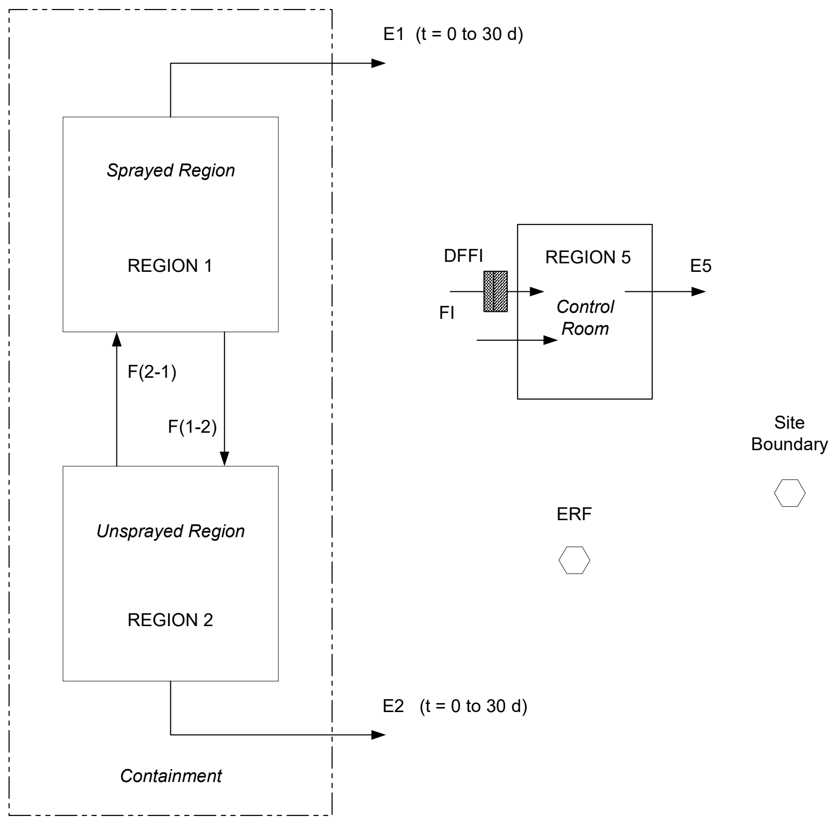
FIGURE 3

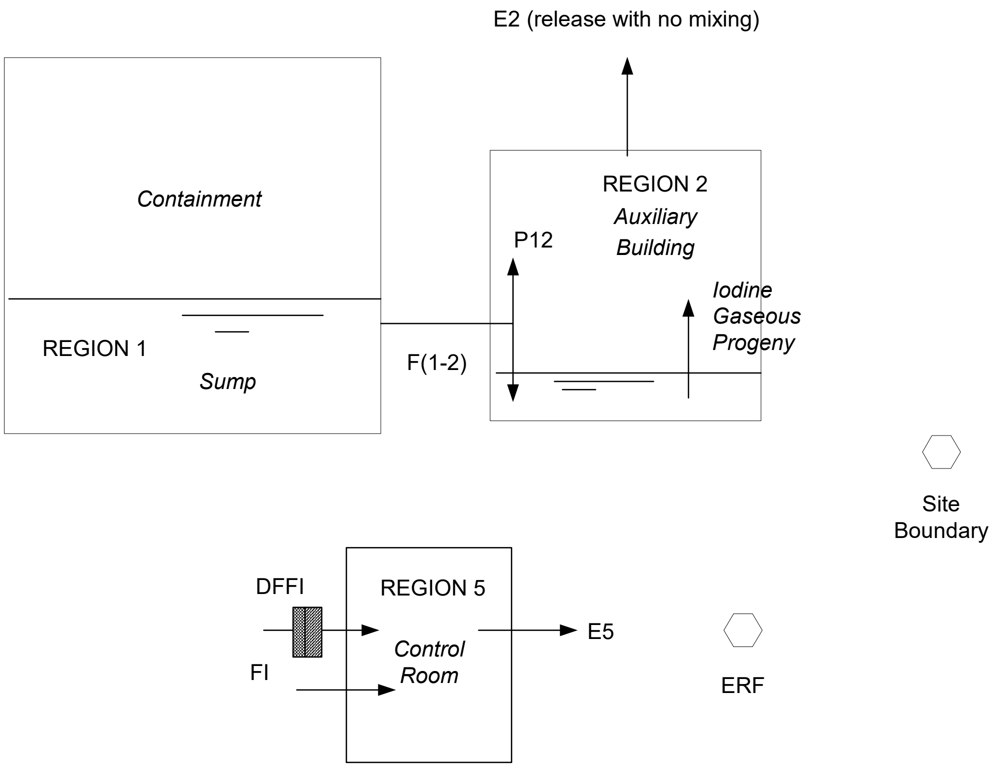
LOCA: Containment Tech Spec Leakage



Notes

See “Computation” Section for details

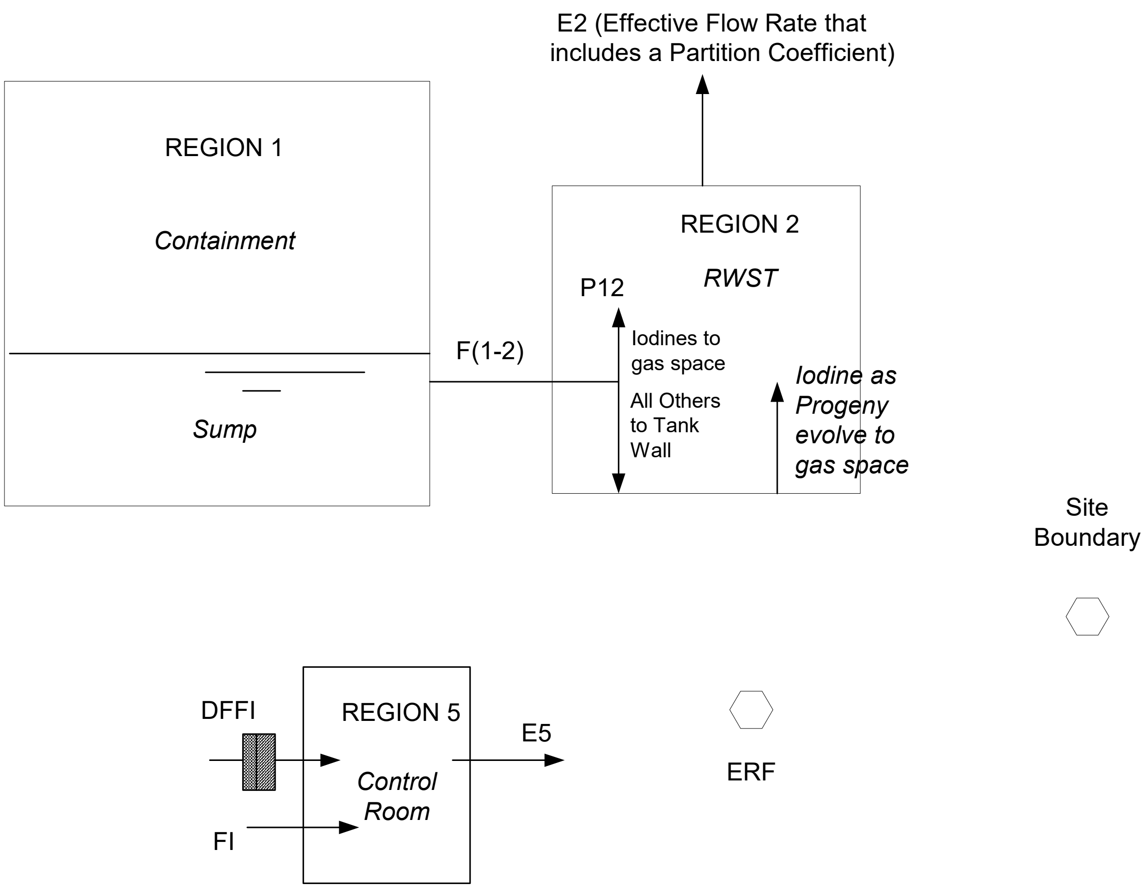
FIGURE 4
LOCA: ESF Leakage



Notes

See “Computation” Section for details

FIGURE 5
LOCA: RWST Back Leakage



Notes

See "Computation" Section for details

2.0 DESIGN INPUTS

All input parameters values associated with BVPS design used in this analysis including identification of the source documents from which the parameter values were obtained, have been verified / approved for use by FENOC and provided to WECTEC via DIN# 1, 48 and 49 (included herein as Attachments 1, 4 and 5). As noted in DIN# 1, 48 and 49 the BVPS specific parameter values provided below reflect the bounding value applicable to Unit 1 and Unit 2 (unless stated otherwise), that is appropriate for use in design basis accident analyses. Comments / explanations associated with the parameter values presented below are provided in DIN# 1, 48 and 49 under the "Comment" column, and provide additional information that may be useful to the user.

General Comment (Per DIN# 1, 48 & 49)

The equipment / parameter values presented below as approved design input reflect safety related components that can be credited in design bases dose consequence analyses; i.e., the components have the appropriate redundancy, environmental qualification, pedigree, seismic support etc. applicable to safety related equipment, and the parameter values reflect single failure criteria.

No.	Item	Value	DIN#
1.	Core Power Level	2918 MWth (1.006 of the rated core power level)	1 (TBL 1 #1)
2.	Equilibrium Core Inventory	Tabulated in Attachment 2	9, 1 (TBL 1 #2)
3.	Reactor Coolant Activity	Tabulated in Attachment 3	18, 1 (TBL 1 #3)
4.	Elements in each group and Release Fractions Released from the Core to Containment Atm Following LOCA	As noted in Reference	1 (TBL 1 #4,#5,#6), 2
5.	Core Inventory release timing for gap phase	Onset: 30 sec Duration: 30 min.	1 (TBL 1 #9), 2
6.	Core Inventory release timing for early-in-vessel phase	Onset: 30.5 min Duration: 1.3 hours	1 (TBL 1,#10), 2
7.	Iodine form of activity released to containment atmosphere from melted and failed fuel	95% cesium iodide 4.85% elemental 0.15% organic	1 (TBL 1,#11), 2
8.	Iodine form of activity released from sump water or RCS	97% elemental 3% organic	1 (TBL 1, #12&13), 2
9.	Minimum of Unit 1 or Unit 2 Containment Free Volume (ft^3)	1.750E6 ft^3	1 (TBL 1 #16), 47
10.	Spray Initiation Time	77.4 (U2)	1 (TBL 1 #18), 47

No.	Item	Value	DIN#
		43.9 (U1)	
11.	Containment Spray Coverage	60% (U2)	1 (TBL 1 #19), 11b, 47
12.	Spray Cutoff Time	96 hours	10, 1 (TBL 1 #20)
13.	Containment Mixing Rate	2 unsprayed volumes per hour	1 (TBL 1 #21), 2
14.	Long Term Sump water pH	pH>7	1 (TBL 1 #24), 10
15.	Aerosol deposition rate in the sprayed region of containment	See Table 2	10, 1 (TBL 1 #22)
16.	Aerosol deposition rate in the unsprayed region of containment	See Table 2	10, 1 (TBL 1 #23)
17.	Elemental Iodine by natural deposition in the sprayed region	0.5358 hr^{-1}	10, 1 (TBL 1 #22)
18.	Max DF for elemental iodine	200	1 (TBL 1 #25), 2
19.	Max DF for Aerosols	No Restriction	1 (TBL 1 #25), 2
20.	Containment Isolation Time	<5 sec	1 (TBL 1 #26)
21.	Unfiltered Leakage Rate from Containment	0.1% day^{-1} (0-1day) 0.05% day^{-1} (1-30 day)	1 (TBL 1 #27)
22.	RCS liquid flash fraction	1.0	1 (TBL 1 #29)
23.	Max Pressure Relief Line (bounding) Release Rate following a LOCA	2200 scfm (U1)	19, 1 (TBL 1 #30)
24.	Duration of Pressure Relief Line Release	< 5 seconds	1 (TBL 1 #31)
25.	SLCRS particulate and carbon filter efficiency	Not Credited in LOCA Assessment (0%)	TBL 1 #17,#32,#40)
26.	ESF leak duration	1200 sec to 30 days	1 (TBL 1 #35)
27.	ESF leak rate	5700 cc/hr (U1) (analysis to use 2x value)	1 (TBL 1 #36)

No.	Item	Value	DIN#
28.	Minimum Volume of Sump Water	20 min to 30 min 19,253 ft^3 (1.1379E6 lbm) 30 min-2hr 24,909 ft^3 (1.5133E6 lbm) 2hr –30 days 43,824 ft^3 (2.6837E6 lbm) See Assumption 4. The Revision 1 values will continue to be used in lieu of those listed above since the changes are negligible.	1 (TBL 1# 37), 47
29.	Peak sump water temperature after recirculation initiates	250 °F max and decreases with time	1 (TBL 1 #38), 10
30.	Fraction of ESF iodine activity leakage that flashes when the liquid temperature is less than 212°F or if the calculated flash fraction is less than 10%.	10%	1 (TBL 1 #39), 2
31.	Earliest Initiation of sump back leakage into RWST after LOCA	1768 seconds (U1)	1 (TBL 1 #43), 47
32.	Sump water back flow into RWST	1 gpm (analysis to use 2x value)	1 (TBL 1 #44)
33.	Earliest Time when RWST back-leakage is released to the environment	3039 seconds (U1)	1 (TBL 1 #45), 47
34.	Iodine and gaseous release rates from RWST vent	See Appendix Table C4	1 (TBL 1 #46),17,47
35.	U1 and U2 Shared Control Room Pressurization Envelope Volume	1.73E5 ft^3	48 (TBL E #1)
36.	Normal CR Operation Unfiltered Flow	1250 cfm (includes 10cfm allowance for ingress/egress and all uncertainties)	48 (TBL E #3)
37.	Time after LOCA when CR is isolated	77 seconds due to CIB signal	1 (TBL 1 #49)

No.	Item	Value	DIN#
38.	CR Infiltration during Isolation Mode	450 cfm (includes 10cfm allowance for ingress/egress and all uncertainties)	48 (TBL E #6)
39.	Time after LOCA when CR Emergency Ventilation is in full operation by means of operator action	30 minutes (includes all uncertainties)	1 (TBL 1 #50)
40.	CR Emergency Ventilation Flow	Range: 800 to 1000 cfm (includes all uncertainties)	48 (TBL E #8)
41.	CR-Intake filter iodine removal efficiency	99% for Aerosols 98% for elemental/organic Iodine	48 (TBL E #10)
42.	CR In-leakage during Emergency Ventilation Mode	165 scfm (total)	48 (TBL E #6)
43.	Control Room Bounding Dispersion Factors (s/m^3) from wall containment leakage (U1)	<u>Period</u> <u>χ/Q</u> 0-2 hr 7.48E-04 2-8 hr 5.77E-04 8-24 hr 2.53E-04 24-96 hr 2.00E-04 96-720 hr 1.78E-04	20, 1 (TBL 1 #51)
44.	Control Room Bounding Dispersion Factors (s/m^3) from Containment Top SLCRS vent (U1)	<u>Period</u> <u>χ/Q</u> 0-2 hr 8.16E-04 2-8 hr 5.78E-04 8-24 hr 2.27E-04 24-96 hr 1.71E-04 96-720 hr 1.47E-04	20, 1 (TBL 1 #51)
45.	Control Room Bounding Dispersion Factors (s/m^3) from RWST Vent (U1)	<u>Period</u> <u>χ/Q</u> 0-2 hr 7.34E-04 2-8 hr 6.17E-04	20, 1 (TBL 1 #51)

No.	Item	Value	DIN#
		8-24 hr 2.54E-04 24-96 hr 1.96E-04 96-720 hr 1.57E-04	
46.	Control Room and ERF Breathing Rate (m^3/s)	3.5E-4 (0-30 days)	48 (TBL E #20), 49, 2
47.	Control Room and ERF Occupancy Factors	1 (0-1 day) 0.6 (1-4 day) 0.4 (4-30 day)	48 (TBL E #21), 49, 2
48.	Site Boundary Dispersion Factors (s/m^3)	EAB 0-2 hr 1.25E-03 (U2) LPZ 0-8 hr 6.04E-05 8-24 hr 4.33E-05 1-4 day 2.10E-05 4-30 day 7.44E-06	48 (TBL E #39)
49.	Site Boundary Breathing Rates (m^3/s)	0-8 hr 3.5E-4 8-24 hr 1.8E-4 1-30 day 2.3E-4	48 (TBL E #40), 2
50.	ERF Bounding Dispersion Factors (s/m^3) from containment wall leakage (U2)	Period χ/Q 0-2 hr 6.72E-05 2-8 hr 5.69E-05 8-24 hr 2.65E-05 24-96 hr 2.13E-05 96-720 hr 1.89E-05	21, 49
51.	ERF Bounding Dispersion Factors (s/m^3) from Containment Top, SLCRS vent (U2)	Period χ/Q 0-2 hr 7.22E-05 2-8 hr 6.43E-05	21, 49

No.	Item	Value		DIN#
		8-24 hr	2.96E-05	
		24-96 hr	2.48E-05	
		96-720 hr	2.15E-05	
52.	ERF Bounding Dispersion Factors (s/m^3) from RWST vent (U2)	Period	χ/Q	21, 49
		0-2 hr	9.42E-05	
		2-8 hr	8.37E-05	
		8-24 hr	3.81E-05	
		24-96 hr	2.97E-05	
		96-720 hr	2.58E-05	

** Inputs regarding direct shine into the Control Room are addressed in Appendix A, C, and D. Inputs associated with the presence of dust filters in the CR recirculation ventilation system is addressed in Appendix D.*

*** Inputs regarding direct shine into the ERF/TSC are addressed in Appendix B, C, and E*

3.0 ASSUMPTIONS

Assumptions utilized in this assessment have been approved by FENOC and were provided to WECTEC via DIN# 1, 48 and 49. None of these assumptions need further verification. Discussions regarding the bases of these assumptions are also included in DIN# 1, 48 and 49. Summarized below are some of the salient assumptions, including those made by the author when developing the transport models:

1. Assumptions used in the LOCA dose consequence transport model that are listed as Design Input No. 4, 5, 6, 7, 8, 13, 18, 19, 30, 46, 47 and 49 are based on the guidance provided in RG 1.183, R0

2. The elemental iodine and aerosol spray lambda is assumed to conservatively start at 77.4 seconds (maximum delay in initiation of quench spray, based on Unit 1). The maximum elemental removal constant by sprays is limited to 20 hr^{-1}. When sprays are initiated it is conservatively assumed that the elemental removal rate by sprays is equal to the rate of removal by aerosols, since the spray removal rate calculated based on SRP 6.5.2 methodology is greater per DIN# 10 (limited to a maximum values of 20 hr^{-1}, as stated). The elemental iodine removal rate in the sprayed region is limited to 0.5358 hr^{-1} (due to plateout) until sprays are initiated. After sprays are initiated the elemental iodine is conservatively assumed to be removed from the sprayed region at the same rate as the aerosols except the spray deposition for elemental iodine is limited to 20 hr^{-1}. The 0.5358 hr^{-1} plateout is valid for spray periods. Therefore, the maximum rate credited for elemental iodine removal in the sprayed region at any time after LOCA is 20 hr^{-1} + 0.5358 hr^{-1} = 20.5358 hr^{-1}. No credit for elemental Iodine removal is taken in the unsprayed region as the rate is insignificant.

3. As discussed in the Revision 0 analysis, the iodine and noble gas releases from the RWST, were conservatively assumed to be twice the RWST iodine release fraction vs time developed in Revision 3 of DIN# 17. These conservative iodine release fractions from DIN# 17, Revision 3 were considered the “design” release fractions, and subsequent revisions of the dose consequence analyses herein have continued to use these “design” values since they are greater than the more rigorously calculated Unit 1 and 2 “bounding” release fractions developed in the subsequent revisions of DIN# 17. Appendix “C” of Revision 2 of this analysis demonstrated that retaining the “design” RWST environmental release fractions remains conservative when compared to dose consequences estimated using the Unit 1 and 2 “bounding” release fractions calculated in Revision 6, Addendum 1 of DIN# 17 (reflects BVPS-2 RSGs/RRVCH taking into consideration impact of NSAL 11-5 on BVPS-2).

   It is noted that the Unit 1 data used in DIN# 17, Revision 6, Addendum 1 *did not* address NSAL-11-5, although the Unit 2 data which was on the RSGs, included the methodology correction discussed in NSAL-11-5. DIN# 17, Revision 6, Addendum 2 addressed the impact of the increased BVPS-1 LOCA M&E releases due to NSAL-11-5 and the potential for continued use of Original Steam Generators at BVPS-2. It concluded that the associated slightly adverse impact on the “bounding” release fractions calculated in DIN# 17, Revision 6, Addendum 1, will not impact the “design” RWST noble gas and iodine release rates used in dose consequence analyses.

Consequently, this analysis will continue to use twice the RWST iodine and gaseous release fractions vs time developed in Revision 3 of DIN# 17, i.e., the “design” values. Thus, the release fractions utilized herein remain the same as that used in Revision 1.

4. Any relevant updates in plant layout / arrangement since issuance of Revision 1 would have been addressed as part of the BVPS modification process and provided to WECTEC as input via DIN# 48 and 49. Therefore it was concluded that the *current* revisions of the drawings referenced in Revision 1 for layout and arrangement information need not be reviewed. Thus the revision numbers of the drawings referenced in Revision 1 have not been updated herein to reflect the current revision.

5. The sump volume as a function of time is and will continue to be based on the values used in Revision 1, i.e.: 20 min → 30 min 19,111 ft^3 (1.13E6 lbm); 30 min → 2 hr 25,333 ft^3 (1.51E6 lbm); 2 hrs → 30 days 43,577 ft^3 (2.68E6 lbm)

   From DIN# 1, the more precise design input values are:

   20 min → 30 min 19,253 ft^3 (1.1379E6 lbm); 30 min → 2 hr 24,909 ft^3 (1.5133E6 lbm); 2 hrs → 30 days 43,824 ft^3 (2.6837E6 lbm)

   To demonstrate that the dose impact of the updated values of the sump water volume is negligible a comparison is made of the respective environmental release lambdas (where λ = Flow/Volume):

<u>Rev.1 ESF Release Lambdas</u>

		A	B	C	D	E	F
		Sump	Sump	Sump	Cold	Pseudo	Release
		Volume	Mass	Density	Volume	Flow	Lambda
	Period	(ft^3)	(lbm)	(lbm/ft^3)	(gallon)	(gpm)	(min^{-1})
1	20 m→30 m	19,111	1.13E6	59.128	135,413	0.11905	3.7069E-07
2	30 m →2 hr	25,333	1.51E6	59.606	180,950	0.08909	2.7740E-07
3	2 hr →720 hr	43,577	2.68E6	61.500	321,156	0.05020	1.5630E-07

Rev.2 & 3 ESF Release Lambdas

		A	B	C	D	E	F
		Sump	Sump	Sump	Cold	Pseudo	Release
		Volume	Mass	Density	Volume	Flow	Lambda
	Period	(ft^3)	(lbm)	(lbm/ft^3)	(gallon)	(gpm)	(min^{-1})
1	20 m→30 m	19,253	1.1379E6	59.102	136,360	0.11839	3.6811E-07
2	30 m →2 hr	24,909	1.5133E6	60.753	181,345	0.08902	2.7680E-07
3	2 hr →720 hr	43,824	2.6837E6	61.238	321,600	0.05020	1.5608E-07

Notes:

C= B/A
D = A x (7.481 gal/ft^3) x C x (0.016019 gm/cc per lbm/ft^3) / 1 gm/cc
E = 5700 cc/hr x 2 / (3785.17 cc/gal x 60 min/hr) x (D(x)/D(3))
F = E(x) / D(3)

As seen from the sump water mass versus time data presented above, the sump water mass increased by the following:

= 1.1379/1.13 = 0.7% for the period between 20 min -30 min after the LOCA
= 1.5133/1.51 = 0.22% for the period between 30 min -2 hours after the LOCA
= 2.6837/2.68 =0.14% for the period between 2 hours-30 days after the LOCA

Since the decrease in the release lambda is very small due to the small increase in water mass (between 0.22% to 0.7%), there is no need to revisit the doses due to ECCS leakage because the gain in the dose margin will be minimal. This demonstration is essentially the same as that presented in Appendix C Section C1.2 of Rev. 2.

6. BVPS is licensed for leak before break (LBB). RG 1.183, Section 3.3 allows the assumption of a delay in the post-LOCA fission product release sequence by 10 minutes for plants that are licensed to LBB. However, RG 1.183 has not defined this accident scenario sufficiently, and crediting this delay was deemed to be a licensing risk. Thus, current licensing basis does not credit LBB to delay the accident sequence.

7. This analysis does not address passive failure since RG 1.183 does not address a requirement to address passive failure. It is noted that BVPS original licensing basis also did not address passive failure, since per SRP 15.6.5, Appendix B, Section III, a dose assessment need not be performed for a plant that provides an ESF atmosphere filtration system in areas of potential leakage from a gross failure of passive components.

8. Per RG 1.183, Appendix A, Sections 5.4 and 5.5, the fraction of the iodine in ESF system leakage that becomes airborne is determined by the flash fraction. If the temperature of the fluid is less than 212°F or if the calculated flash fraction is less than 10%, the iodine in the leakage that is assumed to be airborne is assumed to be 10% of the total iodine activity in the leaked fluid.

9. To provide operational margin, and in accordance with DIN# 48, the analysis herein assumes that during normal plant operation, the BVPS-1 & BVPS-2 unfiltered intake plus inleakage is a maximum of 1250 cfm (total for both Units). This maximum normal operation unfiltered inflow to the CR is an analytical upper bound value that is intended to include a) the CR intake flow rate (including test measurements uncertainties), b) all unfiltered inleakage and c) a 10 cfm allowance for ingress / egress. The above value bounds the test results of BVPS 1/2 Procedure 3BVT 1.44.05 via Order 200699902.

10. As noted in DIN# 48, due to the following reasons, the CR air intake χ/Q values are assumed to be representative / applicable for unfiltered in-leakage (including CR ingress / egress).

    - Component tests performed as part of the 2017 CR Inleakage Tracer Gas Test indicated that a potential source of unfiltered inleakage into the Control Room are the normal operation intake dampers - which can be assigned the same χ/Q as the Control Room air intakes.

    - Regarding other potential locations of inleakage, a χ/Q value that reflects the center of the Control Room boundary at roof level as a receptor could be considered the average value applicable to Unfiltered Inleakage locations around the CRE, and thus representative for all CR unfiltered leakage locations.

    - Review of dwg 8700-RY-1C, R2 indicates that since the post-accident release points are a) closer to the CR intakes and b) the directions from the release points to the CR center and CR intakes are similar, use of χ/Q values associated with the CR intakes, for CR unfiltered inleakage, would be conservative.

    - The 10 cfm allowance for ingress/egress, is assigned to the door leading into the Control Room that is considered the primary point of access. This door (S35-71) is located at grade level on the side of the building facing the BVPS-1 Containment and between the CR air intakes. It is located close enough to the air intakes to allow the assumption that the χ/Q associated with this source of leakage would be reasonably similar to that associated with the air intakes.

11. Following a LOCA, CREVS Train A fan is expected to get a start signal at T=90 secs. Considering the CREVS time delay relay setting for Train B fan start, plus fan acceleration time, the total auto start delay is estimated to be 137 sec (DIN# 1, Item 50). However, per DIN# 1, since the analysis is intended to be bounding for an event at either unit, no credit is taken for automatic initiation of the BVPS-2 control room emergency ventilation system. Rather it is assumed that operator action will be necessary to initiate the control room emergency filtered pressurization system, and that a pressurized control room will be available within T=30 minutes. Thus the analysis herein assumes that the CR remains in an isolated / recirculation mode between t=77 secs and t=30 mins.

12. For the purposes of demonstrating habitability, no credit is taken for the ERF structure/normal or emergency ventilation systems. Because the facility is located a sufficient distance away from the BVPS-1 and 2 Containment Buildings, the atmospheric dispersion characteristics of potential activity releases following a LOCA are highly favorable, and therefore, no ventilation design features are required to ensure habitability. The habitability analysis of the ERF following a LOCA is performed by assuming that there is no ERF structure (i.e., the ERF is modeled as a point in the environment). Breathing rates and occupancy factors utilized are similar to that used for the Control Room.

    Although no structure is accounted for the inhalation and submersion doses, direct shine from the ERF filters is accounted for, since their presence (even if not safety related) poses a risk from direct shine to personnel in the ERF.

13. The expanded RG 1.183 based eight (8) chemical groupings are based on isotopes in the core with similar chemical characteristics. The added isotopes are highlighted in “Bold Font”.

1	Noble gases:	Xe, Kr
2	Halogens:	I, Br
3	Alkali Metals:	Cs Rb
4	Tellurium Grp:	Te, Sb, Se, **Sn, In, Ge, Ga, Cd, As, Ag**
5	Ba,Sr:	Ba, Sr
6	Noble Metals:	Ru, Rh, Pd, Mo, Tc, Co
7	Cerium Grp:	Ce, Pu, Np, **Th**
8	Lanthanides:	La, Zr, Nd, Eu, Nb, Pm, Pr, Sm, Y, Cm, Am, **Gd, Ho, Tb**

14. Isotopes addressed herein are consistent with the AST LAR, Power Uprate analysis, and those addressed in the current analysis of record.

15. As noted in DIN# 48, the maximum unfiltered air inleakage into the CRE during the listed modes of operation are assumed to be as follows:

    a. CR Emergency mode – 165 cfm (this represents an upper bound analytical value which includes test measurement uncertainties and a 10 cfm allowance for egress / ingress).
    b. CR Isolation mode – 450 cfm (this represents an upper bound analytical value which includes test measurement uncertainties and a 10 cfm allowance for egress / ingress)

16. Section 3.3 of RG 1.183 notes that each phase of the radioactivity release sequence (gap, In-vessel) is “sequential”, and that the early in-vessel phase immediately “follows” the gap release phase. Since, per RG 1.183, the gap release starts at t=30 secs and has a duration of 0.5 hours, the early in-vessel phase cannot start before t=30.5 mins. Thus RG 1.183 Table 4 is inconsistent with Section 3.3 when it suggests that the in-vessel release start at t=0.5 hrs. The BVPS LOCA model is consistent with what is believed to be the intent of RG 1.183; i.e., that the early in-vessel phase immediately “follows” the gap release phase. Note: since the duration of the in-vessel release in the model is maintained at the 1.3 hours recommended by the RG, the only real impact

of this minor change in timing is that the in-vessel release has an additional 30 seconds of decay - which has an insignificant impact on dose consequences.

17. Filtration of the Control Room ventilation recirculation flows during all modes of operation by particulate air filters (intended for dust removal) in the CRVS recirculation air-conditioning system, is conservatively not credited. (Refer to Appendix D for detail)

4.0 ACCEPTANCE CRITERIA

EAB and LPZ Dose Criteria for a LOCA (per 10CFR 50.67, and Section 4.4 Table 6 of DIN# 2)

(i) An individual located at any point on the boundary of the exclusion area for any 2-hour period following the onset of the postulated fission product release, should not receive a radiation dose in excess of 0.25 Sv (25 rem) total effective dose equivalent (TEDE).

(ii) An individual located at any point on the outer boundary of the low population zone, who is exposed to the radioactive cloud resulting from the postulated fission product release (during the entire period of its passage), should not receive a radiation dose in excess of 0.25 Sv (25 rem) TEDE.

Control Room Dose Criteria (10 CFR Part 50 § 50.67)

Adequate radiation protection is provided to permit occupancy of the Control Room under accident conditions without personnel receiving radiation exposures in excess of 0.05 Sv (5 rem) total effective dose equivalent (TEDE) for the duration of the accident.

Emergency Response Facility

Per NUREG-0737 Supplement 1, Section 8.2.1, Item f as amended by RG 1.183, Section 1.2.1, which states that a full implementation of AST allows a licensee to utilize the dose acceptance criteria of 10CFR50.67 in all dose consequence analyses:

The dose to an occupant in the TSC should not exceed 5 rem TEDE for the duration of the accident.

5.0 LIST OF COMPUTER PROGRAMS AND OUTPUT FILES

File Name[1],[4]	Run Date	Run Time	Program[2]	Description
Containment leakage				
BV487R101P	10/03/06	15:03:20	PERC2	Unfiltered CR in-leakage & LPZ – PERC.OUT[3]
BV487R101I	10/03/06	15:03:20	PERC2	Unfiltered CR in-leakage & LPZ – DIAG. OUT[3]
BV487R101C	10/03/06	15:03:20	PERC2	Unfiltered CR in-leakage & LPZ – CNTLROOM. OUT[3]
BV487R102P	10/03/06	15:08:15	PERC2	Filtered CR Intake – PERC.OUT[3]
BV487R102C	10/03/06	15:08:15	PERC2	Filtered CR Intake – CNTLROOM.OUT[3]
BV487R102E	10/03/06	15:08:15	PERC2	Filtered CR Intake – EQINT.OUT[3]
BV487R103P	10/03/06	15:09:15	PERC2	Elemental I131 Concentration – PERC.OUT[3]
BV487R103R	10/03/06	15:09:15	PERC2	Elemental I131 Concentration – REGDOSE.OUT[3]
BV487R104P	10/03/06	15:09:51	PERC2	EAB – PERC.OUT[3]
BV487R105P	10/03/06	15:10:23	PERC2	ERF – PERC.OUT[3]

File Name[1],[4]	Run Date	Run Time	Program[2]	Description
ECCS leakage				
BV487R106P	10/03/06	15:17:09	PERC2	Unfiltered CR in-leakage and LPZ – PERC.OUT[3]
BV487R106C	10/03/06	15:17:09	PERC2	Unfiltered CR in-leakage and LPZ – CNTLROOM. OUT[3]
BV487R107P	10/03/06	15:17:53	PERC2	Filtered CR Intake – PERC.OUT[3]
BV487R107C	10/03/06	15:17:53	PERC2	Filtered CR Intake – CNTLROOM.OUT[3]
BV487R107E	10/03/06	15:17:53	PERC2	Filtered CR Intake – EQINT.OUT[3]
BV487R108P	10/03/06	15:18:53	PERC2	EAB – PERC.OUT (combined ESF / RWST)
BV487R109P	10/03/06	15:19:21	PERC2	ERF – PERC.OUT[3]

File Name[1],[4]	Run Date	Run Time	Program[2]	Description
RWST back leakage				
BV487R110P	10/03/06	15:23:54	PERC2	Unfiltered CR in-leakage and LPZ – PERC.OUT[3] (iodine)
BV487R110C	10/03/06	15:23:54	PERC2	Unfiltered CR in-leakage and LPZ – CNTLROOM. OUT[3] (iodine)
BV487R111P	10/03/06	15:25:01	PERC2	Unfiltered CR in-leakage and LPZ – PERC.OUT[3] (progeny)
BV487R111C	10/03/06	15:25:01	PERC2	Unfiltered CR in-leakage and LPZ – CNTLROOM. OUT[3] (progeny)
BV487R112P	10/03/06	15:26:15	PERC2	Filtered CR Intake – PERC.OUT[3] (iodine)
BV487R112C	10/03/06	15:26:15	PERC2	Filtered CR Intake – CNTLROOM.OUT[3] (iodine)
BV487R112E	10/03/06	15:26:15	PERC2	Filtered CR Intake – EQINT.OUT[3]
BV487R113P	10/03/06	15:27:31	PERC2	Filtered CR Intake – PERC.OUT[3] (progeny)
BV487R113C	10/03/06	15:27:31	PERC2	Filtered CR Intake – CNTLROOM.OUT[3] (progeny)
BV487R108P	10/03/06	15:18:53	PERC2	EAB – PERC.OUT[3] (combined ESF / RWST)
BV487R114P	10/03/06	15:28:45	PERC2	ERF – PERC.OUT[3] (iodine)
BV487R115P	10/03/06	15:29:41	PERC2	ERF – PERC.OUT[3] (progeny)

Appendix A files

File Name[4]	Run Date	Run Time	Program[2]	Description
BV487R1A01P,E	10/03/06	15:10:40	PERC2	Cable room source due to containment leakage
BV487R1A02P,E	10/03/06	15:19:37	PERC2	Cable room source due to ESF leakage
BV487R1A03P,E	10/03/06	15:30:00	PERC2	Cable room source due to RWST Iodine leakage
BV487R1A04P,E	10/03/06	15:11:43	PERC2	Cable tray mezzanine source due to containment leakage
BV487R1A05P,E	10/03/06	15:20:19	PERC2	Cable tray mezzanine source due to ESF leakage
BV487R1A06P,E	10/03/06	15:31:08	PERC2	Cable tray mezzanine source due to RWST iodine leakage
BV487R1A07P,E	10/03/06	15:12:43	PERC2	External cloud shine due to containment leakage
BV487R1A08P,E	10/03/06	15:21:01	PERC2	External cloud shine due to ESF leakage
BV487R1A09P,E	10/03/06	15:32:16	PERC2	External cloud shine due to RWST iodine leakage

File Name[4]	Run Date	Run Time	Program[2]	Description
BV487R1A10	10/03/06	16:46:14	SW-QADCGGP	Source to dose response for Unit 1 emergency intake filter
BV487R1A11	10/03/06	16:47:31	SW-QADCGGP	Source to dose response for Unit 2 emergency intake filter
BV487R1A12P,D	10/03/06	15:33:25	PERC2	RWST sump water source strength
BV487R1A13P,E	10/03/06	15:34:26	PERC2	Cable room source due to RWST NG iodine leakage
BV487R1A14P,E	10/03/06	15:35:36	PERC2	Cable tray mezzanine source due to RWST noble gas leakage
BV487R1A15P,E	10/03/06	15:36:44	PERC2	External cloud shine due to RWST noble gas leakage

Appendix B files

File Name[4]	Run Date	Run Time	Program[2]	Description
BV487R1B01	10/03/06	16:48:25	SW-QADCGGP	Semi-infinite cloud unshielded dose rate as a function of gamma energy.
BV487R1B02	10/03/06	16:49:31	SW-QADCGGP	Semi-infinite cloud dose rate shielded by 6.75 inch concrete roof
BV487R1B03P,E	10/03/06	15:13:44	PERC2	External cloud shine due to containment leakage
BV487R1B04P,E	10/03/06	15:21:40	PERC2	External cloud shine due to ESF leakage
BV487R1B05P,E	10/03/06	15:37:53	PERC2	External cloud shine due to RWST iodine release
BV487R1B06P,E	10/03/06	15:39:11	PERC2	External cloud shine due to RWST noble gas release
BV487R1B07P,E	10/03/06	15:14:44	PERC2	ERF filter source due to containment leakage - filtered intake
BV487R1B08P,E	10/03/06	15:15:54	PERC2	ERF filter source due to containment leakage - unfiltered intake
BV487R1B09P,E	10/03/06	15:22:20	PERC2	ERF filter source due to ESF leakage - filtered intake
BV487R1B10P,E	09/15/06	15:23:00	PERC2	ERF filter source due to ESF leakage - unfiltered intake
BV487R1B11	09/15/06	16:51:30	SW-QADCGGP	Source to dose response for ERF normal intake HEPA filter
BV487R1B12	09/15/06	16:52:06	SW-QADCGGP	Source to dose response for ERF emergency recirculation HEPA filter

Appendix C files

File Name[4]	Run Date	Run Time	Program[2]	Description
				§C1 - Containment Leakage
BV487R201P,C	05 OCT 2015	10:20:29	PERC2	Unfiltered CR in-leakage
BV487R202P,C,E	05 OCT 2015	10:21:24	PERC2	Filtered CR Intake
BV487R203P,R	05 OCT 2015	10:22:23	PERC2	Elemental I131 Concentration
BV487R204P	05 OCT 2015	10:22:56	PERC2	EAB Δdose as a function of time after LOCA
BV487R204AP	05 OCT 2015	10:23:11	PERC2	EAB dose from 0.5 to 2.5 hours after a LOCA
BV487R205P	05 OCT 2015	10:23:22	PERC2	ERF
				§C1 - ECCS leakage
BV487R208AP	15 OCT 2015	17:40:21	PERC2	EAB dose from 0.5 to 2.5 hours after a LOCA
				§C1 - RWST back leakage
BV487R208Y1P	05 OCT 2015	10:23:37	PERC2	Case 1a EAB (iodine)
BV487R208Y2P	05 OCT 2015	10:23:51	PERC2	Case 1a EAB (iodine progeny)
BV487RC01AP	05 OCT 2015	10:24:08	PERC2	Case 1b EAB (iodine)
BV487RC01BP	05 OCT 2015	10:30:48	PERC2	Case 2 EAB (iodine)
BV487RC02AP	05 OCT 2015	10:24:22	PERC2	Case 1b EAB (iodine progeny)
BV487RC02BP	05 OCT 2015	10:31:01	PERC2	Case 2 EAB (iodine progeny)
BV487R210AP,C	05 OCT 2015	10:24:33	PERC2	Case 1b Unfiltered CR in-leakage (iodine)
BV487R210BP,C	05 OCT 2015	10:31:16	PERC2	Case 2 Unfiltered CR in-leakage (iodine)
BV487R211AP,C	05 OCT 2015	10:27:00	PERC2	Case 1b Unfiltered CR in-leakage (iodine progeny)
BV487R211BP,C	05 OCT 2015	10:32:47	PERC2	Case 2 Unfiltered CR in-leakage (iodine progeny)
BV487R212AP,C	05 OCT 2015	10:28:06	PERC2	Case 1b Filtered CR Intake (iodine)
BV487R212BP,C	05 OCT 2015	10:34:16	PERC2	Case 2 Filtered CR Intake (iodine)
BV487R213AP,C	05 OCT 2015	10:29:12	PERC2	Case 1b Filtered CR Intake (iodine progeny)
BV487R213BP,C	05 OCT 2015	10:36:14	PERC2	Case 2 Filtered CR Intake (iodine progeny)
BV487R214AP	05 OCT 2015	10:30:23	PERC2	Case 1b ERF (iodine)
BV487R214BP	15 OCT 2015	17:41:35	PERC2	Case 2 ERF (iodine)
BV487R215AP	05 OCT 2015	10:30:36	PERC2	Case 1b ERF(iodine progeny)
BV487R215BP	15 OCT 2015	17:42:08	PERC2	Case 2 ERF(iodine progeny)
				§C2 & C4
BV487R2C07P,E	05 OCT 2015	10:38:29	PERC2	U2 pre-RSG/NSAL: 0-24 hr Containment Lkg. for Containment Airborne and CR Filter Energy Release
BV487R2C08P,E	05 OCT 2015	10:39:29	PERC2	U2 RSG/NSAL: 0-24 hr Containment Lkg. for

File Name[4]	Run Date	Run Time	Program[2]	Description
				Airborne and CR Filter Energy Release
				§C3
BV487R2A07P,E	05 OCT 2015	10:40:25	PERC2	CR: Attenuated Cloud Shine - 24” Concrete Shielding
BV487R2B03 P,E	05 OCT 2015	10:40:39	PERC2	ERF: Attenuated Cloud Shine - 6.75” Concrete Shielding
BV487R2C03 P,E	05 OCT 2015	10:40:50	PERC2	CR: Unit 2 pre-RSG/NSAL – Unshielded cloud shine
BV487R2C04 P,E	05 OCT 2015	10:41:44	PERC2	CR: Unit 2 RSG/NSAL – Unshielded cloud shine
BV487R2C05 P,E	05 OCT 2015	10:41:56	PERC2	ERF: Unit 2 pre-RSG/NSAL – Unshielded cloud shine
BV487R2C06 P,E	05 OCT 2015	10:42:51	PERC2	ERF: Unit 2 RSG/NSAL – Unshielded cloud shine

Files Specific to Revision 3

File Name[4]	Run Date	Run Time	Program[5]	Description
				Containment Leakage
BV487R301P	02/13/2019	10:50:45	PERC2	Unfiltered CR in-leakage & LPZ – PERC.OUT[3]
BV487R301C	02/13/2019	10:50:45	PERC2	Unfiltered CR in-leakage & LPZ – CNTLROOM. OUT[3]
BV487R302P	02/13/2019	10:51:42	PERC2	Filtered CR Intake – PERC.OUT[3]
BV487R302C	02/13/2019	10:51:42	PERC2	Filtered CR Intake – CNTLROOM.OUT[3]
				ECCS Leakage
BV487R306P	02/13/2019	10:52:20	PERC2	Unfiltered CR in-leakage and LPZ – PERC.OUT[3]
BV487R306C	02/13/2019	10:52:20	PERC2	Unfiltered CR in-leakage & LPZ – CNTLROOM. OUT[3]
BV487R307P	02/13/2019	10:52:46	PERC2	Filtered CR Intake – PERC.OUT[3]
BV487R307C	02/13/2019	10:52:46	PERC2	Filtered CR Intake – CNTLROOM.OUT[3]
				RWST Back Leakage
BV487R310P	02/13/2019	10:53:10	PERC2	Unfiltered CR in-leakage and LPZ – PERC.OUT[3] (iodine)
BV487R310C	02/13/2019	10:53:10	PERC2	Unfiltered CR in-leakage and LPZ – CNTLROOM. OUT[3] (iodine)
BV487R311P	02/13/2019	10:54:20	PERC2	Unfiltered CR in-leakage and LPZ – PERC.OUT[3] (progeny)
BV487R311C	02/13/2019	10:54:20	PERC2	Unfiltered CR in-leakage and LPZ – CNTLROOM. OUT[3] (progeny)

File Name[4]	Run Date	Run Time	Program[5]	Description
BV487R312P	02/13/2019	10:53:45	PERC2	Filtered CR Intake – PERC.OUT[3] (iodine)
BV487R312C	02/13/2019	10:53:45	PERC2	Filtered CR Intake – CNTLROOM.OUT[3] (iodine)
BV487R313P	02/13/2019	10:54:56	PERC2	Filtered CR Intake – PERC.OUT[3] (progeny)
BV487R313C	02/13/2019	10:54:56	PERC2	Filtered CR Intake – CNTLROOM.OUT[3] (progeny)

Files Specific to Rev. 3 Appendix D

File Name	Run Date	Run Time	Program	Description
BV487R3D01P,E	02/13/2019	10:56:06	PERC2	Containment leakage: CR Emergency Intake Filter HEPA 30-day Integrated Gamma Energy Release. Does not include CR Occupancy Factors
BV487R3D02P,E	02/13/2019	10:56:38	PERC2	Containment leakage: CR Emergency Intake Filter Carbon 30-day Integrated Gamma Energy Release. Does not include CR Occupancy Factors
BV487R3D03	02/13/2019	10:58:35	SW-QADCGGP	HEPA Filter 251B Direct Shine (1B)
BV487R3D03A	02/13/2019	13:24:22	SW-QADCGGP	File BV487R3D03 with Concrete Buildup
BV487R3D04	02/13/2019	10:59:07	SW-QADCGGP	CARBON Filter 252B Direct Shine (B)
BV487R3D04A	02/13/2019	13:24:44	SW-QADCGGP	File BV487R3D04 with Concrete Buildup
BV487R3D05	02/13/2019	10:59:58	SW-QADCGGP	HEPA Filter 253B Direct Shine (2B)
BV487R3D06	02/13/2019	11:00:30	SW-QADCGGP	HEPA Filter 251A Direct Shine (1A)
BV487R3D07	02/13/2019	11:00:49	SW-QADCGGP	CARBON Filter 252A Direct Shine (A)
BV487R3D08	02/13/2019	11:01:03	SW-QADCGGP	HEPA Filter 253A Direct Shine (2A)
BV487R3D09P,E	02/13/2019	11:01:34	PERC2	Containment leakage: CEDE dose from crediting CR Recirculation HEPA filter
BV487R3D10P,E	02/13/2019	11:02:11	PERC2	Containment leakage: CR Recirculation Filter HEPA 30-day Integrated Gamma Energy Release. Does not include CR Occupancy Factors
BV487R3D11	02/13/2019	11:02:48	SW-QADCGGP	Unit 1 Direct shine contribution from CR Recirculation HEPA filter, DDE dose
BV487R3D12	02/13/2019	11:03:01	SW-QADCGGP	Unit 2 Direct shine contribution from CR Recirculation HEPA filter, DDE dose

Files Specific to Rev. 3 Appendix E

File Name	Run Date	Run Time	Program	Description
BV487R3E01p,e,i	02/13/2019	11:10:25	PERC2	Post-LOCA Containment Lkg. ERF Intake Filter
BV487R3E02	02/13/2019	11:13:56	SW-QADCGGP	ERF Intake Filter Direct Shine
BV487R3E03p,e,i	02/13/2019	11:12:06	PERC2	Post-LOCA Containment Lkg. ERF Recirc Filter
BV487R3E04p,e,i	02/13/2019	11:12:59	PERC2	Post-LOCA ESF Lkg. ERF Recirc Filter
BV487R3E05	02/13/2019	11:14:15	SW-QADCGGP	Std. Block Point Src.TF- shielded detector point
BV487R3E06	02/13/2019	11:14:28	SW-QADCGGP	Std. Block Point Src.TF- unshielded detector point
BV487R3E07	02/13/2019	11:14:48	SW-QADCGGP	Royal Rib Block Point Src TF – shielded det. point
BV487R3E08	02/13/2019	11:15:11	SW-QADCGGP	Royal Rib Block Point Src TF – unshielded det. point
BV487R3E09	02/13/2019	11:15:24	SW-QADCGGP	ERF Recirculation Filter Direct Shine

Notes

[1] File names have station “BV”, calculation number “487”, Revision developed in (i.e., R0, R1, R2, …), and sequence number. The letter at the end of the file names P, I, D, R, E and C signifies a; PERC.OUT, DIAG.OUT, EQDOSE.OUT, REGDOSE.OUT, EQINT.OUT and CNTLROOM.OUT file, respectively.

[2] Computer files were created on **PC# D5F9R91** with **Windows XPpro** OS

[3] PERC.OUT, DIAG.OUT, REGDOSE.OUT, EQDOSE.OUT, REGINT.OUT, EQINT.OUT and CNTLROOM.OUT are output with each PERC2 run. PERC.OUT provides the Input/Library file echo and Site Boundary dose results. DIAG.OUT is a voluminous file that provides activity per nuclide in all regions. CNTLROOM.OUT provides Region 5 integrated operator dose. REGDOSE provides total activity concentrations in all regions. EQDOSE provides the photon energy release rates in all regions and filters EQINT provides the integrated photon energy release in all regions and filters.

[4] The files extension is “*.ASC” for all files (e.g., . BV487R201P is BV487R201P.ASC).

[5] Computer files were created on **PC# 154LH02** with **Windows 7** OS

There are no outstanding error releases associated with PERC2 and SW-QADCGGP that would affect the results of this analysis.

6.0 COMPUTATION

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FirstEnergy	CALCULATION COMPUTATION NOP-CC-3002-01 Rev. 05
CALCULATION NO.: 10080-UR(B)-487	REVISION: 3

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FirstEnergy	CALCULATION COMPUTATION NOP-CC-3002-01 Rev. 05
CALCULATION NO.: 10080-UR(B)-487	REVISION: 3

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FirstEnergy	CALCULATION COMPUTATION NOP-CC-3002-01 Rev. 05
CALCULATION NO.: 10080-UR(B)-487	REVISION: 3

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CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-487

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FirstEnergy	CALCULATION COMPUTATION NOP-CC-3002-01 Rev. 05	Page 58
CALCULATION NO.: 10080-UR(B)-487		REVISION: 3

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Containment leakage

The updated EAB dose due to containment leakage from File R204A that occurs between 0.5 and 2.5 hours is 1.140E+01 rem CEDE plus 3.540E+00 rem DDE = 14.94 rem TEDE. This represents an increase of 2.8% from the Rev.1 value of 14.535 rem (see Appendix "C" for details).

As indicated earlier, DIN# 1 does not impact the design input associated with LOCA releases, thus the estimated EAB doses developed in Appendix C and presented in Revision 2 remain applicable to Revision 3.

ESF Leakage

The ESF contribution to the EAB dose for Revision 2 remained the same as that calculated in Revision 1.

However, in Revision 1 the dose from ESF leakage and RWST back leakage were combined into a single run. In Revision 2, the two contributors were separated since the dose due to RWST releases was impacted by the BVPS-2 RSGs / NSAL 11-5 / NaTB baskets.

The 2-hour EAB dose due to ESF leakage was calculated similar to the containment leakage dose (i.e., by assigning the site boundary occupancy factor equal to zero (0) till 0.5 hours after the LOCA and stopping the run at 2.5 hours after the LOCA). The EAB TEDE dose due to ESF leakage was obtained from file R208A and was estimated to be: 1.294 Rem CEDE +0.2421 DDE = 1.5361 rem TEDE.

As indicated earlier, DIN# 1 does not impact the design input associated with LOCA releases, thus the estimated EAB doses developed in Appendix C and presented in Revision 2 remain applicable to Revision 3.

RWST back leakage

The dose contribution from RWST back leakage to the total EAB TEDE is quite small relative to the dose contribution from containment and ESF leakage.

The EAB dose due to RWST back-leakage for Revision 2 was based on a) the conservative "design" RWST environmental release fractions presented in DIN# 17, and b) the initiation time of sump back leakage into the RWST after LOCA (i.e., t=1768 seconds) and the duration of the environmental release of RWST back leakage (i.e., from t=3039 seconds to t=30 days) via the RWST vent presented in DIN# 47 which reflected BVPS-2 RSGs and NSAL 11-5.

The EAB dose for the above case was developed in Appendix "C". Also developed in Appendix "C" was the case that used the "bounding" environmental release fractions developed in DIN# 17. Appendix C clearly demonstrated that use of the "design" release fractions listed in Table 3 remained conservative for purposes of estimating dose consequences.

The EAB TEDE dose due to RWST back leakage for the worst case 2-hour EAB Dose Window occurring between 0.5 and 2.5 hours after the LOCA were obtained from files R208Y1 and R208Y2:

Type	CEDE	DDE	TEDE
Iodine	1.112E-01	1.529E-02	1.265E-01
Iodine Progeny	0.000E+00	1.871E-02	1.871E-02
Total	1.112E-01	3.400E-02	1.45E-01**

** No change from the original TEDE EAB dose value developed in Rev.1. See Cases 1a and 1b in Section C1 of Appendix C.

As indicated earlier, DIN# 1 does not impact the design input associated with LOCA releases, thus the estimated EAB doses developed in Appendix C and presented in Revision 2 remain applicable to Revision 3.

Worst case 2-hour EAB Dose

The worst case 2-hour EAB TEDE dose (occurs between 0.5hrs to 2.5hrs), is estimated to be **16.62 rem TEDE**, (i.e., 14.940 rem TEDE from containment leakage, 1.536 rem TEDE from ESF leakage, and 0.145 Rem TEDE from RWST back-leakage).

7.0 RESULTS

The integrated dose EAB, LPZ, Control Room and Emergency Response Facility following a design basis Loss of Coolant Accident at either Unit 1 or Unit 2 are tabulated below. According to the regulatory requirement, the 2-hour EAB dose must reflect the "worst case" 2-hour activity release period following the LOCA. As discussed earlier, the "worst" 2-hour EAB dose following a LOCA will occur during the 0.5 hr-2.5 hour period.

The inhalation and immersion doses are obtained directly from PERC2 output. The DDE dose from external / contained sources for the Control Room and ERF is obtained from Appendices C and D (for the CR) and C and E (for the ERF).

TABLE 9

BVPS Unit 1 and Unit 2 Bounding LOCA Site Boundary Dose with Atmospheric Containment Design, Power Uprate and Alternative Source Term Methodology

RELEASE TYPE	LPZ[3] CEDE (rem)	DDE (rem)	TEDE (rem)	EAB[1,3] TEDE (rem)
Vacuum Valve release	Negligible	Negligible	Negligible[2]	Negligible[2]
Containment Leakage	0.81	0.67	1.48	14.940
ESF Leakage	0.96	0.26	1.22	1.536
RWST				
- Iodine	0.067	0.0043	0.071	0.127
- Noble gas	0	0.034	0.034	0.0187
TOTAL	1.9	1.04	**2.9**	**16.62**

Notes

[1] EAB worst case 2-hr window TEDE occurs between 0.5 and 2.5 hours after the LOCA

[2] See "Computation Section" for demonstration that Vacuum Relief Line contribution is negligible

[3] Site boundary doses are calculated in Appendix C

TABLE 10

BVPS Unit 1 and Unit 2 Bounding LOCA Control Room Operator Dose with Atmospheric Containment Design, Power Uprate and Alternative Source Term Methodology

		Control Room		
RELEASE TYPE	Computer File ID	CEDE (rem)	DDE (rem)	TEDE (rem)
Immersion pathway				
Vacuum Valve release[1]	NA	Negligible	Negligible	Negligible
Containment Leakage[3]				
* Unfiltered In-leakage/Intake	BV487R301C	1.780E+00	2.351E-02	1.804
* Filtered Intake	BV487R302C	1.306E-01	9.346E-02	0.224
ESF Leakage				
* Unfiltered In-leakage/Intake	BV487R306C	1.568E+00	4.391E-03	1.572
* Filtered Intake	BV487R307C	1.514E-01	3.433E-03	0.155
RWST[3]				
(Iodine)				
* Unfiltered In-leakage/Intake	BV487R310C	1.074E-01	1.415E-04	0.108
* Filtered Intake	BV487R312C	1.041E-02	7.115E-05	0.010
(Noble gas)				
* Unfiltered In-leakage/Intake	BV487R311C	Negligible	7.267E-04	0.001
* Filtered Intake	BV487R313C	Negligible	3.524E-03	0.004
External Shine[2, 4]				
* All sources except filter shine (from App C) [2]			0.573	0.573
* Emergency filter shine (from App D) [4]			0.0367	0.0367
TOTAL		3.721	0.739	**4.49**

Notes:

[1] See Section 6 for a demonstration which shows that the Vacuum Relief Line contribution is negligible.

[2] The external shine dose contribution from these sources are not affected by Revision 3. They are obtained from App. “A”, and adjusted to reflect Unit 2 RSG/NSAL in App. “C” (principally using scaling factors). The Unit 1 dose is presented since it is bounding. The Unit 2 dose is 0.301 rem.

[3] Doses in the CR due to the Containment leakage and RWST pathway due to immersion are calculated in Rev. 3 using the PERC2 files developed in Appendix C, modified to reflect the latest CR ventilation/leakage parameters.

[4] For purposes of consistency, the Rev. 3 direct shine dose from the CR intake filters is based on Unit 1 since the “total” Unit 1 external shine dose is bounding. The Unit 2 direct shine filter dose is 0.0634 rem.

TABLE 11

BVPS Unit 1 & Unit 2 Bounding LOCA ERF/TSC Personnel Dose with Atmospheric Containment Design, Power Uprate and Alternative Source Term Methodology

RELEASE TYPE	Computer File ID	CEDE (rem)	DDE (rem)	TEDE (rem)
Immersion pathway ***[2]***				
Vacuum Valve release	NA	Negligible	Negligible	Negligible[1]
Containment Leakage[4]	BV487R205P	9.369E-01	6.514E-01	1.59
ESF Leakage	BV487R109P	1.281E+00	2.289E-01	1.51
RWST[4]				
- Iodine	BV487R114P	9.54E-02	4.93E-03	0.10
- Noble gas	BV487R115P	-----	3.69E-02	0.037
External Shine ***[3]***			0.78	0.78
TOTAL		2.313	1.71	**4.02**

Notes

[1] See the “Computation” section for a demonstration which shows that the Vacuum Relief Line contribution is negligible.

[2] The ERF immersion dose analysis does not credit the ERF structure/normal or emergency ventilation systems.

[3] Although the Immersion dose does not credit activity cleanup by ERF filtration, the direct shine dose analysis includes ERF filter shine. External Shine contribution was originally developed in App. “B”, and then adjusted in Revision 2 to reflect RSG/NSAL in App. “C”(principally by using scaling factors). The impact of updated design input values received in support of Revision 3 has been evaluated in Appendix E.

[4] Immersion doses in the ERF due to the Containment leakage and RWST pathway are obtained directly from the listed files and reflect all current design parameters.

8.0 CONCLUSIONS

The BVPS Site Boundary and Control Room doses due to radioactive material released following a LOCA will remain within the regulatory limits set by 10CFR50.67 and Regulatory Guide 1.183. The ERF doses also remain within 5 Rem TEDE. These doses were calculated by using Alternative Source Terms and BVPS Units 1 & 2 design input parameter values provided by FENOC via DIN#s 1, 48 and 49 (see Attachment 1, 4 and 5).

Control Room

The maximum 30-day integrated dose to the Control Room operator is 4.49 Rem TEDE. This value is less than the regulatory limit of 5 Rem TEDE.

Note:

1. *In accordance with current licensing basis, the CR dose estimates following a LOCA is based on the assumption that the CR a) is automatically isolated, and b) placed in emergency pressurization / filtration mode via manual operator action within 30 mins of the accident.*
2. As a result of *scatter through wall penetrations* between the BVPS-2 CR filter cubicle and the CRE, *there is a hot spot near the north stairwell of 0.11 rem due to shine from the CRVS filters (vs the current maximum dose in the general areas of the CRE of 0.0634 rem). (Refer to Table 10 and Appendix D for detail)*
3. *The current model that does not credit the presence of particulate air filters (intended for dust removal) in the CRVS recirculation air-conditioning system, is bounding.*

Emergency Response Facility

The maximum 30-day integrated dose to personnel in the ERF is 4.02 Rem TEDE. This value is less than the acceptance criteria of 5 Rem TEDE and remains unchanged from Revision 2.

Note:

1. *In accordance with current licensing basis, the inhalation / submersion dose estimate following a LOCA does not credit the ERF structure / ventilation system*
2. *The estimated dose includes a dose contribution to ERF/TSC personnel due to daily passage through Room 112 (Service Dock) when accessing / exiting the ERF/TSC (expected occupation: 10 minutes per day for the 30-day duration of the accident)*
3. *A bounding approach is utilized with respect to filter efficiency when estimating the dose due to direct shine from the intake and recirculation ventilation filters, i.e., use of 100% or 0% efficiency, as deemed conservative. This approach provides a basis to eliminate the need for filter efficiency testing.*

Site Boundary

The integrated dose to an individual located at any point on the boundary of the exclusion area for any 2-hour period following the onset of the event is 16.62 Rem TEDE (t=0.5 hr to t=2.5 hr time window). This value is less than the regulatory limit of 25 Rem TEDE and remains unchanged from Revision 2.

The integrated dose to an individual located at any point on the outer boundary of the low population zone for the duration of the release is 2.9 Rem TEDE. This value is less than the regulatory limit of 25 Rem TEDE and remains unchanged from Revision 2.

APPENDIX A

Deep Dose Equivalent (DDE) Contribution from External Sources to an Operator in the Control Room

Table of Contents

Note for Revision 2: The impact of Unit 2 RSG/ NSAL 11-5 on the direct shine dose contribution in the Control Room is evaluated in Appendix C.

Appendix A Computer Files

File Name	Run Date	Run Time	Program	Description
BV487R1A01P,E	10/03/06	15:10:40	PERC2	Cable room source due to containment leakage
BV487R1A02P,E	10/03/06	15:19:37	PERC2	Cable room source due to ESF leakage
BV487R1A03P,E	10/03/06	15:30:00	PERC2	Cable room source due to RWST Iodine leakage
BV487R1A04P,E	10/03/06	15:11:43	PERC2	Cable tray mezzanine source due to containment leakage
BV487R1A05P,E	10/03/06	15:20:19	PERC2	Cable tray mezzanine source due to ESF leakage
BV487R1A06P,E	10/03/06	15:31:08	PERC2	Cable tray mezzanine source due to RWST iodine leakage
BV487R1A07P,E	10/03/06	15:12:43	PERC2	External cloud shine due to containment leakage
BV487R1A08P,E	10/03/06	15:21:01	PERC2	External cloud shine due to ESF leakage
BV487R1A09P,E	10/03/06	15:32:16	PERC2	External cloud shine due to RWST iodine leakage
BV487R1A10	10/03/06	16:46:14	SW-QADCGGP	Source to dose response for Unit 1 emergency intake filter
BV487R1A11	10/03/06	16:47:31	SW-QADCGGP	Source to dose response for Unit 2 emergency intake filter
BV487R1A12P,D	10/03/06	15:33:25	PERC2	RWST sump water source strength
BV487R1A13P,E	10/03/06	15:34:26	PERC2	Cable room source due to RWST NG iodine leakage
BV487R1A14P,E	10/03/06	15:35:36	PERC2	Cable tray mezzanine source due to RWST noble gas leakage
BV487R1A15P,E	10/03/06	15:36:44	PERC2	External cloud shine due to RWST noble gas leakage

Introduction

The purpose of this appendix is to determine the 30-day Deep Dose Equivalent (DDE) to an operator in the combined control room due to the following external radiation sources after a LOCA in either unit of BVPS:

- Direct shine from the airborne radiation source inside the reactor containment
- Direct shine from the cable spreading area airborne source below unit 2 portion of the combined control room through floor penetrations
- Direct shine from the cable tray mezzanine airborne source below unit 1 portion of the combined control room through floor penetrations
- External cloud shine due to containment leakage, ESF leakage, and RWST back leakage
- Direct shine from control room intake filters due to containment leakage, ESF leakage and RWST back leakage
- Direct shine from radiation source inside the RWST

The external shine dose is calculated based on a core power at 2918 Mwt and an atmospheric containment, using the Alternative Source Term methodology (Ref.A1). The input parameters are provided by FENOC (Ref.A2) and included as Attachment 1 of this calculation.

The post-LOCA external shine doses based on TID-14844 source term (Ref.A3), a reactor core power of 2705 MWt, and a sub-atmospheric containment were calculated in Ref.A4 for Unit 1 accident and in Ref.A5 for Unit 2 accident. This appendix will cover a LOCA in either unit as the more conservative input parameters are chosen for the dose calculation. The calculation approach is similar to that used in Ref.A4 (& A5), i.e., the computer code PERC2 (Ref.A6) is used to determine the radiation source strength and computer code SW-QADCGGP (Ref.A7) is typically used to determine the dose rate per unit source strength.

In references A4 & A5 (or their references), the unit source to dose rate response functions (typically mr/hr dose rate per Mev/s/cc source strength) from the containment source, cable spreading area airborne source, cable tray mezzanine airborne source, and RWST source have been calculated as a function of the gamma source energy. The unit source response functions for the control room HEPA filter source will be determined in this appendix by SW-QADCGGP computer code. The source strengths for all sources are determined by PERC2 computer code. The dose rate is calculated by multiplying the unit source response functions by the source strengths per energy groups. The external cloud shine dose is calculated by utilizing a special feature of the PERC2 code, namely, by inputting 2-ft concrete shielding factors (determined by SW-QADCGGP) directly to the PERC2 run.

A1. Containment Direct Shine

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A2. <u>Direct Shine from Cable Spreading Area Airborne Source below Unit 2 Control Room through Penetrations</u>

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A3. Direct Shine from Cable Tray Mezzanine Airborne Source below Unit 1 Control Room through Penetrations

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A4. External Cloud Shine

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A5. Unit 1 Control Room Emergency Filter Shine

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A6. Unit 2 Control Room Emergency Filter Shine

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A7. RWST Direct Shine

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Summary of Results

The 30-day post-LOCA deep dose equivalent to a control room operator from external sources due to a LOCA in either unit, for an atmospheric containment and a core power level of 2918 MWt, using Alternative Source Terms, are summarized in Table A-7 below.

Table A-7
Summary of Control Room External Shine Dose
Following a LOCA in Either Unit (Rem)

Source	Table/Section	Unit 1 Control Room Area	Unit 2 Control Room Area
Containment Shine	TBL.A-1	1.64E-02	1.64E-02
Cable Spreading Room Airborne Source			
Containment Leakage	TBL.A-2		1.52E-01
ESF/RWST Back Leakage	TBL.A-2		3.35E-02
Cable Tray Mezz. Area Airborne Source			
Containment Leakage	TBL.A-3	3.85E-01	
ESF/RWST Back Leakage	TBL.A-3	7.15E-02	
External Cloud Shine			
Containment Leakage	§ A4	3.28E-02	3.28E-02
ESF Leakage	§ A4	1.99E-03	1.99E-03
RWST Iodine Leakage	§ A4	7.33E-05	7.33E-05
RWST Noble Gas Leakage	§ A4	3.51E-05	3.51E-05
Control Room Emerg. Vent. Filter Shine	TBL. A-4, A-5[1]	3.57E-02	6.74E-02
Unit 1 RWST Direct Shine	TBL. A-6b	6.38E-02	6.38E-02
Total		**0.608**	**0.369**

Notes: [1] Dose Point "C"

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References

App A Ref.	Calc DIN#	Reference Title and Revision
A1	2	Reg. Guide 1.183, “Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power reactors”, July 200
A2	1	FirstEnergy letter ND1MDE:0374, 9/20/06, “Containment Sump Modification Dose Inputs, Units 1&2– DIT-FPP-0044-00; “Dose Analysis Inputs for Sump Modifications” and FirstEnergy letter ND1MLM:0379, 10/20/06, Containment Sump Modification Dose Inputs, Units 1&2, DIT-FPP-0045-00 “Control room and ERF inputs for Dose Analysis”
A3	26	TID-14844, J.J. DiNunno, et. al., “Calculation of Distance Factors for Power and Test Reactor Sites”, March 23, 1962
A4	27	S&W Calculation 12241/11700-UR(B)-480, Rev.0, (including CCN1) “Radiological Dose Consequences at the EAB, LPZ, and in the Control Room due to a Postulated LOCA at Beaver Valley Power Station Unit 1”
A5	28	S&W Calculation 12241/11700-UR(B)-481, Rev.0, (including CCN1) “Radiological Dose Consequences at the EAB, LPZ, and in the Control Room due to a Postulated LOCA at Beaver Valley Power Station Unit 2”
A6	15	S&W Computer Program NU-226, Ver. 00, Lev. 01, PERC2, “Passive/Evolutionary Regulatory Consequence Code”
A7	44	S&W computer program NU-222, Ver.00, Lev.02, “SW-QADCGGP – A combinatorial Geometry Version of QAD-5A”
A8	20	S&W Calculation 8700-EN-ME-105, Rev.0, “Relative Atmospheric Dispersion Factors (χ/Qs) at Control Room and ERF Receptors for Unit 1 Accident Releases”
A9	21	S&W Calculation 10080-EN-ME-106, Rev.0, “Relative Atmospheric Dispersion Factors (χ/Qs) at Control Room and ERF Receptors for Unit 2 Accident Releases”
A10	29	BVPS Dwg. No. 8700-RB-17J-15, Dwg. No. 8700-RB-17K-12
A11	30	BVPS Dwg. No. 8700-RC-8C-13
A12	31	BVPS Dwg. No. 8700-10.1-222B
A13	32	American National Standard, ANSI-ANS-6.1-1977, “Neutron and Gamma-Ray Flux-to-Dose Rate Factors”
A14	33	BVPS Dwg. No. 10080-RB-39A-13, Dwg. No. 10080-RB-39B-12
A15	34	BVPS Dwg. No. 8700-RM-3K-4
A16	35	S&W Calculation 12241-UR(B)-193, Rev.0, “Containment Skyshine Dose Rate”

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App A Ref.	Calc DIN#	Reference Title and Revision
A17	36	S&W Calculation 12179-UR(B)-354, Rev.0, "Skyshine Dose Rate from an Accident Containment (Scattered Component only)," (S&W Proprietary)
A18	25	S&W Calculation 12241-UR(B)-390, Rev.0, "Control Room Dose Penetrations Shielding Requirement"

APPENDIX B

Deep Dose Equivalent (DDE) Contribution from External Sources to an Operator in the Emergency Response Center (ERF)

Table of Contents

Note for Revision 2: The impact of Unit 2 RSG/ NSAL 11-5 on the direct shine dose contribution in the ERF is evaluated in Appendix C

Appendix B Computer Files

File Name	Run Date	Run Time	Program	Description
BV487R1B01	10/03/06	16:48:25	SW-QADCGGP	Semi-infinite cloud unshielded dose rate as a function of gamma energy.
BV487R1B02	10/03/06	16:49:31	SW-QADCGGP	Semi-infinite cloud dose rate shielded by 6.75 inch concrete roof
BV487R1B03P,E	10/03/06	15:13:44	PERC2	External cloud shine due to containment leakage
BV487R1B04P,E	10/03/06	15:21:40	PERC2	External cloud shine due to ESF leakage
BV487R1B05P,E	10/03/06	15:37:53	PERC2	External cloud shine due to RWST iodine release
BV487R1B06P,E	10/03/06	15:39:11	PERC2	External cloud shine due to RWST noble gas release
BV487R1B07P,E	10/03/06	15:14:44	PERC2	ERF filter source due to containment leakage - filtered intake
BV487R1B08P,E	10/03/06	15:15:54	PERC2	ERF filter source due to containment leakage - unfiltered intake
BV487R1B09P,E	10/03/06	15:22:20	PERC2	ERF filter source due to ESF leakage - filtered intake
BV487R1B10P,E	09/15/06	15:23:00	PERC2	ERF filter source due to ESF leakage - unfiltered intake
BV487R1B11	09/15/06	16:51:30	SW-QADCGGP	Source to dose response for ERF normal intake HEPA filter
BV487R1B12	09/15/06	16:52:06	SW-QADCGGP	Source to dose response for ERF emergency recirculation HEPA filter

Introduction/ Approach

The purpose of this appendix is to determine the 30-day Deep Dose Equivalent (DDE) to an operator in the Emergency Response Facility (ERF) due to the following external radiation sources after a LOCA in either unit of BVPS:

- Direct shine and skyshine from the reactor containment
- External cloud shine due to containment leakage, ESF leakage, and RWST leakage
- Direct shine from ERF intake filters due to containment leakage, ESF leakage and RWST leakage
- Direct shine from ERF Recirculation filters due to containment leakage, ESF leakage and RWST leakage
- Direct shine from radiation source inside the RWST

The ERF external shine dose is calculated based on a core power at 2918 Mwt and an atmospheric containment, using the Alternative Source Term methodology (Ref.B1). The input parameters are provided by FENOC (Ref.B2) and included as Attachment 1 of this calculation.

The post-LOCA external shine doses to a control room operator are calculated in Appendix A of this calculation. Except for the containment shine dose, the approach in calculating the ERF external shine doses is similar to that used in Appendix A, i.e., the computer code PERC2 (Ref.B4) is used to determine the radiation source strength and computer code SW-QADCGGP (Ref.B5) is used to determine the dose rate per unit source strength. The calculated doses are enveloping for a LOCA in either unit as the more conservative input parameters are chosen for the dose calculation.

The containment dome shine and skyshine dose is calculated based on a generic skyshine calculation from a post-LOCA containment (Ref.B3). Ref.B3 calculates the containment skyshine dose rate as a function of distance and elevation for a unit volumetric particle source (1 photon/s/cm^3) inside a BVPS containment for various gamma energies. The 30-day dose from the containment skyshine is obtained by multiplying this unit source response function by the integrated source strength (photon-hr/s/cm^3) in the containment determined by PERC2 computer code. The reduction factor for the 6.75" concrete roof is incorporated for a dose point inside the Technical Support Center (TSC) or the Emergency Operation Facility (EOF). The unit source response functions for the ERF intake and recirculation HEPA filter sources (mr/hr dose rate per Mev/s/cc source strength) will be determined by SW-QADCGGP computer code. The integrated source strengths for the filter sources are determined by PERC2 computer code. The 30-day dose is calculated by multiplying the unit source response functions by the integrated source strengths per energy groups. The external cloud shine dose is calculated by utilizing a special feature of the PERC2 code, namely, by inputting 6.75 inch concrete shielding factors (determined by SW-QADCGGP) directly to the PERC2 run.

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ERF Description/ Design Input

The Emergency Response Facility is a large one story building (approximately 192' x 164' x 16') located at ~ 1200 ft ESE of Unit 2 containment and ~ 1700 ft ESE of Unit 1 containment. It is clear that the Unit 2 accident will result in a higher dose to personnel in the ERF. The ERF includes Technical Support Center (TSC), Emergency Operation Facility (EOF), computer room, offices, dosimetry / counting room, records/ storage room, and miscellaneous equipment rooms. During normal operation, ERF intake of 3800 cfm is filtered by HEPA filter. During a DBA, the ERF is manually isolated and placed in recirculation mode through a HEPA filter and a charcoal filter. The intake filter is located in room 112 (service dock) and the recirculation filters are located in room 109B (mechanical room B). Both rooms are out of the recirculation ventilation envelope (Ref.B2). However, the radiation source accumulated in the filters can shine to accessible areas in the ERF. The input data used to calculate the ERF direct shine dose are listed below:

No	Description	Reference
1)	ERF gross volume - 5.038E+5 ft^3 (Free volume is 5% less)	B2
2)	Normal intake flow - 3800 cfm ± 10%	B2
3)	Normal intake filter efficiency - 99% on HEPA filter for all particulates	B2
4)	Maximum unfiltered inleakage during normal operation - 2090 cfm	B2
5)	Delay time for initiating ERF isolation and emergency recir ventilation mode - 30 min	B2
6)	Emergency recir ventilation flow rate - 3800 cfm ± 10%	B2
7)	Recir HEPA filter efficiency - 98% for all particulates	B2
8)	Recir charcoal filter efficiency - 90% for elemental and organic iodines	B2
9)	Unfiltered inleakage during emergency recir ventilation mode - 910 cfm	B2
10)	Distance from Unit 2 containment centerline to ERF - 1194 ft	B2
11)	ERF elevation: floor - 730'-6", roof - 746-10"	B9
12)	Containment shine dose rate per unit source at 1100 ft from containment wall and at El. 741 ft - see Section B1	B3
13)	ERF roof thickness and density - 6.75-in structure concrete (2.4 g/cc)	B2
14)	ERF wall thickness and density - double layers of 8" block concrete (2.2 g/cc) and 8" ribbed block, Effective thickness - 8.62 inch, density - 2.2 g/cc	B3, B8
15)	TSC roof penetrations - one 4" plus one 3" plus five 2" plumbing vents	B2
16)	ERF intake HEPA filter dimensions - 46" x 55" x 22.5"	B2, B9
17)	Distance of the intake filter to the closest location in corridor - 36.8 ft	B13
18)	Distance and shielding of the intake filter to the men's sleeping room - 53 ft 7-5/8" block concrete shield (mechanical room 109), 2.2 g/cc	B10
19)	Distance of the intake filter to office room 145 - 116.8 ft	B10

No	Description	Reference
20)	Distance of the intake filter to TSC - 168 ft	B2,B10
21)	ERF recir HEPA filter dimensions - 47" x 57" x 22.5"	B2, B12
22)	ERF recir HEPA filter shielding - 7-5/8" block concrete (2.2 g/cc)	B2, B11
23)	Distance of the recir filter to the center of closest corridor - 13 ft	B10,B2
24)	Distance of the recir filter to the mens' sleeping room - 16 ft	B10
25)	Distance of the recir filter to office room 145 - 80 ft	B10
26)	Distance of the recir filter to TSC - 123 ft	B2, B10
27)	Distance of Unit 2 RWST to the ERF - 1050 ft	B2
28)	Unit 2 RWST bottom nozzle elevation - 738 ft	B14
29)	Unit 2 RWST cross section area - 1963 ft^2	B14
30)	Surface elevation of the state highway Route 168 - 750 ft	B2, B8
31)	χ/Q values from Unit 2 containment leakage, ESF leakage, and RWST back leakage to the ERF edge (which are slightly higher than the values at ERF intake): (Ref.B7, p.115). (The more conservative values (in bold) between the containment edge release point and the containment top release point are used for the containment leakage source.)	B7

Time After LOCA	Containment leakage: Containment Edge (Sec/m^3)	Containment leakage: Containment Top (Sec/m^3)	ESF Lkg. (Sec/m^3)	RWST Lkg. (Sec/m^3)
0 - 2 hr	6.72E-05	**7.22E-05**	7.22E-05	9.42E-05
2 – 8 hr	5.69E-05	**6.43E-05**	6.43E-05	8.37E-05
8 – 24 hr	2.65E-05	**2.96E-05**	2.96E-05	3.81E-05
1 - 4 day	2.13E-05	**2.48E-05**	2.48E-05	2.97E-05
4 – 30 day	1.89E-05	**2.15E-05**	2.15E-05	2.58E-05

The TSC/EOF areas require the same occupancy as the control room and are protected by at least 6.75” of concrete from the skyshine and external cloud shine. They are also located at further distances from the ERF filters. Some of the rest of the ERF are less well protected as they may be subjected to external radiation through windows and other penetrations. The corridor areas near the ERF filters will also receive higher dose than the TSC/EOF areas. Two post-LOCA external shine doses are calculated in this appendix: one for the TSC/EOF area, the other represents the maximum dose for the rest of the ERF.

B1. Containment Dome Shine and Skyshine

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B2. External Cloud Shine

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B3. ERF Intake Filter Shine

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B4. ERF Emergency Recirculation Filter Shine

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B5. RWST Direct Shine

The Unit 2 RWST tank is located at 1050 ft from the ERF. The bottom nozzle elevation of RWST is 738 ft (Ref.B14). The cross section area of the Unit 2 RWST is 1963 ft^2. The radiation source is the post-LOCA containment sump water, which is assumed to back-leak to the RWST at a rate of 2 gpm. The volume of sump water in the RWST at the end of 30 days is 2 gal/min x (60 x 24 x 30) min x 0.1337 ft^3/gal = 1.16E+4 $ft^{3.}$ The height of the source is = 1.16E+4 ft^3 / 1963 ft^2 = 5.9 ft. The elevation of the top of RWST source is therefore 738 ft+5.9 ft = 743.9 ft. Since the highway elevation of Route 168 is 750 ft (Datum # 30), the RWST source is shielded by the interfering roadway for a person in the ERF (730.5 ft floor elevation). The scattered dose will be insignificant.

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Summary of Results

The 30-day post-LOCA deep dose equivalent to an individual located in the ERF from external sources due to a LOCA in BVPS Unit 2, for an atmospheric containment and a core power level of 2918 MWt, using Alternative Source Terms, are summarized in Table B-5 below. The values are bounding for Unit 1 LOCA.

TABLE B-5

Summary of ERF External Shine Dose Following a LOCA in Unit 2 Reactor (Rem)

Source	Table/Section	EOF/TSC	Rest of ERF Occupied Area (Max)
Containment Shine	TBL. B-1	5.84E-02	1.78E-01
External Cloud Shine			
Containment Leakage	§ B2[1]	1.05E-01	6.50E-01
ESF Leakage	§ B2[1]	3.48E-02	2.29E-01
RWST release	§ B2[1]	3.71E-03	4.23E-02
ERF Intake Filter Shine	TBL. B-3[2]	2.81E-04	5.81E-03
ERF Recir Filter Shine	TBL. B-4[2]	5.61E-04	6.00E-02
RWST Direct Shine	§ B5	Negligible	Negligible
Total		**0.203**	**1.17**

Notes
[1] Pages B12 and B11, respectively.
[2] Dose point "TSC" and "Closest Location in Corridor", respectively.

The "max" direct shine values are used to calculate the DDE portion of the TEDE dose reported in Table 15 of the main text and are the sum of the highlighted doses, equal to 0.178 + 0.00581 + 0.060 + 0 = **0.244 rem**. Although reprinted above the "max" external cloud shine is calculated and addressed in Table 15 of the main calculation.

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References

App B Ref.	Calc DIN#	Reference Title and Revision
B1	2	Reg. Guide 1.183, “Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power reactors”, July 200
B2	1	FirstEnergy letter ND1MDE:0374, 9/20/06, “Containment Sump Modification Dose Inputs, Units 1&2– DIT-FPP-0044-00; “Dose Analysis Inputs for Sump Modifications” and FirstEnergy letter ND1MLM:0379, 10/20/06, Containment Sump Modification Dose Inputs, Units 1&2, DIT-FPP-0045-00 “Control room and ERF inputs for Dose Analysis”
B3	35	S&W Calculation 12241-UR(B)-193, Rev.0, “Containment Skyshine Dose Rate”
B4	15	S&W Computer Program NU-226, Ver. 00, Lev. 02, PERC2, “Passive/Evolutionary Regulatory Consequence Code”
B5	44	S&W computer program NU-222, Ver.00, Lev.02, “SW-QADCGGP – A combinatorial Geometry Version of QAD-5A”
B6	20	S&W Calculation 8700-EN-ME-105, Rev.0, “Relative Atmospheric Dispersion Factors (χ/Qs) at Control Room and ERF Receptors for Unit 1 Accident Releases”
B7	21	S&W Calculation 10080-EN-ME-106, Rev.0, “Relative Atmospheric Dispersion Factors (χ/Qs) at Control Room and ERF Receptors for Unit 2 Accident Releases”
B8	37	DLC Calculation ERS-SFL-83-010, Rev.0, “Emergency Response Facility Post- LOCA Dose”
B9	38	BVPS Dwg. No. 8700-RM-60H-3
B10	39	BVPS Dwg. No. 8700-RA-60M-1
B11	40	BVPS Dwg. No. 8700-RA-60J-1
B12	41	BVPS Dwg. No. 8700-9.16-388, Rev. A
B13	42	BVPS Dwg. No. 8700-RM-60E-3
B14	43	FENOC letter ND1MLM:0189, W. R. Kline to E. A Dzenis, Westinghouse, “Containment Analysis Information, Revision 7, Units 1 & 2”, January 30, 2002
B15	32	American National Standard, ANSI-ANS-6.1-1977, “Neutron and Gamma-Ray Flux-to-Dose Rate Factors”

Appendix C
(Developed in support of Revision 2)

Combined effect of Unit 2 RSG/RRVCH, Westinghouse NSAL 11-5 and use of NaTB baskets (instead of NaOH addition) on the Unit 1/2 bounding post-LOCA Site Boundary, Control Room, and ERF Dose Consequences

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Revision 3 Note:

CR Dose due to Direct Shine from the CR Ventilation Filters:

- The dose contribution from the BVPS-2 HEPA filters to an operator in the Control Room (originally developed in Appendix A, and updated in Appendix C), has been updated to reflect the design inputs provided by DIN# 48. The new assessment is documented in Appendix D.

ERF/TSC Dose due to Direct Shine from the ERF /TSC Ventilation filters:

- The dose contribution from the ERF ventilation filters to an operator in the ERF/TSC (originally developed in Appendix B, and updated in Appendix C), has been updated to reflect the design inputs provided by DIN# 49. The new assessment is documented in Appendix E

ERF/TSC Dose due to Shine from the Containment & RWST

- The impact of shorter estimated distances between the ERF/TSC and the containment and RWST sources on the estimated doses (originally developed in Appendix A, and updated in Appendix C), is addressed in Appendix E.

Objective or Purpose

The Objective of this Appendix is to address the following:

- Evaluate the effect of Unit 2 RSGs / RRVCH and Westinghouse NSAL 11-5 (corrects the LOCA M&Es) on the dose consequences at Site Boundary, Control Room, and Emergency Response Facility (ERF) following a postulated Loss-of-coolant Accident (LOCA). Affected parameters are identified in FENOC DIT-SGR2-0046-01 (DIN# 47).
- Incorporate the impact of the change in the sump water buffering agent (i.e., the change from post-accident chemical addition of sodium hydroxide to the spray solution, to sodium tetra borate located in baskets in the containment sump) previously evaluated in Addendum 1 and 2 of Revision 1 combined with the affected parameters associated with RWST back leakage timing identified in items 12 and 13 in FENOC DIT-SGR2-0046-01 (DIN# 47).

Appendix C Computer File Identification

File Name	Run Date	Run Time	Program	Description
				§C1 - Containment Leakage
BV487R201P,C	05 OCT 2015	10:20:29	PERC2	Unfiltered CR in-leakage
BV487R202P,C,E	05 OCT 2015	10:21:24	PERC2	Filtered CR Intake
BV487R203P,R	05 OCT 2015	10:22:23	PERC2	Elemental I131 Concentration
BV487R204P	05 OCT 2015	10:22:56	PERC2	EAB Δdose as a function of time after LOCA
BV487R204AP	05 OCT 2015	10:23:11	PERC2	EAB dose from 0.5 to 2.5 hours after a LOCA
BV487R205P	05 OCT 2015	10:23:22	PERC2	ERF
				§C1 – ESF Leakage
BV487R208AP	15 OCT 2015	17:40:21	PERC2	EAB dose from 0.5 to 2.5 hours after a LOCA
				§C1 - RWST back leakage
BV487R208Y1P	05 OCT 2015	10:23:37	PERC2	Case 1a EAB (iodine)
BV487R208Y2P	05 OCT 2015	10:23:51	PERC2	Case 1a EAB (iodine progeny)
BV487RC01AP	05 OCT 2015	10:24:08	PERC2	Case 1b EAB (iodine)
BV487RC01BP	05 OCT 2015	10:30:48	PERC2	Case 2 EAB (iodine)
BV487RC02AP,C	05 OCT 2015	10:24:22	PERC2	Case 1b EAB (iodine progeny)
BV487RC02BP,C	05 OCT 2015	10:31:01	PERC2	Case 2 EAB (iodine progeny)
BV487R210AP,C	05 OCT 2015	10:24:33	PERC2	Case 1b Unfiltered CR in-leakage (iodine)
BV487R210BP,C	05 OCT 2015	10:31:16	PERC2	Case 2 Unfiltered CR in-leakage (iodine)

File Name	Run Date	Run Time	Program	Description
BV487R211AP,C	05 OCT 2015	10:27:00	PERC2	Case 1b Unfiltered CR in-leakage (iodine progeny)
BV487R211BP,C	05 OCT 2015	10:32:47	PERC2	Case 2 Unfiltered CR in-leakage (iodine progeny)
BV487R212AP,C	05 OCT 2015	10:28:06	PERC2	Case 1b Filtered CR Intake (iodine)
BV487R212BP,C	05 OCT 2015	10:34:16	PERC2	Case 2 Filtered CR Intake (iodine)
BV487R213AP,C	05 OCT 2015	10:29:12	PERC2	Case 1b Filtered CR Intake (iodine progeny)
BV487R213BP,C	05 OCT 2015	10:36:14	PERC2	Case 2 Filtered CR Intake (iodine progeny)
BV487R214AP	05 OCT 2015	10:30:23	PERC2	Case 1b ERF (iodine)
BV487R214BP	15 OCT 2015	17:41:35	PERC2	Case 2 ERF (iodine)
BV487R215AP	05 OCT 2015	10:30:36	PERC2	Case 1b ERF(iodine progeny)
BV487R215BP	15 OCT 2015	17:42:08	PERC2	Case 2 ERF(iodine progeny)
				§C2 & C4
BV487R2C07P,E	05 OCT 2015	10:38:29	PERC2	U2 pre-RSG/NSAL: 0-24 hr after LOCA Containment Airborne and CR Filter Energy Release
BV487R2C08P,E	05 OCT 2015	10:39:29	PERC2	U2 RSG/NSAL: 0-24 hr after LOCA Containment Airborne and CR Filter Energy Release
				§C3
BV487R2A07P,E	05 OCT 2015	10:40:25	PERC2	CR: Attenuated Cloud Shine - 24” Concrete Shielding
BV487R2B03 P,E	05 OCT 2015	10:40:39	PERC2	ERF: Attenuated Cloud Shine - 6.75” Concrete Shielding
BV487R2C03 P,E	05 OCT 2015	10:40:50	PERC2	CR: Unit 2 pre-RSG/NSAL – Unshielded cloud shine
BV487R2C04 P,E	05 OCT 2015	10:41:44	PERC2	CR: Unit 2 RSG/NSAL – Unshielded cloud shine
BV487R2C05 P,E	05 OCT 2015	10:41:56	PERC2	ERF: Unit 2 pre-RSG/NSAL – Unshielded cloud shine
BV487R2C06 P,E	05 OCT 2015	10:42:51	PERC2	ERF: Unit 2 RSG/NSAL – Unshielded cloud shine

Notes

The letter at the end of the file names P, R, E and C signifies a; PERC.OUT, REGDOSE.OUT, EQINT.OUT and CNTLROOM.OUT file, respectively.

All computer files were created on **PC# D5F9R91** with **Windows XPpro** OS

PERC.OUT, DIAG.OUT, REGDOSE.OUT, EQDOSE.OUT, REGINT.OUT, EQINT.OUT and CNTLROOM.OUT are output with each PERC2 run. PERC.OUT provides the Input/Library file echo and Site Boundary dose results. DIAG.OUT is a voluminous file that provides activity per nuclide in all regions. CNTLROOM.OUT provides Region 5 integrated operator dose. REGDOSE provides total activity concentrations in all regions. EQDOSE provides the photon energy release rates in all regions and filters EQINT provides the integrated photon energy release in all regions and filters.

The files extension is “*.ASC” for all files (e.g., . BV487R101P is BV487R101P.ASC) on the CD.

Approach / Design Input

FENOC DIT-SGR2-0046-01 (DIN# 47) has identified several parameters that are impacted by the BVPS-2 RSG/RRVCH and updated LOCA M&E rates per Westinghouse NSAL 11-5.

Table C1

LOCA Input Parameters identified in DIN# 47 as affected by BVPS-2 RSG/NSAL 11-5

DIT Item #	Parameter Description	Revision 1 Value	BVPS-2 RSG / NSAL 11-5 Value	Comment
1	Containment Free Volume	1.75E6 ft^3	1.75E6 ft^3	No Change, does not impact Revision 1
2	Containment Spray Coverage	63%	60%	Unfavorable impact; effect of change is addressed herein
3	Bounding containment spray initiation time after accident	85.4 s	77.4 s	Favorable impact; effect of change is addressed herein
4	Aerosols and elemental iodine removal coefficients in sprayed region	Developed in UR(B)-487 R1 based on values in US(B)-257-R1	Developed in US(B)-257 R2	Updated values that reflect DIN#47 are addressed herein
5	Aerosols removal coefficients in unsprayed region due to gravitational settling	Developed in UR(B)-487 R1 based on values in US(B)-257-R1	Developed in US(B)-257 R2	Updated values that reflect DIN#47 are addressed herein
6	Minimum long term sump pH	Sump pH > 7.0 in < 16 hours	Sump pH > 7.0 in < 16 hours	No change, does not impact Revision 1
7	Max pressure relief line bounding release rate following a LOCA prior to isolation	2200 cfm	2200 cfm	No change, does not impact Revision 1

DIT Item #	Parameter Description	Revision 1 Value	BVPS-2 RSG / NSAL 11-5 Value	Comment
8	Minimum volume of and mass of sump water versus time after switchover to the recirculation phase	20 – 30 min 19,111 ft^3 (1.13E6 lbm) 0.5 – 2 hr 25,333 ft^3 (1.51E6 lbm) 2 hr-30 d 43,577 ft^3 (2.68E6 lbm)	20 – 30 min 19,253 ft^3 (1.1379E6 lbm) 0.5 – 2 hr 24,909 ft^3 (1.5133E6 lbm) 2 hr-30 d 43,824 ft^3 (2.6837E6 lbm)	Revision 1 is slightly conservative; therefore the Rev.1 results remain slightly conservative between 0.14% and 0.70%. Specifically, the sump water release is based on a lambda equal to the sump water leakage rate divided by the sump water volume, adjusted by density. The mass leakage rate is constant and the sump water mass has increased slightly in all 3 cases for BVPS-2 RSG/NSAL 11-5 conditions; therefore the sump water release lambda is lower for BVPS-2 RSG/NSAL 11-5 conditions.
9	Bounding Unit 1/2 Peak sump water temperature after 20 min	250ºF	250ºF	No Change, does not impact Revision 1
10	Release rates via RWST vent versus time	Table 1 & Table 2 of Rev.1, Add2 (based on DIN# 17, R6)	Evaluated in DIN# 17. "Design" values not affected. The "Bounding" values are updated.	Appendix C herein addresses the updated "bounding" RWST release rate values calculated in DIN# 17 and demonstrates that continued use of the "design" RWST release rate values originally developed in Revision 3 of DIN# 17 remain bounding for purposes of dose consequences.
11	Initial RCS Tech Spec concentrations	As established in UR(B)-484 R0	Per DIN# 47, unchanged from UR(B)-484 R0	No Change, does not impact Revision 1
12	Bounding Unit 1/2 - Initiation time of sump back leakage into RWST after LOCA	t= 782 sec	t=1768 sec	Unfavorable impact; effect of change is addressed herein.
13	Bounding Unit 1/2 - Time after LOCA and duration of RWST back leakage to environment via the RWST vent	t=3055 sec to 30 days	t=3039 sec to 30 days	Unfavorable impact; effect of change is addressed herein.

As discussed in the main body of this analysis, the dose consequences associated with the containment vacuum relief release and the ESF leakage pathways are unaffected by the BVPS-2 RSGs / RRVCH and Westinghouse NSAL 11-5. Thus the inhalation and submersion doses addressed in Appendix C are limited to the dose consequences associated with Containment Leakage and RWST back leakage.

With respect to dose consequences due to direct shine (i.e., those developed in Appendix A and Appendix B for the CR and ERF, respectively), only the containment airborne activity (and resultant cloud and filter shine) is addressed since a) the DDE dose due to cloud shine / CR/ERF filter shine due to RWST back leakage is negligible, b) the dose due to cloud shine from ESF leakage is not impacted by U2 RSG/NSAL and c) the dose impact of BVPS-2 RSG / NSAL 11-5 on RWST shine is negligible as will be demonstrated in this Appendix. This approach is possible because the doses are reported in Revision 1 by leakage type as well as the total TEDE.

Evaluation

C1. Inhalation & Submersion of Released Activity

C1.1 Containment Leakage

To update the dose consequences to the control room operator, the Emergency Response Facility personnel, and the public at the EAB and LPZ due to inhalation of and submersion in the radioactivity due to containment leakage, the PERC2 containment leakage related files from Revision 1 (listed below), are revised using the updated information that reflects BVPS2 RSGs and NSAL 11-5 (e.g., change in airborne removal lambdas and reduction in spray coverage) discussed in Table C1.

In support of Appendix C and Revision 2, the following Rev.1 files pertaining to containment leakage were updated as discussed herein

Description	Rev.1 File	Replacement Rev.2 File
Unfiltered CR in-leakage	BV487R101	BV487R201
Filtered CR Intake	BV487R102	BV487R202
Elemental I131 Concentration	BV487R103	BV487R203
EAB	BV487R104	BV487R204A
ERF	BV487R105	BV487R205

Because the spray fraction has changed from 63% to 60% the following PERC2 parameters were updated.

- Mixing rate between the sprayed and unsprayed region, defined as 2 unsprayed region volume fractions per hour.
- Sprayed and unsprayed volume
- Leakage rate based on 0.1% volume fractions per day for 24 hours and 0.05% volume fractions per day for the remaining 29 days

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The updated aerosol and elemental iodine removal rates within the Sprayed and Unsprayed Regions of the containment that reflect the BVPS-2 RSGs / NSAL 11-5 developed in calculation 8700-US(B)-257 R2 (DIN# 10) are listed below in Table C2. In addition to the revised activity removal lambdas the spray region fraction has decreased from 63% to 60%.

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Table C2

Updated Aerosol and Elemental Iodine Removal Rates within Sprayed and Unsprayed Regions of Containment

				Sprayed Region		Unsprayed Region	
From	To	From	To	λp (hr^{-1})	λe (hr^{-1})	λp (hr^{-1})	λe (hr^{-1})
(second)		(hour)		Aerosol	Elemental	Aerosol	Elemental
0	30	0.00000	0.00833	0	0	0	0
30	77	0.00833	0.02139	9.5823	4.1075	0.0030	4.1075
77	263	0.02139	0.07300	5.1476	5.1476	0.0032	0
263	507	0.07300	0.14096	3.4057	3.4057	0.0034	0
507	722	0.14096	0.20056	2.9256	2.9256	0.0037	0
722	967	0.20056	0.26860	2.5650	2.5650	0.0041	0
967	1434	0.26860	0.39841	2.1868	2.1868	0.0048	0
1434	1800	0.39841	0.50000	2.0967	2.0967	0.0057	0
1800	1830	0.50000	0.50833	2.0482	2.0482	0.0061	0
1830	1851	0.50833	031416	2.7954	2.7954	0.0090	0
1851	1963	031416	0.54541	6.7158	6.7158	0.0213	0
1963	2233	0.54541	0.62038	11.6469	11.6469	0.0387	0
2233	2570	0.62038	0.71383	14.5583	14.5583	0.0500	0
2570	2975	0.71383	0.82628	14.6596	14.6596.	0.0545	0
2975	3536	0.82628	0.98233	14.6855	14.6855	0.0578	0
3536	3896	0.98233	1.08230	16.5427	16.5427	0.0611	0
3896	4817	1.08230	1.33802	29.0424	20.5358	0.0650	0
4817	5244	1.33802	1.45671	30.1924	20.5358	0.0688	0
5244	5599	1.45671	1.55529	30.2929	20.5358	0.0706	0
5599	6460	1.55529	1.79435	30.4578	20.5358	0.0727	0
6460	6510	1.79435	1.80833	30.3747	20.5358	0.0741	0
6510	6529	1.80833	1.81353	27.3476	20.5358	0.0743	0
6529	6604	1.81353	1.83451	18.7190	18.7190	0.0749	0
6604	6803	1.83451	1.88966	11.6128	11.6128	0.0764	0
6803	7177	1.88966	1.99361	8.0644	8.0644	0.0792	0
7177	7200	1.88966	2.00000	6.3482	6.3482	0.0793	0
7200	7487	2.00000	2.07982	5.7581	5.7581	0.0822	0
7487	7870	2.07982	2.18606	4.8614	4.8614	0.0843	0
7870	8434	2.18606	2.34274	4.0857	4.0857	0.0864	0
8434	8992	2.34274	2.49782	3.4963	3.4963	0.0882	0

		Sprayed Region		Unsprayed Region	
From To	From To	λp (hr^{-1})	λe (hr^{-1})	λp (hr^{-1})	λe (hr^{-1})
(second)	(hour)	Aerosol	Elemental	Aerosol	Elemental
8992 9579	2.49782 2.66091	3.0940	3.0940	0.0894	0
9579 10832	2.66091 3.00886	2.3312	2.3312	0.0901	0
10832 12518	3.00886 3.47714	1.5493	1.5493	0.0901	0
12518 18000	3.47714 5.00000	1.3892	1.3892	0.0874	0
18000 23040	5.00000 6.40000	1.2533	1.2533	0.0831	0
23040 28800	6.40000 8.00000	1.1568	1.1568	0.0789	0
28800 36000	8.00000 10,00000	1.0765	1.0765	0.0746	0
36000 84285	10.00000 23.41250	0.8901	0.8901	0.0498	0
84285 202202	23.41250 56.16722	0.6923	0.6923	0	0
202202 345600	56.16722 96.00000	0.4	0	0	0

Comparison of Rev.1 and Updated (BVPS-2 RSG/NSAL 11-5) Control Room Inhalation and Submersion Operator Dose

	Rev.1 CR Doses				Updated Rev. 2 CR Doses			Percent Increase		
File	CEDE	DDE	TEDE	File	CEDE	DDE	TEDE	CEDE	DDE	TEDE
R101	6.577E-01	6.412E-03	6.641E-01	R201	6.713E-01	6.437E-03	6.777E-01	2.068%	0.390%	2.052%
R102	1.368E-01	9.564E-02	2.324E-01	R202	1.401E-01	9.572E-02	2.358E-01	2.412%	0.084%	1.454%
Total	7.945E-01	1.021E-01	8.966E-01	Total	8.114E-01	1.022E-01	**9.136E-01**	2.127%	0.103%	1.897%

Comparison of Rev.1 and Updated (BVPS-2 RSG/NSAL 11-5) ERF Inhalation and Submersion Personnel Dose

	Rev.1 ERF				Updated Rev. 2 ERF Doses			Percent Increase		
File	CEDE	DDE	TEDE	File	CEDE	DDE	TEDE	CEDE	DDE	TEDE
R105	9.04E-01	6.48E-01	1.552E+00	R205	9.37E-01	6.51E-01	**1.588E+00**	3.685%	0.494%	2.352%

Comparison of Rev.1 and Updated (BVPS-2 RSG/NSAL 11-5) Inhalation and Submersion Dose at LPZ

	Rev.1 LPZ				Updated Rev. 2 LPZ Doses			Percent Increase		
File	CEDE	DDE	TEDE	File	CEDE	DDE	TEDE	CEDE	DDE	TEDE
R101	7.792E-01	6.631E-01	1.442E+00	R201	8.084E-01	6.657E-01	**1.474E+00**	3.747%	0.392%	2.205%

The worst Case 2-hour window EAB TEDE Dose

The worst Case 2-hour window EAB TEDE Dose for BVPS-2 RSG/NSAL 11-5 will continue to occur between 0.5 and 2.5 hours as shown in Table C3 (copy of Rev.1 Table 12) below. This is because;

a. The containment leakage is by far the dominant EAB dose contributor;
b. The window time frame is largely due to the core release periods following the LOCA that has not changed with the BVPS-2 RSG/NSAL 11-5;
c. The change of spray lambda & spray coverage volume due to the BVPS-2 RSG/NSAL 11-5 is not significant enough to shift the worst 2-hr window; this is clearly demonstrated by the comparison of the calculated Rev. 2 and Rev.1 containment leakage dose vs. time after LOCA shown in Table C3a;
d. The dose due to ESF leakage is not impacted by the BVPS-2 RSG/NSAL 11-5; and
e. The EAB dose due to RWST vent releases remains a minor dose contributor for the BVPS-2 RSGs/NSAL 11-5.

For the reasons stated above, a single PERC2 run is made to determine the dose at the EAB between 0.5 and 2.5 hours. This is accomplished by assigning the site boundary occupancy factor equal to zero (0) till 0.5 hours after the LOCA and stopping the run at 2.5 hours after the LOCA

From Table C3 (Rev.1 Table 12) below, the calculated dose due to containment leakage in Revision 1 was 14.535 rem TEDE (i.e., 15.545 rem TEDE minus 1.01 rem TEDE).

The updated containment leakage dose at the EAB due to the BVPS-2 RSGs / NSAL 11-5 is obtained from File R204A and is = **14.94 rem TEDE** (i.e., 1.140E+01 rem CEDE plus 3.540E+00 rem DDE from PERC2 File BV487R204A).

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C1.2 ECCS (ESF) Leakage

There is no change to the sump water leakage lambda due to ECCS leakage following the BVPS-2 RSG/NSAL 11-5. This is because the assumed mass flow rate, "F", is constant (at STP conditions per RG 1.183) and the mass of the sump water, "V", for the BVPS-2 RSG/NSAL 11-5 has increased (see below). Therefore the leakage lambda (i.e., λ = F/V) is lower for BVPS-2 RSGs / NSAL 11-5 than that calculated and used in Rev.1. For example: Minimum mass of sump water versus time after switchover to the recirculation phase:

Rev.1 (DIN#1, pre-U2 RSG/NSAL 11-5)	BVPS-2 RSG/NSAL 11-5 (DIN#47)
20 – 30 min 1.13E6 lbm	20 – 30 min 1.1379E6 lbm
0.5 – 2 hr 1.51E6 lbm	0.5 – 2 hr 1.5133E6 lbm
2 hr-30 d 2.68E6 lbm	2 hr-30 d 2.6837E6 lbm

As seen from the sump water mass versus time data presented above, the sump water mass increased by the following:

= 1.1379/1.13 = 0.7% for the period between 20 min -30 min after the LOCA
= 1.5133/1.51 = 0.22% for the period between 30 min -2 hours after the LOCA
= 2.6837/2.68 =0.14% for the period between 2 hours-30 days after the LOCA

Since the decrease in the release lambda is very small (between 0.14% to 0.7%, there is no need to revisit the doses due to ECCS leakage because the gain in the dose margin will be minimal.

Thus:

Cntl Rm The control room operator dose from ECCS leakage remains unchanged from Rev.1

ERF The dose to personnel located in the ERF from ECCS leakage remains unchanged from Rev.1

LPZ The dose at the LPZ from ECCS leakage remains unchanged from Rev.1

EAB Because ECCS leakage was combined with the RWST vent leakage in a single PERC2 run in Rev.1 (File R108), the 2 hour EAB dose due to ECCS leakage is calculated herein for the release period between 0.5 and 2.5 hours after LOCA in

PERC2 File R208A. This additional PERC2 run is needed because the dose due to RWST back leakage is being updated in Revision 2

The 0.5 hr to 2.5 hr EAB dose due to ECCS leakage is calculated similar to the containment leakage dose (i.e., by assigning the site boundary occupancy factor equal to zero till 0.5 hours after the LOCA and stopping the PERC file run at 2.5 hours after the LOCA). The EAB TEDE dose due to ECCS leakage from file R208A is then: 1.294 Rem CEDE +0.2421 DDE = 1.5361 rem TEDE.

The following is a status of the Rev.1 files as they pertain to ESF (ECCS) leakage

Description	Rev.1 File	Replacement Rev.2 File
Unfiltered CR in-leakage	BV487R106	Not replaced, remains valid for R2
Filtered CR Intake	BV487R107	Not replaced, remains valid for R2
EAB (combined ESF/RWST)	BV487R108	BV487R208A (replaces ESF only)
ERF	BV487R109	Not replaced, remains valid for R2

C1.3 RWST Back Leakage

Background

BVPS Units 1 and 2 have changed the mechanism of introducing the buffering agent into the post-LOCA sump water from sodium hydroxide addition to the spray solution, to use of sodium tetraborate (NaTB) baskets in the containment sump. It was determined that since the NaTB baskets are to be filled to ensure an ultimate sump water pH of ≥ 7.0, there will be no impact on the current post-LOCA containment and ECCS leakage dose consequence models relative to iodine re-evolution.

The only leakage pathway that was potentially impacted by the change in the sump water pH transient was the post-LOCA RWST back-leakage. The impact of the pH change on the BVPS 1 & 2 bounding post-LOCA iodine releases from the RWST was performed in Revision 5 and 6 of DIN# 17. The impact of Unit 2 RSG/NSAL 11-5 on the RWST iodine release is evaluated in DIN# 17, Revision 6, Addendum 1.

Evaluation

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Thus to inhalation / submersion dose due to RWST back leakage remains unaffected by BVPS-2 RSGs/NSAL 11-5 and the Revision 1 values continue to be applicable.

The following is a status of the files as they pertain to RWST back leakage

Description	Design[1] Case 1a Rev.1 File ID	Design[1] Case 1b Rev.2 File ID	Bounding[1] Case 2 Rev.2 File ID
Unfiltered CR in-leakage (iodine)[2]	BV487R110p,c	BV487R210Ap,c	BV487R210Bp,c
Unfiltered CR in-leakage (iodine progeny)[2]	BV487R111p,c	BV487R211Ap,c	BV487R211Bp,c
Filtered CR Intake (iodine)	BV487R112p,c	BV487R212Ap,c	BV487R212Bp,c
Filtered CR Intake (iodine progeny)	BV487R113p,c	BV487R213Ap,c	BV487R213Bp,c
EAB (iodine)	BV487R208Y1p[3]	BV487R2C01Ap	BV487R2C01Bp
EAB (iodine progeny)	BV487R208Y2p[3]	BV487R2C02Ap	BV487R2C02Bp
ERF (iodine)	BV487R114p	BV487R214Ap	BV487R214Bp
ERF(iodine progeny)	BV487R115p	BV487R215Ap	BV487R215Bp

Notes:

1 The “Design” case refers to a set of conservative release fraction values that includes an added factor of 2 for margin. The “Design” case values are conservative but do not necessarily reflect current operations or the latest plant parameters. These values were originally developed with the intent of bounding future changes. The “Bounding” case refers to the latest calculated release fraction values that bound Unit 1 and 2 and reflect current operations and the latest plant parameters with no added margin.
2 Output file PERC.OUT includes LPZ doses.
3 This file did not exist in Rev. 1, File BV487R108 combined the ESF and RWST contribution in one PERC2 input file. To determine the contribution from both releases in Rev.2, the file was separated into two separate input files, one for ESF leakage and one for RWST vent releases.
4 The suffix p and c refer to PERC2 output files PERC.OUT (includes input validation and site boundary doses) and CNTLROOM.OUT (control room doses), respectively.

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Table C4
Design and Bounding RWST Iodine Release Rates

Period		RWST Vent Iodine Release Rates	
From (hour	To (hour)	Design (Note 1) (day^{-1})	Bounding (Note 2) (day^{-1})
0	0.7011389	0	0
0.7011389	0.83444	0	1.592E-02
0.83444	0.84861	0	7.491E-03
0.84861[3]	1.06777	1.0E-02	7.491E-03
1.06777	1.66667	1.0E-02	2.093E-03
1.66667	1.75	8.0E-03	2.093E-03
1.75	1.7844	6.0E-03	2.093E-03
1.7844	2	6.0E-03	5.773E-04
2	3	4.0E-03	6.500E-05
3	5	2.0E-03	6.500E-05
5	8	1.1E-03	9.302E-06
8	9	1.1E-03	2.807E-06
9	11	1.1E-03	2.807E-06
11	24	2.4E-04	2.807E-06
24	48	2.4E-04	1.548E-06
48	72	1.1E-04	8.210E-07
72	96	3.0E-05	8.210E-07
96	120	1.0E-05	5.524E-07
120	144	6.0E-06	4.841E-07
144	168	2.0E-06	4.386E-07
168	192	1.0E-06	3.985E-07
192	216	8.0E-07	3.667E-07
216	264	7.0E-07	3.289E-07
264	312	6.0E-07	2.901E-07
312	384	5.0E-07	2.534E-07
384	480	4.0E-07	2.115E-07
480	576	3.0E-07	1.844E-07
576	672	2.4E-07	1.574E-07
672	720	2.0E-07	1.574E-07

Notes:
[1] Design values are from Calculation 8700-US(B)-ERS-SNW-92-009 Rev.3 multiplied by 2 and reflect NaOH sump water buffering agent, and confirmed in Rev. 6, Fig. 14 and Add.1 of Rev. 6.
[2] Bounding values are from Calculation 8700-US(B)-ERS-SNW-92-009 Rev.6 Addendum 1 and reflect NaTB sump water buffering agent
[3] Time 0.84861 hour corresponds to 3055 seconds, the start time for the environmental release prior to the Unit 2 RSG/NSAL. This time is updated to 0.84417 hr (3039 seconds) for U2 RSG/NSAL.

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Table C5
Design and Bounding RWST Gaseous Release Rates

Period		RWST Vent Gaseous Release Rates	
From (hour	To (hour)	Design (Note 1) (day^{-1})	Bounding (Note 2) (day^{-1})
0	0.7011389	0	0
0.7011389	0.83444	0	4.068
0.83444	0.84861	0	2.747
0.84861[3]	1.06777	0.78	2.747
1.06777	1.66667	0.78	1.291
1.66667	1.75	0.78	1.291
1.75	1.7844	0.78	1.291
1.7844	2	0.78	0.533
2	3	0.78	0.1319
3	5	0.48	0.1319
5	8	0.48	0.05594
8	9	0.48	0.03792
9	11	0.098	0.03792
11	24	0.098	0.03792
24	48	0.098	0.04019
48	72	0.05	0.03431
72	96	0.05	0.03431
96	120	0.05	0.03130
120	144	0.042	0.03111
144	168	0.042	0.03043
168	192	0.042	0.02981
192	216	0.042	0.02926
216	264	0.042	0.02847
264	312	0.042	0.02756
312	384	0.042	0.02656
384	480	0.042	0.02544
480	576	0.042	0.02453
576	672	0.042	0.0239
672	720	0.042	0.0239

Notes:
[1] Design values are from Calculation 8700-US(B)-ERS-SNW-92-009 Rev.3 multiplied by 2 and reflect NaOH sump water buffering agent, and confirmed in Rev. 6, Fig. 14 and Add.1 of Rev. 6.
[2] Bounding values are from Calculation 8700-US(B)-ERS-SNW-92-009 Rev.6 Addendum 1 and reflect NaTB sump water buffering agent
[3] Time 0.84861 hour corresponds to 3055 seconds, the start time for the environmental release prior to the Unit 2 RSG/NSAL. This time is updated to 0.84417 hr (3039 seconds) for U2 RSG/NSAL.

RWST Back Leakage Dose Summary

Case 1a: "Design" Release Rates; the doses reflect, a) the initiation time of sump back-leakage into the RWST used in Rev.1, b) the time after LOCA and duration of the RWST back leakage release to the environment via the RWST vent used in Rev.1, c) the "design" RWST Vent release Rates used in Rev.1 that are conservatively based on **NaOH sump water buffering agent** multiplied by 2 and were originally developed in DIN# 17, Rev 3.

EAB Dose (Rem) ; worst case(2-hour) integrated dose; window from 0.5 hour to 2.5 hour post LOCA

Type	CEDE	DDE	TEDE	File
Iodine	1.110E-01	1.526E-02	1.263E-01	BV487R208Y1p
Progeny	0.000E+00	1.868E-02	1.868E-02	BV487R208Y2p
Total	1.110E-01	3.394E-02	**1.45E-01**	

LPZ (30-day) Integrated Dose (Rem)

Type	CEDE	DDE	TEDE	File
Iodine	6.671E-02	4.254E-03	7.096E-02	BV487R110p from Rev.1
Progeny	0.000E+00	3.424E-02	3.424E-02	BV487R111p from Rev.1
Total	6.671E-02	3.849E-02	**1.05E-01**	

Control Room Operator (30-day) Integrated Dose (Rem)

Unfiltered Inleakage

Type	CEDE	DDE	TEDE	File
Iodine	2.921E-02	3.544E-05	2.925E-02	BV487R110c from Rev.1
Progeny	0.000E+00	1.825E-04	1.825E-04	BV487R111c from Rev.1

Filtered Intake

Type	CEDE	DDE	TEDE	File
Iodine	1.168E-02	6.605E-05	1.175E-02	BV487R112c from Rev.1
Progeny	0.000E+00	3.651E-03	3.651E-03	BV487R113c from Rev.1

Case 1a CR Total

Type	CEDE	DDE	TEDE
All	4.089E-02	3.935E-03	**4.48E-02**

ERF Personnel 30-day Integrated dose (rem)

Type	CEDE	DDE	TEDE	File
Iodine	9.540E-02	4.928E-03	1.003E-01	BV487R114p from Rev.1
Progeny	0.000E+00	3.694E-02	3.694E-02	BV487R115p from Rev.1
Total	9.540E-02	4.187E-02	**1.37E-01**	

Case 1b: "Design" Release Rates; the doses reflect, a) the initiation time of sump back-leakage into the RWST as a result of the BVPS-2 RSGs/NSAL 11-5, b) the time after LOCA and duration of the RWST back leakage release to the environment via the RWST as a result of the BVPS-2 RSGs/NSAL 11-5, c) the "design" RWST Vent release Rates used in Rev.1 that are conservatively based on **NaOH sump water buffering agent** multiplied by 2 and were originally developed in DIN# 17, Rev 3.

EAB Dose (Rem) ; worst case(2-hour) integrated dose; window from 0.5 hour to 2.5 hour post LOCA

Type	CEDE	DDE	TEDE	File
Iodine	1.112E-01	1.529E-02	1.265E-01	BV487RC01Ap
Progeny	0.000E+00	1.871E-02	1.871E-02	BV487RC02Ap
Total	1.112E-01	3.400E-02	**1.45E-01**	

LPZ (30-day) Integrated Dose (Rem)

Type	CEDE	DDE	TEDE	File
Iodine	6.673E-02	4.256E-03	7.099E-02	BV487R210Ap
Progeny	0.000E+00	3.425E-02	3.425E-02	BV487R211Ap
Total	6.673E-02	3.851E-02	**1.05E-01**	

Control Room Operator (30-day) Integrated Dose (Rem)

Unfiltered Inleakage

Type	CEDE	DDE	TEDE	File
Iodine	2.922E-02	3.546E-05	2.926E-02	BV487R210Ac
Progeny	0.000E+00	1.826E-04	1.826E-04	BV487R211Ac

Filtered Intake

Type	CEDE	DDE	TEDE	File
Iodine	1.169E-02	6.609E-05	1.176E-02	BV487R212Ac
Progeny	0.000E+00	3.652E-03	3.652E-03	BV487R213Ac

Case 1b CR Total

Type	CEDE	DDE	TEDE
All	4.091E-02	3.936E-03	**4.49E-02**

ERF Personnel 30-day Integrated dose (rem)

Type	CEDE	DDE	TEDE	File
Iodine	9.543E-02	4.931E-03	1.004E-01	BV487R214Ap
Progeny	0.000E+00	3.695E-02	3.695E-02	BV487R215Ap
Total	9.543E-02	4.188E-02	**1.37E-01**	

Case 2: “**Bounding” Release Rates**; the doses reflect, a) the initiation time of sump back-leakage into the RWST as a result of the BVPS-2 RSGs/NSAL 11-5, b) the time after LOCA and duration of the RWST back leakage release to the environment via the RWST as a result of the BVPS-2 RSGs/NSAL 11-5, c) the “bounding” RWST Vent release Rates developed in DIN# 17 that reflect BVPS-2 RSGs/NSAL 11-5 and **NaTB as the sump water buffering agent**.

EAB Dose (Rem) ; worst case(2-hour) integrated dose; window from 0.5 hour to 2.5 hour post LOCA

Type	CEDE	DDE	TEDE	File
Iodine	2.014E-02	3.036E-03	2.318E-02	BV487RC01Bp[1]
Progeny	0.000E+00	1.263E-02	1.263E-02	BV487RC02Bp[1]
Total	2.014E-02	1.567E-02	**3.58E-02**	

LPZ (30-day) Integrated Dose (Rem)

Type	CEDE	DDE	TEDE	File
Iodine	1.908E-03	1.747E-04	2.083E-03	BV487R210Bp[1]
Progeny	0.000E+00	1.141E-02	1.141E-02	BV487R211Bp[1]
Total	1.908E-03	1.158E-02	**1.35E-02**	

Control Room Operator (30-day) Integrated Dose (Rem)

Unfiltered Inleakage

Type	CEDE	DDE	TEDE	File
Iodine	9.705E-04	1.662E-06	9.722E-04	BV487R210Bc[1]
Progeny	0.000E+00	7.033E-05	7.033E-05	BV487R211Bc[1]

Filtered Intake

Type	CEDE	DDE	TEDE	File
Iodine	3.889E-04	3.138E-06	3.920E-04	BV487R212Bc[1]
Progeny	0.000E+00	1.407E-03	1.407E-03	BV487R213Bc[1]

Case 2 CR Total

Type	CEDE	DDE	TEDE
All	1.359E-03	1.482E-03	**2.84E-03**

ERF Personnel 30-day Integrated dose (rem)

Type	CEDE	DDE	TEDE	File
Iodine	3.275E-03	2.903E-04	3.565E-03	BV487R214Bp[1]
Progeny	0.000E+00	1.198E-02	1.198E-02	BV487R215Bp[1]
Total	3.275E-03	1.227E-02	**1.56E-02**	

Notes: [1] The PERC input time for the time interval ending at #7 is rounded off from 1.7844 hours to 1.8 hours. This difference is negligible.

C2 Shine from External and Contained Radiation Sources

As discussed earlier, with respect to dose consequences due to direct shine (i.e., those developed in Appendix A and Appendix B for the CR and ERF, respectively), only the containment airborne activity (and resultant cloud and filter shine) is addressed since a) the DDE dose due to cloud shine / CR/ERF filter shine due to RWST back leakage is negligible, b) the dose due to cloud shine from ESF leakage is not impacted by U2 RSG/NSAL and c) the dose impact of BVPS-2 RSG / NSAL 11-5 on RWST shine is negligible (see Section C2.1.4).

This above approach is possible because the doses are reported in Revision 1 by leakage type as well as the total TEDE

C2.1 Development of Direct Shine Dose Scaling Factors

C2.1.1 Containment Shine Scaling Factors

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C2.1.2 Containment Leakage Cloud Shine Scaling Factors

Shielded Gamma Doses

The pre-BVPS-2 RSG/NSAL 11-5 shielded cloud dose estimates in the CR and ERF are taken directly from Revision 1 computer files R1A07 and R1B03, respectively.

The corresponding BVPS-2 RSG/NSAL 11-5 files are created by modifying the referenced Revision 1 files to reflect the activity transport model addressed herein for the BVPS-2 RSGs / NSAL 11-5. This includes the change in spray fraction from 63% to 60% and the updated spray lambdas.

The increase in Rev.2 due to the BVPS-2 RSGs / NSAL 11-5 is estimated as the ratio of the Unit 2 RSG/NSAL dose values divided by the Rev 1 (Pre BVPS-2 RSGs / NSAL 11-5) dose values.

Unshielded Gamma Doses

The unshielded cloud doses are created by using the pre-BVPS-2 RSG/NSAL 11-5 and Unit 2 RSG/NSAL shielded cloud dose PERC2 files discussed above and replacing the shielding factors per energy group from the Table on pg A16 in Appendix A, and Table B-2 in the PERC2 "ENERGY" library to unity.

The increase in Rev.2 due to the BVPS-2 RSGs / NSAL 11-5 is estimated as the ratio of the Unit 2 RSG/NSAL dose values divided by the Rev 1 (Pre-BVPS-2 RSGs / NSAL 11-5) dose values.

CONTROL ROOM	Shielded 24" Concrete		File	Unshielded		File
Rev.1	3.277E-02	Rem	BV487R1A07	6.095E+00	Rem	**BV487R2C03**
Rev.2	3.285E-02	Rem	**BV487R2A07**	6.129E+00	Rem	**BV487R2C04**
Rev 2 Increase →	**0.24%**			**0.56%**		

ERF	Shielded 6.75" Concrete		File	Unshielded		File
Rev.1	1.049E-01	Rem	BV487R1B03	6.48E-01	Rem	**BV487R2C05**
Rev.2	1.055E-01	Rem	**BV487R2B03**	6.51E-01	Rem	**BV487R2C06**
Rev 2 Increase →	**0.57%**			**0.49%**		

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C2.1.3 CR/ERF Filter Shine Dose Scaling Factors

The Revision 1 CR and ERF doses due to filter shine will be scaled to obtain Rev.2 (with BVPS-2 RSG / NSAL 11.5) doses due to filter shine.

The bounding scaling factor is developed by evaluating radiation doses that reflect no shielded, light shielding, and heavy shielding. For convenience the concrete RFs previously developed in Rev.1 for 6.75 inches (light shielding) and 24 inches of concrete (heavy shielding) are used.

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C2.1.4 RWST Shine

The RWST direct shine doses developed in Revision 1 remain valid for RSG/NSAL (Rev.2). The liquid activity in the tank from back leakage is not impacted by the very small changes in the RWST release rates. Secondly, in Rev.1, the back leakage was conservatively assumed to begin at t=0 hour after the LOCA, therefore the small increase in inventory due to the change in back leakage initiation time from 1782 seconds after LOCA to 1768 seconds after LOCA as a result of the BVPS-2 RSG/NSAL 11-5 has no adverse impact.

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C3 Update of Control Room Direct Shine Doses in Appendix A to reflect Unit 2 RSGs/NSAL 11-5

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Table A-7 Summary of Control Room External Shine Dose

Updated Table A-7
Summary of Control Room External Shine Dose
Following a LOCA in Either Unit (Rem)

Source	Table/Section	Unit 1 Control Room Area	Unit 2 Control Room Area
Containment Shine	TBL.A-1	1.64E-02	1.64E-02
Cable Spreading Room Airborne Source			
Containment Leakage	TBL.A-2		1.53E-01
ESF/RWST Back Leakage	TBL.A-2		3.35E-02
Cable Tray Mezz. Area Airborne Source			
Containment Leakage	TBL.A-3	3.87E-01	
ESF/RWST Back Leakage	TBL.A-3	7.15E-02	
External Cloud Shine			
Containment Leakage	§ A4	3.29E-02	3.29E-02
ESF Leakage	§ A4	1.99E-03	1.99E-03
RWST Iodine Leakage	§ A4	7.33E-05	7.33E-05
RWST Noble Gas Leakage	§ A4	3.51E-05	3.51E-05
Control Room Emerg. Vent. Filter Shine	TBL. A-4, A-5[1]	3.67E-02	6.93E-02
Unit 1 RWST Direct Shine	§ A7	6.38E-02	6.38E-02
Total		**0.61**	**0.37**

Notes: [1] Dose Point "C"
[2] Updated doses are Rev.1 values scaled to reflect BVPS-2 RSG / NSAL 11-5

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C4 Update of ERF Direct Shine Doses in Appendix B to reflect Unit 2 RSGs / NSAL 11-5

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Table B-5 Summary of Control Room External Shine Dose

Updated TABLE B-5
Summary of ERF External Shine Dose
Following a LOCA in Unit 2 Reactor (Rem)
(Unit 2 is the bounding unit)

Source	Table/Section	EOF/TSC	Rest of ERF Occupied Area (Max)
Containment Shine	TBL. B-1	5.85E-02	1.78E-01
External Cloud Shine			
Containment Leakage	§ B2[1]	1.06E-01	6.54E-01
ESF Leakage	§ B2[1]	3.48E-02	2.29E-01
RWST release	§ B2[1]	3.71E-03	4.23E-02
ERF Intake Filter Shine	TBL. B-3[2]	2.81E-04	6.05E-03
ERF Recir Filter Shine	TBL. B-4[2]	5.61E-04	6.25E-02
RWST Direct Shine	§ B5	Negligible	Negligible
Total		**0.204**	**1.17**

Notes

[1] Pages B12 and B11, respectively.

[2] Dose point "TSC" and "Closest Location in Corridor", respectively.

The "max" direct shine values are used to calculate the DDE portion of the TEDE dose reported in Table 11 of the main text and are the sum of the highlighted doses, equal to 0.178 + 0.00605 + 0.0625 + 0 = **0.247 rem**. Although reprinted above the "max" external cloud shine is calculated and addressed in Table 11 of the main calculation.

C5 Relevant Historical Information (i.e., portion of Rev.1 that is used in Rev. 2)

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APPENDIX D

(Developed in Support of Revision 3)

Updated Control Room (CR) Dose from Selected External Sources

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Objective or Purpose

The objective of Appendix D is to:

a) Assess the impact of the following changes in design input values, on the Control Room (CR) dose due to shine from the CRVS intake filters (previously estimated in Appendix C):

- Reduction in the maximum CRVS filtered intake rate
- Update of the dimensions of the BVPS-2 emergency HEPA filters
- Presence of wall penetrations, previously not identified, between the BVPS-2 CRVS filter cubicle and the control room envelope (CRE).

b) Assess the effect of crediting the particulate air filters (intended for dust removal) in the CRVS recirculation air-conditioning system, and determine if, the current model that does not address the recirculation loop, is bounding.

Appendix D Computer Files

File Name	Run Date	Run Time	Program	Description
BV487R3D01P,E	02/13/2019	10:56:06	PERC2	Containment leakage: CR Emergency Intake Filter HEPA 30-day Integrated Gamma Energy Release. Does not include CR Occupancy Factors
BV487R3D02P,E	02/13/2019	10:56:38	PERC2	Containment leakage: CR Emergency Intake Filter Carbon 30-day Integrated Gamma Energy Release. Does not include CR Occupancy Factors
BV487R3D03	02/13/2019	10:58:35	SW-QADCGGP	HEPA Filter 251B Direct Shine (1B)
BV487R3D03A	02/13/2019	13:24:22	SW-QADCGGP	File BV487R3D03 with Concrete Buildup
BV487R3D04	02/13/2019	10:59:07	SW-QADCGGP	CARBON Filter 252B Direct Shine (B)
BV487R3D04A	02/13/2019	13:24:44	SW-QADCGGP	File BV487R3D04 with Concrete Buildup
BV487R3D05	02/13/2019	10:59:58	SW-QADCGGP	HEPA Filter 253B Direct Shine (2B)
BV487R3D06	02/13/2019	11:00:30	SW-QADCGGP	HEPA Filter 251A Direct Shine (1A)
BV487R3D07	02/13/2019	11:00:49	SW-QADCGGP	CARBON Filter 252A Direct Shine (A)
BV487R3D08	02/13/2019	11:01:03	SW-QADCGGP	HEPA Filter 253A Direct Shine (2A)
BV487R3D09P,E	02/13/2019	11:01:34	PERC2	Containment leakage: CEDE dose from crediting CR Recirculation HEPA filter
BV487R3D10P,E	02/13/2019	11:02:11	PERC2	Containment leakage: CR Recirculation Filter HEPA 30-day Integrated Gamma Energy Release. Does not include CR Occupancy Factors
BV487R3D11	02/13/2019	11:02:48	SW-QADCGGP	Unit 1 Direct shine contribution from CR Recirculation HEPA filter, DDE dose
BV487R3D12	02/13/2019	11:03:01	SW-QADCGGP	Unit 2 Direct shine contribution from CR Recirculation HEPA filter, DDE dose

The P, E suffix indicates PERC2 Output File <PERC.OUT> and <EQINT.OUT>, respectively.

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Background / Approach / Changes to Design Inputs

Background*: Appendix A was developed in Revision 0* to determine the Deep Dose Equivalent (DDE) Contribution from External Sources to an Operator in the Control Room from the following radiation sources:

- Direct shine from the airborne radiation source inside the reactor containment
- Direct shine from the cable spreading area airborne source below the BVPS-2 portion of the combined control room through floor penetrations
- Direct shine from the cable tray mezzanine airborne source below the BVPS-1 portion of the combined control room through floor penetrations
- External cloud shine due to containment leakage, ESF leakage, and RWST leakage
- Direct shine from the control room emergency intake filters due to containment leakage, ESF leakage and RWST leakage
- Direct shine from radiation source inside the RWST

Appendix A was revised in Revision 1 to address the impact of the changes in the recirculation spray system operation incorporated as part of the resolution to GSI-191
Appendix C was developed in Revision 2 to scale the doses developed in Appendix A Revision 1 to address:

a. BVPS-2 RSGs/RRVCH
b. Westinghouse NSAL 11-5 on the post-LOCA M&Es (and the consequent effect on the containment pressure / temperature transient).

The scaling factors developed in Appendix C were not significant, and the resultant impact on the doses calculated in Appendix A, was minimal.

Approach:

Appendix D herein is developed to revise and replace, as necessary, Section A5 (Unit 1 Control Room Emergency Filter Shine), Section A6 (Unit 2 Control Room Emergency Filter Shine) and associated sections and tables in Appendix C.

Sections D1 and D2 address the Deep Dose Equivalent (DDE) contribution due to the following:

a) Updated design input parameter values to reflect current plant design, specifically:
   i. Changes in the CR emergency intake flow rate and the dimensions of the BVPS-2 CR HEPA filter.
   ii. Newly identified penetrations in the wall separating the Unit 2 CRVS emergency filters and the CRE.

Section D3 determines the dose impact of assuming that the Control Room recirculation HEPA filters (intended for dust removal) are available post-LOCA. The focus of this section is to demonstrate *that the current model (that does not address the CRVS recirculation loop), is bounding, by* confirming that the associated reduction in the inhalation/submersion dose due to the presence of the dust filters, will more than compensate for the added dose due to direct shine from the activity accumulated on the air-conditioning dust filters.

Changes to Design Input [Reference D1]:

a) CR Emergency Intake Flowrate: changed from a conservative value of 1030 cfm (used in the previous revisions) to 1000 cfm (Ref. D1, Item 8)

b) Dimensions of the BVPS-2 emergency HEPA filters: changed from 27-1/2" x 25-3/4" x 7-3/4" (used in the previous revisions) are 24" x 24" x 11.5" cm (Ref. D1, Item 35)

c) Information related to the BVPS-1 and BVPS-2 ventilation air-conditioning system which recirculates CR air through filters intended for dust removal. (Ref. D1, Item 12)

   BVPS-1
   - AC fan 1VS-AC-1A and 1VS-F-40A or the B train
   - roll type/ bag type filters
   - efficiency ~ 90%

   BVPS-2
   - AC fan 2HVC-ACU201A or B
   - roll type/ Hi efficiency type filters
   - efficiency ~ 85%

   Minimum Flow rate:
   Based on that available for CR air purge, i.e., 16,200 cfm per unit or 32,400 cfm

   Duration:
   t=0 to t-30 days

   Per Reference D1, since the dust filters are not subject to a maintenance program, the analysis should conservatively assume 50% of the rated efficiency when crediting the filters to estimate the impact of use of the filters on the inhalation / submersion dose, and 100% efficiency when estimating the dose due to direct shine.

d) Location of the recirculation filters with respect to the CRE: as shown in the BVPS-1 & BVPS-2 sketch attached to Reference D1.

e) Penetrations between the BVPS CR Filter Cubicles and the CRE: as shown in the BVPS-1 & BVPS-2 sketch attached to Reference D1, and noted below:

   - BVPS-1 CR Ventilation Intake filters and the Air-Conditioning Recirculation filters are located in the BVPS-1 CRVS filter room below the BVPS-1 CR. There are no penetrations in the ceiling of the CRVS filter room / floor of the CR.

- BVPS-2 CR Ventilation Intake filters and the Air-Conditioning Recirculation filters are located in the CRVS filter room east of the CR (i.e., adjacent to the computer room). There are 4 penetrations in the wall between the CRVS filter room and the computer room as well as a door leading to the north stairway, adjacent to the CRE.

D1 Impact of Updated Filtered Intake flowrates & BVPS-2 CR Emergency Ventilation System HEPA Filter Dimensions

Updated Intake flowrate:

The maximum emergency filtered intake flowrate into the control has decreased from the value used in Rev.2 (1030 cfm) to 1000 cfm.

This change is conservative since the dose contribution from the filters will decrease by 1030/1000 = 1.03 (or 3 percent). Consequently, the dose estimated in Revision 2 remains bounding.

Updated BVPS-2 CR Intake HEPA filter Dimensions:

Reference D1 updates the dimensions of the BVPS-2 emergency HEPA filters from 27-1/2" x 25-3/4" x 7-3/4" to 24" x 24" x 11.5" cm.

This update has negligible impact since:

a) There is no self-attenuation credited in the model developed in Appendix A
b) The original model is slightly conservative since the face of the filter facing the computer room in the N → S direction was assumed to be 7-3/4" which shorter than the corrected dimension of 11.5" – thus the existing model creates less slant path. (see Section A.6 for detail)

D2 Impact of Wall Penetrations between the CRVS Filter Cubicle and the CRE

D2.1. CR Dose from the U1 Emergency Intake Filters

Per Reference D1, there are no penetrations in the 15" concrete ceiling above the Unit 1 emergency fan/filter room (i.e., which is also part of the Unit 1 CR floor). Consequently, since there has been no change to the filter source term, no further assessment is needed for the BVPS-1 intake filter shine. The dose of record remains **0.0367 rem** per page C33 of Appendix C. This dose reflects a maximum intake rate of 1030 cfm. The current maximum intake rate of 1000 cfm, provides a small conservatism.

D2.2 CR Dose due to Wall Penetrations between the BVPS-2 CRVS Filter Cubicle and the CRE

Several HVAC duct penetrations have been identified in the wall separating the BVPS-2 CRVS filter cubicle and the computer room which is located within the CRE. Review of the sketches attached to Reference D1, indicates that there is no direct line-of-sight through the duct penetrations but there is potential for direct line of sight thru the North stairwell doors. However, an assessment will have to be made of the radiation scatter through these penetrations / doorway.

General

Attachment 2 of Reference D1 has identified 4 duct penetrations and a doorway in the wall separating the BVPS-2 CRVS emergency filters at El 735'-6" and the main control room. The doorway leads to a 15' long stairwell that leads to another door to the CR (See Figure D1 below)

The largest duct penetration measuring 3'-4" x 2'-10" (marked as P4 in Figure D1) is located at the north most corner of the filter room and above the doorway – both the doorway and the penetration do not open directly into the CR proper, rather they abut and open into the stairwell/foyer to the CR (Reference D2 and Attachment 2 of Reference D1). Due to the penetration location, height relative to the intake filter source, and the fact it opens to the stairwell, this penetration, is assumed to have a negligible impact on CR dose, thus it will not be addressed herein.

The 3 remaining penetrations scanning from South to North are P1) 3'-0" x 2'-6"; P2) 3'-0" x 1'-0", and P3) 3'-0" x 1'-2"

From Attachment 2 of Reference D1, the emergency intake filters span up to ~10' above the floor el 735'-6". The height of the 3 penetrations P1, P2 and P3 above the floor elevation is:

P1	(14' - 2") - (1'- 2") - (2' - 6")	= 126" (10'-6")
P2	(14' - 2") - (1'- 2") - (1'- 0")	= 144" (12'-0")
P3	(14' - 2") - (8") - (1'- 2")	= 148" (12'-4")

Based on the above, there is no direct line of sight to an operator in the CRE from the emergency intake filters.

Assuming a 7' tall individual, the minimum distance from the bottom of the penetrations and an individual in the CRE is a minimum of (3.5', 5', 5'.33) or an average of 3.5'. The distance to the penetration center line from 7' above the floor elevation are 4.75', 5'-6" and 5'-11", respectively.

The straight line distance from emergency filters to the 12" thick concrete wall separating the CRVS filter room and CR (along axis Y defined in Figure D1) is 20"-4'.

Note: As indicated before, there is a 3'-4" x 2'-10" duct penetration (P4) and a 7'-3" x 3'-4" door penetration in the Northwest corner of the CRVS filter room at El 735'-6", however, the penetration and door are adjacent to the CR north stairwell/foyer, not the main Control Room. For this assessment an unshielded detector point at the door will provide the dose in the stairwell (20'-4") and one at 20'-4" +

~15' = ~35' from the face of FLTA253A/B. *Note that the other stairwell door on the south side of the fan/filter room is not addressed herein as it has no direct pathway to the CR.*

The existing SW-QADCCGP or "QAD" File BV487R1A11, is used as a starting point for the U2 emergency intake direct shine dose assessment herein. The QAD file is updated herein and used to calculate the direct shine thru the 12 thick concrete wall and thru the north stairwell from the intake filters to locations in the CR. Also, the updated QAD model file is used to determine the incident gamma dose at the base (i.e., at the penetration center line just inside the CRVS filter room) of each of the 3 penetrations to be used later in in Section D2 to determine the scatter dose using a total dose albedo approach.

Emergency Filter Intake Source Term

The source strength (gamma energy release) of the HEPA and Carbon emergency intake filter is listed below as a function of the ORIGEN standard 18 energy groups. The particulate and non-particulate integrated source strength due to containment leakage is calculated herein from files 487R3D01 and 487R3D02. These files are based on modifying the CR region 5 of File 487R302 in the main body of the calculation. The ESF and RWST non-particulate source strength is taken directly from Table A5 of Appendix A.

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D3. Impact of crediting Control Room HEPA recirculation filters

The focus of this section is to demonstrate *that the current model (that does not address the CRVS recirculation loop), is bounding, by* confirming that the associated reduction in the inhalation/submersion dose due to the presence of the dust filters, will more than compensate for the added dose due to direct shine from the activity accumulated on the air-conditioning dust filters. Crediting the control room recirculation system HEPA filters in the LOCA dose consequence analysis will significantly decrease the inhalation dose and have marginal impact on the total direct shine dose.

Impact of the Recirculation HEPA Filter on the Inhalation (CEDE) dose

For the LOCA, *containment leakage is the only radioactivity release pathway that has particulate activity*. Thus, only runs BV487R301 and BV487R302, from Table 10 are affected. The CEDE inhalation dose from file BV487R301 and BV487R302 is 1.884 rem (i.e., 1.753 rem + 0.1306 rem).

Taking into consideration the operation of one Unit 1 and one Unit 2 filtered CRVS recirculation train, the total minimum cleanup rate is 16,200 cfm (2) or 32,400 cfm (Reference D1) of filtered activity. File BV487R301A is created herein by adding 32,400 cfm of filtered recirculation to file BV487R301. The filtered recirculation is for the duration of the accident using half the particulate efficiency provided in Reference D1, i.e., 85%/2 = 42.5%; this equates to an aerosol DF of 1.739.

The updated CEDE inhalation dose with filtered recirculation from file BV487R301Ac is **0.252 rem**.

The *reduction* in CEDE inhalation dose *taking into consideration filtered recirculation* (and assuming a combined normal operation intake/infiltration of 1250 cfm, infiltration during the isolation mode of 450 cfm, and a unfiltered inleakage of 165 cfm during the emergency pressurization mode) is 1.884 rem - 0.252 rem = **1.632 rem**.

Summarized below are the PERC2 Region 5 (CR) ventilation/filtration/inleakage parameters for developing inhalation CEDE dose:

- The PERC2 recirculation filter flow is a continuous 32,400 cfm. The efficiency of the filter is 42.5% (DF 1.739)
- From t = 0 to 77 seconds, 1250 cfm of outside air flow is assumed to enter the CR through the NOP intake (this includes unfiltered inleakage)
- The unfiltered inleakage from t=77 seconds, and until manual operator action initiates emergency ventilation at t= 30 minutes (i.e., during the CR isolation mode), is 450 cfm
- From t=30 minutes to t=30 days, 173 cfm of unfiltered air is assumed to enter the CR (i.e., during the emergency pressurization mode; 165 cfm of unfiltered inleakage plus 1% of the flow that bypasses the intake filter).

Impact on the direct shine (DDE) dose due to Recirculation Filter Shine

The direct shine dose to a control room operator will increase if the recirculation filters are credited. For Unit 1 the dose will increase due to *direct shine* through the U1 CR concrete floor from the recirculation filter located in the U1 CRVS filter room below.

The U2 direct shine dose will increase due to *direct shine* through the wall separating the U2 CRVS filter room and control room, and due to *radiation scatter through the penetrations* in the wall separating the U2 CRVS filter room and control room.

U1/U2 Recirculation Filter Integrated Energy Release

For this assessment the integrated post LOCA source activity on the recirculation HEPA filter is calculated by modifying the PERC2 dose model Region 5 (control Room) parameters in File R301. Only the airborne activity leaking from containment has an aerosol component. The other principal post-LOCA leakage sources addressed by BVPS (i.e., ESF and RWST leakage) are in the form of elemental and organic iodine and thus not relevant to the activity buildup on the HEPA filter. The PERC2 REGION 5 input data to determine the activity buildup in the recirculation HEPA is as follows:

- The PERC2 recirculation filter flow is a continuous 32,400 cfm, 16,200 cfm from Unit 1 and 16,200 from Unit 2. One half of the activity is assigned to the Unit 1 filter and the other half to the Unit 2 filter. The efficiency of the filter is 100% (the assumed DF = 10^4).
- From t = 0 to 77 seconds, 1250 cfm of outside air flow is assumed to enter the CR through the NOP intake (this includes unfiltered inleakage)
- The unfiltered inleakage from t=77 seconds, and until manual operator action initiates emergency ventilation at t= 30 minutes (i.e., during the CR isolation mode), is 450 cfm
- From t=30 minutes to t=30 days, 173 cfm of unfiltered air is assumed to enter the CR (i.e., during the emergency pressurization mode; 165 cfm of unfiltered inleakage plus 1% of the flow that bypasses the intake filter).
- The total (CR) HEPA filter integrated energy release per energy group is calculated by summing/weighting the Region 5 recirculation integrated energy release (ER) interval as follows:

Total ER (MeV-hr-sec) = (∑0-24 hr ER) (1) + (∑24-96hr ER)(0.6) + (96-720 hr ER)(0.4)

The in-leakage pseudo flow of 173 cfm is based on the 165 cfm emergency mode infiltration rate plus 1% of the intake filter bypass flow (i.e.,100%-99%) or 800 cfm x 0.01. Using the minimum CRVS emergency flowrate of 800 cfm is more conservative than using the maximum flowrate of 1000 cfm since the associated exhaust flow acts to deplete the unfiltered inleakage/intake.

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Summary of Results

30-day integrated Dose in CR due to activity buildup on the CRVS emergency intake filters

Unit 1 Control Room Emergency Vent Filter Shine **0.0367 rem** (*unchanged from R2*)

Unit 2 Control Room Emergency Vent Filter Shine (see Figure D1)

Direct Shine	0.062 rem
Penetration Scatter	0.0014 rem
Total	**0.0634 rem**
Hot spot in CR near the North Stairwell door	0.11 rem

Impact of crediting the CRVS recirculation HEPA filters

The 30-day integrated post-LOCA dose to a control room operator will decrease substantially if the recirculation HEPA filters are credited.

From Section D3 the CEDE dose decreases by **1.632 rem** if the recirculation HEPA filters are credited. All of the 1.632 rem is due to post-LOCA airborne aerosols leaking from containment to the environment. Per Ref. D1, in determining the inhalation dose the recirculation filter efficiency is assumed to be only 50% of its expected efficiency rating.

In contrast the maximum DDE dose anywhere inside the CR due to direct and scattered radiation from the U2 and U1 recirculation filters is < 0.1 rem and < 0.02 rem, respectively. In determining the DDE dose, the recirculation HEPA filter efficiency is assumed to be 100%.

Based on the above, it is clear that the current model that does not credit the U1/U2 Recirculation HEPA filters in the LOCA dose consequence evaluation, is bounding.

References

App D Ref.	Calc DIN#	Reference Title and Revision
D1	48	FENOC Letter ND1MDE:0735: BV1 & BV2 Completer reanalysis of Consequences for Tracer Gas Testing and Other Acceptance Criteria Cha Design Input Transmittal DIT-BVDM-0103-02 for Control Room Dose
D2	56	FENOC BVPS-11 Drawing 8700-RM-0003M, Rev. 9, Combined Control Room & Elevation
D3	15	WECTEC Computer Program NU-226, Ver. 00, Lev. 02, PE "Passive/Evolutionary Regulatory Consequence Code"
D4	44	WECTEC Computer Program NU-222, Ver.00, Lev.03, "SW-QADCGGP – A combinatorial Geometry Version of QAD-5A"
D5	32	American National Standard, ANSI-ANS-6.1-1977, "Neutron and Gamma-Ray Flux-to-Dose Rate Factors"
D6	55	ANS/SD-76/14, JC Courtney, "A Handbook of Radiation Shielding Data"

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APPENDIX E
(Developed in Support of Revision 3)

Updated Emergency Response Facility (ERF) / Technical Support Center (TSC) Doses from External Sources

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Objective or Purpose

The objective of Appendix E is assess the impact of the following on the maximum 30-day integrated doses in the Emergency Response Facility, (ERF, represented by Room 143), the Technical Support Center (TSC, Room 119) and the designated entrance to the ERF (Room 112):

a) Changes in design input values of the following parameters used to calculate the dose contribution due to shine from the intake and recirculation filters (previously estimated in Appendix C):

- ERF Minimum Free Volume
- ERF Maximum Recirculation flow rate
- ERF Intake and Recirculation Filter efficiency (specifically, the use of conservative assumptions such that testing is not required)
- ERF Intake filter dimensions
- ERF Recirculation filter dimensions
- Distance between the ERF Intake filter and personnel in the TSC
- Distance between the ERF Recirculation filter and personnel in the TSC
- Distance between the ERF Intake filter and personnel in Room 143 (corridor adjacent to the recirculation filter cubicle, previously not provided)
- Distance between the ERF Recirculation filter and personnel in Room 143 (previously not provided)
- Distance between the ERF Intake filter and personnel in Room 112 (previously not provided)
- Distance / shielding between the ERF Recirculation filter and personnel in Room 112 (previously not provided)
- Occupancy time (previously not provided) for ERF/TSC personnel due to daily passage through Room 112 (Service Dock) when accessing / exiting the ERF/TSC

b) Updated distances between the following external radiation sources and the ERF:

- Distance between the ERF and the Containment
- Distance between the ERF and the RWST

Appendix E Computer Files

File Name	Run Date	Run Time	Program	Description
BV487R3E01p,e,i	02/13/2019	11:10:25	PERC2	Post-LOCA Containment Lkg. ERF Intake Filter
BV487R3E02	02/13/2019	11:13:56	SW-QADCGGP	ERF Intake Filter Direct Shine
BV487R3E03p,e,i	02/13/2019	11:12:06	PERC2	Post-LOCA Containment Lkg. ERF Recirc Filter
BV487R3E04p,e,i	02/13/2019	11:12:59	PERC2	Post-LOCA ESF Lkg. ERF Recirc Filter
BV487R3E05	02/13/2019	11:14:15	SW-QADCGGP	Std. Block Point Src.TF- shielded detector point
BV487R3E06	02/13/2019	11:14:28	SW-QADCGGP	Std. Block Point Src.TF- unshielded detector point
BV487R3E07	02/13/2019	11:14:48	SW-QADCGGP	Royal Rib Block Point Src TF – shielded det. point
BV487R3E08	02/13/2019	11:15:11	SW-QADCGGP	Royal Rib Block Point Src TF – unshielded det. point
BV487R3E09	02/13/2019	11:15:24	SW-QADCGGP	ERF Recirculation Filter Direct Shine

The suffix p, e and I indicate PERC2 output files PERC.OUT, EQDOSE.OUT and EQINT.OUT. PERC.OUT validates all user case input and library data in the subject file. EQDOSE.OUT and EQINT.OUT provide gamma energy release rate (MeV/sec) and integrated gamma energy release (MeV-hr/sec) for 18 standard energy groups.

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Background / Approach / Changes to Design Inputs

Background:

Appendix B was developed in Revision 0 to determine the 30-day Deep Dose Equivalent (DDE) to personnel located in the Emergency Response Facility (ERF) due to the following external radiation sources after a LOCA in either unit of BVPS:

- Direct shine and skyshine from the reactor containment
- External cloud shine due to containment leakage, ESF leakage, and RWST leakage
- Direct shine from ERF intake filters due to containment leakage
- Direct shine from ERF Recirculation filters due to containment leakage, ESF leakage and RWST leakage
- Direct shine from the radiation source inside the RWST due to RWST back leakage

Appendix B was revised in Revision 1 to address the impact of the changes in the recirculation spray system operation incorporated as part of the resolution to GSI-191.

Appendix C was developed in Revision 2 to scale the doses developed in Appendix B, Revision 1 to address:

a) BVPS-2 RSGs/RRVCH
b) Westinghouse NSAL 11-5 on the post-LOCA M&Es (and the consequent effect on the containment pressure / temperature transient).

The scaling factors developed in Appendix C were not significant, and the resultant impact on the doses calculated in Appendix B, was minimal.

Revision 3 has not changed the LOCA activity transport model up to and including the environmental release developed in Revision 2. In addition, there have been no changes in the applicable atmospheric dispersion factors. What has changed are some of the design input values and assumptions associated with the ERF as discussed in the Objective of Appendix E.

Approach:

Appendix E was developed to revise and replace, as necessary, the assessments made for four of the 5 sources listed above, and documented in Appendix B.

a) Section E1 addresses the impact of updated estimated distances between a) the Containment and the ERF and b) the RWST and the ERF, on the associated direct shine dose contribution.

b) Section E2 addresses the impact of updated design input values that effect the dose contribution from the normal operation intake ventilation HEPA filter.
c) Section E3 addresses the impact of updated design input values that effect the dose contribution from the post-accident recirculation ventilation HEPA and charcoal filter.

Changes to Design Input [Reference E1]

As noted in Appendix B, the ERF is a large one story building (approximately 192' x 164' x 16') located at ~1200 ft ESE of Unit 2 containment and ~1700 ft ESE of Unit 1 containment. It is clear that the Unit 2 accident will result in a higher dose to personnel in the ERF. The ERF includes TSC, computer room, offices, dosimetry / counting room, records/ storage room, and miscellaneous equipment rooms (as noted in Reference E1, the Emergency Operation Facility (EOF) has been relocated and no longer resides in the ERF).

During normal operation, the ERF ventilation intake flow is filtered by a HEPA filter. Following a LOCA, the ERF ventilation is manually isolated and placed in the recirculation mode through a HEPA filter and a charcoal filter. The intake filter is located in room 112 (service dock) and the recirculation filters are located in room 109B (mechanical room B). Both rooms are out of the ERF habitability envelope. Refer to Figure E1 for a sketch (obtained from Reference E1) of the ERF/TSC area and the location of the referenced filters.

Summarized below are the changes in design input from that used in Appendix B:

a) ERF Minimum Free Volume – changed from a free volume of 5% less than 5.038E+5 ft^3 to 462,129 ft^3

b) ERF Maximum Recirculation flow rate – changed from 3800 cfm ± 10%, to 7200 cfm ± 10%

c) ERF Intake and Recirculation Filter efficiency – changed from "specified values" to "conservative assumptions" such that testing is not required. Specifically, Appendix E utilizes a bounding approach with respect to estimating the direct shine dose from the ERF/TSC intake and recirculation ventilation filters. Specifically, the filters are assumed to be 100% or 0% efficient, as deemed conservative, when addressing the direct shine dose. For example, to maximize the intake filter shine when calculating the direct shine dose, a 100% efficiency is assumed. However, to maximize the direct shine dose from the recirculation filter, it is assumed that the intake filters have 0% efficiency. Also, to maximize the recirculation filter shine when calculating the direct shine dose, a 100% efficiency is assumed. (also see Note 1)

d) ERF Intake HEPA filter (1-VS-FL-40) dimensions – changed from 46"x55"x22.5", to 48"x48"x11.5" (see Note 1)

e) ERF Recirculation filter dimensions (see Note 1)
   - HEPA filter (1-VS-FL-42) dimensions – changed from 47"x57"x22.5", to 48"x48"x11.5"
   - Charcoal filter (1-VS-FL-43) dimensions – changed from 26.75"x24"x2", to 25.5"x22.75"x2"

f) Distance between the ERF Intake filter and personnel in the TSC - changed from 168 ft, to 156 ft. *No credit is taken for shielding due to the presence of a door between Room 112 (service dock where the intake filter is located) and the ERF. Also, no credit is taken for internal walls in the ERF such as that associated with the TSC.*

g) Distance between the ERF Recirculation filter and personnel in the TSC - changed from 123 ft, to 126 ft. *Shielding credit taken for 8" ribbed block (interior wall between Room 109B, where the recirculation filter is located, and adjacent Corridor 143 in the ERF*). *Also, no credit is taken for internal walls in the ERF such as that associated with the TSC*.

h) Distance between the ERF Intake filter and personnel in Room 143 (corridor adjacent to the recirculation filter cubicle) - 25 ft (previously not provided). *No credit is taken for shielding because of the presence of a door between Room 112 (service dock where the intake filter is located) and the ERF*

i) Distance between the ERF Recirculation filter and personnel in Room 143 – 6.5 ft (previously not provided) *Shielding credit taken for 8" ribbed block (interior wall between Room 109B, where the recirculation filter is located, and adjacent Corridor 143 in the ERF*)

j) Distance between the ERF Intake filter and personnel in Room 112 - 2 ft (previously not provided). *There is no shielding, filter is located overhead*

k) Distance / shielding between the ERF Recirculation filter and personnel in Room 112 – 4.5 ft (previously not provided). *Shielding credit taken for 8" concrete block (interior wall between Room 109B, where the recirculation filter is located, and the service dock Room 112).*

l) Occupancy time (previously not provided) for ERF/TSC personnel due to daily passage through Room 112 (Service Dock) when accessing / exiting the ERF/TSC – 10 mins/day

m) Distance between the ERF and the Containment – changed from 1194 ft to 1150 ft

n) Distance between the ERF and the RWST – changed from 1050 ft to 1004 ft

o) Initiation of recirculation mode – changed from at t=30mins, to anytime between t=30 mins to t=1 hour. Note: Initiation at t=30 mins remains bounding for accumulation of activity in the recirculation filter, so there is no change to the Rev 2 model.

p) 8-inch Standard hollow concrete block has an equivalent thickness of 3.77 inches of concrete, density 2.19 g/cc

q) 8-inch Royal Rib hollow concrete block has an equivalent thickness of 4.85 inches of concrete, density 2.19 g/cc

Note 1: Pre-filters are provided to remove large particles /debris in the flow stream to protect filtration equipment. Post-filters are provided to mainly to collect carbon dust and protect ventilation systems. Both pre-filters and post filters are expected to have minimal activity and are ignored in this assessment. Since the methodology collects 100% of the activity in the HEPA and charcoal filter, this model simplification has no impact on the results

ERF Exterior Shielding

Per Reference E1, the ERF/TSC (exterior) walls are at a minimum comprised of 2 courses of hollow concrete block, each being a nominal 8" thick. The outer course is Royal Rib block having cast-in ribbing on the outside surface. The inner course is standard block. The equivalent thickness of one layer of standard block is 3.77 inches of concrete. The equivalent thickness of one layer of Royal Rib block is 4.85 inches of concrete. There are reinforcing rods and a 3/8" layer of mortar between courses (not addressed in this analysis). The concrete density in the block is 2.19 gm/cc. Some ERF walls are constructed of either a combined 20" thick reinforced concrete and 4" solid ribbed back or 2'-0" thick reinforced concrete. The roof of the ERF is constructed of 6.75" structural concrete with a density of 2.4 gms/cc. (See Ref. E1 Item 18)

A major breach in the ERF design is that there is a hollow core (with polyurethane) double door (119/4) located on the north wall which will allow; a) line of sight to the BVPS-2 containment; and b) direct shine into the ERF/TSC from the contaminated plume outside the ERF.

Direct shine through other doors is shielded by concrete porticos and double door vestibules.

The combined issues concerning breaches in shielding, and ambiguity in the ventilation system design parameters led to the assumption in the Revision 0 analysis, that emergency personnel would be conservatively assumed to be located on the roof of the ERF, (i.e., no credit for structure or ventilation). However, since it was conservative to assume the ERF ventilation filters were available as a direct shine source, they were included Revision 0 as a dose contributor. Revision 3 herein will continue with the approach established in Revision 0.

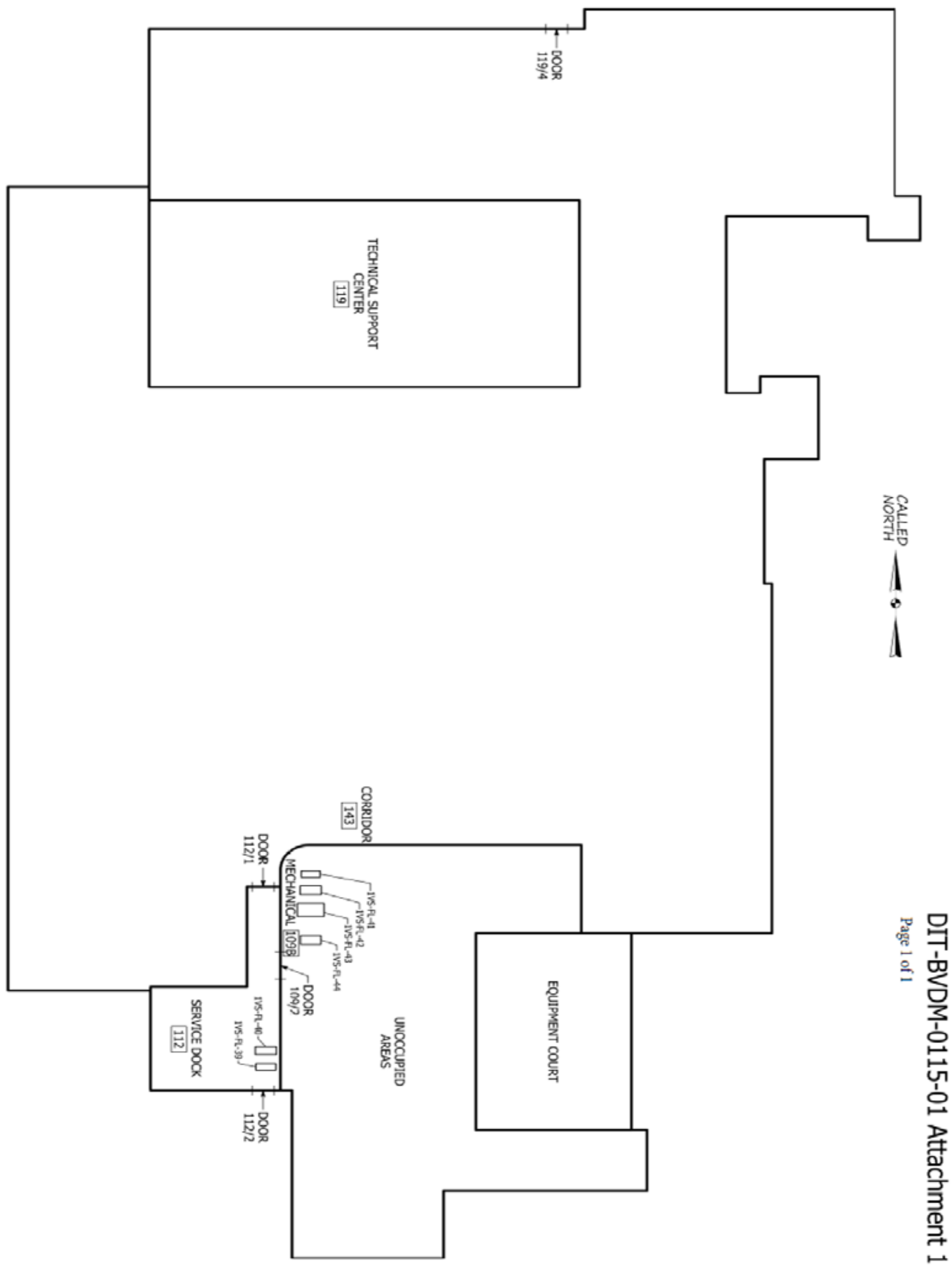
Interior Shielding

The principal source in the ERF/TSC structure that contributes to the DDE are the normal operation intake and emergency recirculation filters:

- The intake filter is located in the Service Dock (Room 112) which is also the designated personnel entrance point. The filter can shine directly, unshielded, into the service dock area. Due to hollow core door 112/1 (See Figure E1) the activity accumulated on the intake filter can also shine directly into the ERF, i.e., into the adjacent corridor 143 and other areas occupied by personnel (such as in the TSC). Thus, in accordance with Reference E1 no shielding is credited for intake filter direct shine assessments.

- The recirculation filters are located in an unoccupied area Room 109B (Mechanical Room). Single layer Standard block walls and Royal Rib block walls as described above shields the filters from occupied areas of the ERF. Gamma radiation scattering is possible to areas in Rm 112 through door 109/2. Review of Ref. E2 indicates that the referenced door has a 3' thick block wall labyrinth. The walls and labyrinth prevent direct shine of the recirculation filters into Rm 112 (Ref.E1, Item 25). Scattered radiation is also possible into occupied areas of the ERF including Rm 143 and Rm 119 (Ref. E1) thru a duct penetration in the Royall Rib block wall that separates these areas from the mechanical room (109B).

Figure E1
ERF Facility Sketch



E1 Dose from External Sources

E1.1 Direct shine and Skyshine from the reactor containment

Per Item 20 of Ref. E1, the minimum distance from containment to the ERF has been updated from the Revision 2 value of 1194 ft, to 1150 ft. The updated value is about 96% of the Rev.2 value. Per Appendix B of Rev.2, Section B1, the actual value used in the dose assessment was 1110 ft., which was a discrete point from the calculation that determined the dose vs distance from containment. Since the value of 1110 ft continues to be conservative (i.e., 1110 ft < 1150 ft), the previously estimated dose contribution in Revision 2 due to containment shine/skyshine *remains unaffected*.

E1.2 External cloud shine due to containment leakage, ESF leakage, and RWST leakage

Since there is no change in the activity transport model addressed in Revision 2, and the detector point representing personnel in the ERF is on the roof of the ERF *(i.e., changes in the ERF building layout, shielding or ventilation are not relevant to this detector location)*, the previously estimated dose due to external cloud shine resulting from containment leakage, ESF leakage, and RWST leakage *remains unaffected*.

E1.3 Direct shine from ERF intake filters due to containment, ESF, and RWST leakage.

Reference E1 has identified several changes to the ERF ventilation system model; therefore, the post-LOCA dose to personnel located in the ERF from intake filter direct shine/scattered radiation is revised in its entirety in section E.2 herein.

E1.4 Direct shine from ERF Recirculation filters due to containment, ESF, and RWST leakage

Reference E1 has identified several changes to the ERF ventilation system model; therefore, the post-LOCA dose to personnel located in the ERF from recirculation filter direct shine is revised in its entirety in section E.3 herein.

E1.5 Direct shine from the radiation source inside the RWST

Per Item 26 of Ref. E1, the minimum distance from the RWST to the ERF has been updated from the Revision 2 value of1050 ft to 1004 ft. The updated value is about 96% of the Rev.2 value. Reference E1 also states that the elevation of the road surface of the Route 168 ramp credited for shielding remains at El. 750 ft. Section B5 of Rev.2 states that the since the highway elevation of Route 168 is 750 ft, the RWST source is shielded by the interfering roadway for a person in the ERF (730.5 ft floor elevation) and goes on to state that the scattered dose will be insignificant. The 4% reduction in the estimated distance from the RWST and the ERF will not change the conclusion in Appendix B of Rev. 2, i.e., that the dose to personnel located in the ERF from the RWST is insignificant. Thus the conclusions of Revision 2 *remains unaffected*.

E2 Dose Due to the Normal Operation Intake Filter

The DDE dose due to direct shine from radioactivity collected on the ERF intake HEPA filter is calculated using WECTEC program SW-QADCGGP. Per Ref.E1, Items 23 & 25, shielding is not credited when estimating the dose due to direct shine from the intake filter to ERF personnel. Thus, the contribution due to scatter may be ignored since it will be negligible when compared to the Line-Of-Site (LOS) dose.

WECTEC program PERC2 is used to calculate the radiation source term that is used in SW-QADCGGP (i.e., the gamma energy release rate and integrated energy release per energy group during the 30 minutes before the filter is isolated after the LOCA, as well as the gamma energy release due to ~30 days of activity decay that occurs after the filter is isolated).

E2.1 Gamma Energy Release Rate and Integrated Release

The normal operation ventilation system provides HEPA filtration of outside air intake flow. Following a LOCA, the intake is manually isolated within 30 minutes of the event. Activity transport and dose program PERC2 (described in the main body text) is used to calculate the gamma energy release rate and integrated energy release due to 30 minutes of containment leakage following a postulated LOCA, as well as the gamma energy release due to ~30 days of activity decay that occurs after the filter is isolated. Note that since there are no particulates in the other leakage pathways following a LOCA (i.e., ESF and RWST), these leakage pathways do not affect the radioactivity accumulated on the ERF intake HEPA filter.

The input data used to calculate the gamma source strength is as follows:

No	Description	Reference
1)	ERF free volume - 462,129 ft^3	E1
2)	Normal intake flow – 4180 cfm (3800 cfm ± 10%)	E1
3)	Normal intake filter efficiency - 99% on HEPA filter for all particulates (100% used herein)	E1
4)	Maximum unfiltered in-leakage during normal operation - 2090 cfm	E1
5)	Delay time for initiating ERF isolation and emergency recirculation ventilation mode - 30 min	E1
6)	ERF Occupancy factors: 1.0 for integration between 0-24 hr; 0.6 for integration between 24-96 hr; 0.4 for integration between 96-720 hr	E1
7)	Maximum Containment X/Qs (Table E1) – unchanged from Appendix B	E7

Table E1

Bounding Containment/ESF Environmental Release to ERF Dispersion Factors (X/Qs)

Time After LOCA	Maximum Containment / ESF Environmental Release X/Qs (Sec/m^3)
0 - 2 hr	7.22E-05
2 – 8 hr	6.43E-05
8 – 24 hr	2.96E-05
1 - 4 day	2.48E-05
4 – 30 day	2.15E-05

Note: The PERC2 LOCA containment leakage activity transport model used herein is based on the latest parameter values outlined in Rev.2 (which is unaffected by Rev. 3), which includes:

a) BVPS2 RSGs/RRVCH
b) Westinghouse NSAL 11-5 on the post-LOCA M&Es (and the consequent effect on the containment pressure / temperature transient)

Therefore, the scaling factors developed in Appendix C of Rev. 2 are not required for the containment leakage activity transport runs generated herein.

The calculated gamma energy release rate and integrated energy release due to 30 minutes of containment leakage following a postulated LOCA as well as the gamma energy release due to ~30 days of the activity decay that occurs after the filter is isolated is presented in Table E2.

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E2.2 Direct shine from ERF Intake Filter

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E3 Dose Due to the Emergency Recirculation Filters

Consistent with Appendix B of Revision 2, the airborne activity due to post-LOCA containment and ESF leakage will be assumed to accumulate on the Recirculation HEPA (1VS-FL-42) and charcoal (1VS-FL-43) filters. As noted in Appendix B, the activity release due to RWST back-leakage is negligible.

As noted in the design input section, the recirculation system is assumed to be initiated 30 minutes after the LOCA, coincident with the isolation of the intake flow. This assumption is more conservative than assuming initiation of the recirculation system at t=60 mins.

The DDE dose due to direct shine from activity accumulated on the ERF recirculation filters is calculated with WECTEC gamma-ray-trace program SW-QADCGGP. Similar to the approach used in Appendix B, the activity in the charcoal filter is combined with the activity on the HEPA filter, all of which is accumulated on the HEPA filter. This approach is conservative because self-attenuation in HEPA filter (typically modeled as an air medium) is less than that in charcoal filter.

Since shielding is credited for recirculation filter shine, and there are penetrations in these shield walls, a dose contribution due to scatter is addressed. As stated above, the recirculation filters are located in an unoccupied area, Rm 109B (See Figure E1). Single layer Standard block and "Royal Rib" block walls shield the filters from occupied areas of the ERF /Service dock area. The analysis herein addresses the potential for radiation scatter from the filters located in the mechanical room, to areas within Rm 112 (through the double door 109/2) and into Rm 143 (through a large duct penetration). The door (109/2) between Room109B and Rm 112 has a 3' labyrinth that prevents direct shine from the filters into Rm 112 (Ref. E1, Item 25 and Ref. E2).

To account for the contribution due to scatter, a conservative/representative unshielded dose is calculated from the recirculation filter *at the same location* as the shielded dose, then a total integrated dose albedo is applied to the unshielded dose value. **[**

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WECTEC activity transport and dose program PERC2 is used to calculate the source input to SW-QADCGGP (i.e., gamma energy release rate and integrated energy release per energy group from 30 minutes to 30 days after the LOCA.

E3.1 Gamma Energy Release Rate and Integrated Release

The input data used to calculate the gamma source strength is as follows:

No	Description	Reference
1)	ERF free volume - 462,129 ft^3	E1
2)	T=0-30 min.: normal Intake rate - 4180 cfm	E1
3)	Normal intake filter efficiency - 99% on HEPA filter for all particulates (*however, 0% efficiency used herein for recirculation filter shine*)	E1

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No	Description	Reference
4)	T=0-30 min: maximum unfiltered in-leakage during normal operation - 2090 cfm	E1
	T= 0-30 min: filtered recirculation rate 0 cfm	E1
5)	Delay time for initiating ERF isolation and emergency recirculation ventilation mode - 30 min	E1
6)	T>30 min: normal intake rate - 0 cfm	E1
7)	T>30 min: maximum in-leakage rate during emergency operation 910 cfm	E1
8)	T>30 min maximum emergency recirculation rate = 7920 cfm	E1
9)	T>30 min: recirculation filter efficiency 100%	E1
10)	ERF Occupancy factors: 1.0 for integration between 0-24 hr; 0.6 for integration between 24-96 hr; 0.4 for integration between 96-720 hr	E1
11)	Bounding X/Qs (Table E1)	E7

Note: The PERC2 LOCA containment leakage activity transport model used herein is based on the latest parameter values outlined in Rev.2 (unaffected by Rev. 3), which includes:

a) BVPS2 RSGs/RRVCH
b) Westinghouse NSAL 11-5 on the post-LOCA M&Es (and the consequent effect on the containment pressure / temperature transient).

Therefore, the scaling factors developed in Appendix C of Rev. 2 are not required for containment leakage activity transport runs generated herein.

The calculated gamma energy release rate and integrated energy release from activity buildup on the recirculation filters due to ~30 days (i.e., the system is initiated 30 minutes after the LOCA) of containment and ESF leakage following a postulated LOCA is presented below in Table E6. As noted earlier, RWST leakage is negligible and not addressed herein.

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E3.2 Shielding – Concrete Block Wall Transmission Factors

From Reference E1, item 18, the equivalent thickness of 8" Standard concrete block is 3.77 inches of concrete with a density of 2.19 gm/cc. Also, the equivalent thickness of 8" Royal Rib concrete block is 4.85" inches of concrete with a density of 2.19 gm/cc.
Reference E1 identifies the following ERF recirculation filter shielding configurations:

- Standard block wall separating the recirculation filter and Rm 119 (TSC)
- Standard block wall separating the recirculation filter and Rm 143 (Corridor)
- Royal Rib block wall separating the recirculation filter and Rm 112 (Service Dock)

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E3.3 Dose to Personnel in ERF due to Recirculation Filter Shine

The SW-QADCGGP model is briefly described below:

- Source[(a)] Dimension – 4 filters at 24" x 24" x 11.5" depth, arranged as 2 by 2 array
  Medium – air
  Source spectrum – 1 Mev/s/cc for each of the 18 PERC2 energy groups
  Source normalization factor (Ao) – 1.0
- Shields none considered
- Detector D1 – 4.5 ft. from the Recirc filter in Rm 109B to Dock Area Rm 112, unshielded[(b)]
  D2 – 6.5 ft. from the Recirc filter in Rm 109B to Corridor Area Rm 143 unshielded[(b)]
  D3 – 126 ft. from the Recirc filter in Rm 109B to TSC Rm 119 unshielded[(b)]
- •Miscellaneous Build-up factor – Air buildup
  Dose conversion factors –Rem/hr per Mev/s/cm^2,
  from ANSI/ANS 6.1-1977 (Ref. E5)

Note:

(a) Consistent with Rev. 2 Appendix B, the airborne containment and ESF post-LOCA environmental activity leakage will conservatively be assumed to accumulate on the Recirculation HEPA filter;

(b) shielding is conservatively credited using point source concrete shield transmission factors from Table E7 and E8.

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E3.3.1: Direct Shine Dose From Recirculation Filter - Containment leakage

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E3.3.2: Direct Shine Dose From Recirculation Filter - ESF leakage

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Summary of Results

Intake and Recirculation Filter Shine

Summarized below are the estimated maximum dose rates in the ERF (represented by Room 143), the TSC (Room 119) and the designated entrance to the ERF (Room 112)

Table E15

Maximum Dose Rates

	Table	Intake Filter rem/hr	Cont Lkg Recirc Filter rem/hr	ESF Lkg Recirc Filter rem/hr	Total Dose Albedo	Dose Rate rem/hr	Comment
Location: Dock (Rm 112) - Time: 30 min							
No Shield	E3	4.90E-02	----	----	----	4.90E-02	from Intake
Block Shield	N/A	----	0	0	----	0.00E+00	from Recirc
Unsh-Scatter	N/A	----	0	0	0.2	0.00E+00	from Recirc scatter
						0.049	T=30 min
Location: Dock (Rm 112) - Time: ~ 4 hours							
No Shield	E3	1.74E-02	----	----	----	1.74E-02	from Intake
Block Shield	E9,E12	----	1.54E-02	1.94E-03	----	1.73E-02	from Recirc
Unsh-Scatter	E9,E12	----	2.53E-02	3.16E-03	0.2	5.69E-03	from Recirc scatter
						0.040	T= 3 to 4 hours
Location: Corridor (Rm 143) - Time: ~ 4 hours							
No Shield	E4	2.23E-04	----	----	----	2.23E-04	from Intake
Block Shield	E10,E13	----	4.74E-03	5.93E-04	----	5.33E-03	from Recirc
Unsh-Scatter	E10,E13	----	9.61E-03	1.20E-03	0.2	2.16E-03	from Recirc scatter
						0.008	T= 3 to 4 hours
Location: TSC (Rm 119) - Time: ~ 4 hours							
No Shield	E5	6.25E-06	----	----	----	6.25E-06	from Intake
Block Shield	E11,E14	----	1.92E-05	2.41E-06	----	2.16E-05	from Recirc
Unsh-Scatter	E11,E14	----	3.88E-05	4.88E-06	0.2	8.74E-06	from Recirc scatter
						3.66E-05	T= 3 to 4 hours

Notes:

1. The max scatter dose rate is the sum of all applicable unshielded contributors times the Total Dose Albedo
2. The maximum dose rate in the Service dock is at t=30 mins, whereas that is the ERF /TSC is at T~4 hrs

Summarized below are the estimated maximum 30-day integrated doses in the ERF (represented by Room 143), the TSC (Room 119) and the designated entrance to the ERF (Room 112)

Table E16

Maximum 30-day Integrated Dose

	Table	Intake Filter rem	Cont Lkg Recirc Filter rem	ESF Recirc Filter rem	Total Albedo	Dose rem	Comment
Location: Dock (Rm 112) - Time: 30 day dose							
No Shield	E3	8.80E-01	----	----	----	8.80E-01	from Intake
Block Shield	E9,E12	----	7.75E-01	5.71E-01	----	1.35E+00	from Recirc
Unsh-Scatter	E9,E12	----	1.32E+00	1.02E+00	0.2	4.68E-01	from Recirc scatter
						2.7	
Location: Corridor (Rm 143) - Time: 30 day Dose							
No Shield	E4	1.13E-02	----	----	----	1.13E-02	from Intake
Block Shield	E10,E13	----	2.32E-01	1.64E-01	----	3.96E-01	from Recirc
Unsh-Scatter	E10,E13	----	5.03E-01	3.87E-01	0.2	1.78E-01	from Recirc scatter
						0.59	
Location: TSC (Rm 119) - Time: 30 day Dose							
No Shield	E5	3.20E-04	----	----	----	3.20E-04	from Intake
Block Shield	E11,E14	----	9.53E-04	6.92E-04	----	1.65E-03	from Recirc
Unsh-Scatter	E11,E14	----	2.04E-03	1.61E-03	0.2	7.30E-04	from Recirc scatter
						0.0027	

Note:

1. The maximum scatter contribution to the 30-day integrated dose is the sum of all applicable unshielded contributors times the Total Dose Albedo

1. **Dose to personnel in the Service Dock (Rm 112) due to the Intake and Recirculation Filters:**

The maximum dose rate occurs at t=30 min after the LOCA from the Intake filter 49 mrem/hr

The maximum dose rate occurs at t=3 to 4 hrs post-LOCA from the Intake & Recirc filter (including scatter) 40 mem/hr

The 30-day integrated dose in the dock area from the Intake & Recirc filter (including scatter), with occupancy factors is: 2.7 rem

Assuming 10 minute stay time per day in the Service Dock, the 30-day integrated dose is reduced to

2.7 rem (10 min/1440 min) = **0.02 rem**

Note: The dose and dose rates above are conservative as they assume that an individual is located in the dock area at the worst location for each filter source, not at a specific point.

2. **Dose to personnel located in the ERF Corridor (Rm 143):**

The maximum dose rate occurs at t=3 to 4 hrs post-LOCA from the Intake & Recirc filter (including scatter) 8 mrem/hr

The 30-day integrated dose in Rm 143 from the Intake & Recirc filter (including scatter), with occupancy factors is 0.59 rem

Note: The dose and dose rates above are conservative as they assume that an individual is located in ERF corridor (Room 143) at the worst location for each filter source, not at a specific point.

3. **Dose to personnel located in the TSC (Rm 119):**

The maximum dose rate occurs at t=3 to 4 hrs post-LOCA from the Intake & Recirc filter (including scatter) 0.037 mrem/hr

The 30-day integrated dose in Rm 119 from the Intake & Recirc filter (including scatter), with occupancy factors is: 0.0027 rem

Note: The dose and dose rates above are conservative as they assume that an individual is located in the TSC at the worst location for each filter source, not at a specific point.

In summary

The maximum dose to an individual located in the ERF following a postulated LOCA due to ERF filter shine is based on the 30-day integrated dose in Room 143, plus the dose received during the 10 mins spent in Service Dock (Room 112) due to daily passage through Room 112 (Service Dock) when accessing / exiting the ERF/TSC

= 0.59 (1430 min /1440 min/day) + 2.7 rem (10 min/1440 min/day) = **0.6 rem**

Where the dose contribution of the filters are as follows:

- Intake Filter: (0.0113 rem x (1430/1440) + 0.88 rem x (10/1440) = **0.017 rem**
- Recirculation Filter: (0.59-0.0113) x (1430/1440) + (2.7-0.88) rem x (10/1440) **= 0.583 rem**

Based on the information summarized above, the results documented in Appendix C, Revision 2 is updated as follows:

Updated TABLE B-5 of Appendix C (see § C4)
Summary of ERF External Shine Dose
Following a LOCA in Unit 2 Reactor (Rem)
(Unit 2 is the bounding unit)

Source	Reference	ERF Occupied Areas (Max)
Containment Shine	App C, § C4, TBL. B-1	1.78E-01
External Cloud Shine[3]	See Table 11	
ERF Intake Filter Shine[1,2]	§ E2 & Summary	1.70E-02
ERF Recirculation Filter Shine[1,2]	§ E3 & Summary	5.83E-01
RWST Direct Shine	Appendix B § B5	Negligible
Total		**0.78**

[1] Dose point "Corridor, Rm 143"

[2] Value includes 10 minutes per day occupancy in Service dock area Rm 112 (ERF Entryway Point)

[3] Since the dose point representing the ERF is on the roof of the building (i.e., outside the structure), no direct shine shielding assessment is needed to estimate the contribution of shine into the ERF from the external cloud. The PERC2 results presented in Table 11 under the DDE column of the "Immersion Pathway" section, for Containment, ESF and RWST leakage, represents the contribution of "external cloud shine".

References

App D Ref.	Calc DIN#	Reference Title and Revision
E1	49	FENOC Letter ND1MDE:0739: BV1 & BV2 Completer reanalysis of Dose Consequences for Tracer Gas Testing and Other Acceptance Criteria Changes: Design Input Transmittal DIT-BVDM-0115-01 for Emergency Response Facility (ERF)
E2	54	FENOC Drawing 8700-RA-60A-2, Emergency Response Facility Structure
E3	15	WECTEC Computer Program NU-226, Ver. 00, Lev. 02, PERC2, "Passive/Evolutionary Regulatory Consequence Code"
E4	44	WECTEC Computer Program NU-222, Ver.00, Lev.03, "SW-QADCGGP – A combinatorial Geometry Version of QAD-5A"
E5	32	American National Standard, ANSI-ANS-6.1-1977, "Neutron and Gamma-Ray Flux-to-Dose Rate Factors"
E6	20	S&W Calculation 8700-EN-ME-105, Rev.0, "Relative Atmospheric Dispersion Factors (X/Qs) at Control Room and ERF Receptors for Unit 1 Accident Releases"
E7	21	S&W Calculation 10080-EN-ME-106, Rev.0, "Relative Atmospheric Dispersion Factors (X/Qs) at Control Room and ERF Receptors for Unit 2 Accident Releases"
E8	55	Courtney, J.C., ANS/SD-76/14, A Handbook of Radiation Shielding Data, July 1976

FirstEnergy	CALCULATION COMPUTATION NOP-CC-3002-01 Rev. 05
CALCULATION NO.: 10080-UR(B)-487	REVISION: 3

Attachment 1

FirstEnergy Design Input Transmittal

DIT-BVDM-0113-00 transmitted via Letter ND1MDE:0733

October 30, 2018

FENOC
FirstEnergy Nuclear Operating Company

Beaver Valley Power Station
P.O. Box 4
Shippingport, PA 15077

Patrick G. Pauvlinch
Manager, Design Engineering
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Phone: 724-682-4982
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ND1MDE:0733
October 30, 2018

Sreela Ferguson
WECTEC
720 University Ave.
Norwood, MA 02062

BV1 & BV2 Complete Reanalysis of Dose Consequences
For CRE Tracer Gas Testing and Other Acceptance Criteria Changes
Design Input Transmittal DIT-BVDM-0113-00 for Loss of Coolant Accident (LOCA)

Dear Ms. Ferguson:

Attached is Design Input Transmittal DIT-BVDM-0113-00 which provides information for performing the Loss of Coolant Accident analysis.

Should you have any questions about the attached information, please contact Douglas Bloom at 724-682-5078 or Mike Ressler at 724-682-7936.

Sincerely,

Patrick G. Pauvlinch
Manager, Design Engineering

DTB/bls

Attachment

cc: M. G. Unfried
M. S. Ressler
D. T. Bloom
BVRC

FirstEnergy

CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-487	REVISION: 3

Form 1/2-ADM-2097.F01, Rev 0 RTL# A1.105V

DESIGN INPUT TRANSMITTAL

☒ SAFETY RELATED / AUG QUAL ☐ NON-SAFETY RELATED	Originating Organization: ☒ FENOC ☐ Other (Specify)	DIT- BVDM-0113-00 Page 1 of 1
Beaver Valley Unit: ☐1 ☐2 ☒Both System Designation: Various Engineering Change Package: N/A		To: Sreela Ferguson Organization: WECTEC

Subject: **Design Input Transmittal for Reanalysis of Dose Consequences For a BV1 or BV2 Loss of Coolant Accident**

Status of Information: ☒Approved for Use ☐Unverified

For Unverified DITs, Notification number tracking verification: ______________________

Description of Information:

Safety Analysis Design Inputs? ☒Yes ☐No

Reconciled to Current Design Basis? ☒Yes ☐N/A

This DIT provides information required for the performance of the Loss of Coolant Accident dose consequence design basis accident calculation. This supports a proposed License Amendment Request (LAR) involving the control room envelope tracer gas testing criteria.

Purpose of Issuance:

This DIT provides information required for the performance of design basis accident dose consequence calculation UR(B)-487.

Source of Information (Reference, Rev, Title, Location): Engineering Judgment Used? ☐Yes ☒No

See attachment to DIT table.

Preparer: D. T. Bloom	Preparer Signature: [signature]	Date: 10-29-18
Reviewer: K. J. Frederick	Reviewer Signature: [signature]	Date: 10-29-18
Approver: M. S. Ressler	Approver Signature: MS Ressler	Date: 10/30/2018

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comments**

General Notes:

1. The equipment / parameter values presented in the table below as approved design inputs to be used for the LOCA analysis reflect safety related components that can be credited in design bases dose consequence analyses; i.e., the components have the appropriate redundancy, environmental qualification, pedigree, seismic support, etc., applicable to safety related equipment, and the parameter values reflect single failure criteria.
2. The critical input values are: Core Inventory, Fuel peak burnup(≤ 62,000 MWD/MTU), Minimum containment free volume, Maximum spray initiation time after receipt of CIB signal, Containment spray coverage, Spray cutoff time, Containment mixing rate, Aerosols and elemental iodine removal coefficients in sprayed region, Aerosol removal lambda in unsprayed region due to gravitational settling, Long term sump water pH, Leakage rate from containment, ESF leak rate & duration, Minimum volume and mass of sump water versus time after switchover to the recirculation phase, Peak sump water temp after switchover, Initiation time of sump back leakage into RWST after LOCA, Sump water back flow rate into RWST, Time after LOCA (including duration) when RWST back-leakage is released to the environment via the RWST vent, Iodine release fraction via RWST vent versus time, Maximum delay in attaining control room isolation, CR emergency ventilation initiation, CR intake atmospheric dispersion factors, Control Room unfiltered inleakage
3. Parameter values provided below reflect the bounding value applicable to Unit 1 and Unit 2

Source Term

Parameter	Value	Reference	Value	Reference	Comments
1. Core Power Level (with power uncertainty) used to establish radiation source terms	2918 MWt	FENOC letter ND1MDE:0374, [Table 1], 09/20/06	2918 MWt	BV1 Renewed Operating License DPR-66 BV2 Renewed Operating License NPF-73 BV1 LRM B 3.3.8 BV2 LRM B 3.3.8 BV1/2 TS 5.6.3	Rated Thermal Power shall not exceed 2900 MWt. Total power measurement uncertainty of better than +/- 0.6% of RTP at full power is achieved using the Leading Edge Flow Meter. 2900 MWt x 1.006 = 2917.4 MWt

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comments**
2. Design Basis Core Activity	As provided in S&W reference calculation	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 S&W calculation 10080-UR(B)-483, R0	As provided in Reference	BV1/2 Calculation UR(B)-483	The current design basis composite equilibrium core inventory, which is based on 2918 MWt, an 18 month burnup cycle and initial enrichments from 4.2% to 5%, is appropriate and is not being changed.
3. Initial Reactor Coolant System (RCS) activity concentrations (μCi/gm) – Technical Specification (T/S) values	Reactor coolant activity limited to: ≤ 0.35 μCi/gm Dose Equivalent I-131 (DE I-131) ≤ 100/E_{BAR} μCi/gm Isotopic inventory from referenced calculation	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 BVPS 1 T/S Section 3.4.8 BVPS 2 Tech spec Section 3.4.8 S&W calculation 10080-UR(B)-484, R0/A1	Reactor Coolant Dose Equivalent I-131 specific activity limited to: ≤ 0.35 μCi/gm Reactor Coolant gross specific activity limited to: ≤ 100/E_{bar} μCi/gm Isotopic inventory obtained from referenced calculation	BV1/2 TS 3.4.16 BV1/2 Calculation UR(B)-484	In support of BV2 Original Steam Generators with Alternate Repair Criteria, a License Amendment Request will explain that a bounding value of ≤ 0.35 μCi/gm I-131 DE is used for all BV1 and BV2 accidents with the exception of the BV2 MSLB for OSGs, for which the BV2 specific TS limit of 0.10 μCi/gm I-131 DE is used.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comments**
4. Elements in each radionuclide group released to containment following a LOCA	Noble gases: Xe, Kr, **Rn, H** Halogens: I, Br Alkali Metals: Cs, Rb Tellurium Metals: Te, Sb, Se, **Sn, In, Ge, Ga, Cd, As, Ag** Ba, Sr: Ba, Sr, **Ra** Noble Metals: Ru, Rh, Pd, Mo, Tc, Co Ce Group: Ce, Pu, Np, **Th, U, Pa, Cf, Ac** Lanthanides: La, Zr, Nd, Eu, Nb, Pm, Pr, Sm, Y, Cm, Am, **Gd, Ho, Tb, Dy**	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 RG 1.183 Rev. 0	Noble gases: Xe, Kr, **Rn, H** Halogens: I, Br Alkali Metals: Cs, Rb Tellurium Metals: Te, Sb, Se, **Sn, In, Ge, Ga, Cd, As, Ag** Ba, Sr: Ba, Sr, **Ra** Noble Metals: Ru, Rh, Pd, Mo, Tc, Co Ce Group: Ce, Pu, Np, **Th, U, Pa, Cf, Ac** Lanthanides: La, Zr, Nd, Eu, Nb, Pm, Pr, Sm, Y, Cm, Am, **Gd, Ho, Tb, Dy**	FENOC letter ND1MDE:0374 NRC Regulatory Guide 1.183	Isotopes listed in bold are additional to RG 1.183 groupings, based upon chemical properties.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comments**
5. Core inventory fraction release into containment atmosphere of each radionuclide group during the Gap release phase	Noble gases: 0.05 Halogens: 0.05 Alkali Metals: 0.05 Fuel will have peak burnup ≤ 62,000 MWD/MTU	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 RG 1.183 Rev.0 WCAP-12610	Noble Gases: 0.05 Halogens: 0.05 Alkali Metals: 0.05	FENOC letter ND1MDE:0374 NRC Regulatory Guide 1.183 WCAP-12610 BV1 UFSAR Section 14.3.5.2 BV2 UFSAR Section 15.6.5.4	All fission products released from the fuel are instantaneously and homogeneously mixed in the containment atmosphere at the time of release from the core. Note that per RG 1.183, these release fractions are based on LWR fuel with a peak pin burnup of 62,000 MWD/MTU.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comments**
6. Core inventory fraction release into containment atmosphere of each radionuclide group during Early In-Vessel release phase	Noble gases: 0.95 Halogens: 0.35 Alkali Metals: 0.25 Tellurium Metals: 0.05 Ba, Sr: 0.02 Noble Metals: 0.0025 Cerium Group: 0.0005 Lanthanides: 0.0002 Fuel will have peak burnup ≤ 62,000 MWD/MTU	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 RG 1.183 Rev.0 WCAP-12610	Noble gases: 0.95 Halogens: 0.35 Alkali Metals: 0.25 Tellurium Metals: 0.05 Ba, Sr: 0.02 Noble Metals: 0.0025 Cerium Group: 0.0005 Lanthanides: 0.0002 Fuel will have peak burnup ≤ 62,000 MWD/MTU	NRC Regulatory Guide 1.183 BV1 UFSAR Section 14.3.5.2 BV2 UFSAR Section 15.6.5.4 WCAP-12610	All fission products released from the fuel are instantaneously and homogeneously mixed in the containment atmosphere at the time of release from the core. Note that per RG 1.183, these release fractions are based on LWR fuel with a peak pin burnup of 62,000 MWD/MTU.
7. Core inventory fraction release into sump of each radionuclide group during the Gap release phase	Noble gases: 0.00 Iodines: 0.05 Alkali Metals: 0.05	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 RG 1.183 Rev.0	Noble gases: 0.00 Iodines: 0.05 Alkali Metals: 0.05	FENOC Letter ND1MDE:0374 NRC Regulatory Guide 1.183 BV1 UFSAR Section 14.3.5.2 BV2 UFSAR Section 15.6.5.4	With the exception of noble gases, all fission products released from the fuel are instantaneously and homogeneously mixed in the sump water at the time of release from the core.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comments**
8. Core inventory fraction release into containment sump water of each radionuclide group during Early In-Vessel release phase	Noble gases: 0.00 Halogens: 0.35 Alkali Metals: 0.25 Tellurium Grp: 0.05 Ba, Sr: 0.02 Noble Metals: 0.0025 Cerium Grp: 0.0005 Lanthanides: 0.0002	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 RG 1.183 Rev.0	Noble gases: 0.00 Halogens: 0.35 Alkali Metals: 0.25 Tellurium Grp: 0.05 Ba, Sr: 0.02 Noble Metals: 0.0025 Cerium Grp: 0.0005 Lanthanides: 0.0002	FENOC Letter ND1MDE:0374 NRC Regulatory Guide 1.183 BV1 UFSAR Section 14.3.5.2 BV2 UFSAR Section 15.6.5.4	With the exception of noble gases, all fission products released from the fuel are instantaneously and homogeneously mixed in the sump water at the time of release from the core.
9. Core inventory release timing – Gap release phase	Onset: 30 sec. Duration: 30 min	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 RG 1.183 Rev.0	Onset: 30 sec. Duration: 0.5 hr	NRC Regulatory Guide 1.183	Although BV1 and BV2 are licensed with leak-before-break methodology, the onset of the gap release phase is not assumed to be 10 minutes per NRC RG 1.183, Section 3.3.
10. Core inventory release timing – Early In-Vessel release phase	Onset: 30.5 min Duration: 1.3 hrs	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 RG 1.183 Rev.0	Onset: 0.5 hr Duration: 1.3 hr	NRC Regulatory Guide 1.183	Per RG 1.183, Section 3.3, the release phases are sequential.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comments**
11. Iodine form of activity released to containment atmosphere from melted and failed fuel	4.85% elemental 95% particulate 0.15% organic	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 RG 1.183 Rev.0	4.85% elemental 95% particulate 0.15% organic	NRC Regulatory Guide 1.183	Appendix A of NRC Regulatory Guide 1.183 states, in part: "the chemical form of radioiodine released to the containment should be assumed to be 95% cesium iodide (CsI), 4.85 percent elemental iodine, and 0.15 percent organic iodide. Iodine species, including those from iodine re-evolution, for sump or suppression pool pH values less than 7 will be evaluated on a case-by-case basis." In summary, per RG 1.183, R0, the chemical form of the iodine as provided by the guidance document is based on the assumption that, in the long term, the sump water pH is controlled at values of 7 or greater.
12. Iodine form of activity released from sump water	97% elemental 3% organic	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 RG 1.183 Rev.0	97% elemental 3% organic	NRC Regulatory Guide 1.183 BV1 UFSAR Section 14.3.5.2 BV2 UFSAR Section 15.6.5.4	BV1 UFSAR Section 14.3.5.2 states, in part: "the chemical form of the iodine released from the RCS is assumed to be 97% elemental and 3% organic." BV2 UFSAR Section 15.6.5.4 is worded similarly.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comments**
13. Iodine form of activity released from RCS	97% elemental 3% organic	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 RG 1.183 Rev.0	97% elemental 3% organic	NRC Regulatory Guide 1.183	See Parameter 12 Note.
14. Release paths to be addressed for the Design Basis Large-Break LOCA	Airborne: • Containment leakage • Containment pressure relief line discharge • ESF leakage • RWST leakage	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06	Airborne: • Containment leakage • Containment pressure relief line discharge • ESF leakage • RWST leakage	FENOC Letter ND1MDE:0374 NRC Regulatory Guide 1.183 BV1 UFSAR Section 14.3.5.2 BV2 UFSAR Section 15.6.5.4	

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comments**
Activity Transport (Containment Leakage)					
15. Containment leakage activity release path	Release from core to containment to environment via containment leakage <u>Release point</u> : containment wall or containment top (SLCRS) vent	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 Reference 8700-RY-1C, R2	Release from core to containment to environment via containment leakage <u>Release point</u>: containment wall or containment top (SLCRS) vent	FENOC Letter ND1MDE:0374 BV1 Drawing RY-0001C BV1 UFSAR Section 14.3.5.2 BV2 UFSAR Section 15.6.5.4	

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comments**
16. Minimum containment free volume (ft³)	BV1: 1.752 x 10^6 BV2: 1.750 x 10^6	FENOC letter BV2SGRP:2014, 12/07/15 FAI/01-48 R3 FAI/13-0446, R0 US(B)-261 R3/ A3	BV1 1,762,940 ft³ BV2 1,767,345 ft³ Use 1,750,000 ft³ for BV1 & BV2 minimum volumes	BV1/2 Calculation US(B)-261 BV1 UFSAR Table 14.3-14a, Parameters Used in Evaluating the Radiological Consequences of a Loss-of-Coolant Accident BV2 UFSAR Table 15.6-11, Parameters Used in Evaluating the Radiological Consequences of a Loss-of-Coolant Accident	A bounding estimate for the minimum containment free air volume is used, which provides margin to accommodate potential future changes.
17. Containment leakage filtration	NA	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06	Not credited	FENOC Letter MD1MDE:0374 BV1 UFSAR Section 14.3.5.2 BV2 UFSAR Section 15.6.5.4	No credit is taken for processing the containment leakage via the safety related ventilation exhaust and filtration system that services the areas contiguous to containment (i.e., the Supplementary Leak Collection and Release System (SLCRS) filters).

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comments**
18. Maximum spray initiation time after accident initiation	BV1: Quench spray = 43.9 sec Recirc Spray = 2080 sec BV2: Quench spray =77.4 sec Recirc Spray = 3855 sec	FENOC Letter BV2SGRP:2014 [DIT-SGR2-0046-01], 12/07/15 8700-US(B)-263, R7 / A1 & A2 8700-US(B)-257, R2 10080-US(B)-239, R6 8700-US(B)-257, R2	BV1: Quench spray = 43.9 sec Recirc Spray = 2080 sec BV2: Quench spray =77.4 sec Recirc Spray = 3855 sec	BV1 Calculation US(B)-263 BV1/2 Calculation US(B)-257 BV2 Calculation US(B)-239	Quench Spray initiation for BV2: The BV2 OSG value of 77.4 seconds is used.
19. Containment spray coverage (Effective quench or recirculation spray coverage)	60% (BV2)	FENOC Letter BV2SGRP:2014 [DIT-SGR2-0046-01], 12/07/15 11700-PE(B)-194, R0 A2 12241-US(B)-163, R0, A3	63% (BV1) 60% (BV2)	BV1 Calculation PE(B)-194 BV2 Calculation US(B)-163	No credit is taken for quench spray when recirculation spray is in operation.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comments**
20. Spray cutoff time	Credit for recirculation sprays taken up to T=96 hours post- LOCA. Time to terminate quench spray is based on maximum ESF and incorporated in the calculated fission product removal lambda	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 8700-US(B)-257, R2	Credit for recirculation sprays taken up to T=96 hours post- LOCA. Time to terminate quench spray is based on maximum ESF and incorporated in the calculated fission product removal lambda	BV1/2 Calculation US(B)-257	BV1/2 Calculation US(B)-257 shows RS termination times for both BV1 and BV2 as 345,600 seconds (equivalent to 96 hours).
21. Containment mixing rate	2 unsprayed volumes per hour	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 RG 1.183 Rev.0	2 unsprayed volumes per hour	NRC Regulatory Guide 1.183	NRC Regulatory Guide 1.183 states, in part: "The mixing rate attributed to natural convection between sprayed and unsprayed regions of the containment building, provided that adequate flow exists between these regions, is assumed to be two turnovers of the unsprayed regions per hour".

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comments**
22. Aerosols and elemental iodine removal coefficients in sprayed region	Aerosol and elemental iodine removal rates as presented in Table 2 of the referenced calculation.	FENOC Letter BV2SGRP:2014 [DIT-SGR2-0046-01], 12/07/15 8700-US(B)-257, Rev. 2	Aerosol and elemental iodine removal rates as presented in Table 2 of the referenced calculation.	BV1/2 Calculation US(B)-257	Recirculation and Quench spray flowrates used to estimate the aerosol removal by sprays are conservatively based on minimum ESF. Aerosol removal is via diffusiophoresis, which starts at t = 30 sec. Aerosol removal rates for the sprayed containment volume are the time dependent values presented in Table 2 of referenced calculation The elemental iodine removal coefficient due to sprays is equal to the aerosol removal coefficient up to 20 hr^{-1}; at higher aerosol removal rates, the iodine removal coefficient is conservatively assumed to be 20 hr^{-1}

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comments**
23. Aerosol removal lambda in unsprayed region due to gravitational settling.	Aerosol removal rates for the unsprayed containment volume are the time dependent values listed in presented in Table 2 of the referenced calculation	FENOC Letter BV2SGRP:2014 [DIT-SGR2-0046-01], 12/07/15 8700-US(B)-257, Rev. 2	Aerosol removal rates for the unsprayed containment volume are the time dependent values presented in Table 2 of the referenced calculation	BV1/2 Calculation US(B)-257	No credit is taken for elemental iodine removal in the unsprayed region.
24. Minimum Long term sump water pH	Sump pH > 7.0 in < 16 hrs	FENOC Letter BV2SGRP:2014 [DIT-SGR2-0046-01], 12/07/15 RG 1.183, R0 NUREG/CR 5732, April 1992 8700- US(B)-257, R2 10080-US(B)-278, Rev. 0/A1/A2 (Unit 2) 8700-US(B)-279, Rev. 0 (Unit 1)	Sump pH > 7.0 in < 16 hrs	NRC Regulatory Guide 1.183 NUREG/CR 5732 BV1/2 Calculation US(B)-257 BV2 Calculation US(B)-141	NUREG/CR 5732 defines long-term as after 16 hours post LOCA. Note: Iodine revolution will not occur if pH > 7.0 in less than 16 hours.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	Value	Reference	Value	Reference	Comments
25. Maximum allowable decontamination factor (DF) for elemental and particulate iodine	The average concentration in containment is limited to a maximum DF for elemental iodine of 200. Since the aerosol spray removal coefficients are based on the calculated time dependent airborne aerosol mass, there is no restriction on the DF for particulate iodine	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 RG 1.183 Rev.0	The average concentration in containment is limited to a maximum DF for elemental iodine of 200. Since the aerosol spray removal coefficients are based on the calculated time dependent airborne aerosol mass, there is no restriction on the DF for particulate iodine	FENOC Letter MD1MDE:0374 NRC Regulatory Guide 1.183	No credit is taken for organic iodine deposition.
26. Containment isolation time (from CIB signal actuation)	< 5 sec for lines carrying containment atmosphere and < 60 sec for all other isolation valves	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 U1 T/S 3.6.3 U2 T/S 3.6.3	< 5 sec for lines carrying containment atmosphere and < 60 sec for all other isolation valves	BV1/2 TS Table 3.3.2-1 BV1/2 TS 3.6.3 BV1 LRM Table 3.6.1-1 BV2 LRM Table 3.6.1-1	**WECTEC Comment:** Meets closure requirements of SRP 6.2.4. Analysis will assume containment isolation at t = 0 hrs.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comments**
27. Leakage rate from containment per Plant Technical Specifications and duration	0.001 volume fraction per day for 24 hours after LOCA 0.0005 volume fraction per day from 1 to 30 days after LOCA	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 U1 T/S 3.6.1.2 U2 T/S 3.6.1.2 RG 1.183, Rev 0	0.001 volume fraction per day for 24 hours after LOCA 0.0005 volume fraction per day from 1 to 30 days after LOCA	BV1/2 TS 5.5.12 NRC Regulatory Guide 1.183 BV1 Calculation US(B)-263 BV2 Calculation US(B)-239	MAAP-DBA containment pressure time history following a LOCA demonstrates that containment pressure is < 50% of the peak within 24 hours.
Containment Pressure Relief Line Release					
28. Activity release path	RCS release to containment and environment via containment pressure relief line <u>Release point</u>: Containment wall or top of containment dome via SLCRS	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 RG 1.183, App. A 8700-RM-418-1, Rev. 10 Reference 8700-RY-1C, R2	RCS release to containment and environment via containment pressure relief line <u>Release point</u>: Containment wall or top of containment dome via SLCRS	NRC Regulatory Guide 1.183 BV1 Drawing RY-0001C	Per RG 1.183, no iodine spiking is assumed. No credit is taken for the release point at the top of the cooling towers because the 2-in line outside containment is non-safety.
29. RCS flash fraction	100%	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 Conservative assumption	100%	FENOC Letter ND1MDE:0374 Conservative Assumption	

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comments**
30. Maximum Pressure relief line bounding release rate following a LOCA prior to isolation	2200 scfm (Unit 1) 1600 scfm (Unit 2)	FENOC Letter BV2SGRP:2014 [DIT-SGR2-0046-01], 12/07/15 S&W calculations 8700-UR(B)-213, R0 10080-UR(B)-485, R0	2200 scfm (BV1) 1600 scfm (BV2)	BV1 Calculation UR(B)-213 BV2 Calculation UR(B)-485	
31. Duration of release via the pressure relief line.	< 5 seconds max stroke time	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 Surveillance Test Acceptance Criteria Pen. No. 92 and 93 (Unit-1) Pen. No. x92 and x93 (Unit-2) CR 02-03664	< 5 seconds maximum stroke time	BV1 Licensing Requirements Manual Table 3.6.1-1 BV2 Licensing Requirements Manual Table 3.6.1-1	Isolation valves TV-1CV-150A through D in BV1 (2CVS-SOV151A, 151B, 152A and 152B in BV2) are closed on CIA signal.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comments**
32. Containment pressure relief line filter efficiency (if applicable)	NA	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06	Not Applicable	FENOC Letter ND1MDE:0374	Containment pressure relief is via Gaseous Waste Disposal filters, which are not safety related and not credited for DBA mitigation.
Activity Transport (ECCS Leakage)					
33. Activity release path	Release from core to sump and then to environ due to equip leakage. Release Point: SLCRS	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 RG 1.183, Rev. 0 8700-RY-1C, R2	Release from core to sump and then to environ due to equip leakage. Release Point: SLCRS	NRC Regulatory Guide 1.183 BV1 Drawing RY-0001C	No credit is taken for holdup or mixing in the Auxiliary Building.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comments**
34. SLCRS safety classification	SLCRS is classified as QA Category I, Safety Class 3, Seismic Category I	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 Curator/EMPAC, BVPS component safety classification database	SLCRS exhaust fans 1VS-F-4A and 2HVS-FN204A are Quality Class Q (safety related), Seismic Class S (Seismic Category I), and emergency powered. Related SLCRS components are similarly classified.	SAP BV1 Drawing RE-0001K BV2 Drawing RE-0001J	
35. Assumed ESF leak duration	1200 sec. to 30 days	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 8700-US(B)-263, R2 Conservative assumption	1200 sec. to 30 days	BV1 Calculation US(B)-263 BV2 Calculation US(B)-239 Conservative Assumption	Recirculation Spray starts on RWST level and is conservatively assumed to operate continuously for the duration of the accident, 30 days, although it is only credited for operating for 4 days. Early initiation of recirculation flow is conservative.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comments**
36. Maximum Integrated ESF leak rate	Unit-1 5700 cc/hr Unit-2 2134 cc/hr Analysis to use twice the listed value per RG 1.183 Rev. 0	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 Acceptance Criterion 1BVT 1.11.2, SI Recirculation Mode Leak Test, Issue I, Rev. 11, and 2BVT 1.11.2, Iss. 2 Rev.2, step VIII.A RG 1.183, Rev. 0	BV1 5700 cc/hr BV2 2134 cc/hr Analysis to use twice the listed value per RG 1.183 Appendix A.	BV1 Procedure 1BVT1.11.2 BV2 Procedure 2BVT1.11.2 NRC Regulatory Guide 1.183	

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comments**
37. Minimum volume and mass of sump water versus time after switchover to the recirculation phase.	**BV1** 20 min to 30 min: 19,253 ft³ (1.1379E6 lbm) 30 min.-2hr: 24,909 ft³ (1.5133E6 lbm) 2 hr-30 days: 43,824 ft³ (2.6837E6 lbm) **BV2 OSG** 20 min to 30 min: 20,364 ft³ (1.2007E6 lbm) 30 min.-2hr: 28,195 ft³ (1.6693E6 lbm) 2 hr-30 days: 69,380 ft³ (4.2693E6 lbm) **BV2 RSG** 20 min to 30 min: 20,706 ft³ (1.2202E6 lbm) 30 min.-2hr: 28,710 ft³ (1.6949E6 lbm) 2 hr-30 days: 72,037 ft³ (4.3912E6 lbm)	FENOC letter BV2SGRP:2014, [DIT-SGR2-0046-01], 12/07/15 8700-US(B)-263, R7/A1/A2 (Unit 1) 10080-US(B)-239 R6/A1 (Unit 2) (FAI/13-0929, R1) (Unit 2)	**BV1** 20 min to 30 min: 19,253 ft³ (1.1379E6 lbm) 30 min to 2hr: 24,909 ft³ (1.5133E6 lbm) 2 hr to 30 days: 43,824 ft³ (2.6837E6 lbm) **BV2** 20 min to 30 min: 20,364 ft³ (1.2007E6 lbm) 30 min to 2hr: 28,195 ft³ (1.6693E6 lbm) 2 hr to 30 days: 69,380 ft³ (4.2693E6 lbm)	BV1 Calculation US(B)-263 BV2 Calculation US(B)-239	BV1 values are lower (minimum).

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comments**
38. Peak sump water temp after 20 minutes	250°F (bounding value) BV1 = 240°F BV2 OSG = 245°F BV2 RSG = 246.4°F	FENOC letter BV2SGRP:2014, [DIT-SGR2-0046-01], 12/07/15 8700-US(B)-263, R7/A1/A2 (Unit 1) 10080-US(B)-239 Rev 6 (Unit 2), CASE1L_MIX_MST 10080-US(B)-239 Rev 6/A1 (Unit 2) (FAI/13-0929, R1, Table 5-9, CASE1L_MIX_MAX SW)	BV1 = 240°F BV2 = 245°F 250°F (bounding value)	BV1 Calculation US(B)-263 BV2 Calculation US(B)-239	
39. Fraction of ESF leakage that flashes if the liquid temperature is less than 212 °F or the calculated flash fraction is less than 10%	10%	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 RG 1.183, R0	10%	NRC Regulatory Guide 1.183	
40. SLCRS filter iodine removal efficiency T/S acceptance criteria:	None Credited	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06	None Credited	FENOC Letter ND1MDE:0374	The site boundary, control room and ERF inhalation and immersion dose calculations should not credit SLCRS filtration.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comments**
41. Portion of ESF and containment leakage that bypasses SLCRS filter for human dose calculations.	100%	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 Assumption	100%	Assumption	
Activity Transport (RWST Back Leakage)					
42. Activity release path	RWST back-leakage: Release from core to sump and environment via RWST vent Release Point: RWST vent	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 8700-RY-1C, R2	RWST back-leakage: Release from core to sump and environment via RWST vent Release Point: RWST vent	BV1 Drawing RY-0001C BV1 UFSAR Section 14.3.5.2 BV2 UFSAR Section 15.6.5.4	
43. Initiation time of sump back leakage into RWST after LOCA	BV1 t =1768 sec. BV2 t=2473 secs	FENOC letter BV2SGRP:2014, 12/07/15 8700-US(B)-263, R7 FAI/13-0929	BV1 t =1768 sec. BV2 t=2476 secs	BV1 Calculation US(B)-263 BV2 Calculation US(B)-239	RWST back-leakage is initiated at SI switchover. The BV1 value is bounding. Due to the substantially smaller BV1 RWST volume, the BV1 suction switchover time will always bound the BV2 value.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comments**
44. Sump water back flow rate into RWST	1 gpm	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06	1 gpm	BV1 UFSAR Section 14.3.5.2 BV2 UFSAR Section 15.6.5.4	Analysis to utilize 2 gpm (factor of 2 margin, similar to ESF leakage).
45. Time after LOCA (including duration) when RWST back-leakage is released to the environment via the RWST vent	BV1: T=3039 sec. to t=30 days. BV2: T=9221 sec. to t=30 days.	FENOC letter BV2SGRP:2014, 12/07/15 8700-US(B)-263, R7 FAI/13-0929, R1	BV1 T=3039 sec. to t=30 days. BV2 T=9220 sec. to t=30 days.	BV1 Calculation US(B)-263 BV2 Calculation US(B)-239	Environmental releases via the RWST vent is initiated at QS cutoff. The BV1 time period is bounding. Due to the substantially smaller BV1 RWST volume, the recirculation mode time interval will always bound the BV2 value.
46. Iodine and gaseous release rates via RWST vent versus time	Design release rates Per Rev 3 of reference As noted in Table 1 of Rev 6/A1 of Reference	FENOC letter BV2SGRP:2014, 12/07/15 ERS-SNW-92-009, Rev 3 ERS-SNW-92-009, Rev 6/A1	Design release rates Per Rev 3 of reference As noted in Table 1 of Rev 6/A1 of Reference	BV1/2 Calculation ERS-SNW-92-009	Environmental releases via the RWST vent is initiated at QS cutoff. BV1 is bounding.
47. RWST back leakage filtration	N/A	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06	Not Applicable		

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comments**
Control Room Isolation / Emergency Ventilation (following a LOCA)					
48. CR isolation / emergency ventilation initiation signal following a LOCA	CIB signal	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 8700-120-65D S&W 2001-409-001	CIB signal	BV1 Drawing 01.020-0065 BV2 Drawing 2001.409-001-024	
49. Maximum delay in attaining control room isolation (taking into consideration damper re-alignment for emergency ventilation operation mode) after receipt of CIB signal.	77 sec for diesel start, sequencing, & damper movement	FENOC Letter ND1MLM:0374, [Table 1], 09/20/06 T/S 3.7.7.1	77 sec for diesel start, sequencing, & damper movement	BV1 UFSAR Table 14.3-14a BV2 UFSAR Section 15.6.5.4	A CIB signal isolates control room & initiates emergency ventilation.

**DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION**

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comments**
50. CR emergency ventilation initiation	Manual: Yes (see Note 1) Automatic: Yes t = 0 to t = 77 sec: time delay associated with achieving CR isolation; assume normal ventilation (unfiltered) U -1 (bounding) t=77 sec to t = 30 min, CR isolated but not pressurized, t = 30 min to 30 days, CR pressurized/ emergency filtered intake mode	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 Unit 1 T/S 3/4.7.7 SRP 6.4 specifies that a substantial delay be assumed where manual isolation is assumed. ANS 58.8, "Time Response Design Criteria for Safety Related Operations"	Manual: Yes (see Note 1) Automatic: Yes t = 0 to t = 77 sec: time delay associated with achieving CR isolation; assume normal ventilation (unfiltered) BV1 (bounding) t=77 sec to t = 30 min, CR isolated but not pressurized, t = 30 min to 30 days, CR pressurized/ emergency filtered intake mode	BV1/2 Technical Specification 3.7.10 BV1 UFSAR Section 14.3.5.2 and UFSAR Table 14.3-14a BV2 UFSAR Section 15.6.5.4 FENOC Letter ND1MDE:0379	A CIB from either unit isolates CR & initiates BV2 emergency ventilation BV TS 3.7.10 permits operation with one (of 2) BV2 CREVS train operable and BV1 train operable. A single failure of the BV2 train would require manual start of the BV1 system. For conservatism, all delays are assumed to be sequential. Note 1: For auto-start of the BV2 CREVS fan, the timer setting for Train A fan start is planned at 90 secs after the start signal. If this fan's start signal is inhibited, the B fan start signal occurs 30 seconds later. The time for a fan to come up to speed is estimated to be 17 secs. Allowing for train B to come up to speed provides the latest estimated pressurization time, approximately 137 secs. In the event of a total failure of the BV2 CREVS fan start, a manual start of the BV1 CREVS with a 30-minute delay has to be addressed because this involves manual damper manipulations outside the CR.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 1: Parameters for Calculating Loss of Coolant Accident (LOCA) Dose Consequences

	AOR [10080-UR(B)-487, R2]		LAR - Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comments**
Control Room Atmospheric Dispersion Factors					
51. Control Room intake atmospheric dispersion factors	<u>Containment Wall</u>: Containment leakage, and containment pressure relief. Unit-1 N3778 Unit-2 N3904.1 <u>Containment Dome</u>: Containment leakage, ECCS leakage, and containment pressure relief release via SLCRS: Unit-1 N3730 Unit-2 N3910 <u>RWST Vent</u>: Unit-1 N3808 Unit-2 N3911	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 8700-RY-1C, R2	<u>Containment Wall</u>: Containment leakage, and containment pressure relief. BV1 N3778 BV2 N3904.1 <u>Containment Dome</u>: Containment leakage, ECCS leakage, and containment pressure relief release via SLCRS: BV1 N3730 BV2 N3910 <u>RWST Vent</u>: BV1 N3808 BV2 N3911	BV1 Drawing RY-0001C	The CR normal ventilation intake is the same as the emergency ventilation intake.

References

1. NRC Regulatory Guide 1.183, Rev. 0, Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors
2. BV1 Renewed Operating License DPR-66
3. BV2 Renewed Operating License NPF-73
4. BV1/2 Technical Specifications, including BV1 Amendment 302 and BV2 Amendment 191
5. BV1/2 Technical Specification Bases, Rev. 35
6. BV1 Licensing Requirements Manual (including Bases), Rev. 101
7. BV2 Licensing Requirements Manual (including Bases), Rev. 92
8. BV1 Updated Final Safety Analysis Report, Rev. 30
9. BV2 Updated Final Safety Analysis Report, Rev. 23
10. BV1/2 Calculation ERS-SNW-92-009, Rev. 6 through and including Add. 1, Iodine Release from the Beaver Valley Unit 1 and 2 Refueling Water Storage Tank
11. BV1 Calculation PE(B)-194, Rev. 0 through and including Add. 1 to 2, Volume Coverage of Modified Recirculation Spray System
12. BV1 Calculation UR(B)-213, Rev. 0, Containment Vacuum System Maximum Flowrate for Radiological Input
13. BV1/2 Calculation UR(B)-483, Rev. 0, Composite Reactor Core Inventory for BVPS Following Power Uprate (2918 MWth, Initial 4.2% to 5% Enrichment, 18-month Fuel Cycle)
14. BV1/2 Calculation UR(B)-484, Rev. 1, Primary and Secondary Coolant Design / Technical Specification Activity Concentrations including Pre-Accident Iodine Spike Concentrations and Equilibrium Iodine Appearance Rates following Power Uprate
15. BV2 Calculation UR(B)-485, Rev. 0, Containment Vacuum System Maximum Flowrate for Radiological Input
16. BV2 Calculation US(B)-141, Rev. 5, Sump PH Transient as a Function of Time
17. BV2 Calculation US(B)-163, Rev. 0 through and including Add. 1 to 2, Recirculation Spray Volume Coverage
18. BV2 Calculation US(B)-239, Rev. 6 including Add. 1, Assessment of Beaver Valley Unit 2 Containment Response for Design Basis Accidents for Containment Atmospheric Conversion Project
19. BV1/2 Calculation US(B)-257, Rev, 2, Iodine Removal Coefficients
20. BV1/2 Calculation US(B)-261, Rev. 3, through and including Add. 1 to 6, Beaver Valley Power Station MAAP – DBA Parameter File Documentation
21. BV1 Calculation US(B)-263, Rev. 7 through and including Add. 1 to 2, Assessment of Containment Response for Design Basis Accidents for Containment Atmospheric Conversion Project
22. BV1 Calculation EN-ME-105, Rev. 0 including Add. 1, Atmospheric Dispersion Factors (X/Qs) at Control Room and ERF Receptors for Unit 1 Accident Releases Using the ARCON96 Methodology
23. BV2 Calculation EN-ME-106, Rev. 0 including Add. 1, Atmospheric Dispersion Factors (X/Qs) at Control Room and ERF Receptors for Unit 2 Accident Releases Using the ARCON96 Methodology
24. BV1 Drawing 01.020-0065, Rev. E, Functional Diagrams Safeguard Actuation Signals
25. BV2 Drawing 2001.409-001-024, Rev. L, Functional Diagrams Safeguard Actuation Signals
26. BV1 Drawing RE-0001K, Rev. 29, 480V One Line Diagram – Sheet 4
27. BV2 Drawing RE-0001J, Rev. 19, 480V US One Line Diagram – Sheet 3
28. BV1/2 Drawing RY-0001C, Rev. 2, Site Postulated Release and Receptor Points
29. FENOC Letter ND1MDE:0374, Containment Sump Modification Dose Inputs, Unit 1 & 2 – DIT-FPP-0044-00, 9/20/2006
30. Fauske and Associates, Inc. Calculation FAI/01-48, Rev. 12, Beaver Valley Power Station MAAP-DBA Parameter File Documentation
31. Westinghouse Report WCAP-12610-P-A, Optimized ZIRLO, July 2006
32. NUREG/CR 5732, Iodine Chemical Forms in LWR Severe Accidents, April 1992

33. BV1 Procedure 1BVT1.11.2, Rev. 16, Safety Injection Recirculation Mode Leak Test
34. BV2 Procedure 2BVT1.11.2, Rev. 12, Safety Injection Recirculation Mode Leak Test

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DESIGN VERIFICATION RECORD

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Page 1 of 1

SECTION I: TO BE COMPLETED BY DESIGN ORIGINATOR		
DOCUMENT(S)/ACTIVITY TO BE VERIFIED: DIT-BVDM-0113-00		
☒ SAFETY RELATED	☐ AUGMENTED QUALITY	☐ NONSAFETY RELATED
SUPPORTING/REFERENCE DOCUMENTS		
DESIGN ORIGINATOR: *(Print and Sign Name)* Douglas T Bloom [signature]		DATE 10-29-18
SECTION II: TO BE COMPLETED BY VERIFIER		
VERIFICATION METHOD *(Check one)*		
☑ DESIGN REVIEW *(Complete Design Review Checklist or Calculation Review Checklist)*	☐ ALTERNATE CALCULATION	☐ QUALIFICATION TESTING
JUSTIFICATION FOR SUPERVISOR PERFORMING VERIFICATION: NA		
APPROVAL: *(Print and Sign Name)* NA		DATE
EXTENT OF VERIFICATION: Design Review Checklist		
COMMENTS, ERRORS OR DEFICIENCIES IDENTIFIED? ☐ YES ☑ NO		
RESOLUTION: *(For Alternate Calculation or Qualification Testing only)* NA		
RESOLVED BY: *(Print and Sign Name)* NA		DATE
VERIFIER: *(Print and Sign Name)* K.J. Frederick [signature]		DATE 10-29-18
APPROVED BY: *(Print and Sign Name)* MSRessler [signature]		DATE 10/30/2018

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DESIGN REVIEW CHECKLIST

NOP-CC-2001-02 Rev. 04

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):

DIT-BVOM-0113-00

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
1. Were the basic functions of each structure, system or component considered?		✓			
2. Have performance requirements such as capacity, rating, and system output been considered?		✓			
3. Are the applicable codes, standards and regulatory requirements including applicable issue and/or addenda properly identified and are their requirements for design and/or material been met or reconciled?		✓			
4. Have design conditions such as pressure, temperature, fluid chemistry, and voltage been specified?		✓			
5. Are loads such as seismic, wind, thermal, dynamic and fatigue factored in the design?	✓				
6. Considering the applicable loading conditions, does an adequate structural margin of safety exist for the strength of components?	✓				
7. Have environmental conditions anticipated during storage, construction and operation such as pressure, temperature, humidity, soil erosion, run-off from storm water, corrosiveness, site elevation, wind direction, nuclear radiation, electromagnetic radiation, and duration of exposure been considered?	✓				
8. Have interface requirements including definition of the functional and physical interfaces involving structures, systems and components been met?		✓			
9. Have the material requirements including such items as compatibility, electrical insulation properties, protective coating, corrosion, and fatigue resistance been considered?	✓				
10. Have mechanical requirements such as vibration, stress, shock and reaction forces been specified?	✓				
11. Have structural requirements covering such items as equipment foundations and pipe supports been identified?	✓				
12. Have hydraulic requirements such as pump net positive suction head (NPSH), allowable pressure drops, and allowable fluid velocities been specified?	✓				
13. Have chemistry requirements such as the provisions for sampling and the limitations on water chemistry been specified?	✓				
14. Have electrical requirements such as source of power, voltage, raceway requirements, electrical insulation and motor requirements been specified?	✓				
15. Have layout and arrangement requirements been considered?	✓				
16. Have operational requirements under various conditions, such as plant startup, normal plant operation, plant shutdown, plant emergency operation, special or infrequent operation, and system abnormal or emergency operation been specified?		✓			

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DESIGN REVIEW CHECKLIST

NOP-CC-2001-02 Rev. 04

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):

DIT-BVOM-0113-00

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
17. Have instrumentation and control requirements including instruments, controls, and alarms required for operation, testing, and maintenance been identified? Other requirements such as the type of instrument, installed spares, range of measurement, and location of indication should also be included.	✓				
18. Have adequate access and administrative controls been planned for plant security?	✓				
19. Have redundancy, diversity, and separation requirements of structures, systems, and components been considered?		✓			
20. Have the failure requirements of structures, systems, and components, including a definition of those events and accidents which they must be designated to withstand been identified?	✓				
21. Have test requirements including in-plant tests, and the conditions under which they will be performed been specified?		✓			
22. Have accessibility, maintenance, repair and in-service inspection requirements for the plant including the conditions under which they will be performed been specified?	✓				
23. Have personnel requirements and limitations including the qualification and number of personnel available for plant operation, maintenance, testing and inspection and permissible personnel radiation exposure for specified areas and conditions been considered?		✓			
24. Have transportability requirements such as size and shipping weight, limitations and Interstate Commerce Commission regulations been considered?	✓				
25. Have fire protection or resistance requirements been specified?	✓				
26. Are adequate handling, storage, cleaning and shipping requirements specified?	✓				
27. Have the safety requirements for preventing undue risk to the health and safety of the public been considered?		✓			
28. Are the specified materials, processes, parts and equipment suitable for the required application?	✓				
29. Have safety requirements for preventing personnel injury including such items as radiation hazards, restricting the use of dangerous materials, escape provisions from enclosures and grounding of electrical equipment been considered?	✓				
30. Were the inputs correctly selected and incorporated into the design?		✓			
31. Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed?		✓			
32. Are the appropriate quality and quality assurance requirements specified?		✓			

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NOP-CC-2001-02 Rev. 04

DESIGN REVIEW CHECKLIST

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):

DIT-BVDM-0113-00

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
33. Have applicable construction and operating experience been considered?		√			
34. Have the design interface requirements been satisfied?		√			
35. Was an appropriate design method used?		√			
36. Is the output reasonable compared to inputs?		√			
37. Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?	√				
38. Have adequate maintenance features and requirements been specified?	√				
39. Has the design properly considered radiation exposure to the public and plant personnel?		√			
40. Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfied?	√				
41. Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?	√				
42. Are adequate identification requirements specified?	√				
43. Are requirements for record preparation, review, approval, retention, etc., adequately specified?		√			
44. Have protective coatings qualified for Design Basis Accident (DBA) been specified to structures, equipment and components installed in the containment/drywell?	√				
45. Are the necessary supporting calculations completed, checked and approved?		√			
46. Have the equipment heat load changes been reviewed for impact on HVAC systems?	√				
47. **IF** a computer program was used to obtain the design by analysis, **THEN** has the program been validated per NOP-SS-1001 and documented to verify the technical adequacy of the computer results contained in the design analysis?	√				
48. Have Professional Engineer (PE) certification requirements been addressed and documented where required by ASME Code (if applicable).	√				
49. Does the design involve the installation, removal, or revise software/firmware and have the requirements of NOP-SS-1001 been addressed?	√				
50. Does the design involve the installation, removal, or change to a digital component(s) and have the requirements of NOP-SS-1201 been addressed?			√		

COMPLETED BY: (*Print and Sign Name*)	DATE	ADDITIONAL VERIFIER (*Print and Sign Name*)	DATE
K. J. Frederick [signature]	10-29-18	N/A	

IF CHECKLIST IS REVIEWED BY MORE THAN ONE VERIFIER, SIGN BELOW:

Attachment 2

BVPS 1&2 Equilibrium Core Inventory
(Power Level: 2918 MWth)

FirstEnergy	CALCULATION COMPUTATION NOP-CC-3002-01 Rev. 05	Pg Att2-2 of Att2-5
CALCULATION NO.: 10080-UR(B)-487		REVISION: 3

Attachment 2

BVPS 1 & 2 Equilibrium Core inventory (Power Level : 2918 MWth)

ISOTOPE	PARENT RELATIONSHIP	PARENT ISOTOPE	ACTIVITY (CURIES)	ISOTOPE	PARENT RELATIONSHIP	PARENT ISOTOPE	ACTIVITY (CURIES)
AG-111			5.05E+06	PU-239			2.86E+04
	PARENT:	AG-111M	5.06E+06		PARENT:	NP-239	1.66E+09
	GRAND PARENT:	PD-111	5.04E+06		GRAND PARENT:	U-239	1.66E+09
AG-112			2.28E+06	PU-240			3.87E+04
	PARENT:	PD-112	2.27E+06		PARENT:	NP-240	4.32E+06
AM-241			1.17E+04	PU-241			1.13E+07
	PARENT:	PU-241	1.13E+07	PU-242			2.01E+02
BA-137M			9.35E+06		PARENT:	AM-242	7.04E+06
	PARENT:	CS-137	9.81E+06	RB-86			1.69E+05
	GRAND PARENT:	XE-137	1.46E+08	RB-88			5.57E+07
BA-139			1.41E+08		PARENT:	KR-88	5.43E+07
	PARENT:	CS-139	1.37E+08		GRAND PARENT:	BR-88	2.99E+07
	GRAND PARENT:	XE-139	1.01E+08	RB-89			7.26E+07
BA-140			1.42E+08		PARENT:	KR-89	6.75E+07
	PARENT:	CS-140	1.23E+08		GRAND PARENT:	BR-89	2.08E+07
	GRAND PARENT:	XE-140	7.06E+07	RB-90			6.69E+07
BA-142			1.21E+08		PARENT:	KR-90	7.24E+07
	PARENT:	CS-142	5.48E+07		GRAND PARENT:	BR-90	1.13E+07
	GRAND PARENT:	XE-142	1.07E+07		2ND PARENT:	RB-90M	2.11E+07
BR-82			3.02E+05	RB-90M			2.11E+07
	PARENT:	BR-82M	2.62E+05		PARENT:	KR-90	7.24E+07
BR-83			9.37E+06		GRAND PARENT:	BR-90	1.13E+07
	PARENT:	SE-83M	4.69E+06	RH-103M			1.26E+08
	2ND PARENT:	SE-83	4.42E+06		PARENT:	RU-103	1.26E+08
BR-85			1.95E+07	RH-105			8.16E+07
CE-141			1.30E+08		PARENT:	RH-105M	2.53E+07
	PARENT:	LA-141	1.29E+08		GRAND PARENT:	RU-105	8.90E+07
	GRAND PARENT:	BA-141	1.28E+08		2ND PARENT:	RU-105	8.90E+07
CE-143			1.21E+08	RH-105M			2.53E+07
	PARENT:	LA-143	1.20E+08		PARENT:	RU-105	8.90E+07
CE-144			9.82E+07		GRAND PARENT:	TC-105	8.76E+07
CM-242			4.22E+06	RH-106			5.13E+07
	PARENT:	AM-242	7.04E+06		PARENT:	RU-106	4.63E+07
CM-244			5.97E+05	RU-103			1.26E+08
	PARENT:	AM-244	1.89E+07		GRAND PARENT:	MO-103	1.24E+08
CS-134			1.57E+07	RU-106			4.63E+07
	PARENT:	CS-134M	3.69E+06		2ND PARENT:	SN-125M	1.20E+06
CS-134M			3.69E+06	SB-127			6.92E+06
CS-135M			4.39E+06		PARENT:	SN-127	2.78E+06

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CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-487 | REVISION: 3

Attachment 2

BVPS 1 & 2 Equilibrium Core inventory (Power Level : 2918 MWth)

ISOTOPE	PARENT RELATIONSHIP	PARENT ISOTOPE	ACTIVITY (CURIES)
CS-136			4.97E+06
CS-137			9.81E+06
	PARENT:	XE-137	1.46E+08
	GRAND PARENT:	I-137	7.47E+07
CS-138			1.48E+08
	PARENT:	XE-138	1.36E+08
	GRAND PARENT:	I-138	3.80E+07
CS-139			1.37E+08
	PARENT:	XE-139	1.01E+08
	GRAND PARENT:	I-139	1.83E+07
CS-140			1.23E+08
	PARENT:	XE-140	7.06E+07
	GRAND PARENT:	I-140	4.81E+06
	PARENT:	SM-155	3.11E+06
EU-156			2.29E+07
	PARENT:	SM-156	1.93E+06
EU-157			2.41E+06
H-3			4.36E+04
I-129			2.86E+00
	PARENT:	TE-129	2.40E+07
	GRAND PARENT:	TE-129M	4.87E+06
	2ND PARENT:	TE-129M	4.87E+06
I-130			2.07E+06
	PARENT:	I-130M	1.10E+06
I-131			7.78E+07
	PARENT:	TE-131	6.54E+07
	GRAND PARENT:	TE-131M	1.57E+07
	2ND PARENT:	TE-131M	1.57E+07
I-132			1.14E+08
	PARENT:	TE-132	1.12E+08
	GRAND PARENT:	SB-132	3.67E+07
I-133			1.60E+08
	PARENT:	TE-133	8.66E+07
	GRAND PARENT:	SB-133	5.08E+07
	2ND PARENT:	TE-133M	7.12E+07
I-134			1.77E+08
	PARENT:	TE-134	1.41E+08
	2ND PARENT:	I-134M	1.59E+07
I-135			1.52E+08
I-136			6.99E+07

ISOTOPE	PARENT RELATIONSHIP	PARENT ISOTOPE	ACTIVITY (CURIES)
	2ND PARENT:	SN-127M	3.76E+06
SB-129			2.52E+07
	PARENT:	SN-129	9.90E+06
	2ND PARENT:	SN-129M	9.29E+06
SB-130			8.37E+06
SB-130M			3.47E+07
	PARENT:	SN-130	2.61E+07
SB-131			6.09E+07
	PARENT:	SN-131	2.24E+07
SB-132			3.67E+07
	PARENT:	SN-132	1.81E+07
SB-133			5.08E+07
SE-83			4.42E+06
SM-153			4.02E+07
	PARENT:	PM-153	7.37E+06
SN-127			2.78E+06
SR-89			7.61E+07
	PARENT:	RB-89	7.26E+07
	GRAND PARENT:	KR-89	6.75E+07
SR-90			7.21E+06
	PARENT:	RB-90	6.69E+07
	GRAND PARENT:	KR-90	7.24E+07
	2ND PARENT:	RB-90M	2.11E+07
SR-91			9.50E+07
	PARENT:	RB-91	8.85E+07
	GRAND PARENT:	KR-91	4.98E+07
SR-92			1.01E+08
	PARENT:	RB-92	7.83E+07
	GRAND PARENT:	KR-92	2.66E+07
SR-93			1.14E+08
	GRAND PARENT:	KR-93	9.04E+06
SR-94			1.14E+08
	GRAND PARENT:	KR-94	4.18E+06
TC-99M			1.29E+08
	PARENT:	MO-99	1.45E+08
	GRAND PARENT:	NB-99	8.50E+07
TC-101			1.33E+08
	PARENT:	MO-101	1.33E+08
TC-104			1.05E+08
	PARENT:	MO-104	9.99E+07

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CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-487 | REVISION: 3

Attachment 2

BVPS 1 & 2 Equilibrium Core inventory (Power Level : 2918 MWth)

ISOTOPE	PARENT RELATIONSHIP	PARENT ISOTOPE	ACTIVITY (CURIES)	ISOTOPE	PARENT RELATIONSHIP	PARENT ISOTOPE	ACTIVITY (CURIES)
KR-83M			9.46E+06	TC-105			8.76E+07
	PARENT:	BR-83	9.37E+06		PARENT:	MO-105	7.38E+07
	GRAND PARENT:	SE-83M	4.69E+06	TE-127			6.81E+06
KR-85			8.27E+05		PARENT:	TE-127M	1.13E+06
	PARENT:	KR-85M	1.95E+07		GRAND PARENT:	SB-127	6.92E+06
	GRAND PARENT:	BR-85	1.95E+07		2ND PARENT:	SB-127	6.92E+06
	2ND PARENT:	BR-85	1.95E+07	TE-127M			1.13E+06
KR-85M			1.95E+07		PARENT:	SB-127	6.92E+06
	PARENT:	BR-85	1.95E+07		GRAND PARENT:	SN-127	2.78E+06
KR-87			3.91E+07	TE-129			2.40E+07
	PARENT:	BR-87	3.09E+07		PARENT:	TE-129M	4.87E+06
KR-88			5.43E+07		GRAND PARENT:	SB-129	2.52E+07
	PARENT:	BR-88	2.99E+07		2ND PARENT:	SB-129	2.52E+07
KR-89			6.75E+07	TE-129M			4.87E+06
	PARENT:	BR-89	2.08E+07		PARENT:	SB-129	2.52E+07
KR-90			7.24E+07		GRAND PARENT:	SN-129	9.90E+06
	PARENT:	BR-90	1.13E+07	TE-131			6.54E+07
LA-140			1.46E+08		PARENT:	SB-131	6.09E+07
	PARENT:	BA-140	1.42E+08		GRAND PARENT:	SN-131	2.24E+07
	GRAND PARENT:	CS-140	1.23E+08		2ND PARENT:	TE-131M	1.57E+07
LA-141			1.29E+08	TE-131M			1.57E+07
	PARENT:	BA-141	1.28E+08		PARENT:	SB-131	6.09E+07
LA-142			1.26E+08		GRAND PARENT:	SN-131	2.24E+07
	PARENT:	BA-142	1.21E+08	TE-132			1.12E+08
	GRAND PARENT:	CS-142	5.48E+07		PARENT:	SB-132	3.67E+07
LA-143			1.20E+08		GRAND PARENT:	SN-132	1.81E+07
MO-99			1.45E+08	TE-133			8.66E+07
	PARENT:	NB-99M	5.82E+07		PARENT:	TE-133M	7.12E+07
	2ND PARENT:	NB-99	8.50E+07		GRAND PARENT:	SB-133	5.08E+07
MO-101			1.33E+08		2ND PARENT:	SB-133	5.08E+07
NB-95			1.34E+08	TE-133M			7.12E+07
	PARENT:	ZR-95	1.33E+08		PARENT:	SB-133	5.08E+07
	GRAND PARENT:	Y-95	1.28E+08	TE-134			1.41E+08
	2ND PARENT:	NB-95M	1.52E+06	XE-131M			1.08E+06
NB-95M			1.52E+06		PARENT:	I-131	7.78E+07
	PARENT:	ZR-95	1.33E+08		GRAND PARENT:	TE-131M	1.57E+07
	GRAND PARENT:	Y-95	1.28E+08	XE-133			1.60E+08
NB-97			1.27E+08		PARENT:	I-133	1.60E+08
	PARENT:	NB-97M	1.19E+08		GRAND PARENT:	TE-133M	7.12E+07
	GRAND PARENT:	ZR-97	1.26E+08		2ND PARENT:	XE-133M	5.05E+06

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CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-487 | REVISION: 3

Attachment 2

BVPS 1 & 2 Equilibrium Core inventory (Power Level : 2918 MWth)

ISOTOPE	PARENT RELATIONSHIP	PARENT ISOTOPE	ACTIVITY (CURIES)
	2ND PARENT:	ZR-97	1.26E+08
NB-97M			1.19E+08
	PARENT:	ZR-97	1.26E+08
ND-147			5.22E+07
	PARENT:	PR-147	5.18E+07
	GRAND PARENT:	CE-147	4.92E+07
NP-239			1.66E+09
	GRAND PARENT:	PU-243	4.23E+07
	2ND PARENT:	U-239	1.66E+09
PD-109			3.26E+07
PM-147			1.38E+07
	PARENT:	ND-147	5.22E+07
	GRAND PARENT:	PR-147	5.18E+07
PM-148			1.41E+07
	PARENT:	PM-148M	2.37E+06
PM-148M			2.37E+06
PM-149			4.82E+07
	PARENT:	ND-149	3.02E+07
	GRAND PARENT:	PR-149	2.80E+07
PM-151			1.60E+07
	PARENT:	ND-151	1.58E+07
PR-142			5.57E+06
PR-143			1.18E+08
	PARENT:	CE-143	1.21E+08
	GRAND PARENT:	LA-143	1.20E+08
PR-144			9.89E+07
	PARENT:	CE-144	9.82E+07
	2ND PARENT:	PR-144M	1.38E+06
PU-238			3.40E+05
	2ND PARENT:	NP-238	3.98E+07

ISOTOPE	PARENT RELATIONSHIP	PARENT ISOTOPE	ACTIVITY (CURIES)
XE-133M			5.05E+06
	PARENT:	I-133	1.60E+08
	GRAND PARENT:	TE-133M	7.12E+07
XE-135			4.84E+07
	PARENT:	I-135	1.52E+08
	2ND PARENT:	XE-135M	3.36E+07
XE-135M			3.36E+07
	PARENT:	I-135	1.52E+08
XE-137			1.46E+08
	PARENT:	I-137	7.47E+07
XE-138			1.36E+08
	PARENT:	I-138	3.80E+07
Y-90			7.49E+06
	PARENT:	SR-90	7.21E+06
	GRAND PARENT:	RB-90	6.69E+07
Y-91			9.87E+07
	PARENT:	SR-91	9.50E+07
	GRAND PARENT:	RB-91	8.85E+07
	2ND PARENT:	Y-91M	5.51E+07
Y-91M			5.51E+07
	PARENT:	SR-91	9.50E+07
	GRAND PARENT:	RB-91	8.85E+07
Y-92			1.02E+08
	PARENT:	SR-92	1.01E+08
	GRAND PARENT:	RB-92	7.83E+07
Y-93			7.73E+07
	PARENT:	SR-93	1.14E+08
Y-94			1.23E+08
	PARENT:	SR-94	1.14E+08
Y-95			1.28E+08
ZR-95			1.33E+08
	PARENT:	Y-95	1.28E+08
ZR-97			1.26E+08

FirstEnergy	CALCULATION COMPUTATION NOP-CC-3002-01 Rev. 05
CALCULATION NO.: 10080-UR(B)-487	REVISION: 3

Attachment 3

Copy-in-part of DIN# 18

Table 9b
Primary and Secondary Coolant Concentrations (no VCT Purge)
Limited by the BVPS-1 Technical Specifications
(RCS at 0.35 µCi/gm DE I-131; Secondary Liquid at 0.1 µCi/gm DE I-131)

Nuclide		Reactor[(1)] Coolant (µCi/gm)
KR 83M		4.09E-02
KR 85M		1.48E-01
KR 85		1.30E+01
KR 87		9.68E-02
KR 88		2.74E-01
KR 89		7.80E-03
XE131M		5.54E-01
XE133M		4.59E-01
XE133		3.34E+01
XE135M		9.87E-02
XE135		1.02E+00
XE137		2.03E-02
XE138		6.86E-02
BR83		7.64E-03
BR84		3.84E-03
BR85		4.07E-04
BR87		2.11E-04
I129		1.04E-08
I130		4.52E-03
I131		2.73E-01
I132		1.13E-01
I133		4.17E-01
I134		6.47E-02
I135		2.46E-01
I136		7.07E-04

Note: The RCS technical specification activity is revised here in Rev. 3, the differences between the Rev. 2 and Rev. 3 are small and have negligible impact on the conclusions of Rev. 2 regarding the purge activity releases being negligible.

FirstEnergy	CALCULATION COMPUTATION NOP-CC-3002-01 Rev. 05
CALCULATION NO.: 10080-UR(B)-487	REVISION: 3

Attachment 4

FirstEnergy Design Input Transmittal

DIT-BVDM-0103-03 transmitted via FENOC letter ND1MDE:0738

January 29, 2019

FirstEnergy	CALCULATION COMPUTATION NOP-CC-3002-01 Rev. 05
CALCULATION NO.: 10080-UR(B)-487	REVISION: 3

FENOC

FirstEnergy Nuclear Operating Company

Beaver Valley Power Station
P.O. Box 4
Shippingport, PA 15077

Patrick G. Pauvlinch
Manager, Design Engineering
pauvlinchp@firstenergycorp.com

Phone: 724-682-4982
Fax: 330-315-9717

ND1MDE:0738
January 29, 2019

Sreela Ferguson
WECTEC
720 University Ave.
Norwood, MA 02062

BV1 & BV2 Complete Reanalysis of Dose Consequences
For CRE Tracer Gas Testing and Other Acceptance Criteria Changes
Design Input Transmittal DIT-BVDM-0103-03 for Control Room Dose

Dear Ms. Ferguson:

Attached is Design Input Transmittal DIT-BVDM-0103-03 which provides information for evaluating the control room operator dose for various design-basis accidents.

Should you have any questions about the attached information, please contact Doug Bloom at 724-682-5078 or Mike Ressler at 724-682-7936.

Sincerely,

Patrick G. Pauvlinch
Manager, Design Engineering

DTB/bls

Attachment

cc: D. T. Bloom
M. G. Unfried
M. S. Ressler
BVRC

FirstEnergy

CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-487	REVISION: 3

Form 1/2-ADM-2097.F01, Rev 0

RTL# A1.105V

DESIGN INPUT TRANSMITTAL

☒ SAFETY RELATED / AUG QUAL ☐ NON-SAFETY RELATED	Originating Organization: ☒ FENOC ☐ Other (Specify)	DIT- BVDM-0103-03 Page 1 of 1
Beaver Valley Unit: ☐1 ☐2 ☒Both System Designation: Various Engineering Change Package: N/A		To: Sreela Ferguson Organization: WECTEC

Subject: **Design Input Transmittal for Parameter List for Calculating Dose Consequences at the Control Room and Site Boundary**

Status of Information: ☒Approved for Use ☐Unverified

For Unverified DITs, Notification number tracking verification: ____________________

Description of Information:

Safety Analysis Design Inputs? ☒Yes ☐No
Reconciled to Current Design Basis? ☒Yes ☐N/A

This DIT provides information required for the performance of calculating dose consequences at the BV1 and BV2 Control Rooms and Site Boundary.

Purpose of Issuance:
This DIT provides information required for the performance of design basis accident dose consequence calculation UR(B)-487.

Source of Information (Reference, Rev, Title, Location): Engineering Judgment Used? ☐Yes ☒No

See attachment to DIT table.

Preparer: Douglas T Bloom	Preparer Signature: [signature]	Date: 1-29-19
Reviewer: M. G. Unfried	Reviewer Signature: [signature]	Date: 1/29/2019
Approver: M. S. Ressler	Approver Signature: [signature]	Date: 1/29/2019

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE E: Parameter List for Calculating Dose Consequences at the Control Room & Site Boundary

	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
General Notes: 1. As noted in Design Input transmittals provided in support of the BVPS-2 RSGs (e.g., DIT-SGR2-0046-01 for the LOCA) the CR parameters such as shielding configuration, volume, ventilation system parameters (flows, filter efficiency, signals that initiate emergency ventilation, timing of manual action, etc.) have not changed since the Containment Sump modification 2. The critical input values are: CR volume, CR ventilation flows (NOP intake, unfiltered inleakage and filtered intake during pressurization mode), CR filter efficiencies, CREVS initiation times, and atmospheric dispersion factors.					
Control Room (Inhalation / Submersion Dose)					
1. Minimum Control Room (CR) Free Volume	1.73E5 ft^3	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]: 10/20/06 DQL Calc B-74, Rev. 0. 12/8/81 DLC EM 11578 (NOT IN FILENET RECORDS) Confirmed by DLC EM 116251	1.73E5 ft^3	BV1 Calculations CR-AC-1 & DMC-3171 BV1 UFSAR Table 11.5-8 & Table 14.3-14a BV2 Calculations B-029A & B-074 BV2 Drawing RB-0039A BV2 UFSAR Table 6.4-1 & Table 6.4-1a	BV1 and BV2 share a joint control room inside a single Control Room Envelope. Dimensions used in BV2 Calculation B-074 are consistent with those derived from BV2 Drawing RB-0039A. The net free volume has historically been assumed to be approximately 75% of the gross volume for the radiological dose consequence analyses; it is noted that 30% was used for estimating the occupied volume (resulting in 70% net free volume) in BV2 Calculation B-029A involving refrigerant. The assumption of 75% is adopted here.

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	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
2. Control Room Ventilation Intake Design	Single intake for each unit; same intake used for normal ventilation as well as emergency ventilation.	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 Drawing # 8700-RY-1C, R2 Receptors 2 and 3 for Unit-1, and Unit-2, respectively.	One intake for BV1 and one intake for BV2, which supply the common Control Room. The same intakes are used for normal ventilation as well as emergency ventilation.	BV1/2 Drawing RY-0001C BV1 Drawings RM-0003K & RM-0444A-004 BV2 Drawing RM-0444A-2	There is a single intake for each Unit; the same intake is used for normal ventilation as well as emergency ventilation. The total unfiltered normal operation air intake flow rate is usually unequally divided between the BV1 and BV2 intakes. Receptor 2 represents the BV1 intake, and receptor 3 represents the BV2 intake.
3. Maximum Normal Operation Unfiltered Inflow into Control Room (includes Ventilation Intake Flow Rate and all Unfiltered Inleakage) and postulated Location of referenced Unfiltered Inleakage	Unit 1: Unfiltered: 300 cfm Unit 2: Unfiltered: 200 cfm Total (Unfiltered): 500 cfm Filtered: 0 cfm *All NOP ventilation flowrate values include uncertainties.* *Total unfiltered flow includes 10 cfm for ingress/egress.*	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 2DBD-44A2, Rev. 8, para. 2.2, pg. 6 NDINEM:1144 EM:116251	BV1 & BV2 Unfiltered Intake / Inleakage: 1250 cfm maximum (total for both Units) This maximum normal operation ventilation intake flow rate value is an analytical upper bound value that is intended to include: a) flow rate test measurement uncertainties, b) alll unfiltered inleakage, and c) a 10 cfm ingress/ egress allowance	Assumed value - intended to provide operational margin.	Location of Unfiltered Inleakage Component tests performed as part of 2017 tracer gas testing indicated that potential sources of unfiltered inleakage into the Control Room are the normal operation intake dampers – which can be assigned the same χ/Q as the Control Room air intakes. Regarding other potential locations of inleakage, a χ/Q value that reflects the center of the Control Room boundary at roof level as a receptor could be considered the average value applicable to Unfiltered Inleakage locations around the CRE, and thus representative for

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Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
			The above value bounds the test results of BV1/2 Procedure 3BVT 1.44.05 via Order 200699902. All Unfiltered Inleakage (including that associated with ingress/egress) may be assumed to occur at same location as intakes (i.e., receptor points 2 and 3 of BV1/2 Drawing RY-0001C).	Engineering judgement – see comment column for basis BV1/2 Drawing RY-0001C BV1/2 Procedure 3BVT 1.44.05 Order 200699902 Vendor Report, NCS Corporation, Control Room Envelope Inleakage Testing at Beaver Valley Power Station 2017, Final Report	all CR unfiltered leakage locations. Review of BV1/2 Drawing RY-0001C indicates that since the post-accident release points are a) closer to the CR intakes and b) the directions from the release points to the CR center and CR intakes are similar, use of χ/Q values associated with the CR intakes, for CR Unfiltered Inleakage, would be conservative. The 10 cfm allowance for ingress/egress, is assigned to the door leading into the Control Room that is considered the primary point of access. This door (S35-71) is located at grade level on the side of the building facing the BV1 Containment and between the CR air intakes. It is located close enough to the air intakes to allow the assumption that the χ/Q associated with this source of leakage would be reasonably similar to that associated with the air intakes.

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Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
4. CR Emergency Ventilation Intake Design	Filtered emergency intake with recirculation which pressurizes the CRE to +1/8" w.g. above outside air pressure. CREVS provides for 0.35 filtered air changes per hour	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 U-1 T/S SR 4.7.7.1.1.d.3, .2.d.4 U-2 T/S SR 4.7.7.1.1.e.4 UFSAR-2, Table 6.4-1, *Control Room Envelope Ventilation Design Parameters*	CREVS provides for 0.28 filtered air changes per hour (based on 800 cfm minimum filtered intake) and 0.35 filtered air changes per hour (based on 1000 cfm maximum filtered intake).	The number of air changes per hour is based on filtered emergency intake flow rate [parameter 8] and minimum Control Room free volume [parameter 1].	The filtered air intake flow path is normally not in service. With the adoption of tracer gas testing for the Control Room Envelope, the relative pressure comparison is no longer important from a design and licensing basis perspective. It may be used for other purposes, such as ventilation balancing.
5. CREBAPS Design Basis	CREBAPS has been eliminated	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 Amendments 257/139	The Control Room Emergency Bottled Air Pressurization System has been eliminated.	Engineering Change Packages ECP-02-0243-ID-01 through ECP-02-0243-ID-09 & ECP-02-0243-RD NRC Safety Evaluation for Amendments 257 (BV1) & 139 (BV2)	

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	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
6. Maximum control room unfiltered inleakage during CR isolation and emergency pressurization mode and postulated Location of reference Unfiltered Inleakage	Isolation (recirculation) mode: 300 scfm with no pressurization Emergency (pressurization) mode: 30 scfm ○ Allowance for ingress/egress 10 ○ Allowance for dampers: 4 ○ Allowance for doors & seals: 6 ○ Allowance for degradation: 10 TOTAL 30 All unfiltered inleakage may be assumed to occur at same location as intakes, i.e. receptor points 2 and 3. These values include measurement uncertainties	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 Control Room Envelope Inleakage Testing at Beaver Valley Power Station; Final Report; NCS Corp. (Lagus) 7/23/01, Table 20, p.69 8700-RY-1C, R2	CR Isolation (recirculation) mode: 450 cfm maximum CR Emergency (pressurization) mode: 165 cfm maximum Each maximum control room unfiltered flow rate value listed above is an upper bound analytical value that includes test measurement uncertainties and a 10 cfm allowance for ingress and egress. All Unfiltered Inleakage (including that associated with ingress/egress) may be assumed to occur at same location as intakes (i.e., receptor points 2 and 3 of BV1/2 Drawing RY-0001C).	Assumed values are intended to provide operational margin. Engineering judgment – see comment column for parameter 3 BV1/2 Drawing RY-0001C	Refer to Comment for parameter 3.

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	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
7. Allowance for Ingress/Egress (all modes)	10 scfm	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 RG 1.78, position C.10 D.G. 1087, 3.4 SRP NuReg-0800, 6.4 SRP NuReg-0800, 6.4.III.3.d.iii	10 cfm	NRC Regulatory Guide 1.197 BV1 Drawing RA-0020A BV2 Drawing RA-0006B Engineering judgment	There are multiple doors that form part of the Control Room Envelope. Door S35-71 on the south wall of the Control Room at grade elevation 735'-6", between the two Control Room air intakes, accounts for most ingress and egress. Although the door for the Control Room south entrance is protected by a vestibule, no reduction in the 10 cfm allowance is credited.
8. Filtered emergency intake flow rate	600 - 1030 cfm range includes allowance for measurement uncertainties	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 T/S-1; 4.7.7.1.2 T/S-2; 4.7.7.1.2 Control Room Envelope Inleakage Testing at BVPS; Final Report; NCS Corp. (Lagus) 7/23/01, Table 7, p.44 and Table 11, p.50	800 to 1000 cfm Control room filtered inleakage ventilation flow rate values are analytical values that include test measurement uncertainties.	BV1/2 TS 5.5.7 BV1 Specification BVS-367 BV2 Specification 2BVS-157	WECTEC Note: A greater filtered emergency intake flow would reduce the CR dose because the greater depletion rate of the existing airborne activity associated with the larger intake eclipses the larger filtered activity intake.

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Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
9. Margin used on all CR ventilation flows	Not required Flows are based on measurements with reported uncertainty included.	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06	CR ventilation flow rates provided in parameters 3, 6, & 8, above, are analytical values that include test measurement uncertainties.		

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	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
10. CR Intake filter iodine removal efficiency DBA analysis values:	a) 99% for particulate b) 98% for elemental and organic	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 G.L. 99-02	99% for particulate 98% for elemental and organic	Regulatory Position C.5.c of NRC Regulatory Guide 1.52 BV1/2 TS 5.5.7.a Per NRC Generic Letter 99-02; to ensure that the efficiency assumed in the accident analysis is still valid at the end of the operating cycle, a minimum safety factor of 2 is to be applied to the laboratory test acceptance criteria. A SF of 2 is assumed. See comment and parameter 11 for additional detail.	The inplace dioctyl phthalate (DOP) test of the HEPA filters in accordance with ANSI N510-1980 confirming a penetration and system bypass of less than 0.05% at design flow rate can be considered to warrant a 99% removal efficiency for particulate matter in accident dose evaluations. WECTEC Notes: The penetration and bypass for the CREVS HEPA Filter per TS 5.5.7.a of < 0.05% warrants the use of an efficiency of 99% in safety analysis. Thus, the current licensing basis value of 99% remains valid. Per parameter 11, the proposed penetration and system bypass acceptance criterion for the CREVS Charcoal Filter (to be documented in updated TS 5.5.7.b) is < 0.5%. Per NRC GL 99-02, safety analyses can assume a charcoal filter efficiency of 100% - [(0.5% + 0.5%) x 2) = 98%. Thus, the current licensing basis value of 98% remains valid.

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Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
11. a) T/S Surveillance Acceptance Criterion for CR charcoal filters	a) ≥ 99 % efficiency acceptance criterion using radioactive methyl iodide.	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 U-1 T/S 4.7.7.1.c.2, T/S 4.7.7.2.c.2 U-2 T/S 4.7.7.1.d	a) ≥ 99.5% removal efficiency acceptance criterion for the charcoal adsorber using methyl iodide (i.e., as demonstrated by a laboratory test of a sample)	***a) Proposed change to BV1/2 TS 5.5.7.c acceptance criteria***	Charcoal adsorber sample is tested in laboratory in accordance with ASTM D3803-1989. System Engineering requested flexibility in charcoal adsorber testing acceptance criteria.
b) T/S Surveillance Acceptance Criterion for CR charcoal filters	b) ≥ 99.95 % efficiency acceptance criterion using R-11 refrigerant.	U-1 T/S 4.7.7.1.c.1, T/S 4.7.7.2.c.1 U-2 T/S 4.7.7.1.c.1	b) < 0.5% penetration and system bypass acceptance criterion for the charcoal adsorber (i.e., as demonstrated by an inplace test)	***b) Proposed change to BV1/2 TS 5.5.7.b acceptance criteria***	Charcoal adsorber is tested inplace in accordance with ANSI N510-1980. WECTEC Note: An efficiency ≥ 99.5% for the charcoal adsorber using R-11 refrigerant means the penetration and system bypass is less than 0.5% for the charcoal adsorber, as demonstrated by an inplace test.
c) T/S Surveillance Acceptance Criterion for CR HEPA filters	c) ≥ 99.95% for particulate using DOP.	U-1 T/S 4.7.7.1.c.1, T/S 4.7.7.2.c.1 U-2 T/S 4.7.7.1.c.2	c) < 0.05% penetration and system bypass for the HEPA filters (i.e., as demonstrated by an inplace test)	c) BV1/2 TS 5.5.7.a	

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Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
12. CR Filtered Recirculation Rate	N/A	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06	The BV1 and BV2 ventilation air-conditioning system recirculates CR air through filters intended for dust removal. <u>BV1</u> - AC fan 1VS-AC-1A and 1VS-F-40A or the B train - bag type filters - efficiency ~ 90% <u>BV2</u> - AC fan 2HVC-ACU201A or B - Hi efficiency type filters - efficiency ~ 85% <u>Minimum Flow rate</u>: Based on that available for CR air purge, i.e., 16,200 cfm per unit or 32,400 cfm <u>Duration</u>: t=0 to t-30 days	Location of Recirculation filters with respect to the CR are shown in the BV1 & BV2 sketch attached to this DIT BV1 Vendor Manual 10.001-0644 BV1 Specification BVS-0431 BV2 Vendor Manual 2510.140-179-005 BV2 Stock Code 10008727 BV2 Procedure 3BVT1.44.06 BV1 UFSAR Table 14.3-14a BV2 UFSAR Table 15.6-11	BV licensing basis does not credit / address recirculation filters. Analysis should evaluate if this approach remains conservative *Since the filters are not subject to a maintenance program, the analysis should conservatively assume 50% of the rated efficiency when crediting the filters to estimate the impact of use of the filters on the inhalation / submersion dose, and 100% efficiency when estimating the dose due to direct shine.* Roll Filters have an approximate 20% efficiency based on ASHRAE 52.1 – 1992 Test Method (Reference: Flanders Filter Efficiency Guide). Also reference BV1 Drawing RM-0444A-004, BV2 Drawing RM-0444A-001 and BV2 Drawing RM-0444A-002

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	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
13. Signals that automatically initiate CR emergency Ventilation	- Control Room Area Monitors - CIB signal	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 8700-120-65D S&W 2001-409-001	Signals originate from the Control Room Area Radiation Monitors or as Containment Isolation Phase B	BV1 Drawing LSK-021-001K BV1 UFSAR Section 11.3.5 BV2 UFSAR Section 6.4.2.2	For the purposes of DBA analyses, no credit is taken for CREVS initiation by CR area radiation monitors: BV1 Radiation Monitors RM-1RM-218A & B BV2 Radiation Monitors 2RMC-RQ201 & 202
14. Power supply to safety related instrumentation (i.e., the CIB signal) that initiate CR emergency Ventilation	Uninterrupted power	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 DCP 1302, Rev. 0, Solid State Protection System AC Power	Vital Bus System supplies Class 1E Uninterruptible Power System	BV1 Drawings RE-0001U & RE-0001AA BV2 Drawings RE-0001AY & RE-0001AZ BV1 UFSAR Section 8.5.4 BV2 UFSAR Section 8.3.1.1.17	

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Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
15. CR Emergency Ventilation initiation.	Manual: Yes (see Note 1) Automatic: Yes t = 0 to t = 77 sec: time delay associated with achieving CR isolation; assume normal ventilation (unfiltered) <u>U -1 (bounding)</u> t=77 sec to t = 30 min, CR isolated but not pressurized, t = 30 min to 30 days, CR pressurized/ emergency filtered intake mode	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 Unit 1 T/S 3/4.7.7 SRP 6.4 specifies that a substantial delay be assumed where manual isolation is assumed. ANS 58.8, "Time Response Design Criteria for Safety Related Operations"	The Control Room is automatically isolated within 77 seconds of receipt of a CIB signal; for this time period, normal (unfiltered) ventilation is assumed. Following the CIB signal, the Control Room would remain isolated from 77 seconds to 30 minutes (to bound manual actuation of BV1 CREVS), while on recirculation. From 30 minutes to 30 days, the Control Room will be placed in the emergency filtered intake mode and pressurized via CREVS.	BV1/2 TS 3.7.10 including Bases BV1 LRM Table 3.3.2-1 BV2 LRM Table 3.3.2-1	A CIB from either Unit isolates the Control Room and initiates BV2 CR emergency ventilation. There are three CREVS fan pressurization systems, one at BV1 and two at BV2. Operation with the one BV1 system and one of the two BV2 systems is permitted; a single failure of the operable BV2 system would require manual start of the BV1 system. The 30 minute allowance is for performing manual operator actions outside the Control Room, such as damper manipulations, and bounds the sequencing scheme of automatically starting a BV2 CREV system. The 30 minute allowance is consistent with the current design and licensing basis. For conservatism, all delays are assumed to be sequential.

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Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
16. Radiation monitor alarm set point to initiate CR emergency ventilation (non-1E)	≤ 0.476 mR/hr	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 T/S –1 Table 3.3-6	N/A	N/A	The CREVS initiation function from CR Radiation Monitors (listed in parameter 13) is not credited.
17. Radiation monitor response delay time after CR environment has reached alarm setpoint	≤180 sec following Hi Radiation	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06	N/A	N/A	The CREVS initiation function from CR Radiation Monitors (listed in parameter 13) is not credited.
Control room ventilation isolation delay time on Hi-Hi Containment Pressure (CIB)	≤22.0 sec following CIB signal ≤ 77.0 sec. (including <u>D.G. start and sequencer delays)</u>	Unit -1 & -2 LRM, Table 3.2-1	≤ 22.0 seconds following CIB signal, and ≤ 77.0 seconds following CIB signal and including Emergency Diesel Generator start and EDG load sequencer delays	BV1 LRM Table 3.3.2-1 BV2 LRM Table 3.3.2-1 BV1 Procedure 1BVT1.1.2 BV2 Procedure 2BVT1.1.2	Time response testing demonstrates that the acceptance criteria are satisfied. Actuation times and delays involving the sensor, channel, slave relay, Emergency Diesel Generator (start and coming up to speed), EDG load sequencer, and damper (stroke) are included as appropriate.
18. Radiation monitor accuracy	± 22% of reading	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06	N/A	N/A	The CREVS initiation function from CR Radiation Monitors (listed in parameter 13) is not credited.

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Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
19. CIB signal processing delay time after LOCA	Assumed instantaneous	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06	Assumed instantaneous (see parameter 15)		This parameter is included within the time delay values quoted for parameter 15 (except for the manual actuation at 30 minutes).
20. CR Breathing rate	3.5E-4 m^3/s	R.G. 1.183 Rev 0	3.5E-4 m^3/s	NRC Regulatory Guide 1.183	See RG 1.183 section 4.2.6.
21. Control Room Occupancy Factors	0-24 hr 1.0 1-4 day 0.6 4-30 day 0.4	R.G. 1.183 Rev 0, 4.2.6 SRP, NuReg-0800, 6.4 Appendix A	0 to 24 hours: 1.0 1 to 4 days: 0.6 4 to 30 days: 0.4	NRC Regulatory Guide 1.183	See RG 1.183 section 4.2.6.

Control Room Shielding (General)					
22. Control Room Penetrations	All penetrations in CR walls / ceiling, including CR door have equivalent shielding	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 This will have to be listed as an assumption.	<u>BV1</u> CR ventilation Intake filters and the air-conditioning recirculation filters are located in the BV1 fan room below the BV1 CR. There are no penetrations between the fan room (ceiling) and CR (floor) <u>BV2</u> ventilation Intake filters and the air-conditioning recirculation filters are located in the fan room east of the CR (i.e., adjacent to the computer room). There are penetrations in the wall between the fan room and the computer room.	BV1 Drawing 8700-RM-0003M BV1 sketch attached to this DIT BV2 sketch attached to this DIT	

23. Release paths to be addressed for the LOCA analysis	Direct Shine to Control Room: Containment Shine, CR Penetration Shine due to Airborne Activity in the Cable spreading area under Unit 2 CR, CR Penetration Shine due to Airborne Activity in the Cable Tray Mezzanine under Unit 1 CR, Cloud shine due to Containment, ESF, and RWST Leakage, CR filter shine due to containment, ESF and RWST leakage, RWST direct shine	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 U1 UFSAR 14.3.5, U2 UFSAR 15.6.5	Direct Shine to Control Room: 1. Containment Shine, 2. Control Room Penetration Shine due to Airborne Activity in BV2 Cable Spreading Area under BV2 CR, 3. CR Penetration Shine due to Airborne Activity in the Cable Tray Mezzanine under BV1 CR, 4. Cloud shine due to Containment, Engineered Safety Features, and Refueling Water Storage Tank leakage, 5. CR filter shine due to Containment, ESF and RWST leakage, and 6. RWST direct shine	The current design and licensing basis is to be carried forward in BV1/2 Calculation UR(B)-487.	Release paths defined in the current design and licensing basis are applicable.

Control Room Shielding (Containment Shine)					
24. LOCA dose to control room due to direct shine from Containment	From Reference	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 S&W calc 12241/11700-UR(B)-487, R0 including Addendum 1 and 2	The shielding model developed in BV1/2 Calculation UR(B)-487 Rev 0 remains applicable.	Engineering judgment	There have been no significant plant changes to the layout and arrangement (including materials) of the Control Room, the CREVS filters, the outer walls of the Reactor Containments, the Refueling Water Storage Tanks, or the RWST biological shield walls since the original shielding model was developed.
Control Room Shielding (Direct Shine from airborne activity in the Cable Spreading Area Below Unit 2 CR via Penetrations)					
25. LOCA dose to control room due to direct shine from Airborne Activity in the Cable Spreading Area below Unit 2 Control room via penetrations	From Reference	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 S&W calc 12241/11700-UR(B)-487, R0 including Addendum 1 and 2	See parameter 24		
26. χ/Q from Unit 1&2 containment edges to vent chase cable tunnel supply intake located at the NW corner on top of Unit 2 Auxiliary Bldg.	From Reference	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 S&W Calculations 8700-EN-ME-105, R0, Addendum 1 10080-EN-ME-106, R0, Addendum 1	From References	BV1 Calculation EN-ME-105 and BV2 Calculation EN-ME-106	

27. χ/Q from Unit 1&2 containment tops to vent chase cable tunnel supply located at the NW corner on top of Unit 2 Auxiliary Bldg.	From Reference	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 S&W Calculations 8700-EN-ME-105, R0 Addendum 1 10080-EN-ME-106, R0 Addendum 1	From References	BV1 Calculation EN-ME-105 and BV2 Calculation EN-ME-106	
28. χ/Q from Unit 1&2 RWSTs to vent chase cable tunnel supply intake located at the NW corner on top of Unit 2 Auxiliary Bldg.	From Reference	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 S&W Calculations 8700-EN-ME-105, R0 Addendum 1 10080-EN-ME-106, R0 Addendum 1	From References	BV1 Calculation EN-ME-105 and BV2 Calculation EN-ME-106	

Control Room Shielding (Direct Shine from Airborne Activity in the Cable Tray Mezzanine Below Unit 1 Control Room via Penetrations)					
29. LOCA dose to CR due to direct shine from airborne activity in the Cable Tray Mezzanine Area below Unit 1 CR via penetrations	From Reference	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 S&W calc 12241/11700-UR(B)-487, R0 including Addendum 1 and 2	See parameter 24		
30. χ/Q from containment edge to Unit 1 Service Building intake which supplies air to Cable Tray Mezzanine	From Reference	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 S&W Calculations 8700-EN-ME-105, R0, Addendum 1 10080-EN-ME-106, R0 Addendum 1	From References	BV1 Calculation EN-ME-105 and BV2 Calculation EN-ME-106	
31. χ/Q from containment top to Unit 1 Service Building intake which supplies air to Cable Tray Mezzanine	From Reference	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 S&W Calculations 8700-EN-ME-105, R0 10/20/06 10080-EN-ME-106, R0 10/20/06	From References	BV1 Calculation EN-ME-105 and BV2 Calculation EN-ME-106	

Control Room Shielding (RWST Direct Shine)					
38. LOCA dose to CR due to direct shine from the RWST	From Reference	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 S&W calc 12241/11700-UR(B)-487, R0 including Addendum 1 and 2	See parameter 24		
Site Boundary Atmospheric Dispersion Factors and Breathing Rates					
39. Offsite atmospheric dispersion factors (s/m³)	<u>EAB</u> 0-2hrs:1.04E-3 (U1) 0-2hrs:1.25E-3 (U2) <u>LPZ</u> 0-8 hr: 6.04E-5 8-24: 4.33E-5 1-4days: 2.10E-5 4-30 days: 7.44E-6	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 ERS-SFL-96-021	<u>Exclusion Area Boundary</u> 0 to 2 hours: 1.04E-3 (BV1) 1.25E-3 (BV2) <u>Low Population Zone</u> 0 to 8 hours: 6.04E-5 8 to 24 hours: 4.33E-5 1 to 4 days: 2.10E-5 4 to 30 days: 7.44E-6	BV1/2 Calculation ERS-SFL-96-021 BV2 UFSAR Table 15.0-11	
40. Offsite Breathing rates (m³/sec)	0-8 hrs: 3.5E-4 8-24 hr: 1.8E-4 1-30 days: 2.3E-4	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 RG 1.183 R0	0 to 8 hours: 3.5E-4 8 to 24 hours: 1.8E-4 1 to 30 days: 2.3E-4	NRC Regulatory Guide 1.183	

32. χ/Q from RWST vent to Unit 1 Service Building intake which supplies air to Cable Tray Mezzanine	From Reference	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 S&W Calculations 8700-EN-ME-105, R0 10/20/06 10080-EN-ME-106, R0 10/20/06	From References	BV1 Calculation EN-ME-105 and BV2 Calculation EN-ME-106	
Control Room Shielding (Cloud shine from Containment leakage, ESF leakage, and RWST leakage)					
33. LOCA dose to CR due to direct shine from the cloud surrounding the CR (includes Containment, ESF and RWST leakage)	From Reference	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 S&W calc 12241/11700-UR(B)-487, R0 including Addendum 1 and 2	See parameter 24		

Control Room Shielding (Intake Filter shine from Containment leakage, ESF leakage, and RWST leakage)					
34. LOCA dose to CR due to direct shine from the CR Ventilation Intake filter	From Reference	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 S&W calc 12241/11700-UR(B)-487, R0 including Addendum 1 and 2	See parameter 24		As noted in parameter 24, there have been no significant plant changes that would affect the original shielding model; however, the dimensions of the BV2 HEPA filters have been updated as specified in parameter 35 and the information regarding the shielding between the HEPA filters and the Control Room has been updated in parameter 37.
35. CR HEPA filter dimensions: Unit 1: Unit 2:	 HEPA Filter Tray: 24 x 24 x 11.5 in. 27-1/2 x 25-3/4 x 7-3/4 in.	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 Specification for Ventilation Filter Assemblies 1BVS-367 & 2BVS-157 DLCo Dwg. No. 8700-10.001-0222 S&W Drawing 2010.800-157-003	BV1 HEPA Filter 1VS-FL-3: 24" x 24" x 11.5" BV2 HEPA Filter 2HVC-FLTA253A&B: 24" x 24" x 11.5"	BV1 Drawing 10.001-0222 BV1 Specification BVS-367 BV2 Vendor Manual 2510.800-157-002 FENOC Stock Item 9735047	

36. Charcoal residence time	0.25 sec. (minimum)	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 R.G. 1.52, 7/1/76	Minimum of 0.241 seconds (BV1) Minimum of 0.25 seconds (BV2)	BV1 Drawings 10.001-0222 & 10.001-0363 BV1 Procedure 1CMP-44VS-FL-2-1M BV1 UFSAR Table 9.13-2 FENOC Stock Item 100075371 (direct inspection) BV2 Specification 2BVS-157 FENOC Stock Item 9735717	BV1 charcoal filter 1VS-FL-2 contains three drawers with two beds per drawer. The exposed face of one side of a drawer is estimated to be 25.5" x 22.75", with a 2" bed. The maximum flow rate is 1000 cfm. Thus, 0.241 seconds is the minimum time. WECTEC Notes: Per Regulatory Position C.3.i of NRC Regulatory Guide 1.52, Rev 2, the adsorber system should be designed for an average atmosphere residence time of 0.25 sec per 2 inches of adsorbent bed. Per parameter 8, the ventilation flowrate through the CREVS filters ranges from 800 cfm to 1000 cfm. WECTEC Notes: Based on the data presented in documents listed below, it is concluded that *this minor deviation from the required residence time of 0.25 sec has minimal impact on the filter efficiency used in safety analyses.* Ref. 2 developed a correlation for predicting the effect of various operating and physical parameters on the penetration of radioiodine in charcoal filters. The "change" in the penetration for the face velocity represented

					by the residence time of 0.241 sec when compared to the 0.25 sec, is ~3.6% which is a minimal impact on the filter removal efficiency. Ref. 1 Table 3 presents a data set that demonstrates that for high filter efficiency the effect of face velocity over a wide range is small. Ref. 1: "Research on Removal of Radioiodine on Charcoal" by Li Wangchang; Huang Yuying; *et al* 1/1/1993 and located in INIS Ref. 2: "Correlation of Radioiodine Efficiencies Resulting From a Standardized Test Program for Activated Carbons" by R.D.Rivers, *et al* AAF, Session 8, 12th Air Cleaning Conference
37. Concrete wall thickness between CR HEPA filter and CR	2'0"	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 Drawing No. 8700-RC-8C-13 Service Building Slab Plan at EL.735'6" Outline	15" (BV1 – Control Room floor slab above 1VS-FL-3) 12" (BV2 – one 12" wall between 2HVC-FLTA253A & B and CR Computer Room)	BV1 Drawings RB-0017J & RC-0008C BV2 Drawing RB-0039A	The BV1 HEPA filter is located in the BV1 Service Building on Floor Elevation 713'-6". The 12" thick wall between the BV2 HEPA filters and the CR Computer Room has no door. There is also a 12" thick wall, with a door opening, that separates the CR Controls Area from the CR Computer Room. The BV2 HEPA filters are stacked one on top of the other and located in the BV2 Control Building on Floor Elevation 735'-6".

Control Room Shielding (RWST Direct Shine)					
38. LOCA dose to CR due to direct shine from the RWST	From Reference	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 S&W calc 12241/11700-UR(B)-487, R0 including Addendum 1 and 2	See parameter 24		
Site Boundary Atmospheric Dispersion Factors and Breathing Rates					
39. Offsite atmospheric dispersion factors (s/m^3)	EAB 0-2hrs:1.04E-3 (U1) 0-2hrs:1.25E-3 (U2) LPZ 0-8 hr: 6.04E-5 8-24: 4.33E-5 1-4days: 2.10E-5 4-30 days: 7.44E-6	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 ERS-SFL-96-021	Exclusion Area Boundary 0 to 2 hours: 1.04E-3 (BV1) 1.25E-3 (BV2) Low Population Zone 0 to 8 hours: 6.04E-5 8 to 24 hours: 4.33E-5 1 to 4 days: 2.10E-5 4 to 30 days: 7.44E-6	BV1/2 Calculation ERS-SFL-96-021 BV2 UFSAR Table 15.0-11	
40. Offsite Breathing rates (m^3/sec)	0-8 hrs: 3.5E-4 8-24 hr: 1.8E-4 1-30 days: 2.3E-4	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 RG 1.183 R0	0 to 8 hours: 3.5E-4 8 to 24 hours: 1.8E-4 1 to 30 days: 2.3E-4	NRC Regulatory Guide 1.183	

References for Table E

1. BV1 Updated Final Safety Analysis Report, Rev 30
2. BV1 Licensing Requirements Manual (including Bases), Rev 101
3. BV1 Calculation CR-AC-1, Rev 0, Volume of Control Room Area Air Conditioning Spaces
4. BV1 Calculation DMC-3171, Rev 0, Verification of Control Room Area Volume
5. BV1 Calculation EN-ME-105, Rev 0 including Add 1, Atmospheric Dispersion Factors (X/Qs) at Control Room and ERF Receptors for Unit 1 Accident Releases Using the ARCON96 Methodology
6. BV1 Drawing LSK-021-001K, Rev 5, Logic Diagram – Air Conditioning and Refrigeration – Control Room
7. BV1 Drawing RA-0020A, Rev 10, Floor Plans Main Entrance & Control Room
8. BV1 Drawing RB-0017J, Rev 16, Air Conditioning Plan – Control Room Service Building
9. BV1 Drawing RC-0008C, Rev 13, Slab Plan at Elevation 735'-6" Outline Service Building
10. BV1 Drawing RE-0001U, Rev 39, 120V AC Vital Bus – I One Line Diagram (Red)
11. BV1 Drawing RE-0001AA, Rev 36, 120V AC Vital Bus – II One Line Diagram (White)
12. BV1 Drawing RM-0444A-004, Rev 15, Valve Operating Number Diagram, Control Room Area – Air Conditioning System
13. BV1 Drawing 10.001-0222, Rev B, Control Room Emergency Filter
14. BV1 Procedure 1BVT1.1.2, Rev 25, Engineered Safety Features Time Response Test
15. BV1 Procedure 1CMP-44VS-FL-2-1M, Rev 2, Control Room Emergency Outside Air Filter Replacement
16. BV1 Specification BVS-0367, Rev 3 through and including Add 3, Specification for Primary Ventilation Filter Assemblies
17. BV1 Specification BVS-0431, Rev. 2, Central Station Air Handling Units and Heating and Ventilation Units
18. BV1 Vendor Manual 10.001-0644, Rev. N, Central Station Climate Changers Installation and Maintenance Manual
19. BV2 Updated Final Safety Analysis Report, Rev 23
20. BV2 Licensing Requirements Manual (including Bases), Rev 92
21. BV2 Calculation B-029A, Rev 0, Control Room Ventilation System – Freon-22 Concentration
22. BV2 Calculation B-074, Rev 0, Determination of Control Room Volume
23. BV2 Calculation EN-ME-106, Rev 0 including Add 1, Atmospheric Dispersion Factors (X/Qs) at Control Room and ERF Receptors for Unit 2 Accident Releases Using the ARCON96 Methodology
24. BV2 Drawing RA-0006B, Rev 23, Door Schedule & Details
25. BV2 Drawing RB-0039A, Rev 14, Air Conditioning & Ventilation, Control Building
26. BV2 Drawing RE-0001AY, Rev 13, 120 VAC Vital Bus I One Line Diagram (Red)
27. BV2 Drawing RE-0001AZ, Rev 13, 120 VAC Vital Bus II One Line Diagram (White)
28. BV2 Drawing RM-0444A-001, Rev 8, Valve Operating Number Diagram, Control Building Ventilation System
29. BV2 Drawing RM-0444A-002, Rev 16, Valve Operating Number Diagram, Computer and Control Room Air Conditioning
30. BV2 Drawing 2010.800-157-003, Rev G, Control Room Air Pressurization Filter
31. BV2 Vendor Manual 2510.140-179-005, Rev. F, Installation, Startup and Service Instruments for Carrier 39E Air Handling Units
32. BV2 Vendor Manual 2510.800-157-002, Rev Y, Installation, Operation and Maintenance Manual – Ventilation Filter Assemblies
33. BV2 Procedure 2BVT1.1.2, Rev 15, Safeguards Time Response Test
34. BV2 Specification 2BVS-157, Final Revision (2/2/1988), Specification for Ventilation Filter Assemblies

35. BV1/2 Calculation UR(B)-487, Rev 2 [Pending], Site Boundary, Control Room and Emergency Response Facility Doses following a Loss-Of-Coolant Accident Based on Core Uprate, an Atmospheric Containment and Alternative Source Terms
36. BV1/2 Calculation ERS-SFL-96-021, Rev 0, RG 1.145 Short-Term Accident X/Q Values for EAB and LPZ, based on 1986 – 1995 Observations
37. BV1/2 Drawing RY-0001C, Rev 2, Site Postulated Release and Receptor Points
38. BV1/2 Engineering Change Packages for CREBAPS Deletion and CREVS Modification (i.e., ECP-02-0243-ID-01 Rev 5 through ECP-02-0243-ID-09 Rev 2, plus ECP-02-0243-RD Rev 5)
39. BV1/2 Procedure 3BVT 1.44.05, Rev. 6, Control Room Envelope Air In-Leakage Test
40. BV1/2 Technical Specifications (including Bases), 6/14/2018
41. Order 200699902 (2017), Perform 3BVT-01_44_05
42. Vendor Report, NCS Corporation, Control Room Envelope Inleakage Testing at Beaver Valley Power Station 2017, Final Report (1/31/2018)
43. FENOC Stock Item 9735047, Charcoal Filter Tray
44. FENOC Stock Item 9735717, Charcoal Filter Tray
45. FENOC Stock Item 100075371, Charcoal Filter Tray
46. FENOC Stock Item 10008727, Cambridge Hi-Flo Filter
47. NRC Generic Letter 99-02, Laboratory Testing of Nuclear-Grade Activated Charcoal (6/3/1999), including Errata (8/23/1999)
48. NRC Regulatory Guide 1.52, Rev 2 (3/1978), Design, Testing, and Maintenance Criteria for Post Accident Engineered-Safety-Feature Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants
49. NRC Regulatory Guide 1.183, Rev 0 (7/2000), Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors
50. NRC Regulatory Guide 1.197, Rev 0 (5/2003), Demonstrating Control Room Envelope Integrity at Nuclear Power Reactors
51. NRC Safety Evaluation for Amendments 257 (BV1) & 139 (BV2) for selective implementation of an Alternative Source Term methodology for the Loss-Of-Coolant Accident and the Control Rod Ejection Accident, incorporation of ARCON96 methodology for release points associated with the LOCA and CREA, elimination of the Control Room Emergency Bottled Air Pressurization System changes to the Control Room Emergency Ventilation System, and a change to the BV1 CREVS filter bypass leakage acceptance test criteria

Note: Increasing the current fresh air flow rate (500 cfm) has been requested during normal operation. Unfiltered normal operation air intake flow rates are often stated in the BV1 UFSAR and BV2 UFSAR to be 300 cfm (BV1) and 200 cfm (BV2), or a total of 500 cfm. These UFSAR values are to be changed after the Amendments are received. Other documents showing analogous flow rates are likewise affected.

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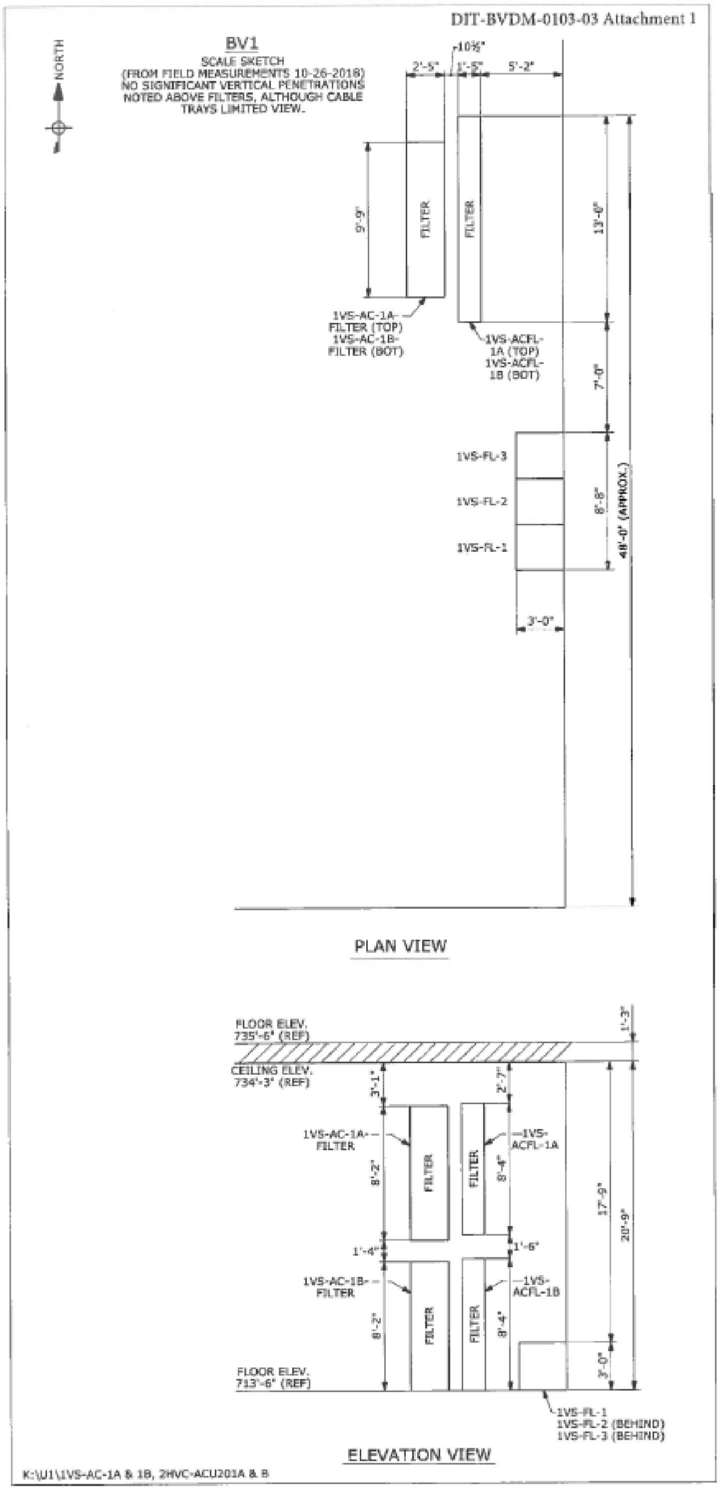
CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-487	REVISION: 3



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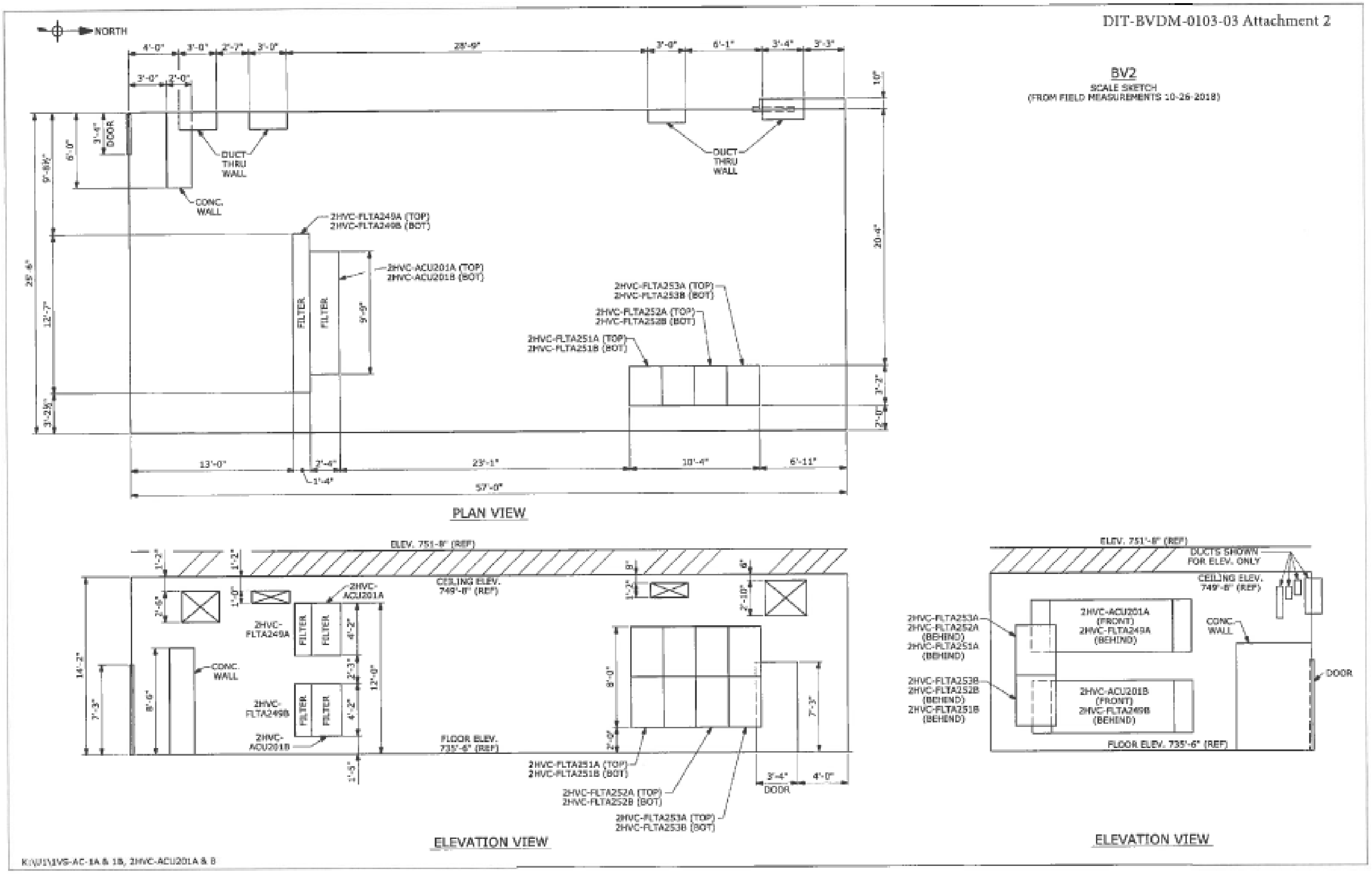
CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-487

REVISION: 3



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CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-487	REVISION: 3

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DESIGN VERIFICATION RECORD

Page 1 of 1

NOP-CC-2001-01 Rev. 00

SECTION I: TO BE COMPLETED BY DESIGN ORIGINATOR

DOCUMENT(S)/ACTIVITY TO BE VERIFIED:

DIT-BVDM-0103-03

☒ SAFETY RELATED ☐ AUGMENTED QUALITY ☐ NONSAFETY RELATED

SUPPORTING/REFERENCE DOCUMENTS

DESIGN ORIGINATOR: *(Print and Sign Name)* Douglas T Bloom [signature] DATE 1-28-19

SECTION II: TO BE COMPLETED BY VERIFIER

VERIFICATION METHOD *(Check one)*

☒ DESIGN REVIEW *(Complete Design Review Checklist or Calculation Review Checklist)* ☐ ALTERNATE CALCULATION ☐ QUALIFICATION TESTING

JUSTIFICATION FOR SUPERVISOR PERFORMING VERIFICATION:

N/A

APPROVAL: *(Print and Sign Name)* N/A DATE

EXTENT OF VERIFICATION:

Design Review Checklist completed.

COMMENTS, ERRORS OR DEFICIENCIES IDENTIFIED? ☐ YES ☒ NO

RESOLUTION: *(For Alternate Calculation or Qualification Testing only)*

N/A

RESOLVED BY: *(Print and Sign Name)* N/A DATE

VERIFIER: *(Print and Sign Name)* Michael G. Unfried [signature] DATE 1/28/2019

APPROVED BY: *(Print and Sign Name)* M S Ressler [signature] DATE 1/29/2019

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DESIGN REVIEW CHECKLIST

NOP-CC-2001-02 Rev. 04

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):

DIT- BVDM-0103-03

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
1. Were the basic functions of each structure, system or component considered?		✓			
2. Have performance requirements such as capacity, rating, and system output been considered?		✓			
3. Are the applicable codes, standards and regulatory requirements including applicable issue and/or addenda properly identified and are their requirements for design and/or material been met or reconciled?		✓			
4. Have design conditions such as pressure, temperature, fluid chemistry, and voltage been specified?		✓			
5. Are loads such as seismic, wind, thermal, dynamic and fatigue factored in the design?	✓				
6. Considering the applicable loading conditions, does an adequate structural margin of safety exist for the strength of components?	✓				
7. Have environmental conditions anticipated during storage, construction and operation such as pressure, temperature, humidity, soil erosion, run-off from storm water, corrosiveness, site elevation, wind direction, nuclear radiation, electromagnetic radiation, and duration of exposure been considered?	✓				
8. Have interface requirements including definition of the functional and physical interfaces involving structures, systems and components been met?		✓			
9. Have the material requirements including such items as compatibility, electrical insulation properties, protective coating, corrosion, and fatigue resistance been considered?	✓				
10. Have mechanical requirements such as vibration, stress, shock and reaction forces been specified?	✓				
11. Have structural requirements covering such items as equipment foundations and pipe supports been identified?	✓				
12. Have hydraulic requirements such as pump net positive suction head (NPSH), allowable pressure drops, and allowable fluid velocities been specified?	✓				
13. Have chemistry requirements such as the provisions for sampling and the limitations on water chemistry been specified?	✓				
14. Have electrical requirements such as source of power, voltage, raceway requirements, electrical insulation and motor requirements been specified?	✓				
15. Have layout and arrangement requirements been considered?		✓			
16. Have operational requirements under various conditions, such as plant startup, normal plant operation, plant shutdown, plant emergency operation, special or infrequent operation, and system abnormal or emergency operation been specified?		✓			

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DESIGN REVIEW CHECKLIST

NOP-CC-2001-02 Rev. 04

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):

DIT-BVDM-0103-03

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
17. Have instrumentation and control requirements including instruments, controls, and alarms required for operation, testing, and maintenance been identified? Other requirements such as the type of instrument, installed spares, range of measurement, and location of indication should also be included.	✓				
18. Have adequate access and administrative controls been planned for plant security?	✓				
19. Have redundancy, diversity, and separation requirements of structures, systems, and components been considered?		✓			
20. Have the failure requirements of structures, systems, and components, including a definition of those events and accidents which they must be designated to withstand been identified?	✓				
21. Have test requirements including in-plant tests, and the conditions under which they will be performed been specified?	✓				
22. Have accessibility, maintenance, repair and in-service inspection requirements for the plant including the conditions under which they will be performed been specified?	✓				
23. Have personnel requirements and limitations including the qualification and number of personnel available for plant operation, maintenance, testing and inspection and permissible personnel radiation exposure for specified areas and conditions been considered?	✓				
24. Have transportability requirements such as size and shipping weight, limitations and Interstate Commerce Commission regulations been considered?	✓				
25. Have fire protection or resistance requirements been specified?	✓				
26. Are adequate handling, storage, cleaning and shipping requirements specified?	✓				
27. Have the safety requirements for preventing undue risk to the health and safety of the public been considered?		✓			
28. Are the specified materials, processes, parts and equipment suitable for the required application?	✓				
29. Have safety requirements for preventing personnel injury including such items as radiation hazards, restricting the use of dangerous materials, escape provisions from enclosures and grounding of electrical equipment been considered?	✓				
30. Were the inputs correctly selected and incorporated into the design?		✓			
31. Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed?	✓				
32. Are the appropriate quality and quality assurance requirements specified?	✓				

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DESIGN REVIEW CHECKLIST

NOP-CC-2001-02 Rev. 04

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):
DIT- BVDM- 0103-03

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
33. Have applicable construction and operating experience been considered?		✓			
34. Have the design interface requirements been satisfied?	✓				
35. Was an appropriate design method used?		✓			
36. Is the output reasonable compared to inputs?		✓			
37. Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?	✓				
38. Have adequate maintenance features and requirements been specified?	✓				
39. Has the design properly considered radiation exposure to the public and plant personnel?		✓			
40. Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfied?	✓				
41. Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?	✓				
42. Are adequate identification requirements specified?	✓				
43. Are requirements for record preparation, review, approval, retention, etc., adequately specified?	✓				
44. Have protective coatings qualified for Design Basis Accident (DBA) been specified to structures, equipment and components installed in the containment/drywell?	✓				
45. Are the necessary supporting calculations completed, checked and approved?	✓				
46. Have the equipment heat load changes been reviewed for impact on HVAC systems?	✓				
47. IF a computer program was used to obtain the design by analysis, **THEN** has the program been validated per NOP-SS-1001 and documented to verify the technical adequacy of the computer results contained in the design analysis?	✓				
48. Have Professional Engineer (PE) certification requirements been addressed and documented where required by ASME Code (if applicable).	✓				
49. Does the design involve the installation, removal, or revise software/firmware and have the requirements of NOP-SS-1001 been addressed?	✓				
50. Does the design involve the installation, removal, or change to a digital component(s) and have the requirements of NOP-SS-1201 been addressed?	✓				

COMPLETED BY: *(Print and Sign Name)*	DATE	ADDITIONAL VERIFIER *(Print and Sign Name)*	DATE
M. G. Unfried [signature]	1/28/2019	N/A	

IF CHECKLIST IS REVIEWED BY MORE THAN ONE VERIFIER, SIGN BELOW:

Attachment 5

FirstEnergy Design Input Transmittal

DIT-BVDM-0115-01 transmitted via Letter ND1MDE:0739

January 30, 2019

FENOC

Beaver Valley Power Station
P.O. Box 4
Shippingport, PA 15077

Patrick G. Pauvlinch
Manager, Design Engineering
pauvlinchp@firstenergycorp.com

Phone: 724-682-4982
Fax: 330-315-9717

ND1MDE:0739
January 30, 2019

Sreela Ferguson
WECTEC
720 University Ave.
Norwood, MA 02062

BV1 & BV2 Complete Reanalysis of Dose Consequences
For CRE Tracer Gas Testing and Other Acceptance Criteria Changes
Design Input Transmittal DIT-BVDM-0115-01 for Emergency Response Facility (ERF)

Dear Ms. Ferguson:

Attached is Design Input Transmittal DIT-BVDM-0115-01 which provides information for evaluating the Emergency Response Facility dose consequences.

Should you have any questions about the attached information, please contact Douglas Bloom at 724-682-5078 or Mike Ressler at 724-682-7936.

Sincerely,

Patrick G. Pauvlinch
Manager, Design Engineering

DTB/bls

Attachment

cc: M. G. Unfried
M. S. Ressler
D. T. Bloom
BVRC

CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-487 | REVISION: 3

Form 1/2-ADM-2097.F01, Rev 0 RTL# A1.105V

DESIGN INPUT TRANSMITTAL

☒ SAFETY RELATED / AUG QUAL ☐ NON-SAFETY RELATED	Originating Organization: ☒ FENOC ☐ Other (Specify)	DIT- BVDM-0115-01 Page __1__ of __1__
Beaver Valley Unit: ☐1 ☐2 ☒Both System Designation: Various Engineering Change Package: N/A		To: Sreela Ferguson Organization: WECTEC

Subject: **Design Input Transmittal for Parameter List for Calculating Emergency Response Facility (ERF) Dose Consequences**

Status of Information: ☒Approved for Use ☐Unverified

For Unverified DITs, Notification number tracking verification: ____________________

Description of Information:

Safety Analysis Design Inputs? ☒Yes ☐No

Reconciled to Current Design Basis? ☒Yes ☐N/A

This DIT provides information required for the performance of calculating dose consequences at the BV1/2 Emergency Response Facility (ERF).

Purpose of Issuance:

This DIT provides information required for the performance of design basis accident dose consequence calculation UR(B)-487.

Source of Information (Reference, Rev, Title, Location): Engineering Judgment Used? ☐Yes ☒No

See attachment to DIT table.

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DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE F: Parameter List for Calculating Emergency Response Facility (ERF) Dose Consequences

	AOR [10080-UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**

General Notes:

1. In accordance with current licensing basis, dose consequences in the ERF are only assessed for the Loss-of-Coolant Accident (LOCA). As shown in the design input table below, the Technical Support Center is located in the ERF. Note that the Emergency Operations Facility (EOF) is no longer part of the ERF as it has been relocated outside of the 10-mile radius from the plant.
2. The critical input parameters are the X/Q values. *(Due to highly favorable atmospheric dispersion factors associated with radioactivity releases resulting from a LOCA to the ERF, and as demonstrated in the current Analysis of Record (AOR), ERF habitability can be demonstrated without taking credit of the ERF structure/ventilation systems; specifically, the inhalation and immersion doses are based on a semi-infinite cloud model considering activity release rates, X/Qs, breathing rate, and occupancy factors.)*

ERF (Inhalation / Submersion Dose)

1. Minimum Emergency Response Facility (ERF) free volume	TSC: 84,150 ft³ EOF: 33,150 ft³ ERF: 192 x 164 x 16 ft. (approx.) = 5.038E+05 ft³ *The listed volumes should be reduced by 5% to account for internal walls, furniture and equipment, where it is conservative.*	FENOC letter ND1MDE:0379; [DIT-FPP-0045-00]; 10/20/06 ERS-SFL-95-013, Rev 1, Attach. 5 Drawing 8700-RA-60A-1 Drawing 8700-RM-60E-3 Drawing 8700-RA-60F-1	ERF recirculation ventilation envelope with 5% reduction: 462,129 cu ft	BV1 Drawing RA-0060A BV1 Drawing RA-0060F BV1 Drawing RM-0060E FENOC Letter ND1MDE:0379	The TSC is located within the Emergency Response Facility. The ERF services both BV1 and BV2. ERF recirculation ventilation envelope excludes: Room 103 (Vestibule), Room 107 (Electric), Room 108 (Switchgear), Room 108A (Control Room), Room 109A (Mechanical), Room 109B (Mechanical), Room 110 (Battery), Room 112 (Service Dock), Room 113 (Critical Records Vault), Room 114 (Storage), Room 140 (Corridor), Room 146 (Vestibule), Room 147 (Water Treatment), and Equipment Court, This DIT continues to include parameter values designated as the EOF, even though Emergency Response Organization personnel assigned to the EOF report to an offsite location. *The listed volumes have been reduced by 5% to account for internal walls, furniture and equipment*

2. ERF ventilation intake design	During a DBA, the ERF is manually isolated and placed in recirculation mode through a second train of filters consisting of a pre-filter, HEPA and charcoal filter.	FENOC letter ND1MDE:0379; [DIT-FPP-0045-00]; 10/20/06 DLC Calc. ERS-SFL-95-013, R1, Attachment 2 EPP/IP 1.4, R15, Attachment 1 Drawing 8700-RM-60E-3	A single outside air intake supplies the normal ventilation for the occupied portion of the ERF. Fresh outside air supplying normal ventilation passes through prefilter 1VS-FL-39 and HEPA filter 1VS-FL-40 before being circulated. During an emergency, the ERF normal outside air intake is manually isolated, and the ventilation system is placed in recirculation mode; the recirculated air is passed through prefilter 1VS-FL-41, HEPA filter 1VS-FL-42, charcoal filter 1VS-FL-43, and HEPA filter 1VS-FL-44.	BV1/2 Procedure 1/2-EPP-IP-1.4 BV1 Drawing RM-0060E TER-009012	Prefilter 1VS-FL-39 and HEPA filter 1VS-FL-40 are located in Room 112 (Service Dock). The charcoal and the downstream HEPA filter media have been removed from the intake filter train. Prefilter 1VS-FL-41, HEPA filter 1VS-FL-42, charcoal filter 1VS-FL-43, and HEPA filter 1VS-FL-44 are located in Room 109B (Mechanical).

3. Maximum normal operation ERF ventilation intake flow rate Maximum Unfiltered inleakage while on normal operation, taken as 50% of the maximum intake flow rate.	ERF Intake flow: 3800 cfm +10%, -10% 2090 cfm	FENOC letter ND1MDE:0379; [DIT-FPP-0045-00]; 10/20/06 TER 9012 Drawing 8700-RM-60E-3 1BVT 1.58.6, Iss. 3, Rev. 7 Current design basis based on DLC Calc. ERS-SFL-95-013, R 1, Attachment 3	Maximum normal ERF ventilation intake flow: 4180 cfm (3800 cfm +10%) Maximum normal ERF ventilation unfiltered inleakage: 2090 cfm = 50% of (3800 cfm + 10%) See item 11.	NUREG-0800 Section 6.4 FENOC Letter ND1MDE:0379 Activity Summary Report dated 11/22/1995 attached to BV1 historical Calculation ERS-SFL-95-013 TER-009012 BV1 Procedure 1-MSP-M-58-300	A normal ventilation intake flow of 2200 cfm with one fan running is established in TER-009012.

4. Normal intake HEPA filter removal efficiency	99% for all particulate	FENOC letter ND1MDE:0379; [DIT-FPP-0045-00]; 10/20/06 1BVT 1.58.6, Iss. 3, Rev. 7	Filters are not credited for any reduction when calculating the inhalation dose. To maximize the intake filter shine when calculating the direct shine dose, 100% efficiency is to be used for the intake filters. To maximize the recirculation filter shine when calculating the direct shine dose, 0% efficiency is to be used for the intake filters. (See parameter 12.)	Bounding approach with conservative assumptions	ERF ventilation filters are not included in the BV Technical Specification 5.5.7 Ventilation Filter Testing Program.

5. Maximum Delay time following a LOCA associated with: a. ERF isolation and b. initiation of emergency ventilation	Manual: 30 min. post-LOCA	FENOC letter ND1MDE:0379; [DIT-FPP-0045-00]; 10/20/06 EPP/IP 1.4, Rev. 15, Attachment 1	a. Maximum of 30 minutes post-LOCA to manually isolate intake dampers and realign dampers to the recirculation path b. Between 30 and 60 minutes post-LOCA to start a second fan while in the emergency (recirculation) ventilation alignment	BV1/2 Procedure 1/2-EPP-IP-1.4	These steps are included in the Technical Support Center activation procedure. Per Attachment A of procedure 1/2-EPP-IP-1.4, the ERF Ventilation System is to be isolated by Security personnel immediately after they have established the ERF Emergency Access Station. This will realign the system to the recirculation flow path. Thirty minutes is a reasonable allowance for the time needed to accomplish this action. The TSC should be activated as soon as possible, but in all cases, within 1 hour of an ALERT or higher classification. BV will continue to maintain an ERO and notification system which will have the objective of meeting the 30/60 minute response time criteria specified in NUREG-0654. It is recognized that 100% staff augmentation, within 30 minutes, may not be achievable under all circumstances. The onsite staff shall be augmented as soon as reasonably achievable. Per Attachment A of the implementing procedure, a second ventilation fan is to be started by ERO personnel. Sixty minutes is a reasonable allowance for this action.

6. Max Unfiltered inleakage at ERF structural joints, doors, and roof penetrations above the ERF (Emergency mode)	75 cfm	FENOC letter ND1MDE:0379; [DIT-FPP-0045-00]; 10/20/06 Various measurements EM 111490	75 cfm	FENOC Letter ND1MDE:0379 EM-111490	Assume closest (north) wall as the location of this 75 cfm (rounded up from 74.97 cfm) inleakage.
7. Max Unfiltered inleakage at doors (Emergency mode): a. due to ingress / egress b. leakage at TSC north exterior door	a. 10 cfm b. 5 cfm	FENOC letter ND1MDE:0379; [DIT-FPP-0045-00]; 10/20/06 SRP 6.4 EM 111490	a. 10 cfm b. 5 cfm	NUREG-0800 Section 6.4 AEC Regulatory Guide 1.78 FENOC Letter ND1MDE:0379 EM-111490	Assume 10 cfm for ERF building ingress/egress, which is similar to the approach used for BV1/BV2 Control Room ingress/egress. Assume 5 cfm (rounded up from 4.84 cfm) inleakage at door 119/4 on the north side of the building. Upon arrival, Emergency Response Organization personnel enter the ERF via the emergency entrance (door 112/2) on the south side of the building, stop to perform a personal frisk if required, and, after badging in, proceed through door 112/1 into Room 143 (Corridor), which is part of the ventilated occupied space.

8. Max Unfiltered inleakage flow at ERF emergency ventilation intake damper and at the suction duct between the filter and the fan (after manual shift to recirculation mode, i.e., inleakage past shut damper resulting in unfiltered inleakage into the ERF area).	20 cfm	FENOC letter ND1MDE:0379; [DIT-FPP-0045-00]; 10/20/06 Assumption based on engineering judgement, considering measured damper leakage in other HVAC systems of comparable duct sizes. Drawing 8700-RM-60E-3 EPP/IP 1.4, R15, Attachment 1	20 cfm	FENOC Letter ND1MDE:0379 Assumption based on engineering judgement, considering measured damper leakage in other HVAC systems of comparable duct sizes. BV1 Drawing RM-0060E BV1/2 Procedure 1/2-EPP-IP-1.4	Intake flow is secured by closing the intake damper. This inleakage is located at the ERF ventilation intake.
9. Min ERF exhaust fan EF-1 capacity (runs when ERF is in emergency mode)	800 cfm	FENOC letter ND1MDE:0379; [DIT-FPP-0045-00]; 10/20/06 Drawing 8700-RM-60E-3	800 cfm	FENOC Letter ND1MDE:0379 BV1 Drawing RM-0060E	When the normal startup of the ERF ventilation system is performed, Exhaust Fan No. 2 (1VSE-F-13) is placed in operation. The fan is located at the ceiling of Room 107 (Electric) near the southeast corner. Its operation, however, will result in equivalent unfiltered inleakage. Assume the location to be at the worst-case χ/Q (i.e., at the ERF north wall).

10. Max Total unfiltered inleakage into the ERF during emergency mode	910 cfm	FENOC letter ND1MDE:0379; [DIT-FPP-0045-00]; 10/20/06 Engineering judgement based on parameter # 6, 7, 8, & 9 values	910 cfm	FENOC Letter ND1MDE:0379 Engineering judgement based on the values for parameters 6, 7, 8 and 9.	The air handler draws air from areas internal to the ERF (but external to the TSC) and passes the air through the recirculation filter and then supplies the air to various locations in the occupied portions of the ERF.
11. ERF emergency ventilation maximum recirculation flowrate based on charcoal residence time	3800 cfm (see note at par. #22) ± 10% (for uncertainty)	FENOC letter ND1MDE:0379; [DIT-FPP-0045-00]; 10/20/06 8700-RM-60E-3 8700-RM-60K-3 DLC Calc ERS-SFL-95-013, Rev 1, Attachment 3 CR 02-02630, CA16	7200 cfm + 10% (for uncertainty) as a bounding maximum flowrate. This is not based on charcoal residence time. See item 3.	FENOC Letter ND1MDE:0379 BV1 Drawing RM-0060E BV1 Drawing RM-0060K EM-111490 TER-009012	The rated flow through a single AAF AstroCel I HEPA filter is 1050 scfm at 1.0" w.g. For a 2x2 array, the rated flow is 4200 scfm. The rated flow through a single Farr NPP-1 charcoal filter tray (or equivalent model) is 333 cfm. For a 2x6 array, the rated flow is 4000 cfm. Thus, the nominal rated flow through this filter train is 4000 cfm. As a datapoint demonstrating the capacity of two fans in operation, EM-111490 (1/21/1996) measured 7156.3 cfm with both fans running and fan speeds set to 8.75. A maximum emergency ventilation recirculation flow with two fans running of 7200 cfm is established in TER-009012.

12. Recirculation filter removal efficiency test acceptance criteria	Charcoal filter: ≥99% of halogenated hydrocarbon tested in place per ANSI N510-1975. Charcoal filter: ≥95% with radioactive methyl iodine tested per ASTM D3803-1989. HEPA filter: 99% for all particulate	FENOC letter ND1MDE:0379; [DIT-FPP-0045-00]; 10/20/06 1BVT 01.58.06, Issue 3, Rev 7, 10/26/00, Section VIII, Acceptance Criteria A.1, 2, & 3 GL 99-02 DLC Calc. ERS-SFL-95-013, Rev 1, Attachment 3 Note: GL 99-02 recommends a safety factor of 2 for charcoal filters in DBA analysis. FENOC has determined that this factor shall also be applied to HEPA filter efficiency.	Filters are not credited for any reduction when calculating the inhalation dose. To maximize the recirculation filter shine when calculating the direct shine dose, 0% efficiency is to be used for the intake filters and 100% efficiency is to be used for the recirculation filters. (See parameter 4.)	Bounding approach with conservative assumptions	ERF ventilation filters are not included in the BV Technical Specification 5.5.7 Ventilation Filter Testing Program.
13. Margin used on all ERF ventilation / recirculation design flows	± 10%	FENOC letter ND1MDE:0379; [DIT-FPP-0045-00]; 10/20/06	± 10%	FENOC Letter ND1MDE:0379	Not required if the quoted flow includes measurement uncertainty.
14. ERF breathing rate	3.5E-4 m^3/s	FENOC letter ND1MDE:0379; [DIT-FPP-0045-00]; 10/20/06 R.G. 1.183 Rev. 0	3.5E-4 m^3/s	FENOC Letter ND1MDE:0379 NRC Regulatory Guide 1.183	Assumed value is similar to that used for the BV1/BV2 common Control Room analysis.

15. ERF occupancy factors	0-24 hr. 1.0 1-4 day 0.6 4-30 day 0.4	FENOC letter ND1MDE:0379; [DIT-FPP-0045-00]; 10/20/06 R.G. 1.183 Rev 0	0 to 24 hours 1.0 1 to 4 days 0.6 4 to 30 days 0.4	FENOC Letter ND1MDE:0379 NRC Regulatory Guide 1.183	Assumed values are similar to those used for the BV1/BV2 common Control Room analysis.
16. ERF dose assessment bases	A. Inhalation and immersion doses to be based on a semi-infinite cloud model considering X/Q, breathing rate, and occupancy factors. B. Direct shine doses to be based on ERF ventilation design plus ERF proximity to the containment and RWST	FENOC letter ND1MDE:0379; [DIT-FPP-0045-00]; 10/20/06	A. Inhalation and immersion doses to be based on a semi-infinite cloud model considering X/Q, breathing rate, and occupancy factors. B. Direct shine doses to be based on ERF ventilation design plus ERF proximity to the Containment and Refueling Water Storage Tank.	FENOC Letter ND1MDE:0379	

ERF Shielding (General)					
17. Release paths to be addressed for the LOCA direct shine analysis	Direct Shine to ERF: - Containment Shine - Penetration Shine due to Airborne Activity (See comment) - Cloud shine due to Containment, ESF, and RWST back leakage - ERF filter shine due to containment, ESF and RWST back leakage (intake and recirculation filters) - RWST direct shine	FENOC letter ND1MDE:0379; [DIT-FPP-0045-00]; 10/20/06 8700-RM-60F-2 8700-RA-60C-1 8700-RA-60A-2 8700-RM-60C-1 8700-RA-60B-1	Direct Shine to ERF: - Containment shine - Penetration shine due to airborne activity - Cloud shine due to Containment, Engineered Safety Features, and RWST leakage - ERF intake and recirculation filters shine due to Containment, ESF, and RWST leakage - RWST direct shine	FENOC Letter ND1MDE:0379 BV1 Drawing RA-0060A BV1 Drawing RA-0060B BV1 Drawing RA-0060C BV1 Drawing RM-0060C BV1 Drawing RM-0060F	

ERF Bulk Shielding					
18. ERF Wall thickness and density	Double layer of 8-in. concrete block (2.19 g/cc) and 8-in. ribbed block, augmented for 68'8" of the North Wall with EOF wall, and 65' of West wall with counting room and dosimetry lab shielding walls	FENOC letter ND1MDE:0379; [DIT-FPP-0045-00]; 10/20/06 Drawing 8700-RA-60M-1 and 8700-RA-60A-2 DLC Calc ERS-SFL-83-010	Exterior Walls – Minimum of double layer of 8" concrete block and 8" ribbed block with some walls constructed of either a combined 20" thick reinforced concrete and 4" solid ribbed block or 2'-0" thick reinforced concrete. Material density is assumed to be 2.19 g/cc.	FENOC Letter ND1MDE:0379 BV1 Drawing RA-0060A BV1 Drawing RA-0060E BV1 Drawing RA-0060G BV1 Drawing RA-0060M BV1 Drawing RC-0060J BV1 Drawing RS-0060D BV1 Calculation ERS-SFL-83-010 (historical)	As noted in BV1 historical calculation ERS-SFL-83-010, "the TSC [exterior] walls are comprised of two courses of concrete block, each a nominal 8" thick, and hollow. The outer course is Royal Rib block having cast-in ribbing on the outside surface. The inner course is standard hollow block. … the equivalent thickness of the standard block is 3.77 inches. The equivalent thickness of the Royal Rib is 4.85 inches. There are reinforcing rods and a 0.375 layer of mortar between the courses. The block density is 2.19 g/cc.." The walls for Room 120 (Emergency Operations Room) are constructed of thicker concrete. ERF door 119/4 is described as a pair of 2'-6" x 7'-10" x 1¾" doors of hollow metal construction with polyurethane core; this door is located on the north wall, which will allow a line of sight to the BV2 Containment. Direct shine through other doors is shielded by concrete porticos and double-door vestibules. No other significant wall penetrations facing either the BV1 Containment/RWST or the BV2 Containment/RWST exist.

19. ERF roof thickness and density	6.75-in. structural concrete (2.4 g/cc) poured on a 2.0-in. epicore metal deck, no significant roof penetrations.	FENOC letter ND1MDE:0379; [DIT-FPP-0045-00]; 10/20/06 8700-RA-60G-1 DLC Calc. ERS-SFL-83-010	In general, the ERF roof is constructed of 6.75" structural concrete poured on an epicore metal deck that is 0.0358" thick (20 gauge). Material density is assumed to be 2.4 g/cc.	FENOC Letter ND1MDE:0379 BV1 Drawing RA-0060B BV1 Drawing RA-0060G BV1 Drawing RM-0060C BV1 Drawing RS-0060B BV1 Drawing RS-0060D BV1 Calculation ERS-SFL-83-010 (historical)	As noted in BV1 historical calculation ERS-SFL-83-010, the TSC roof is built up above the poured concrete over metal sheeting, and, "although the steel sheeting forms triangular voids in the concrete, the wide beam nature of the incident radiation, and the existence of the additional roofing material, allows consideration of the slab as being solid (150 lbs/ft^3; 2.4 g/cc)." The roof for Room 120 (Emergency Operations Room) is constructed of thicker concrete. Roof penetrations are limited to 21 roof drains; 10 plumbing vents (i.e., seven 2-inch, two 3-inch, and one 4-inch), which use schedule 40 galvanized steel pipe and a 180 degree return bend; and, 2 capped 5-inch schedule 160 pipes for mounting hardware and communications equipment. No other significant roof penetrations exist.
20. Distance from containment centerline to TSC	1194 ft Derived from U-2 Containment and ERF coordinates	FENOC letter ND1MDE:0379; [DIT-FPP-0045-00]; 10/20/06	BV2 Containment Coordinates: E8125, N3910 ERF (TSC) Coordinates: E9200, N3500 1150 ft	FENOC Letter ND1MDE:0379 BV1 Drawing RY-0060G BV1/2 Drawing RY-0001C	BV2 Containment is used as it is closer to the ERF and has fewer intervening structures than the BV1 Containment. Distance is derived from BV2 Containment and ERF coordinates.

ERF Shielding (Intake / Recirculation Filter Shine from Containment Leakage, ESF Leakage, and RWST Leakage)					
21. ERF Intake Filter dimensions: Pre-filter (1VS-FL-39) HEPA filter (1VS-FL-40) Charcoal (1VS-FL-)	 46 x 42 in. 46 x 55 in. x 22.5 in Removed	FENOC letter ND1MDE:0379; [DIT-FPP-0045-00]; 10/20/06 8700-RM-60E-3 Drawing 8700-RM-60H, R3 TER-9012	Ductwork connected to the housing of filter 1VS-FL-39 measures 42"x46". Filter 1VS-FL-40 is comprised of (4) AAF AstroCel I modules, each 24"x 24"x11.5", arranged in a two wide by two high array. Charcoal filter has been removed.	FENOC Letter ND1MDE:0379 BV1 Drawing RM-0060E BV1 Drawing RM-0060G BV1 Drawing RM-0060H Order 200486058 Stock Material 100080659 TER-009012	The size of each HEPA filter is essentially 48"x48"x11.5".

22. ERF Recirculation Filter dimensions: Pre-filter (1VS-FL-41) HEPA filter (1VS-FL-42) Charcoal (1VS-FL-43) HEPA filter (1VS-FL-44)	43 x 48 in. 47 x 57 in. x 22.5 in Each module 2 x 26.75" x 24" x 2" beds 12 Charcoal modules in 2 x 6 array	FENOC letter ND1MDE:0379; DIT-FPP-0045-00]; 10/20/06 8700-RM-60E-3 8700-9.16-388A, R2 8700-10.1-363 (vendor drawing C-43060 rev. J) ERS-SFL-95-013, R1	Ductwork connected to the housing of filter 1VS-FL-41 measures 43"x48". Filter 1VS-FL-42 is comprised of (4) AAF AstroCel I modules, each 24"x 24"x11.5", arranged in a two wide by two high array. Filter 1VS-FL-44 is identical. Filter 1VS-FL-43 contains twelve drawers with two beds per drawer. The exposed face of one side of a drawer is estimated to be 25.5"x22.75", with a 2" bed. The drawers are arranged in a two wide by six high array.	FENOC Letter ND1MDE:0379 BV1 Drawing RM-0060E BV1 Drawing RM-0060G BV1 Drawing 09.016-0388 BV1 Drawing 10.001-0363 BV1 Procedure 1-MSP-M-58-300 Order 200487047 Stock Material 100080659 Order 200486031 Stock Material 20006587 (bulk)	The rated flow through a single AAF AstroCel I filter is 1050 scfm at 1.0" w.g., so for four cells: (4 * 1050 scfm = 4200 scfm) The rated flow through a single Farr NPP-1 filter (or equivalent model) is 333 cfm, so for 12 cells: (12 * 333 cfm = 4000 cfm) Thus, the nominal rated flow through this filter train is 4000 cfm. The size of each HEPA filter is essentially 48"x48"x11.5". HEPA filter 1VS-FL-44 is assumed to capture charcoal fines and need not be modeled.

23. Shielding thickness/density from Intake Filter to Personnel in a. ERF Occupied Space (TSC) b. ERF Service Dock Room 112 (Emergency Access)	Shielding thickness: 8-in. Concrete block Density: 2.19 g/cc	FENOC letter ND1MDE:0379; DIT-FPP-0045-00]; 10/20/06 Drawing 8700-RA-60J-1 Drawing 8700-RA-60M-1 ERS-SFL-83-010, p 9 of 61	a. Interior wall between Room 112 (Service Dock) and Room 143 (Corridor) is 8" concrete block and contains door 112/1, which is described as a pair of 3'-0" x 8'-0" x 1¾" doors of hollow metal construction. b. There is no wall between the intake filter train and personnel in Room 112 (Service Dock). The filter train is located overhead and accessed via a platform. Per parameter 18, material density is assumed to be 2.19 g/cc.	FENOC Letter ND1MDE:0379 BV1 Drawing RA-0060J BV1 Drawing RA-0060M	The intake filter train is located overhead in Room 112 (Service Dock) and accessed via a platform. It is assumed that Room 112 (Service Dock) is occupied by ERO personnel for 10 minutes of transient travel per day for the 30 day duration of the accident. Other interior walls between Room 112 (Service Dock) and Room 119 (Technical Support Center) are not modeled.

24. Distance between Intake Filter to Personnel in a. ERF Occupied Space (TSC) b. ERF Service Dock Room 112 (Emergency Access)	168 ft.	FENOC letter ND1MDE:0379; DIT-FPP-0045-00]; 10/20/06 8700-RM-60E, R3 8700-RA-60A, R2	a. 156 ft b. 2 ft	FENOC Letter ND1MDE:0379 BV1 Drawing RA-0060A BV1 Drawing RM-0060E	The bottom of each filter housing is 108" above the floor. Minimum distances are specified. Per the Emergency Plan (Re: Procedure 1/2-EPP-IP-1.5, Attachment C), emergency response personnel will be relocated if the results of surveys indicate adverse conditions.

25. Shielding thickness/density from Recirculation Filter to Personnel in a. ERF Occupied Space (TSC) b. ERF Service Dock 112 (Emergency Access)	Shielding thickness: 8-in. Concrete block density: 2.19 g/cc	FENOC letter ND1MDE:0379; DIT-FPP-0045-00]; 10/20/06 Drawing 8700-RA-60J-1 Drawing 8700-RA-60M-1 ERS-SFL-83-010, p 9 of 61	a. Interior wall between Room 109B (Mechanical) and Room 143 (Corridor) is 8" ribbed block. b. Interior wall between Room 109B (Mechanical) and Room 112 (Service Dock) is 8" concrete block. Per parameter 18, material density is assumed to be 2.19 g/cc.	FENOC Letter ND1MDE:0379 BV1 Drawing RA-0060J BV1 Drawing RA-0060M	The recirculation filter train is located overhead in Room 109B (Mechanical) and accessed via a platform. Although there are penetrations (including Door 109/2 and intake filter ductwork) between Room 109B (Mechanical) and Room 112 (Service Dock), it is judged that there is no direct line of sight from the recirculation filter train in Room 109B (Mechanical) to personnel that might be passing through Room 112 (Service Dock). It is not planned to station emergency response personnel in Room 109B (Mechanical), Room 112 (Service Dock) or Room 143 (Corridor). Other than the penetration for the recirculation filter ductwork, there are no other significant penetrations between Room 109B (Mechanical Room) and Room 143 (Corridor). It is judged that there is no direct line of sight from the recirculation filter train to personnel that might be passing through Room 143 (Corridor). Other interior walls between Room 109B (Mechanical) and Room 119 (Technical Support Center) are not modeled.

26. Distance between Recirculation Filter and Personnel in a. ERF Occupied Space (TSC) b. ERF Service Dock 112 (Emergency Access)	123 ft.	FENOC letter ND1MDE:0379; DIT-FPP-0045-00]; 10/20/06 8700-RM-60E, R3 8700-RA-60A, R2	a. 126 ft b. 4.5 ft	FENOC Letter ND1MDE:0379 BV1 Drawing RA-0060A BV1 Drawing RM-0060E	The bottom of each filter housing is 104" above the floor. Minimum distances are specified. Per the Emergency Plan (Re: Procedure 1/2-EPP-IP-1.5, Attachment C), emergency response personnel will be relocated if the results of surveys indicate adverse conditions.
27. Minimum horizontal distance between Filter and Personnel in adjoining corridor (Room 143) of ERF a. Intake HEPA Filter 1VS-FL-40 b. Recirc HEPA Filter 1VS-FL-42	13 ft	FENOC letter ND1MDE:0379; DIT-FPP-0045-00]; 10/20/06 8700-RA-60M, R1, E11 (to centerline of corridor) 8700-9.16-388A (for elev.)	a. 25 ft b. 6.5 ft	FENOC Letter ND1MDE:0379 BV1 Drawing RA-0060M BV1 Drawing 09.016-0388	
ERF Shielding (RWST Direct Shine)					
28. Shielding and distance between RWST and Personnel in TSC	U-2 RWST Coordinates: E8283.5, N3911 ERF (TSC) Coordinates: E9220, N3435 Shielding: 0 ft of concrete Distance: 1050 ft	FENOC letter ND1MDE:0379; DIT-FPP-0045-00]; 10/20/06 8700-RY-1C, R2 ERS-SFL-83-010, R0, Attachments 1 & 7	BV2 RWST Coordinates: E8283.5, N3911 ERF (TSC) Coordinates: E9200, N3500 Shielding: 0 ft of concrete Distance: 1004 ft	FENOC Letter ND1MDE:0379 BV1 Drawing RY-0060G BV1/2 Drawing RY-0001C	BV2 RWST is used as it is closer to the ERF and has fewer intervening structures than the BV1 RWST. Credit may be taken for the shielding provided by the Route 168 ramp to the Shippingport to Midland bridge, whose road surface is at elevation 750 ft. The biological shield wall that surrounds a lower portion of each RWST is not credited.

ERF Atmospheric Dispersion Factors					
29. ERF normal intake atmospheric dispersion factors	Release point: Containment Wall: N3904.1 SLCRS (top of containment dome): N3910 RWST Vent: N3911	FENOC letter ND1MDE:0379; DIT-FPP-0045-00]; 10/20/06 8700-RY-1C, R2 X/Qs determined in S&W calculations: 8700-EN-ME-105, Rev. 0/A1; 10080-EN-ME-106, Rev. 0/A1	Release points - BV2 Containment Wall: N3904.1, E8057.3 BV2 Supplemental Leak Collection & Release System Vent (top of Containment dome): N3910, E8125 BV2 RWST Vent: N3911, E8283.50	FENOC Letter ND1MDE:0379 BV1/2 Drawing RY-0001C X/Qs determined in: BV1 Calculation EN-ME-105 and BV2 Calculation EN-ME-106	BV2 release points are assumed as they are closer to the ERF than the BV1 release points.

References:

1. BV1 Calculation EN-ME-105, Rev. 0 including Add. 1, Atmospheric Dispersion Factors (X/Qs) at Control Room and ERF Receptors for Unit 1 Accident Releases Using the ARCON96 Methodology
2. BV1 Calculation ERS-SFL-95-013, Rev. 1, Consequence Assessment of EOF/TSC 30 Day Post-Accident Dose Due to LOCA at Unit 2 with ERF Intake Filters Removed (historical)
3. BV1 Drawing RA-0060A, Rev. 2, ERF – Floor Plan
4. BV1 Drawing RA-0060B, Rev. 1, ERF – Roof Plan and Details
5. BV1 Drawing RA-0060C, Rev. 1, ERF – Door Schedule and Details
6. BV1 Drawing RA-0060F, Rev. 1, ERF – Exterior Elevations
7. BV1 Drawing RA-0060G, Rev. 1, ERF – Building and Wall Sections
8. BV1 Drawing RA-0060J, Rev. 1, ERF – Restroom Elevation and Misc Details
9. BV1 Drawing RA-0060M, Rev. 1, ERF – Full Height Interior Wall Plan
10. BV1 Drawing RC-0060J, Rev. 1, ERF – Plan and Details, Emergency Operation Room
11. BV1 Drawing RM-0060C, Rev. 1, ERF – Plumbing Details
12. BV1 Drawing RM-0060E, Rev. 3, ERF Floor Plan – Sheet Metal
13. BV1 Drawing RM-0060F, Rev. 2, ERF – Floor Plan Piping

14. BV1 Drawing RM-0060G, Rev. 3, ERF – ¼" Scale Partial Plan
15. BV1 Drawing RM-0060H, Rev. 3, ERF – 1/4" Scale Sections
16. BV1 Drawing RM-0060K, Rev. 3, ERF – Schedules and Details
17. BV1 Drawing RS-0060D, Rev. 1, ERF – Roof and Wall Details
18. BV1 Drawing 09.016-0388, Rev. A, HVAC Ductwork – Sections
19. BV1 Drawing 10.001-0363, Rev. A, Carbon Filter Model NPP-1
20. BV1 Procedure 1-MSP-M-58-300, Rev. 0, ERF Building Emergency Filters 1VS-FL-42, 43, 44 Efficiency Test and Emergency and Normal Air Flow Measurements
21. BV1 Technical Evaluation Report TER-009012, Rev. 0, ERF Building Outdoor Ventilation Air Charcoal Removal
22. BV2 Calculation EN-ME-106, Rev. 0 including Add. 1, Atmospheric Dispersion Factors (X/Qs) at Control Room and ERF Receptors for Unit 2 Accident Releases Using the ARCON96 Methodology
23. BV1/2 Drawing RY-0001C, Rev. 2, Site Postulated Release and Receptor Points
24. BV1/2 Procedure 1/2-EPP-IP-1.4, Rev. 38, Technical Support Center Activation, Operation and Deactivation
25. BV1/2 Procedure 1/2-EPP-IP-1.5, Rev. 23, Operations Support Center (OSC) Activation, Operation and Deactivation
26. BV1/2 Technical Specifications, 10/5/2018, BV1 Amendment 303 & BV2 Amendment 192
27. BV Engineering Memorandum (EM) 111490, 02/28/1996, Review/Revise Calculation ERF-SFL-95-013
28. FENOC Letter ND1MDE:0379, 10/20/2006, Containment Sump Modification Dose Inputs, Units 1 and 2 – DIT-FPP-0045-00
29. Order 200486031, Replace 12 Charcoal Trays for ERF Filter BV-1VS-FL-43
30. Order 200486058, High D/P on ERF HEPA Filter BV-1VS-FL-40
31. Order 200487047, Replace HEPA Filters BV-1VS-FL-42
32. Order 200611328, ERF Building Emergency Filters (1VS-FL-42, 43, 44), Completed 1/13/2017
33. FENOC Stock Item 100080659, Filter 24 in x 24 in x 11-1/2 in HEPA 0.3 micron particulate
34. FENOC Stock Item 20006587, Charcoal, nuclear grade moisture activated coconut carbon [bulk]
35. AEC Regulatory Guide 1.78, 6/1974, Assumptions for Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release [ADAMS Accession Number ML003740298]
36. NRC Regulatory Guide 1.183, Rev. 0, Alternate Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors [ADAMS Accession Number ML003716792]
37. NRC NUREG-0800, Standard Review Plan, Section 6.4, Rev. 2 (7/1981), Control Room Habitability System [ADAMS Accession Number ML052340712]

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CALCULATION NO.: 10080-UR(B)-487		REVISION: 3

DIT-BVDM-0115-01 Attachment 1

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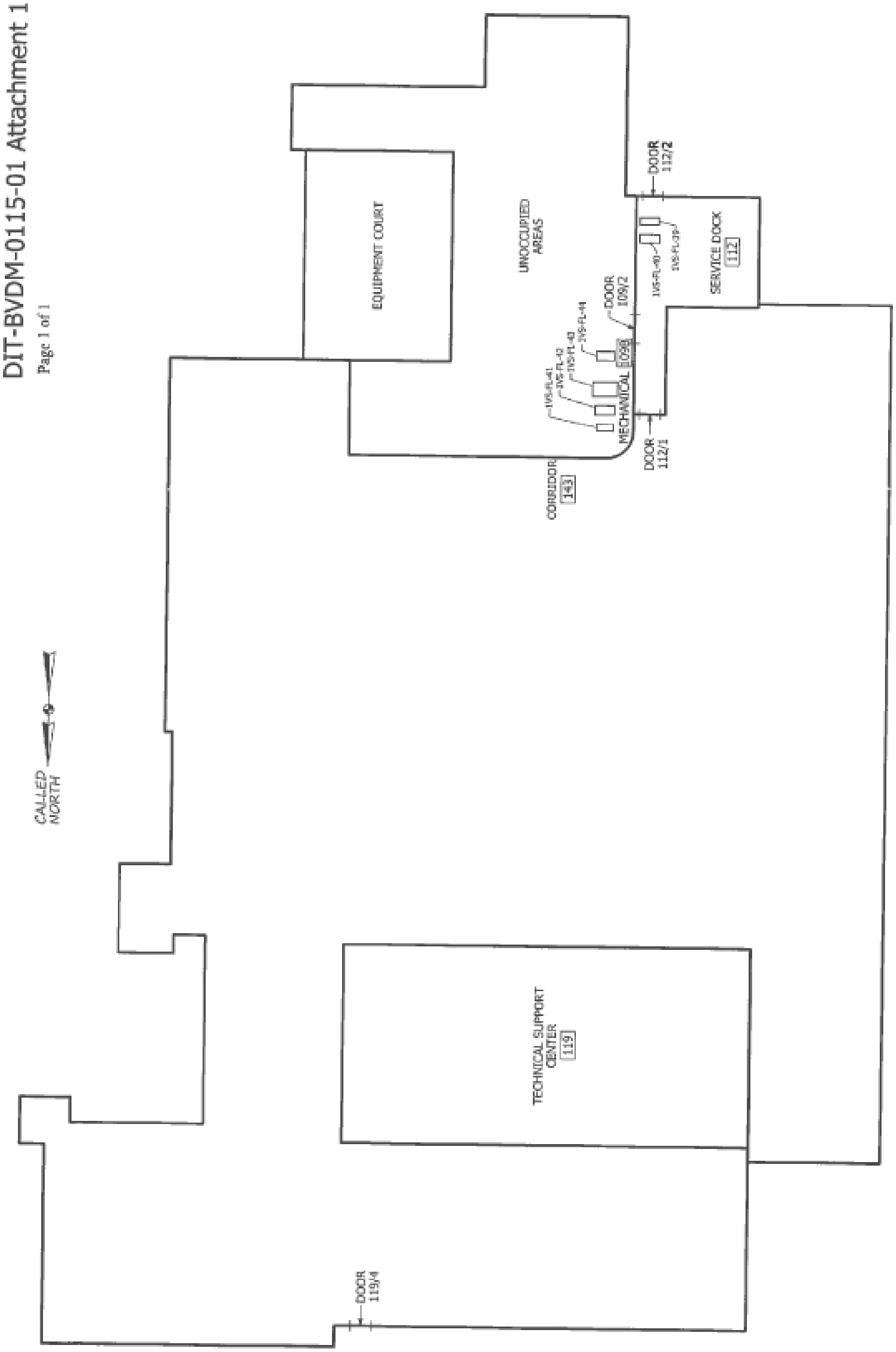

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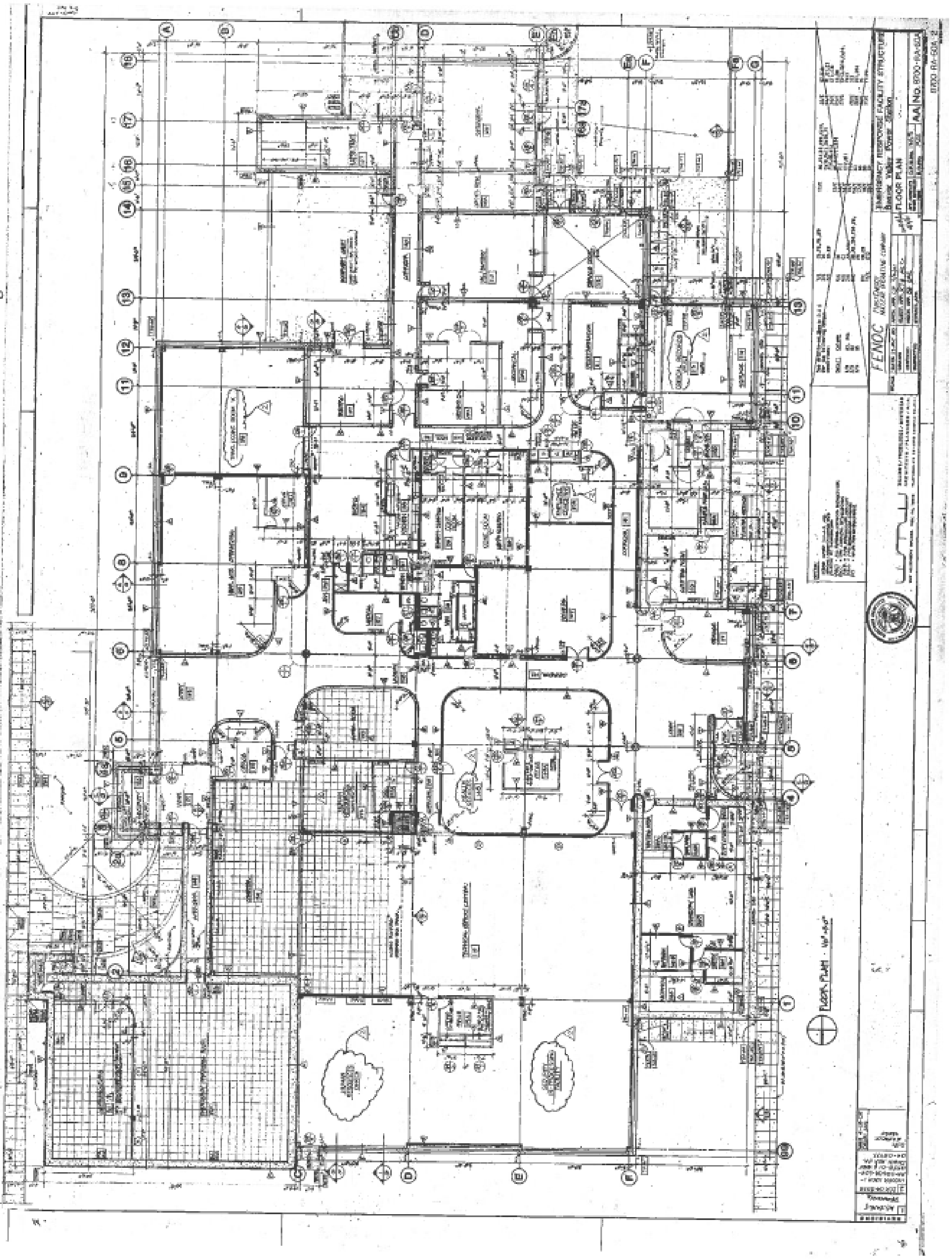
CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-487	REVISION: 3

DIT-BVDM-0115-01 Attachment 2
Page 1 of 1



FirstEnergy	CALCULATION COMPUTATION NOP-CC-3002-01 Rev. 05	Pg Att5-28 of Att5-31
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DESIGN VERIFICATION RECORD

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NOP-CC-2001-01 Rev. 00

SECTION I: TO BE COMPLETED BY DESIGN ORIGINATOR

DOCUMENT(S)/ACTIVITY TO BE VERIFIED:

DIT-BVDM-0115-01

☒ SAFETY RELATED ☐ AUGMENTED QUALITY ☐ NONSAFETY RELATED

SUPPORTING/REFERENCE DOCUMENTS

DESIGN ORIGINATOR: *(Print and Sign Name)* Douglas T Bloom [signature] DATE 1-30-19

SECTION II: TO BE COMPLETED BY VERIFIER

VERIFICATION METHOD *(Check one)*

☒ DESIGN REVIEW *(Complete Design Review Checklist or Calculation Review Checklist)* ☐ ALTERNATE CALCULATION ☐ QUALIFICATION TESTING

JUSTIFICATION FOR SUPERVISOR PERFORMING VERIFICATION:

N/A

APPROVAL: *(Print and Sign Name)* N/A DATE

EXTENT OF VERIFICATION:

Design Review Checklist.

COMMENTS, ERRORS OR DEFICIENCIES IDENTIFIED? ☐ YES ☒ NO

RESOLUTION: *(For Alternate Calculation or Qualification Testing only)*

N/A

RESOLVED BY: *(Print and Sign Name)* N/A DATE

VERIFIER: *(Print and Sign Name)* Michael G. Unfried [signature] DATE 1/30/2019

APPROVED BY: *(Print and Sign Name)* MSRessler [signature] DATE 1/30/2019

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DESIGN REVIEW CHECKLIST

NOP-CC-2001-02 Rev. 04

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):

DIT-BVDM-0115-01

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
1. Were the basic functions of each structure, system or component considered?		✓			
2. Have performance requirements such as capacity, rating, and system output been considered?		✓			
3. Are the applicable codes, standards and regulatory requirements including applicable issue and/or addenda properly identified and are their requirements for design and/or material been met or reconciled?		✓			
4. Have design conditions such as pressure, temperature, fluid chemistry, and voltage been specified?	✓				
5. Are loads such as seismic, wind, thermal, dynamic and fatigue factored in the design?	✓				
6. Considering the applicable loading conditions, does an adequate structural margin of safety exist for the strength of components?	✓				
7. Have environmental conditions anticipated during storage, construction and operation such as pressure, temperature, humidity, soil erosion, run-off from storm water, corrosiveness, site elevation, wind direction, nuclear radiation, electromagnetic radiation, and duration of exposure been considered?	✓				
8. Have interface requirements including definition of the functional and physical interfaces involving structures, systems and components been met?		✓			
9. Have the material requirements including such items as compatibility, electrical insulation properties, protective coating, corrosion, and fatigue resistance been considered?	✓				
10. Have mechanical requirements such as vibration, stress, shock and reaction forces been specified?	✓				
11. Have structural requirements covering such items as equipment foundations and pipe supports been identified?	✓				
12. Have hydraulic requirements such as pump net positive suction head (NPSH), allowable pressure drops, and allowable fluid velocities been specified?	✓				
13. Have chemistry requirements such as the provisions for sampling and the limitations on water chemistry been specified?	✓				
14. Have electrical requirements such as source of power, voltage, raceway requirements, electrical insulation and motor requirements been specified?	✓				
15. Have layout and arrangement requirements been considered?		✓			
16. Have operational requirements under various conditions, such as plant startup, normal plant operation, plant shutdown, plant emergency operation, special or infrequent operation, and system abnormal or emergency operation been specified?		✓			

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DESIGN REVIEW CHECKLIST

NOP-CC-2001-02 Rev. 04

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):

DIT-BVDM-0115-01

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
17. Have instrumentation and control requirements including instruments, controls, and alarms required for operation, testing, and maintenance been identified? Other requirements such as the type of instrument, installed spares, range of measurement, and location of indication should also be included.	✓				
18. Have adequate access and administrative controls been planned for plant security?	✓				
19. Have redundancy, diversity, and separation requirements of structures, systems, and components been considered?	✓				
20. Have the failure requirements of structures, systems, and components, including a definition of those events and accidents which they must be designated to withstand been identified?		✓			
21. Have test requirements including in-plant tests, and the conditions under which they will be performed been specified?	✓				
22. Have accessibility, maintenance, repair and in-service inspection requirements for the plant including the conditions under which they will be performed been specified?	✓				
23. Have personnel requirements and limitations including the qualification and number of personnel available for plant operation, maintenance, testing and inspection and permissible personnel radiation exposure for specified areas and conditions been considered?		✓			
24. Have transportability requirements such as size and shipping weight, limitations and Interstate Commerce Commission regulations been considered?	✓				
25. Have fire protection or resistance requirements been specified?	✓				
26. Are adequate handling, storage, cleaning and shipping requirements specified?	✓				
27. Have the safety requirements for preventing undue risk to the health and safety of the public been considered?		✓			
28. Are the specified materials, processes, parts and equipment suitable for the required application?	✓				
29. Have safety requirements for preventing personnel injury including such items as radiation hazards, restricting the use of dangerous materials, escape provisions from enclosures and grounding of electrical equipment been considered?	✓				
30. Were the inputs correctly selected and incorporated into the design?		✓			
31. Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed?		✓			
32. Are the appropriate quality and quality assurance requirements specified?	✓				

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CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-487

REVISION: 3

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DESIGN REVIEW CHECKLIST

NOP-CC-2001-02 Rev. 04

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):
DIT- BVDM-0115-01

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
33. Have applicable construction and operating experience been considered?		✓			
34. Have the design interface requirements been satisfied?		✓			
35. Was an appropriate design method used?		✓			
36. Is the output reasonable compared to inputs?		✓			
37. Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?	✓				
38. Have adequate maintenance features and requirements been specified?	✓				
39. Has the design properly considered radiation exposure to the public and plant personnel?		✓			
40. Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfied?	✓				
41. Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?	✓				
42. Are adequate identification requirements specified?	✓				
43. Are requirements for record preparation, review, approval, retention, etc., adequately specified?	✓				
44. Have protective coatings qualified for Design Basis Accident (DBA) been specified to structures, equipment and components installed in the containment/drywell?	✓				
45. Are the necessary supporting calculations completed, checked and approved?		✓			
46. Have the equipment heat load changes been reviewed for impact on HVAC systems?	✓				
47. IF a computer program was used to obtain the design by analysis, **THEN** has the program been validated per NOP-SS-1001 and documented to verify the technical adequacy of the computer results contained in the design analysis?	✓				
48. Have Professional Engineer (PE) certification requirements been addressed and documented where required by ASME Code (if applicable).	✓				
49. Does the design involve the installation, removal, or revise software/firmware and have the requirements of NOP-SS-1001 been addressed?	✓				
50. Does the design involve the installation, removal, or change to a digital component(s) and have the requirements of NOP-SS-1201 been addressed?	✓				

COMPLETED BY: *(Print and Sign Name)*	DATE	*IF CHECKLIST IS REVIEWED BY MORE THAN ONE VERIFIER, SIGN BELOW:* ADDITIONAL VERIFIER *(Print and Sign Name)*	DATE
Michael G. Unfried [signature]	1/30/2019	N/A	

FirstEnergy	Pg Att6-1 of Att6-12 **CALCULATION COMPUTATION** NOP-CC-3002-01 Rev. 05
CALCULATION NO.: 10080-UR(B)-487	REVISION: 3

Attachment 6

FirstEnergy Design Input Transmittal

DIT- SGR2-0046-01 transmitted via Letter BV2SGRP:2014

December 7, 2014

FENOC
FirstEnergy Nuclear Operating Company

Office of the Manager, Steam Generator Replacement Project

December 7, 2015
BV2SGRP:2014

Transmittal of DIT-SGR2-0046-01, DIT-SGR2-0091-00

Dear Sreela Ferguson;

This letter is FENOC's formal transmittal of Design Inputs DIT-SGR2-0046-01 and DIT-SGR2-0091-00. These Design Inputs provide CBI with inputs for the development of final analysis for the Replacement Steam Generator Project. These DITs are issued as "Approved for Use" If there are any questions, I can be reached at 724-682-7048.

Thank you.

Neil A. Morrison
Manager, SGRP
Beaver Valley Power Station

CC:

Mike Testa	FENOC
William Provencher	CBI
Central File	

FirstEnergy	CALCULATION COMPUTATION NOP-CC-3002-01 Rev. 05
CALCULATION NO.: 10080-UR(B)-487	REVISION: 3

Form 1/2-ADM-2097.F01, Rev 0 RTL# A1.105V

DESIGN INPUT TRANSMITTAL

☒ SAFETY RELATED / AUG QUAL ☐ NON-SAFETY RELATED	Originating Organization: ☒ FENOC ☐ Other (Specify)	DIT- SGR2-0046-01 Page 1 of 6
Beaver Valley Unit: ☐1 ☐2 ☒Both System Designation: N/A Engineering Change Package: 13-0397		To: Sreela Ferguson Organization: CBI

Subject: BVPS Unit 2 SGRP – Inputs for Calculation 10080-UR(B)-487

Status of Information: ☒Approved for Use ☐Unverified

For Unverified DITs, Notification number tracking verification: N/A

Description of Information:

Safety Analysis Design Inputs? ☒Yes ☐No

Reconciled to Current Design Basis? ☒Yes ☐N/A

DIT-SGR2-0046-01 SUPERSEDES DIT-SGR2-0046-00 IN ITS ENTIRETY

CBI Letter L-SHW-BV2-000137, dated October 23, 2013, provided a request for specific inputs for the revision of Calculation 10080-UR(B)-487, site boundary, Control Room, and Emergency Response Facility doses following a loss-of-coolant accident (LOCA). The revision supports the Unit 2 RSG/RRVCH project and NSAL 11-5 updates to the LOCA M&E rates.

The following design inputs for UR(B)-487 Rev. 1 / Add 1 & 2 are not changed by Unit 2 RSG / NSAL 11-5:

- Power level
- Core inventory
- Activity release paths
- Activity available for release
- RCS coolant Technical Specification (TS) iodine concentration limit
- RCS flash fraction (conservatively assumed to be 100%)
- Duration of release via the pressure relief line
- RG 1.183 based core inventory release fractions, timing, chemical form, etc
- Chemical form of Iodine released from reactor coolant system (RCS) and sump water
- Containment isolation time
- Containment leakage rates per Technical Specifications
- No credit for release filtration via the SLCRS filter bank
- RG 1.183 based containment mixing rate
- Spray termination time
- Maximum allowable DF for elemental and particulate iodine
- ESF leakage duration
- Integrated ESF leak rate
- Sump water back-flow rate into RWST
- No filtration of RWST back-leakage
- Control Room and ERF parameters such as shielding configuration, volume, ventilation system parameters (flows, filter efficiency, signals that initiate emergency ventilation, timing for manual initiation) etc.
- Atmospheric dispersion factors (CR / EAB/ LPZ / ERF)

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CALCULATION COMPUTATION

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CALCULATION NO.: 10080-UR(B)-487 REVISION: 3

DESIGN INPUT TRANSMITTAL

The following inputs are provided for Calculation UR(B)-487:

	AOR		RSG/NSAL		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
1. Minimum Containment Free Volume	1.750 x 10^6 ft^3 (Unit 2 value)	UR(B)-487 Rev. 1 / A1 & A2	1.750 x 10^6 ft^3 (Unit 2 value)	FAI/13-0446 Rev. 0 US(B)-261 Rev. 3 / A3	FAI/13-0446 states that the nominal containment free air volume is 1,768,735 ft^3. Based on this, the minimum containment free air volume used in the draft LOCA containment analysis is 1,759,085 ft^3. These values are from US(B)-261 Rev. 3 / Add A3. DIT-SGR2-0048-00 reviewed adjustments for anticipated impacts of the Unit 2 RSG/RRVCH project and other modifications and concluded that an adjustments to the Unit 2 values would increase the containment free air volume by less than 0.05% and that this increase would be insignificant). Therefore 1,750,000 ft^3 is a bounding estimate for the minimum containment free air volume.
2. Containment Spray coverage	63% effective quench or recirculation spray coverage	UR(B)-487 Rev. 1 / A1 & A2	US(B)-163 Rev. 0, Add. 2	60% recirculation spray coverage	
3. Maximum Containment spray initiation time after accident initiation	bounding value: 85.4 sec 85.4 sec (Unit 1) 76.3 sec (Unit 2)	UR(B)-487 Rev. 1 / A1 & A2 US(B)-263 Rev. 3 (Unit 1) US(B)-239 Rev. 2 (Unit 2)	bounding value: 77.4 sec 43.9 sec (Unit 1) 77.4 sec (Unit 2)	US(B)-263 Rev. 7 / A1 & A2 (Unit 1 RSG) US(B)-239 Rev. 6 (Unit 2 OSG) FAI/13-0929 Rev. 1	The Unit 2 value is now bounding. The Unit 1 value was changed from 85.4 to 43.9 seconds (Table 5-10 of US(B)-263). The Unit 2 post-RSG installation value is 76.3 seconds (Table 5-9 of FAI/13-0929 Rev. 1); however, the more conservative Unit 2 OSG value of 77.4 seconds was selected as the bounding value (Table 5-10 of US(B)-239 Rev. 6).

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CALCULATION COMPUTATION

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DESIGN INPUT TRANSMITTAL

	AOR		RSG/NSAL		
Parameter	Value	Reference	Value	Reference	Comment
4. Aerosols and elemental iodine removal coefficients in sprayed region	Aerosol removal rates for the sprayed containment volume are the time dependent values listed in Table 2 of US(B)-257 from 0 to 4 days (Provided in Attachment 4 of UR(B)-487). The elemental iodine removal coefficient due to sprays is equal to the aerosol removal coefficient up to 20 hr^{-1}; at higher aerosol removal rates, the iodine removal coefficient is conservatively assumed to be 20 hr^{-1}.	UR(B)-487 Rev. 1 / A1 & A2 US(B)-257 Rev. 1	Aerosol and elemental iodine removal rates as presented in table 2 of reference.	US(B)-257 Rev 2	
5. Aerosols removal in unsprayed region due to gravitational settling	Aerosol removal rates for the unsprayed containment volume are the time dependent values listed in Table 2 of US(B)-257 from 0 to 10 hours (Provided in Attachment 5 of UR(B)-487).	UR(B)-487 Rev. 1 / A1 & A2 US(B)-257 Rev. 1	Aerosol and elemental iodine removal rates as presented in table 2 of reference.	US(B)-257 Rev 2	
6. Min Long term sump water pH	Sump pH > 7.0 in < 16 hrs	UR(B)-487 Rev. 1 / A1 & A2 US(B)-ERS-SNW-92-009 Rev. 6 (Unit 1 & Unit 2)	Sump pH > 7.0 in < 16 hrs	US(B)-279 Rev. 0 (Unit 1) US(B)-278 Rev. 0 / A1 (Unit 2)	
7. Max Pressure relief line bounding release rate following a LOCA prior to isolation	bounding value: 2200 scfm 2200 scfm (Unit 1 value) 1600scfm (Unit 2 value)	UR(B)-487 Rev. 1 / A1 & A2 UR(B)-213 Rev. 0 UR(B)-485 Rev. 0	Same as AOR	Same as AOR	UR(B)-213 and -485 have not been updated since Unit 1 RSG/EPU / Unit 2 EPU.

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CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-487 | REVISION: 3

DESIGN INPUT TRANSMITTAL

Parameter	AOR Value	AOR Reference	RSG/NSAL Value	RSG/NSAL Reference	Comment
8. Minimum volume and mass of sump water versus time after switchover to the recirculation phase	UNIT 1 20 min – 30 min: 19,111 ft³ (1.13 x 10⁶ lbm) 30 min – 2 hrs: 25,333 ft³ (1.51 x 10⁶ lbm) 2 hrs – 30 days: 43,577 ft³ (2.68 x 10⁶ lbm) (Unit 1 values are bounding)	UR(B)-487 Rev. 1 / A1 & A2 US(B)-263 Rev. 3 (Unit 1) US(B)-239 Rev. 2 (Unit 2)	UNIT 1 20 min – 30 min: 19,253 ft³ (1.1379 x 10⁶ lbm) 30 min – 2 hrs: 24,909 ft³ (1.5133 x 10⁶ lbm) 2 hr – 30 days: 43,824 ft³ (2.6837 x 10⁶ lbm) (Unit 1 values are bounding) (Unit 1 values bound those computed for Unit 2 with 51M OSGs per US(B)-239 Rev. 6 and bound those computed for Unit 2 with 54F RSGs per FAI/13-0929 Rev. 1)	US(B)-263 Rev. 7 / A1 & A2 (Unit 1) US(B)-239 Rev. 6 / A1 (Unit 2) FAI/13-0929 Rev. 1 (Unit 2)	Per US(B)-239 Rev. 6 (w/51M OSG): UNIT 2 20 min – 30 min: 20,364 ft³ (1.2007 x 10⁶ lbm) 30 min – 2 hrs: 28,195 ft³ (1.6693 x 10⁶ lbm) 2 hr – 30 days: 69,380 ft³ (4.2693 x 10⁶ lbm) Per FAI/13-0929 Rev. 1 (w/54F RSG): UNIT 2 20 min – 30 min: 20,706 ft³ (1.2202 x 10⁶ lbm) 30 min – 2 hrs: 28,710 ft³ (1.6949 x 10⁶ lbm) 2 hr – 30 days: 72,037 ft³ (4.3912 x 10⁶ lbm)
9. Peak sump water temperature after 20 min	bounding value: 250°F 240°F (Unit 1 value) 245°F (Unit 2 value)	UR(B)-487 Rev. 1 / A1 & A2 US(B)-263 Rev. 3 (Unit 1) US(B)-239 Rev. 2 (Unit 2)	bounding value: 250°F 240°F (Unit 1 value) 246.4°F (Unit 2 value)	US(B)-263 Rev. 7 / A1 & A2 (Unit 1) US(B)-239 Rev. 6 / A1 (Unit 2) FAI-13-0929 Rev. 1 (Unit 2)	A bounding value of 250°F was used. The Unit 2 value w/51M OSGs was 245°F (US(B)-239 Rev. 6, CASE1L_ MIX_MST). The Unit 2 value w/54F RSGs is 246.4°F (FAI-13-0929 Rev. 1, Table 5-9, CASE1L_ MIX_ MAXSW)
10. Release rates via RWST vent versus time	UR(B)-487 Rev. 1 / A2 Tables 1 & 2	UR(B)-487 Rev. 1 / A2 US(B)-ERS-SNW-92-009 Rev. 6	As provided in reference	US(B)-ERS-SNW-92-009 Rev 6 Add 1	

DESIGN INPUT TRANSMITTAL

Parameter	AOR		RSG/NSAL		Comment
	Value	Reference	Value	Reference	
11. Initial RCS Tech Spec concentrations	Calculation 10080-UR(B)-484 Rev. 0 Sec. 3.	UR(B)-487 Rev. 1 / A1 & A2 UR(B)-484 Rev. 0	Same as AOR	UR(B)-484 Rev 0 Add1 and 2	
12. Initiation time of sump back-leakage into RWST after LOCA	bounding value: 1782 sec 1782 sec (Unit 1) 2482 sec (Unit 2)	UR(B)-487 Rev. 1 / A1 & A2 US(B)-263 Rev. 3 (Unit 1) US(B)-239 Rev. 2 (Unit 2)	bounding value: 1768 sec 1768 sec (Unit 1) 2473 sec (Unit 2)	US(B) -263 Rev. 7 (Unit 1) FAI/13-0929 Rev. 1 (Unit 2)	RWST Back Leakage is initiated at SI switchover. The Unit 1 value is bounding. Due to the substantially smaller Unit 1 RWST volumes, the Unit 1 suction switchover time will always bound the Unit 2 value.
13. Time after LOCA and duration of RWST back-leakage release to environment via the RWST vent	bounding time period: T= 3055 sec to T=30 days T= 3055 sec to T=30 days (Unit 1) T= 9307 sec to T= 30 days (Unit 2)	UR(B)-487 Rev. 1 / A1 & A2 US(B)-263 Rev. 3 (Unit 1) US(B)-239 Rev. 2 (Unit 2)	bounding time period: T= 3039 sec to T=30 days T= 3039 sec to T= 30 days (Unit 1) T= 9221 sec to T= 30 days (Unit 2)	US(B) -263 Rev. 7 (Unit 1) FAI/13-0929 Rev. 1 (Unit 2)	Environmental release via the RWST vent is initiated at Quench Spray cutoff. The Unit 1 time period is bounding. Due to the substantially smaller Unit 1 RWST volumes, the Unit 1 recirculation mode time interval will always bound the Unit 2 value.

Purpose of Issuance:

The inputs included in this transmittal are to be used to revise Calculation 10080-UR(B)-487 with values revised for the Steam Generator Replacement Project.

Source of Information (Reference, Rev, Title, Location): Engineering Judgment Used? ☐Yes ☒No

- 10080-UR(B)-487 Rev. 1 / Addenda A1 and A2, "Site Boundary, Control Room and Emergency Response Facility Doses following a Loss-of-Coolant Accident Based on Core Uprate, an Atmospheric Containment and Alternative Source Terms" (Units 1 and 2)
- FENOC Letter ND1MDE:0374, "Containment Sump Modification Dose Inputs, Units 1 & 2 – DIT-FPP-0044-00," dated September 20, 2006 (Units 1 and 2)
- FAI/13-0446 Rev. 0, "Beaver Valley Unit 2 Power Station MAAP-DBA Replacement Steam Generator (RSG) and Replacement Reactor Vessel (RRVCH) Parameter File Upgrade" (Unit 2)

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CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-487	REVISION: 3

DESIGN INPUT TRANSMITTAL

Source of Information (Reference, Rev, Title, Location): Engineering Judgment Used? ☐Yes ☒No

- 8700-US(B)-261 Rev. 3 / Addenda A3, "Beaver Valley Power Station MAAP-DBA Parameter File Documentation" (Units 1 and 2)
- 12241-US(B)-163 Rev. 0 / Addendum A2, "Recirculation Spray Volume Coverage" (Unit 2)
- 8700-US(B)-263 Rev. 3, "Assessment of Beaver Valley Unit 1 Containment Response for Design Basis Accidents for Containment Atmospheric Conversion Project" (FAI/02-04 Rev. 7) (Unit 1 – AOR reference)
- 10080-US(B)-239 Rev. 2, "Assessment of Beaver Valley Unit 2 Containment Response for Design Basis Accidents for Containment Atmospheric Conversion Project" (FAI/02-05 Rev. 8) (Unit 2 – AOR reference)
- 10080-N-797 Rev. 9, "Documentation of Miscellaneous Unit 2 Containment Conversion inputs" (Unit 2)
- 8700-US(B)-263 Rev. 7 / Addenda A1 and A2, "Assessment of Beaver Valley Unit 1 Containment Response for Design Basis Accidents for Containment Atmospheric Conversion Project" (Unit 1)
- 10080-US(B)-239 Rev. 6 / Addendum A1, "Assessment of Beaver Valley Unit 2 Containment Response for Design Basis Accidents for Containment Atmospheric Conversion Project" (Unit 2)
- FAI/13-0929 Rev 1, "Assessment of Beaver Valley Unit 2 Containment Response for Design Basis Accidents for Replacement Steam Generator and Reactor Vessel Head Project" (Unit 2)
- 8700-US(B)-257 Rev. 1, "Iodine Removal Coefficients" (Units 1 and 2)
- 8700-US(B)-ERS-SNW-92-009 Rev. 6, "Iodine Release from the Beaver Valley Unit 1 & 2 Refueling Water Storage Tank" (Units 1 & 2)
- 8700-US(B)-279 Rev. 0, "Determination of the Mass/Volume of Sodium Tetraborate Decahydrate (NaTB) required to Replace Sodium Hydroxide (NaOH) as the Post-LOCA Sump Water Buffering Agent, and the associated Maximum Sump Water / Containment Spray pH" (Unit 1)
- 8700-US(B)-278 Rev. 0 / Addendum A1, "Determination of the Mass/Volume of Sodium Tetraborate Decahydrate (NaTB) required to Replace Sodium Hydroxide (NaOH) as the Post-LOCA Sump Water Buffering Agent, and the associated Maximum Sump Water / Containment Spray pH" (Unit 2)
- 8700-UR(B)-213 Rev. 0, "Containment Vacuum System Maximum Flowrate for Radiological input" (Unit 1)
- 10080-UR(B)-485 Rev. 0, "Containment Vacuum System Maximum Flowrate for Radiological input" (Unit 2)
- 10080-UR(B)-484 Rev. 0 / Addendum A1, "Primary and Secondary Coolant Design/Technical Specification Activity Concentrations including Pre-Accident Iodine Spike Concentrations and Equilibrium Iodine Appearance Rates following Power Uprate" (Units 1 and 2)
- DIT-SGR2-0048-00, "BVPS Unit 2 RSG Project – Inputs for Calculation 12241-US(B)-163"

Preparer: Stephen Dristas	Preparer Signature: *Stephen W Dristas*	Date: 05/07/2015
Reviewer: Jack Wakeland	Reviewer Signature: *Jack Wakeland*	Date: 05/08/15
Approver: Mike Testa	Approver Signature: *M Testa*	Date: 12/04/15

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CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-487 | REVISION: 3

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DESIGN VERIFICATION RECORD

Page 1 of 1

NOP-CC-2001-01 Rev. 00

SECTION I: TO BE COMPLETED BY DESIGN ORIGINATOR

DOCUMENT(S)/ACTIVITY TO BE VERIFIED:

DIT-SGR2-0046-01

☒ SAFETY RELATED ☐ AUGMENTED QUALITY ☐ NONSAFETY RELATED

SUPPORTING/REFERENCE DOCUMENTS

Calculation UR(B)-487 Rev. 1 / Add. 1 & 2	Calculation US(B)-257 Rev. 1
Calculation US(B)-261 Rev. 3 / Add. 3	Calculation US(B-279 Rev. 0
Calculation US(B)-163 Rev. 0 / Add. 2	Calculation US(B)-278 Rev. 0 / Add. 1
Calculation US(B)-263 Rev. 7 / Add. 1 & 2	Calculation UR(B)-213 Rev. 0
Calculation US(B)-239 Rev. 6	Calculation UR(B)-485 Rev. 0
Fauske Calculation FAI/13-0929 Rev. 1	Calculation US(B)-ERS-SNW-92-009 Rev. 6
	Calculation US(B)-484 Rev. 0

DESIGN ORIGINATOR: *(Print and Sign Name)*
Steven W. Dristas [signature] DATE 05/08/2015

SECTION II: TO BE COMPLETED BY VERIFIER

VERIFICATION METHOD *(Check one)*

☐ DESIGN REVIEW *(Complete Design Review Checklist or Calculation Review Checklist)* ☐ ALTERNATE CALCULATION ☐ QUALIFICATION TESTING

JUSTIFICATION FOR SUPERVISOR PERFORMING VERIFICATION:
N/A

APPROVAL: *(Print and Sign Name)* DATE
N/A

EXTENT OF VERIFICATION:

Verification of design inputs obtained from approved documents.

Calculation Review Checklist.

COMMENTS, ERRORS OR DEFICIENCIES IDENTIFIED? ☐ YES ☐ NO

RESOLUTION: *(For Alternate Calculation or Qualification Testing only)*

RESOLVED BY: *(Print and Sign Name)* DATE

VERIFIER: *(Print and Sign Name)*
Jack F. Wakeland [signature] DATE 05/08/15

APPROVED BY: *(Print and Sign Name)*
Michael F. Testa [signature] DATE 12/04/15

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CALCULATION REVIEW CHECKLIST

NOP-CC-2001-04 Rev. 05

CALCULATION NO. DIT-SGR2-0046
REV. 01
ADDENDUM NO. N/A
UNIT 1/2

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
GENERAL					
1 Does the stated objective/purpose clearly describe why the calculation is being performed?		X			
2. Are design input / output documents and references listed and clearly identified in the document index, including edition and addenda, where applicable?		X			
3. Were verbal inputs from third parties properly documented?	X				
4. Are design input parameters, such as physical and geometric characteristic and regulatory or code and standard requirements, accurately taken from the design input documents and correctly incorporated, including tolerances and units?		X			
5. Are the design inputs relevant, current, consistent with design/licensing bases and directly applicable to the purpose of the calculation, including appropriate tolerances and ranges/modes of operation?		X			
6. Are all design inputs retrievable? If not, have they been added as attachments?		X			
7. Are preliminary or conceptual inputs clearly identified for later confirmation as open assumptions?	X			Information from FAI/13-0929 Rev. 1 is verified	
8. Where applicable, were construction and operating considerations included as input information?		X			
9. Were design input / output documents properly updated to reference this calculation?		X		UR(B)-487 will reference this DIT	
ASSUMPTIONS					
10. Have the assumptions necessary to perform the analysis been clearly identified and adequately described?	X				
11. Are all assumptions for the calculation reasonable and consistent with design/licensing bases?	X				
12. Have all open assumptions needing later confirmation been clearly identified on the Calculation cover sheet, including when the open assumption needs to be closed?	X				
13. Has an SAP Activity Initiation Form been created for open assumptions?	X				
14. Have engineering judgments been clearly identified?	X				
15. Are engineering judgments reasonable and adequately documented?	X				
16. Is suitable justification provided for all assumptions/engineering judgements (except those based upon recognized engineering practice, physical constants or elementary scientific principles)?	X				
METHOD OF ANALYSIS					
17. Is the method used appropriate considering the purpose and type of calculation?	X				
18. Is the method in accordance with applicable codes, standards, and design/licensing bases?	X				
IDENTIFICATION OF COMPUTER CODES (Ref: NOP-SS-1001)					
19. Have the versions of the computer codes employed in the design analysis been certified for this application?	X				
20. Are codes properly identified along with source (vendor, organization, etc.)?	X				
21. Is the code applicable for the analysis being performed?	X				
22. Is the computer program(s) being used listed on the FENOC Usable Software List for the site?	X				

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CALCULATION REVIEW CHECKLIST

NOP-CC-2001-04 Rev. 05

CALCULATION NO. DIT-SGR2-0046
REV. 01
ADDENDUM NO. N/A
UNIT 1/2

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
23. Does the computer model, that has been created, adequately reflect actual (or to be modified) plant conditions (e.g., dimensional accuracy, type of model/code options used, time steps, etc.)?	X				
24. Did the computer output generate any ERROR or WARNING Messages that could invalidate the results?	X				
25. Is the computer output reasonable when compared to inputs and what was expected?	X				
COMPUTATIONS 26. Are the equations used consistent with recognized engineering practice and design/licensing bases?	X				
27. Is there a reasonable justification provided for the uses of any equations not in common use?	X				
28. Were the mathematical operations performed properly and the results accurate?					
29. Have adjustment factors, uncertainties, empirical correlations, etc., used in the analysis been correctly applied?		X			
30. Is the result presented with proper units and tolerance?					
31. Has proper consideration been given to results that may be overly sensitive to very small changes in input?		X			
CONCLUSIONS 32. Is the magnitude of the result reasonable and expected when compared to inputs?		X			
33. Is there a reasonable justification provided for deviations from the acceptance criteria?	X				
34. Are stated conclusions justifiable based on the calculation results?		X			
35. Are all pages sequentially numbered and marked with a valid calculation and revision number?		X			
36. Is all information legible and reproducible?		X			
37. Is the calculation presentation complete and understandable without any need to refer back to the Originator for clarification or explanations?		X			
38. Is calculation format presented in a logical and orderly manner, in conformance with the standard calculation content of NOP-CC-3002 (Attachment 1)?	X			DIT is per 1/2-ADM-2097	
39. Have all changes in the documentation been initialed (or signed) and dated by the author of the change and all required reviewers?	X				
DESIGN/LICENSING 40. Have all calculation results stayed within existing design/licensing basis parameters?		X			
41. If the response to Question 40 is NO, has Licensing been notified as appropriate? (i.e. UFSAR or Tech Spec Change Request has been initiated).	X				
42. Is the direction of trends reasonable?		X			
43. Has the calculation Preparer used all applicable design information/requirements provided?	X				
44. Did the calculation Preparer determine if the calculation was referenced in design basis documents and/or databases?		X		Covered in document impact review for revision of UR(B)-487	
45. Did the Preparer determine if the calculation was used as a reference in the UFSAR?	X			Covered in document impact review for revision of UR(B)-487	
46. If the calculation is used as a reference in the UFSAR, is a change to the UFSAR required or an update to the UFSAR Validation Database, if applicable, required?	X			Covered in document impact review for revision of UR(B)-487	

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CALCULATION REVIEW CHECKLIST

NOP-CC-2001-04 Rev. 05

CALCULATION NO. DIT-SGR2-0046
REV. 01
ADDENDUM NO. N/A
UNIT 1/2

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
47. If the answer to Question 46 is YES, have the appropriate documents been initiated?	X				
48. Has the applicability of 10CFR50.59 to this calculation been considered and documented?	X			10CFR50.59 process does not apply	
ACCEPTABLE					
49. Does the calculation meet its purpose/objective?		X			
50. Is the calculation acceptable for use?		X			
51. What checking method was used to review the calculation? Check all that apply.					
• spot check for math					
• complete check for math		X			
• comparison with tests					
• check by alternate method					
• comparison with previous calculation		X		UR(B)-487 Rev. 1 & Add. 1 & 2	
52. If the calculation was prepared by a vendor, does it comply with the technical and quality requirements described in the Procurement Documents? Reference the Purchase Order number or other procurement document number in the Comments Section of this question.	X				
53. Have Professional Engineer (PE) certification requirements been addressed and documented where required by ASME Code (if applicable).	X				

Review Summary:
DIT-SGR2-0046-01 is acceptable for use.

Technical Review *(Print and Sign Name)* Jack Wakeland	Date 05/08/15	**Owner's Acceptance Review** *(Required for calculations prepared by a vendor)*	
		Reviewer *(Print and Sign Name)*	Date
Design Verification *(Print and Sign Name)* Jack Wakeland	Date 05/08/15	Approver *(Print and Sign Name)*	Date

Enclosure D
L-20-161

L-SHW-BV2-000240 NP-Attachment 3 Calculation 10080-UR(B)-493, Revision 1, “Site Boundary and Control Room Doses based on Core Uprate and Alternative Source Term Methodology following a) a Locked Rotor Accident b) a Loss of AC Power Accident” (Nonproprietary Version)

(102 pages follow)

FirstEnergy	CALCULATION NOP-CC-3002-01 Rev. 05	Page i

CALCULATION NO.	VENDOR CALCULATION NO.
10080-UR(B)-493	N/A

☒ BV1 ☒ BV2 ☐ BV1/2 ☐ BV3 ☐ BVSWT | ☐ DB | ☐ PY

Title/Subject: Site Boundary and Control Room Doses based on Core Uprate and Alternative Source Term Methodology following a) a Locked Rotor Accident b) a Loss of AC Power Accident

Category:	☒ Active	☐ Historical	☐ Study	**Vendor Calc Summary:** Yes ☐ No ☒
Classification:	☒ Tier 1 Calculation	☒ Safety-Related/Augmented Quality	☐ Non-safety-Related	
Open Assumptions?:	☐ Yes ☒ No If Yes, Enter Tracking Number			
System Number:	N/A			
Functional Location :	N/A			
Commitments:	None			
Initiating Documents:	CR-2017-10857			

(PY) Calculation Type:

(PY) Referenced In USAR Validation Database ☐ Yes ☐ No | (PY) Referenced In Atlas? ☐ Yes ☐ No

Computer Program(s)

Program Name	Version / Revision	Category	Status	Description
PERC2	V00 / L02	B	Active	Activity Transport and Consequence

Revision Record

Rev.	Affected Pages	Originator *(Print, Sign & Date)*	Reviewer/Design Verifier *(Print, Sign & Date)*	Approver *(Print, Sign & Date)*
1	All	Keith Ferguson [signature] 2/1/2019	Joseph S Baron [signature] 2/1/2019	Sreela Ferguson [signature] 2/1/2019
	Description of Change: As part of a Long Term Objective, the dose consequences at the Site Boundary and Control Room following a Locked Rotor Accident or a Loss of AC Power Accident has been updated to facilitate relaxation of operational limits that currently affect plant operation; specifically to allow a) an increase in the allowable unfiltered inleakage into the Control Room Envelope, and b) an increase in the core design limit with respect to linear heat generation by use of fuel gap fractions provided in Table 3 Draft Guide 1199 for all BVPS Non-LOCA events that experience fuel damage (with the exception of the Control Rod Ejection Accident). Also included is a review / update of all design input parameter values / references to reflect current plant design.			
	Describe where the calculation will be evaluated for 10CFR50.59 and/or 10CFR72.48 applicability. Regulatory Applicability Determination and 10CFR50.59 Screen 18-01777 is attached to this calculation.			
Rev.	**Affected Pages**	**Originator** *(Print, Sign & Date)*	**Reviewer/Design Verifier** *(Print, Sign & Date)*	**Approver** *(Print, Sign & Date)*
0	N/A	Yi J Yu 12/04/2002	Joseph S Baron 12/04/2002	Sreela Ferguson 12/04/2002
	Description of Change:			
	Describe where the calculation will be evaluated for 10CFR50.59 and/or 10CFR72.48 applicability.			

~~PROPRIETARY~~

FirstEnergy	CALCULATION NOP-CC-3002-01 Rev. 05	Page ii
CALCULATION NO. **10080-UR(B)-493, Revision 1A**	**[ ] VENDOR CALC SUMMARY** **VENDOR CALCULATION NO. N/A**	

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CALCULATION NO. **10080-UR(B)-493, Revision 1**		**[ ] VENDOR CALC SUMMARY** **VENDOR CALCULATION NO. N/A**

OBJECTIVE OR PURPOSE:

The objective of this calculation is to determine the airborne dose at the Exclusion Area Boundary (EAB), Low Population Zone (LPZ) and Control Room (CR) at Beaver Valley Power Station (BVPS) Units 1 & 2 following a postulated: a) Locked Rotor Accident (LRA); and b) a Loss of AC Power (LACP). The analysis is based on a core power level of 2918 MWt (i.e., the uprated core thermal power level with margin for power uncertainty).

The calculated dose is based on "Alternative Source Terms" per Regulatory Guide (RG) 1.183, Revision 0, fuel gap fractions for all Non-LOCA events that experience fuel damage (with the exception of the Control Rod Ejection Accident (CREA)) as depicted in Table 3 of Draft Guide (DG) - 1199, increased allowable unfiltered inleakage into the Control Room Envelope (CRE), and current design input parameter values as provided by First Energy Nuclear Operating Company (FENOC) via DIN# 1, 2 and 12, and included as Attachments 1, 2 and 3 of this calculation.

Use of Non-LOCA fuel gap fractions from Table 3 of DG-1199 represents a proposed change in the BVPS licensing basis which is currently based on the fuel gap fractions listed in Table 3 of RG 1.183, Revision 0. This change is intended to support an increase in the core design limit for future fuel management schemes.

SCOPE OF CALCULATION:

As part of a Long Term Objective, and with the intent of providing operational margin, the BVPS design basis site boundary and control room dose consequence analyses are being updated to facilitate relaxation of certain operational limits that have significant effect on plant operation. To that end, Revision 1 herein investigates the impact of the following operational changes on the dose consequences following a LRA or LACP at either Unit 1 or Unit 2:

- A proposed increase in the allowable unfiltered inleakage into the Control Room Envelope (CRE)
- An increase in the core design limit (currently limited by BVPS commitment to Note 11 of Regulatory Guide 1.183, Revision 0). Specifically, as a result of the current use of RG 1.183 Revision 0, Table 3 fuel gap fractions in determining the dose consequences of BVPS Non-LOCA events that experience fuel damage (with the exception of the CREA), the current linear heat generation rate in the reactor core at BVPS is limited to <6.3 kw/ft. peak rod average power for burnups exceeding 54,000 MWD/MTU. This limitation has a significant impact on BVPS fuel management schemes.

The objective of Revision 1 is to demonstrate continued compliance with the dose acceptance criteria of 10CFR50.67 (as modified by Table 6 of RG 1.183 R0) after taking into consideration the following:

a) An increase in allowable unfiltered inleakage into the CRE (inclusive of that associated with ingress /egress) from 30 cfm to 165 cfm.
b) Use of fuel gap fractions from Table 3 DG-1199 for all Non-LOCA events that experience fuel damage with the exception of the CREA. (Review of the NRC Safety Evaluation Report for the AST Licensing Application Request for Diablo Canyon Power Plant indicates that such an approach is acceptable as long as the licensee can demonstrate that BVPS operation falls within, and intends to continue to operate within, the maximum allowable power operating envelop for PWRs shown in Figure 1 of DG-1199.

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CALCULATION NO. **10080-UR(B)-493, Revision 1**	**[ ] VENDOR CALC SUMMARY** **VENDOR CALCULATION NO. N/A**	

c) Review / Update (as needed) of all design input parameter values / references to reflect current plant design.

SUMMARY OF RESULTS/CONCLUSIONS:

The BVPS Site Boundary and Control Room doses due to airborne radioactive material released following a LRA or LACP will remain within the regulatory limits set by 10CFR50.67 as modified by Table 6 of RG 1.183 R0.

Note that the estimated dose consequences following a LRA takes into consideration the following proposed change to plant operations; specifically, BVPS will operate within the maximum allowable power operating envelop for PWRs shown in Figure 1 of DG-1199.

As noted in Section 8, the dose consequences following a LRA is bounding.

Control Room

The 30-day integrated dose to the Control Room (CR) operator is 2.9 rem TEDE. This value is below the regulatory limit of 5 rem TEDE.

Site Boundary

The integrated dose to an individual located at any point on the boundary of the exclusion area (EAB) for any 2-hour period following the onset of the event is 2.3 rem TEDE (t=6 hr to t=8 hour time window). This dose is are less than the regulatory limit of 2.5 rem TEDE.

The integrated dose to an individual located at any point on the outer boundary of the low population zone (LPZ) for BVPS for the 8-hour duration of the release is 0.35 rem TEDE, which is less than the regulatory limit of 2.5 rem TEDE.

The CR, EAB and the LPZ dose consequences reported above reflect that associated with a postulated LRA, and bound the dose consequences following a LACP.

LIMITATIONS OR RESTRICTIONS ON CALCULATION APPLICABILITY:

NRC approval of the

- Use of fuel gap fractions from Table 3 DG-1199 for all Non-LOCA events that experience fuel damage with the exception of the CREA.
- Increase in the maximum allowable unfiltered inleakage into the CRE (inclusive of that associated with ingress /egress) from 30 cfm to 165 cfm.

IMPACT ON OUTPUT DOCUMENTS:

Unit 1 UFSAR Section 14.1.11 & 14.2.7 and associated Tables
Unit 2 UFSAR Section 15.2.6 and 15.3.3 and associated Tables

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CALCULATION NO. **10080-UR(B)-493, Revision 1**		**[ ] VENDOR CALC SUMMARY** **VENDOR CALCULATION NO. N/A**

DESIGN VERIFICATION FORM

Project Name:	**BVPS Control Room Dose Consequence Analyses Update**	**Job Number:**	**7001041**
Verified Document No.:	**10080-UR(B)-493**	**Revision:**	**1**
Verified Document Title:	**Site Boundary and Control Room Doses based on Core Uprate and Alternative Source Term Methodology following a) a Locked Rotor Accident b) a Loss of AC Power Accident**	**Date Verified:**	**2/1/2019**
Verifier's Name/Signature:	**Joseph S. Baron** [signature]		**2/1/2019**
Lead Engr. Concurrence Name/Signature/ Date	**Sreela Ferguson** [signature]		**2/1/2019**
Extent of Review: (entire document or not)	Full ☒ Partial ☐	If partial, specify what was reviewed:	
Method of Review	Design Review ☒ Alternate Calculation/Analysis ☐ Qualification Testing ☐		
Incomplete or unverified portions of design:	NA		
Consideration of known problems affecting the standard or previously proven design document:	NA		

THE FOLLOWING QUESTIONS ARE SUMMARIZED. REFER TO NEPP 4-43 FOR COMPLETE REVIEW REQUIREMENTS. ADDRESS ADDITIONAL APPLICABLE REVIEWS IN COMMENT/JUSTIFICATION BLOCK AS NECESSARY.

Design Reviews	Inputs have been properly selected?	Yes ☒ No ☐
	Assumptions are adequately described and reasonable?	Yes ☒ No ☐
	Methodology, including computer programs, to assure the appropriateness of the overall approach, its implementation, and the correctness of the specific information and correlations utilized?	Yes ☒ No ☐
	Inputs are correctly used in the document, including validity of references identified?	Yes ☒ No ☐
	Design Output is reasonable compared to the inputs used?	Yes ☒ No ☐
	Design Input and Verification Requirements for interfacing organizations are specified in design documents or in supporting procedures?	Yes ☒ No ☐
Administrative Check Of Format And Content		Yes ☒ No ☐

Comments/Justification (Identify comment subject and associated response.)
The results of this calculation are based on the design input provided by FENOC

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DOCUMENT INDEX

DIN No.	Document Number/Title	Revision, Edition, Date	Reference	Input	Output
1	FENOC Letter: ND1MDE:0727; BV1 & BV2 Complete Reanalysis of Dose Consequences for CRE Tracer Gas Testing and other Acceptance Criteria Changes - Design Input Transmittal DIT-BVDM-0105-00 for Locked Rotor Accident Dose.	July 13, 2018	☒	☒	☐
2	FENOC Letter: ND1MDE:0726; BV1 & BV2 Complete Reanalysis of Dose Consequences for CRE Tracer Gas Testing and other Acceptance Criteria Changes - Design Input Transmittal DIT-BVDM-0106-00 for the Loss of Non-Emergency AC Power Accident Dose	July 13, 2018	☒	☒	☐
3	Reg. Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power reactors"	July 2000	☐	☒	☐
4	WECTEC Calculation 10080-UR(B)-484, "Primary and Secondary Coolant Design/Technical Specification Activity Concentration including Pre-Accident Iodine Spike Concentrations and Equilibrium Iodine Appearance Rates Following Power Uprate."	Rev.1	☐	☒	☐
5	WECTEC Calculation 8700-EN-ME-105, "Atmospheric Dispersion Factors (χ/Qs) at Control Room and ERF Receptors for Unit 1 Accident Releases Using the ARCON96 Methodology."	Rev.0	☐	☒	☐
6	WECTEC Calculation 10080-EN-ME-106, "Atmospheric Dispersion Factors (χ/Qs) at Control Room and ERF Receptors for Unit 2 Accident Releases Using the ARCON96 Methodology."	Rev.0	☐	☒	☐
7	TID-24190, Air Resources Laboratories, "Meteorology and Atomic Energy"	July 1968	☐	☒	☐
8	ANSI/ANS 6.1.1-1991, "Neutron and Gamma-ray Fluence-to-dose Factors	1991	☐	☒	☐
9	EPA-520/1-88-020, September 1988, Federal Guidance Report No.11, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion and Ingestion"	September 1988	☐	☒	☐

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DIN No.	Document Number/Title	Revision, Edition, Date	Reference	Input	Output
10	WECTEC Computer Program PERC2, NU-226, Ver.00, Lev.02, QA Cat. I, "PERC2 - Passive Evolutionary Regulatory Consequence Code"	September 22, 2006	☐	☒	☐
11	WECTEC Calculation 10080-UR(B)-483, "Composite Reactor Core Inventory for BVPS Following Power Uprate (2918 MWth, Initial 4.2%-5% Enrichment, 18 month Fuel Cycle)"	Rev.0	☐	☒	☐
12	FENOC Letter ND1MDE:0738, BV1 & BV2 Complete Reanalysis of Dose Consequences for CRE Tracer Gas Testing and Other Acceptance Criteria Changes - Design input Transmittal DIT-BVDM-0103-03 for Control Room Dose	January 29, 2019	☒	☒	☐
13	Radiological Engineering & Waste Management Generic Library Data Volume I, Average β/γEnergies and Inhalation Dose Conversion Factors	September 26 1996	☒	☒	☐
14	Draft Regulatory Guide DG-1199, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors	October 2009	☐	☒	☐
15	NUREG 0800, Standard Review Plan Section 15.2.6, Loss of Non-Emergency AC Power to Station Auxiliaries	Revision 1	☐	☒	☐
16	BV Condition Report CR-2017-10857, 3BVT1.44.5 testing 1VS-D-40-1D Component Test Results	October 28, 2017	☒	☐	☐

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REVISION STATUS

Revision Number	**Affected Sections**	**Description of Revision**
0	N/A	Original Issue
0, Add. A1	All	(1). Address the impact of minor changes in the Environmental Steam Releases and the SG liquid mass with the finalized values of BV1 Replaced Steam Generators. (2). Address the impact of changes of the BV1 primary coolant Tech Spec concentration from 0.1 μCi/gm Dose Equivalent I-131 to 0.35 μCi/gm DE I-131 and the secondary coolant Tech Spec concentration from 0.05 μCi/gm DE I-131 to 0.1 μCi/gm DE I-131. (3). All design inputs remain the same as Rev.0 except as revised by Ref.4.2 of Addendum 1.
0, Add. A2	1.0, 3.0, 8.0,9.0	Address the impact of changes in the accident design input parameter values due to implementation of BVPS2 RSGs on the site boundary and control room doses calculated in Rev. 0/Add 1 for a Locked Rotor Accident and a Loss of AC Power Accident.
1	All	Complete update to address: 1) An increase in allowable unfiltered inleakage into the Control Room Envelope from 30 cfm to 165 cfm. 2) Change in the fuel gap fractions applicable to all Non-LOCA events with the exception of the CREA, from values presented in Table 3 of RG 1.183 Revision 0, to Table 3 of Draft Guide-1199. 3) Review / Update (as needed) of all design input parameter values / references to reflect current plant design.

1.0 BACKGROUND / APPROACH

1.1 Background

Beaver Valley Power Station (BVPS) has implemented Alternative Source terms (AST) in accordance with Regulatory Guide (RG) 1.183, Revision 0. The dose consequences at the Exclusion Area Boundary (EAB), Low Population Zone (LPZ) and Control Room (CR) for a postulated a) Locked Rotor Accident (LRA), and b) for a Loss of AC Power Accident (LACP), at BVPS Units 1 & 2, based on AST methodology and Extended Power Uprate (EPU) was originally documented in Revision 0.

As part of a Long Term Objective, and with the intent of providing operational margin, the BVPS design basis site boundary and control room dose consequence analyses are being updated to facilitate relaxation of the following operational limits that have significant effect on plant operation. To that end, Revision 1 investigates the impact of the following operational changes on the dose consequences following a LRA or LACP at either BVPS Unit 1 or Unit 2:

- A proposed increase in the allowable unfiltered inleakage into the Control Room Envelope (CRE).

- An increase in the core design limit (currently limited by BVPS commitment to Note 11 of RG 1.183, R0). Specifically, as a result of the current use of RG 1.183 R0, Table 3 fuel gap fractions in determining the dose consequences of BVPS Non-LOCA events that experience fuel damage (with the exception of the CREA), the current linear heat generation rate in the reactor core at BVPS is limited to <6.3 kw/ft. peak rod average power for burnups exceeding 54,000 MWD/MTU. This limitation has a significant impact on BVPS fuel management schemes.

In summary, the objective of Revision 1 is demonstrate continued compliance with the dose acceptance criteria of 10CFR50.67, as modified by Table 6 of RG 1.183 R0, based on the following:

a) An increase in allowable unfiltered inleakage into the CRE (inclusive of that associated with ingress/egress) from 30 cfm to 165 cfm. This is intended to address the fact that recent CRE Tracer Gas Tests indicate unfiltered CRE inleakage that are in excess of the values used in the design basis dose consequence analyses.

b) Use of fuel gap fractions from Table 3 DG-1199 for all Non-LOCA events that experience fuel damage, with the exception of the CREA. (Review of the NRC Safety Evaluation Report for the AST Licensing Application Request for Diablo Canyon Power Plant indicates that such an approach is acceptable as long as the licensee can demonstrate that BVPS operation falls within, and intends to continue to operate within, the maximum allowable power operating envelop for PWRs shown in Figure 1 of DG-1199.

c) Review / Update (as needed) of all design input parameter values / references to reflect current plant design.

1.2 Approach

As indicated earlier, the focus of this analysis to estimate the bounding dose consequences following a Locked Rotor Accident (LRA) or a Loss of Non-Emergency AC Power to the Station Auxiliaries Accident (LACP) at either BVPS Unit 1 or Unit 2. Summarized below are brief descriptions of the two events.

- Locked Rotor Accident (LRA):

  This event is caused by an instantaneous seizure of a primary reactor coolant pump rotor. Flow through the affected loop is rapidly reduced, causing a reactor trip due to a low primary loop flow signal. Fuel damage is predicted to occur as a result of this accident. There is no breach of the reactor coolant system, however, due to the pressure differential between the primary and secondary systems, and assumed SG tube leakage, elevated concentrations of fission products are assumed to be discharged from the primary coolant into the secondary coolant system. Following reactor trip, and based on an assumption of a Loss of Offsite Power (LOOP) coincident with reactor trip, the condenser is assumed to be unavailable and reactor cooldown is achieved using steam releases to the environment via the steam generators (SGs) Atmospheric Dump Valves (ADVs) and Main Steam Safety Valves (MSSVs) until initiation of the Residual Heat Removal (RHR) system. The analysis of the LRA is based on the guidance set forth in Regulatory Guide 1.183, Revision 0 (DIN# 3) and BVPS Units 1 & 2 design input parameters values as provided via DIN#s 1 and 12.

- Loss of Non-Emergency AC Power (LACP)

  The Loss of Non-Emergency AC Power (LACP) to the Station Auxiliaries Accident is the result of a complete loss of either the external (offsite) grid or the onsite ac distribution system. All reactor coolant circulation pumps are tripped simultaneously by the initiating event resulting in a flow coast-down as well as a decrease in heat removal by the secondary system. The Loss of AC power condition results in the condenser becoming unavailable, a reactor trip, and reactor cooldown being achieved using steam releases via the SG MSSVs and ADVs until initiation of the RHR system. The LACP is described in NUREG 0800, SRP 15.2.6 (DIN# 15). BVPS Units 1 & 2 design input parameter values are provided via DIN#s 2 and 12.

Due to the higher primary coolant activity concentrations postulated as a result of the fuel damage associated with the LRA, the dose consequences associated with the LRA are expected to bound that due to the LACP. Consequently, and in accordance with SRP 15.2.6 and current licensing basis, the LACP is not specifically analyzed.

The design inputs associated with the LRA and LACP are presented, respectively, in Section 2 and discussed in Section 6.

A comparison of the input parameters for the two accidents is utilized in Section 6 to show that the LRA is the bounding event.

Activity Transport

WECTEC Computer program PERC2 is used to calculate the airborne dose to the operator in the control room and to a member of the Public located at the EAB/LPZ. PERC2 is a QA Cat 1 code. It utilizes an exact solution analytical computational process that addresses radionuclide progeny, time dependent releases, transport rates between regions and deposition of radionuclide concentrations in sumps, walls and filters.

The PERC2 code is configured to evaluate the radiological characteristics of nuclides released from a core and transported to the site boundary and control room by way of a confinement and its auxiliary spaces (i.e., a series of regions). The program utilizes inputs which describe the release rates of radionuclides from the core (for use in Alternative Source Term analyses), the path and rate of exchange between regions including filter efficiencies, deposition rates, atmospheric dispersion, breathing rates, dose conversion and occupancy factors.

The BVPS design input parameters utilized in the LRA & LACP dose consequence assessments are provided via DIN# 1, 2 & 12. A bounding analysis is performed, thus the results represent the worst of the two referenced accidents, and are applicable to both Unit 1 and Unit 2.

1. *Locked Rotor Accident*

Regulatory guidance provided in Regulatory Guide (RG) 1.183, Revision 0, Appendix G, is used to develop the LRA dose consequence model. Consistent with current licensing basis and in accordance with DIN# 1, the BVPS LRA is postulated to result in ≤ 20% fuel failure, resulting in the release of the associated gap activity. In accordance with DIN# 1, a radial peaking factor of 1.70 is applied to the activity release from the fuel gap. No melted fuel is predicted.

The dose significant isotopes assumed to be in the gap are consistent with Rev.0.

As discussed in Design Input 6 and Assumption 3, and in accordance with Draft Guide (DG)-1199, the fuel gap activity is assumed to be comprised of:

Group	Fraction of Core Activity
Noble gases (except Kr-85)	0.04
Halogens (except I-131, I-132)	0.05
Kr-85	0.35
I-131	0.08
I-132	0.23
Alkali Metals (Cs,Rb):	0.46

In accordance with RG 1.183, the activity from the fuel gap is assumed to be released instantaneously and mixed homogenously through the primary coolant. This radioactivity is then transferred to the secondary system via SG tube leakage. Per DIN# 1, BVPS Plant Technical Specification 3.4.13 limits primary to secondary SG tube leakage to 150 gpd per steam generator, for a total of 450 gpd in all 3 SGs.

The activity associated with the release of the primary to secondary leakage of normal operation RCS, (at Technical Specification levels) via the MSSVs/ADVs are insignificant compared to the failed fuel release and are therefore not included in this assessment.

Per DIN# 1, the effect of SG tube uncovery in intact SGs (for SGTR and non-SGTR events), has been evaluated for potential impact on dose consequences as part of a Westinghouse Owners Group (WOG) Program and demonstrated to be insignificant; therefore, and per RG 1.183, R0, the gap iodines are assumed to have a partition coefficient of 100 in the SG and released to the environment in proportion to the steaming rate and the partition coefficient. In accordance with RG 1.183, R0, the iodine releases to the environment from the SG are assumed to be 97% elemental and 3% organic. The gap noble gases are released freely to the environment without retention in the SG whereas the particulates are assumed to be carried over in accordance with the design basis SG moisture carryover fraction.

The condenser is assumed unavailable due to the loss of offsite power. Consequently, the radioactivity release resulting from a LRA is discharged to the environment from all steam generators via the MSSVs and ADVs. Per DIN# 1, the SG releases continue for 8 hours, at which time shutdown cooling is initiated via operation of the RHR system, and environmental releases are terminated.

2. *Loss of AC Power Accident*

Per DIN# 2, an LACP will not result in either failed or melted fuel. Thus the environmental release is limited to the maximum activity permitted by the BVPS Technical Specifications in both the primary and secondary coolant.

3. *EAB 2 hr Worst Case Window*

AST methodology requires that the worst case dose to an individual located at any point on the boundary at the EAB, for any 2-hr period following the onset of the accident be reported as the EAB dose. For the LRA, the worst two hour period can occur either during the 0-2 hr period when the noble gas release rate is the highest, or during the t=6hr to 8 hr period when the iodine and particulate level in the SG liquid peaks (Per DIN# 1, SG releases are terminated at T=8 hrs). Regardless of the starting point of the worst 2 hr window, the 0-2 hr EAB χ/Q is utilized.

Control Room Design/Operation/Transport Model

Control Room Design / Operation

Beaver Valley Power Station is served by a single control room that supports both Units. The joint control room is serviced by two ventilation intakes, one assigned to BVPS-1 and the other to BVPS-2. These air intakes are utilized for both the normal as well as the accident mode.

During normal plant operation, both ventilation intakes are operable providing a total supply of 1250 cfm of unfiltered outside air makeup which includes all potential inleakage and uncertainties (Note: this value is the total for both U1 and U2 intakes with margin; it includes the intake flow and all unfiltered inleakage (including that associated with ingress / egress and all potential inleakage) with uncertainties). (DIN# 12)

The containment high-high pressure signal (CIB) signals from either unit initiate the BVPS-2 control room emergency ventilation system. In the event one of the BVPS-2 trains is out of service, and the second train fails to start, operator action will be utilized to initiate the BVPS-1 control room emergency pressurization system.

The CR emergency pressurization intake filter has an efficiency of 99% for particulates, and 98% for elemental and organic iodine (DIN# 12).

Filtration of the Control Room ventilation recirculation flows during all modes of operation by particulate air filters (intended for dust removal) in the CRVS recirculation air-conditioning system, is not credited.

The control room emergency filtered ventilation intake flow varies between 800 to 1000 cfm, which includes allowance for measurement uncertainties (DIN# 12). The control room unfiltered inleakage during the emergency pressurization mode is conservatively assumed to be 165 cfm (includes 10 cfm unfiltered inleakage due to ingress / egress) to reflect the results of tracer gas testing in the pressurized mode, and to also accommodate margin for potential future deterioration.

Control Room Transport Model

Since the BVPS control rooms (CR) are contained in a single control room envelope, they are modeled as a single region. Isotopic concentrations in areas outside the control room envelope are assumed to be comparable to the isotopic concentrations at the control room intake locations. To support development of bounding control room doses, the most limiting χ/Q associated with the release point / receptor for an event in either unit, is utilized.

The control room post-accident ventilation model utilized in the dose analysis corresponds to an assumed "single intake" which utilizes the worst case atmospheric dispersion factor (χ/Q) from release points associated with accidents at either unit, to the limiting control room intake. The atmospheric dispersion factors are provided in Section 2.

Based on DIN# 12, the atmospheric dispersion factors associated with control room inleakage are assumed to be the same as those utilized for the control room intake. (Also, see Assumption 6)

To provide operational margin, and in accordance with DIN# 12, the analysis herein assumes that during normal plant operation, the BVPS-1 & BVPS-2 unfiltered intake plus inleakage is a maximum of 1250 cfm (total for both Units). This maximum normal operation unfiltered inflow to the CR is an analytical upper bound value that is intended to include a) the CR intake flow rate (including test measurements uncertainties), b) all unfiltered inleakage and c) a 10 cfm allowance for ingress / egress.

The above value bounds the test results of BV1/2 Procedure 3BVT 1.44.05 via Order 200699902. See Section 3, Assumption 6 for additional details.

Based on DIN# 1, the analysis herein conservatively assumes that the control room emergency pressurization system is not initiated and the control room remains in normal operation mode. Thus the unfiltered intake flow into the control room (including all inleakage and measurement uncertainties) is assumed to be 1250 cfm for the duration of the accident.

The control room model is included in Figures 6-1 and 6-2.

Dose Calculation Model

WECTEC radiological consequence program PERC2 is used to calculate the Committed Effective Dose Equivalent (CEDE) from inhalation and the Deep Dose Equivalent (DDE) from submersion due to halogens and noble gases transported to offsite locations and in the control room. The CEDE is calculated with dose conversion factors from DIN# 9, which uses the methodology provided in ICRP-30. The committed doses to other organs due to inhalation of halogens, particulates and noble gas daughters are also calculated. PERC2 is a multiple compartment activity transport code with the dose model consistent with the regulatory guidance. The decay and daughter build-up during the activity transport among compartments and the various cleanup mechanisms are included.

The PERC2 activity transport model, first calculates the integrated activity (using a closed form integration solution) at the offsite locations and in the control room air region, and then calculates the cumulative doses as described below:

Committed Effective Dose Equivalent (CEDE) Inhalation Dose - The dose conversion factors by isotope and internal organ type are applied to the activity in the air space of the control room, or at the EAB/LPZ. The exposure is adjusted by the appropriate respiration rate and occupancy factors for the CR dose at each integration interval as follows:

$$Dh(j) = A(j) \times h(j) \times C2 \times C3 \times CB \times CO$$

Where:

Dh(j) = Committed Effective Dose Equivalent (rem) from isotope j
A(j) = Integrated Activity (Ci-s/m^3)
h(j) = Isotope j Committed Effective Dose Equivalent (CEDE) dose conversion factor (mrem/pCi) based on Federal Guidance Report No.11, Sept. 1988 (DIN# 9)
C2 = Unit conversion of $1x10^{12}$ pCi/Ci
C3 = Unit conversion of $1x10^{-3}$ rem/mrem
CB = Breathing rate (m^3/s)
CO = Occupancy factor

Deep Dose Equivalent (DDE) from External Exposure - According to the guidance provided in Section 4.1.4 and Section 4.2.7 of RG 1.183 R0, (DIN# 3), the Effective Dose Equivalent (EDE) may be used in lieu of DDE in determining the contribution of external dose to the TEDE if the whole body is irradiated uniformly. The EDE in the control room is based on a finite cloud model that addresses buildup and attenuation in air. The dose equation is based on the assumption that the dose point is at the center of a hemisphere of the same volume as the control room. The dose rate at that point is calculated as the sum of typical differential shell elements at a radius R. The equation utilizes, the integrated activity in the control room air space, the photon energy release rates per energy group from activity airborne in the control room based on using the isotopic gamma energy library data developed in DIN# 13, and the ANSI/ANS 6.1.1-1991 "Neutron and Gamma-ray Fluence-to-dose Factors", DIN# 8.

The Deep Dose Equivalent at the EAB and LPZ locations is very conservatively calculated using the semi-infinite cloud model outlined in TID-24190 (DIN# 7), Section 7-5.2, Equation 7.36, where 1 rad is assumed to be equal to 1 rem.

$\gamma D\infty$ (x,y,0) rad = 0.25 $E\gamma_{BAR}$ ψ (x,y,0)

$E\gamma_{BAR}$ = average gamma energy released per disintegration (Mev/dis) is based on the isotopic gamma energy library data developed in DIN# 13

ψ (x,y,0) = concentration time integral (Ci-sec/m^3)

0.25 = $[1.11 \bullet 1.6\text{x}10^{-6} \bullet 3.7\text{x}10^{10}] / [1293 \bullet 100 \bullet 2]$

Where:

1.11	=	ratio of electron densities per gm of tissue to per gm of air
$1.6\text{x}10^{-6}$ (erg/Mev)	=	number of ergs per Mev
$3.7\text{x}10^{10}$ (dis/sec-Ci)	=	disintegration rate per curie
1293 (g/m^3)	=	density of air at S.T.P.
100	=	ergs per gram per rad
2	=	factor for converting an infinite to a semi-infinite cloud

2.0 DESIGN INPUTS

All input parameters values associated with BVPS design used in this analysis including identification of the source documents from which the parameter values were obtained, have been verified / approved for use by FENOC and provided to WECTEC via DIN# 1, 2 and 12 (included herein as Attachments 1, 2 and 3). As noted in DIN# 1, 2 and 12, the BVPS specific parameter values provided below reflect the bounding value applicable to Unit 1 and Unit 2 (unless stated otherwise), that is appropriate for use in design basis accident analyses. Comments / explanations associated with the parameter values presented below are provided in DIN# 1, 2 and 12 under the "Comment" column, and provide additional information that may be useful to the user.

General Comment (Per DIN# 1, 2 & 12)
The equipment / parameter values presented below as approved design input reflect safety related components that can be credited in design bases dose consequence analyses; i.e., the components have the appropriate redundancy, environmental qualification, pedigree, seismic support etc. applicable to safety related equipment, and the parameter values reflect single failure criteria.

Design Input Parameter / Value **DIN#**

Design Input for the Locked Rotor Accident

1. Reactor Core thermal power – 2918 MWt (the uprate core thermal power including margin power uncertainty) [1]
2. Core Activity of dose-significant isotopes in the gap at the power level of 2918 MWt [1,11]

Nuclide	Core Activity (Ci)
KR83M	9.46E+06
KR85	8.27E+05
KR85M	1.95E+07
KR87	3.91E+07
KR88	5.43E+07
KR89	6.75E+07
KR90	7.24E+07
XE131M	1.08E+06
XE133	1.60E+08
XE133M	5.05E+06
XE135	4.84E+07
XE135M	3.36E+07
XE137	1.46E+08
XE138	1.36E+08
BR 82	3.02E+05

Nuclide	Core Activity (Ci)
BR 83	9.37E+06
BR 85	1.95E+07
I129	2.86E+00
I130	2.07E+06
I131	7.78E+07
I132	1.14E+08
I133	1.60E+08
I134	1.77E+08
I135	1.52E+08
I136	6.99E+07
RB 86	1.69E+05
RB 88	5.57E+07
RB 89	7.26E+07
RB 90	6.69E+07
RB 90M	2.11E+07
CS134	1.57E+07
CS134M	3.69E+06
CS135M	4.39E+06
CS136	4.97E+06
CS137	9.81E+06
CS138	1.48E+08
CS139	1.37E+08
CS140	1.23E+08
BA137M	9.35E+06

3. Maximum Failed Fuel Percentage - 20% [1]
4. Maximum Melted Fuel Percentage - None [1]
5. Activity Available for Release - Gap activity in failed fuel [1]
6. Fraction of Core Activity in the Fuel gap [1, 14]

Group	Fraction
Noble gases (except Kr-85)	0.04
Halogens (except I-131, I-132)	0.05
Kr-85	0.35
I-131	0.08
I-132	0.23
Alkali Metals (Cs,Rb):	0.46

<u>Note</u>: Operation is limited to the maximum allowable operating power envelope for PWRs shown in Figure 1 of DG-1199

7. Radial Peaking Factor to be applied to Failed Fuel [1]
   1.70
8. Chemical form of halogens available for environmental release from failed fuel [1,3]
   97% elemental, 3% organic
9. Primary to Secondary Coolant Leakage via Intact Steam Generator [1]
   450 gpd (all 3 SGs) with 1.0 g/cc density
10. Moisture Carryover Fraction in SGs (to determine carryover of particulates in fuel gap release) [1]
    BV1 RSG: 0.1% BV2 OSG: 0.25% BV2 RSG: 0.1%
11. Maximum Time Period that tubes in SGs are uncovered [1]
    Negligible
12. Partition Coefficient in Steam Generators with tubes totally submerged]
    Noble Gas - released freely without retention
    All Iodines - 100
13. Initial & Minimum RCS Mass, excluding pressurizer liquid and steam masses [1]

Unit 1 RSG	345,097 lbm (22% SGTP)
Unit 2 OSG	341,331 lbm (22% SGTP)
Unit 2 RSG	346,381 lbm (22% SGTP)

14. Initial and Minimum post-accident Mass of Secondary Coolant in SGs [1]

Unit 1 RSG	101,799 lbm/SG
Unit 2 OSG	105,076 lbm/SG
Unit 2 RSG	103,019 lbm/SG

15. Termination of Environmental Release [1]

    8 hours after the accident

16. Maximum Steam Release from SGs [1]

Time Interval	U1 RSG	U2 OSG	U2 RSG
0 - 2 hours	340,000 lbm	348,000 lbm	332,000
2 - 8 hours	778,000 lbm	773,000 lbm	753,000

Design Input for the Loss of AC Power Accident

DIN#

1. Reactor Core thermal power – 2918 MWt (the uprate core thermal power) [2]
2. Maximum Failed Fuel Percentage - None [2]
3. Maximum Melted Fuel Percentage - None [2]
4. Activity Available for Release - Tech Spec RCS activity [2]
5. Initial Tech Spec RCS activity concentration [2,4]

   (Based on 0.35 μCi/gm Dose Equivalent I-131. See Table 9b of DIN# 4

Nuclide	Tech Spec RCS activity concentration (μCi/gm)
KR83M	4.09E-02
KR85M	1.48E-01
KR85	1.30E+01
KR87	9.68E-02
KR88	2.74E-01
KR89	7.80E-03
XE131M	5.54E-01
XE133M	4.59E-01
XE133	3.34E+01
XE135M	9.87E-02
XE135	1.02E+00
XE137	2.03E-02
XE138	6.86E-02
I129	1.08E-04
I130	4.52E-03
I131	2.73E-01
I132	1.13E-01
I133	4.17E-01
I134	6.47E-02
I135	2.46E-01
I136	7.07E-04

6. Initial Tech Spec Secondary Side Iodine Liquid Activity - 0.1 µCi/gm DE I-131 [2, 4]

   (From DIN# 4 Table 9b)

Nuclide	Tech Spec Secondary Liquid Activity Concentration (µCi/gm)
I129	3.34E-09
I130	8.38E-04
I131	8.34E-02
I132	1.39E-02
I133	9.32E-02
I134	1.90E-03
I135	3.34E-02
I136	5.79E-07

7. Chemical form of halogens available for environmental release from steam generator [2, 3]

   97% elemental, 3% organic

8. Primary to Secondary Coolant Leakage via Intact Stem Generators [2]

   450 gpd (all 3 SGs) with 1.0 g/cc density

9. Maximum Time Period of Tube Uncovery in SGs [2]

   Negligible

10. Partition Coefficient in Steam Generators with tubes totally submerged [2]

    Noble Gas - released freely without retention

    All Iodines – 100

11. Initial & Minimum RCS Mass, excluding pressurizer liquid and steam masses [2]

    Unit 1 RSG 345,097 lbm (22% SGTP)

    Unit 2 OSG 341,331 lbm(22% SGTP)

    Unit 2 RSG 346,381 lbm (22% SGTP)

12. Initial and Minimum post-accident mass of Secondary Coolant in SGs [2]

    Unit 1 RSG 101,799 lbm/SG

    Unit 2 OSG 105,076 lbm/SG

    Unit 2 RSG 103,019 lbm/SG

13. Termination of Environmental Release [2]

    8 hours after the accident

14. Maximum Steam Release from SGs [2]

Time Interval	U1 RSG	U2 OSG	U2 RSG
0 - 2 hours	340,000 lbm	348,000 lbm	332,000
2 - 8 hours	778,000 lbm	773,000 lbm	753,000

Design Inputs Common to both the Locked Rotor / Loss of AC Power Accident

Site Boundary

1. Offsite Breathing Rate [12, 3]

   0-8 hr 3.5E-04 m^3/sec

   8-24 hr 1.8E-04 m^3/sec

   1-30 day 2.3E-04 m^3/sec

2. Exclusion Area Boundary χ/Q [12]

   1.04E-03 sec/m^3, U-1

   1.25E-03 sec/m^3, U-2

   Note: The more restrictive U-2 value is used in the analysis.

3. Low Population Zone χ/Q [12]

   0-8 hr 6.04E-05 sec/m^3

   8-24 hr 4.33E-05 sec/m^3

   24-96 hr 2.10E-05 sec/m^3

   96-720 hr 7.44E-06 sec/m^3

Control Room

4. Minimum Control Room Volume [12]

   1.73E+05 ft^3

5. Maximum normal operation Control Room ventilation intake / inleakage flow rate [12]

   1250 cfm (unfiltered)

   (Total for both U1 and U2 intakes with margin, includes intake and all unfiltered inleakage, including that associated with ingress / egress)

   This is an assumed value intended to provide operational margin – see Assumption 5.

6. Control Room Breathing Rate [12,3]

   0-30 day 3.5E-04 m^3/sec

7. Control Room Occupancy Factors [12,3]

   0-1 day 1.0

   1-4 day 0.6

   4-30 day 0.4

8. Atmospheric dispersion factors from the U1 & U2 MS Relief Valves (i.e., MSSVs) to the U1 & U2 CR intake [5,6]

Unit 1 Release Points

Release	Receptor	0 - 2 hr	2 - 8 hr	8 - 24 hr	1 - 4 day	4 - 30 day
U 1 MS Relief Valves	Unit 1 CR Intake	***1.24E-03***	***9.94E-04***	4.08E-04	3.03E-04	2.51E-04
U 1 MS Relief Valves	Unit 2 CR Intake	7.46E-04	6.31E-04	2.62E-04	1.98E-04	1.62E-04

Unit 2 Release Points

Release	Receptor	0 - 2 hr	2 - 8 hr	8 - 24 hr	1 - 4 day	4 - 30 day
U 2 MS Relief Valves	Unit 1 CR Intake	3.33E-04	2.38E-04	1.09E-04	7.88E-05	5.66E-05
U 2 MS Relief Valves	Unit 2 CR Intake	5.01E-04	3.58E-04	1.61E-04	1.19E-04	8.32E-05

Note:

The dispersion factor from the U-1 MS Relief Valves to the U-1 CR intake (see above - bold, italicized font) is used in the analysis because it is most restrictive of all the other dispersion factors.

3.0 ASSUMPTIONS

General (Common to both LRA and LACP)

Assumptions utilized in this assessment have been approved by FENOC and were provided to WECTEC via DIN# 1, 2 and 12. None of these assumptions need further verification. Discussions regarding the bases of these assumptions are also included in DIN# 1, 2 and 12. Summarized below are some of the salient assumptions, including those made by the author when developing the transport models:

1. Assumptions used in the LRA and LACP dose consequence transport model that are listed as Design Input based on Regulatory Guidance are as follows:

Design Input Section	Design Input #.	Regulatory Guidance
Section 2, LRA	6	DG-1199
Section 2, LRA	5, 8, 9 (leak density),12	RG 1.183, R0
Section 2, LACP	4	NUREG 0800, SRP 15.2.6
Section 2, LACP	7, 8 (leak density),10	RG 1.183, R0
Section 2, Common	1, 6, 7	RG 1.183, R0

2. RG 1.183, R0, Table 3 provides the gap fractions for Non-LOCA events (with the exception of the CREA) for AST applications. The gap fractions provided in Table 3 of RG 1.183 are contingent upon meeting Note 11 of Table 3. Note 11 indicates that the release fractions listed in Table 3 are "acceptable for use with currently approved LWR fuel with a peak burnup of 62,000 MWD/MTU provided that the maximum linear heat generation rate does not exceed 6.3 kw/ft peak rod average power for burnups exceeding 54 GWD/MTU." As documented in NRC communications with other licensees, (Millstone, ML041320350), the burnup criterion associated with the maximum allowable linear heat generation rate is applicable to the peak rod average burnup in any assembly and is not limited to assemblies with an average burnup that exceeds 54 GWD/MTU.

   As noted in DIN# 1, item No. 6, to support flexibility of fuel management with respect to meeting the RG 1.183 criteria for linear heat generation rate, and based on NRC Safety Evaluation Report for the Diablo Canyon Power Plant AST application, the gap fractions used for the LRA is based on Table 3 of DG-1199. As documented in the referenced SER, this approach is acceptable to NRC as long as FENOC can demonstrate that BVPS falls within, and intends to operate within, the maximum allowable power operating envelop for PWRs shown in Figure 1 of DG-1199.

3. The Control Room is assumed to remain in normal operation mode for the duration of the accident.

4. Since no credit is taken for filtration of the post-accident activity as it enters the control room, the transport model treats all iodines, regardless of their chemical forms, as one group.

5. To provide operational margin, and in accordance with DIN# 12, the analysis herein assumes that during normal plant operation, the BVPS-1 & BVPS-2 unfiltered intake plus inleakage is a maximum of 1250 cfm (total for both Units). This maximum normal operation unfiltered inflow to the CR is an analytical upper bound value that is intended to include a) the CR intake flow rate (including test

measurements uncertainties), b) all unfiltered inleakage and c) a 10 cfm allowance for ingress / egress. The above value bounds the test results of BV1/2 Procedure 3BVT 1.44.05 via Order 200699902.

6. As noted in DIN# 12, due to the following reasons, the CR air intake χ/Q values are assumed to be representative / applicable for unfiltered in-leakage (including CR ingress / egress):

- Component tests performed as part of the 2017 CR Inleakage Tracer Gas Test indicated that a potential source of unfiltered inleakage into the Control Room are the normal operation intake dampers - which can be assigned the same χ/Q as the Control Room air intakes.

- Regarding other potential locations of inleakage, a χ/Q value that reflects the center of the Control Room boundary at roof level as a receptor could be considered the average value applicable to Unfiltered Inleakage locations around the CRE, and thus representative for all CR unfiltered leakage locations.

  Review of Dwg. 8700-RY-1C, R2, indicates that since the post-accident release points are closer to the CR intakes, and the directions from the release points to the CR center and CR intakes are similar, use of χ/Q values associated with the CR intakes, for CR unfiltered inleakage, is conservative.

- The 10 cfm allowance for ingress/egress, is assigned to the door leading into the Control Room that is considered the primary point of access. This door (S35-71) is located at grade level on the side of the building facing the BV1 Containment and between the CR air intakes. It is located close enough to the air intakes to allow the assumption that the χ/Q value associated with this source of leakage is reasonably similar to that associated with the air intakes.

7. In accordance with RG 1.183 R0, the condenser is assumed unavailable due to a coincident loss of offsite power. Consequently, the radioactivity release resulting from a LRA/LACP is discharged to the environment from steam generators via the MSSVs and the ADVs.

Locked Rotor Accident (only)

8. The portion of the activity associated with the release of secondary steam and from the primary-to-secondary leakage due to the RCS at the maximum allowable values permitted by Technical Specifications for normal operation is *insignificant* in comparison with the release of gap activity due to failed fuel. For example, the I-131 Tech Spec RCS and secondary coolant activity concentration is *2.73E-01 µCi/gm* (see Design Input No. 6 under LACP) and 8.34E-02 *µCi/gm* (see Design Input No. 5 under LACP), respectively, versus the I-131 RCS activity concentration of *1.37E4 µCi/gm* (=2.12E6 Ci I-131 (see Table 6-1) x (10^6 µCi/Ci) / (RCS mass of 341,331 lbm) (454 gm/lbm) due to the 20% failed fuel / release of associated fuel gap activity following the LRA.

Loss of Offsite Power Accident (only)

9. Because the LRA activity release to the environment (reflects fuel damage) eclipses the LACP activity release to the environment (Tech spec RCS and secondary coolant concentrations), and the

activity transport models for both the LRA and LACP are essentially the same, the LACP dose consequences will not be calculated. The LRA will be considered the bounding event for the two scenarios. See Section 6.1 for detail.

4.0 ACCEPTANCE CRITERIA

EAB and LPZ Dose Criteria (per 10 CFR Part 50 § 50.67, and Section 4.4 Table 6 of DIN# 3)

LRA
An individual located at any point on the boundary of the exclusion area for any 2-hour period following the onset of the postulated fission product release, should not receive a radiation dose in excess of 0.025 Sv (2.5 rem) total effective dose equivalent (TEDE).

An individual located at any point on the outer boundary of the low population zone, who is exposed to the radioactive cloud resulting from the postulated fission product release (during the entire period of its passage), should not receive a radiation dose in excess of 0.025 Sv (2.5 rem) TEDE.

LACP
The LACP is not specifically addressed in Regulatory Guide 1.183. However, to maintain consistency with AST methodology, the most limiting dose criterion in Table 6 of DIN# 3 is utilized for the LACP. This limit is identical to that applicable to the LRA documented above; i.e., 0.025 Sv (2.5 rem) TEDE for both the EAB and LPZ.

Control Room Dose Criteria (10 CFR Part 50 § 50.67)

Adequate radiation protection is provided to permit occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 0.05 Sv (5 rem) total effective dose equivalent (TEDE) for the duration of the accident.

5.0 LIST OF COMPUTER PROGRAMS AND OUTPUT FILES

IDENTIFICATION OF COMPUTER HARDWARE

Dell Precision T1700 PC, Intel Core i5-4570, Windows 7 Professional Version 2009, Service Pack 1, WECTEC Serial/ID number: 154LH02.

IDENTIFICATION OF COMPUTER PROGRAMS

PERC2, NU-226, Ver.00, Lev.02, QA Cat. I, “PERC2 - Passive Evolutionary Regulatory Consequence Code”, created September 22, 2006.

There are no outstanding error releases associated with PERC2 that would affect the results of this analysis.

LIST OF COMPUTER OUTPUT FILES

File Name	Run Date	Run Time	Description
R1-01p,c	08/27/2018	14:14:02	30 day Control Room and 8 hr LPZ dose from halogens
R1-02p	08/27/2018	14:14:20	2 hr EAB dose from the 0-2hr window from halogens
R1-03p	08/27/2018	14:14:38	2 hr EAB dose from the 6-8 hr window
R1-04p,c	08/27/2018	14:14:56	30 day Control Room and 8 hr LPZ dose from halogen daughters
R1-05p	08/27/2018	14:15:22	2 hr EAB dose from the 0-2hr window halogen daughters
R1-06p	08/27/2018	14:15:32	2 hr EAB dose from the 6-8 hr window
R1-07p,c	08/27/2018	14:15:50	30 day Control Room and 8 hr LPZ dose from noble gases
R1-08p	08/27/2018	14:16:40	2 hr EAB dose from the 0-2hr window
R1-09p	08/27/2018	14:16:50	2 hr EAB dose from the 6-8 hr window
R1-10p,c	08/27/2018	14:17:05	30 day Control Room and 8 hr LPZ dose from particulates
R1-11p	08/27/2018	14:17:17	2 hr EAB dose from the 0-2hr window
R1-12p	08/27/2018	14:17:27	2 hr EAB dose from the 6-8 hr window

Notes:

1. The full calculation output file number is for example 10080-UR(B)-493R1-01. The suffix “p” and “c” indicates PERC.OUT and CNTLROOM.OUT, which are 2 of the 7 PERC2 output files.
2. PERC.OUT provides input echo of accident scenario values and library data entered as well as the calculated integrated site boundary dose.
3. CNTLROOM.OUT provides, in this case, the 30 day integrated control room operator dose information.
4. All files listed above reflect the LRA. The LACP is not calculated since the LRA results in the bounding dose, due to having significantly higher initial RCS activity concentrations (see Section 6.1 for additional detail)

Computer run files are retained in the WECTEC Offices.

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6.0 COMPUTATION

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CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-493	REVISION: 1

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7.0 RESULTS

The airborne doses at the EAB, LPZ and Control Room for a postulated locked rotor accident are tabulated below. Note that 2-hour EAB doses were calculated for the 0-2 hour and 6-8 hour periods. According to the regulatory requirement, the 2-hour EAB dose must reflect the "worst case" 2-hour activity release period following the LRA. The noble gas release rate is at its highest level at the onset of the event and then decreases exponentially. In contrast, the release rate of halogens, halogen daughters, and particulates from the steam generator is zero at the start and then increases monotonically. Therefore, the "worst" 2-hour EAB dose following a LRA will occur either during the 0-2 hour period or during the 6-8 hour period. Regardless of the starting point of the "worst 2-hour window", the 0-2 hour EAB χ/Q is utilized.

30-day Integrated CR Dose (rem)

	CEDE	DDE	TEDE
Halogen	1.84E+00	3.81E-03	1.84E+00
Halogen Daughters	0.00E+00	1.00E-02	1.00E-02
Noble Gas	3.34E-02	2.78E-02	6.12E-02
Particulates	9.48E-01	8.86E-04	9.49E-01
Total			**2.86E+00**

8-hour Integrated LPZ Dose (rem)

	CEDE	DDE	TEDE
Halogen	1.12E-01	9.50E-03	1.22E-01
Halogen Daughters	0.00E+00	7.66E-02	7.66E-02
Noble Gas	2.84E-03	8.28E-02	8.56E-02
Particulates	5.65E-02	1.87E-03	5.84E-02
Total			**3.43E-01**

2-hour Integrated EAB Dose (rem)--- 0-2 hour window

	CEDE	DDE	TEDE
Halogen	2.05E-01	3.66E-02	2.41E-01
Halogen Daughters	0.00E+00	1.72E-01	1.72E-01
Noble Gas	2.83E-02	9.07E-01	9.35E-01
Particulates	9.68E-02	8.34E-03	1.05E-01
Total			**1.45E+00**

2-hour Integrated EAB Dose (rem)--- 6-8 hour window

	CEDE	DDE	TEDE
Halogen	9.69E-01	5.45E-02	1.02E+00
Halogen Daughters	0.00E+00	5.49E-01	5.49E-01
Noble Gas	5.79E-03	1.66E-01	1.72E-01
Particulates	4.99E-01	1.35E-02	5.12E-01
Total			**2.26E+00**

8.0 CONCLUSIONS

The BVPS Site Boundary and Control Room doses due to airborne radioactive material released following a LRA will remain within the regulatory limits set by 10CFR50.67 and Regulatory Guide 1.183. These doses were calculated by using Alternative Source Terms and the design parameter values provided by FENOC via DIN#s 1, 2 and 12 (see Attachment 1, 2 and 3).

The LRA and the LACP have similar design inputs except the activity available for release. Since the activity available for release associated with the LRA (gap activity in the failed fuel) is much higher than that associated with the loss LACP (Tech Spec RCS activity), the dose consequences resulting from the LRA bound the dose consequences resulting from a LACP.

Note that the estimated dose consequences take into consideration the following proposed change to plant operations; specifically:

- BVPS will operate within the maximum allowable power operating envelop for PWRs shown in Figure 1 of DG-1199

Control Room

The 30-day integrated dose to the Control Room operator is 2.9 rem TEDE. This value is below the regulatory limit of 5 rem TEDE.

Site Boundary

Site Boundary

The integrated dose to an individual located at any point on the boundary of the exclusion area for any 2-hour period following the onset of the event is 2.3 rem TEDE (t=6 hr to t=8 hour time window). This doses are less than the regulatory limit of 2.5 rem TEDE.

The integrated dose to an individual located at any point on the outer boundary of the low population zone for BVPS for the 8-hour duration of the release is 0.4 rem TEDE, which is less than the regulatory limit of 2.5 rem TEDE.

As indicated earlier, the CR, EAB and the LPZ dose consequences reported above reflect that associated with a postulated LRA, and bound the dose consequences following a LACP.

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CALCULATION NO.: 10080-UR(B)-493	REVISION: 1

Attachment 1

FirstEnergy Design Input Transmittal

DIT-BVDM-0105-00 transmitted via FENOC Letter ND1MDE:0727

July 13, 2018

FENOC
FirstEnergy Nuclear Operating Company

Beaver Valley Power Station
P.O. Box 4
Shippingport, PA 15077

Patrick G. Pauvlinch
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Phone: 724-682-4982
Fax: 330-315-9717

ND1MDE:0727
July 13, 2018

Sreela Ferguson
WECTEC
720 University Ave.
Norwood, MA 02062

BV1 & BV2 Complete Reanalysis of Dose Consequences
for CRE Tracer Gas Testing and Other Acceptance Criteria Changes
Design Input Transmittal DIT-BVDM-0105-00 for Locked Rotor Accident Dose

Dear Ms. Ferguson:

Attached is Design Input Transmittal DIT-BVDM-0105-00 which provides information for evaluating the Locked Rotor Accident.

Should you have any questions about the attached information, please contact Michael Unfried at 724-682-5993 or Mike Ressler at 724-682-7936.

Sincerely,

MSRessler

MS Ressler for
Patrick G. Pauvlinch
Manager, Design Engineering

MGU/bls

Attachment

cc: M. G. Unfried
M. S. Ressler
BVRC

FirstEnergy	CALCULATION COMPUTATION NOP-CC-3002-01 Rev. 05	Page Att1-3 of Att1-21
CALCULATION NO.: 10080-UR(B)-493		REVISION: 1

Form 1/2-ADM-2097.F01, Rev 0 RTL# A1.105V

DESIGN INPUT TRANSMITTAL

☒ SAFETY RELATED / AUG QUAL ☐ NON-SAFETY RELATED	Originating Organization: ☒ FENOC ☐ Other (Specify)	DIT- BVDM-0105-00 Page __1__ of __1__
Beaver Valley Unit: ☐1 ☐2 ☒Both System Designation: Various Engineering Change Package: N/A		To: Sreela Ferguson Organization: WECTEC

Subject: **Design Input Transmittal for Reanalysis of Dose Consequences For a BV1 or BV2 Locked Rotor Accident**

Status of Information: ☒Approved for Use ☐Unverified

For Unverified DITs, Notification number tracking verification: ________________________

Description of Information:

Safety Analysis Design Inputs? ☒Yes ☐No

Reconciled to Current Design Basis? ☒Yes ☐N/A

This DIT provides information required for the performance of the Locked Rotor dose consequence design basis accident calculation. This supports a proposed License Amendment Request (LAR) involving the control room envelope tracer gas testing criteria.

Purpose of Issuance:

This DIT provides information required for the performance of design basis accident dose consequence calculation UR(B)-493.

Source of Information (Reference, Rev, Title, Location): Engineering Judgment Used? ☐Yes ☒No

See attachment to DIT table.

Preparer: Michael G. Unfried	Preparer Signature: Michael G. Unfried	Date: 7/12/2018
Reviewer: D. T. Bloom	Reviewer Signature: [signature]	Date: 7-13-18
Approver: M. S. Ressler	Approver Signature: M S Ressler	Date: 7/13/2018

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

Table 7: Parameters for Calculating Locked Rotor Accident (LRA) Dose Consequences

	AOR [UR(B)-493, R0, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**

General Notes:

1. The equipment / parameter values presented in the table below as approved design inputs to be used for the Locked Rotor analysis reflect safety related components that can be credited in design bases dose consequence analyses; i.e., the components have the appropriate redundancy, environmental qualification, pedigree, seismic support, etc., applicable to safety related equipment, and the parameter values reflect single failure criteria.
2. The critical input values are: Core Inventory, Maximum Failed Fuel percentage, Maximum Melted Fuel percentage, Fraction of core activity in the fuel gap, Radial peaking factor to be applied to failed fuel, Primary-to-secondary leak rate, Maximum time period of tubes being uncovered, Maximum moisture carryover fraction in SGs, Maximum steam releases, Minimum RCS mass, Initial and minimum post-accident SG mass, Control Room (CR) atmospheric dispersion factors
3. Parameter values provided below reflect the bounding value applicable to Unit 1 and Unit 2

Parameter	Value	Reference	Value	Reference	Comment
1. Core Power Level (with power uncertainty) used to establish radiation source terms	2918	FENOC letter ND1MLM:0327 [Table 7], 11/05/02 FENOC letter BV2SGRP:0971, 3/27/14	2918 MWt	BV1 Renewed Operating License DPR-66 BV2 Renewed Operating License NPF-73 BV1 LRM B 3.3.8 BV2 LRM B 3.3.8 BV1/2 TS 5.6.3	Rated Thermal Power shall not exceed 2900 MWt. Total power measurement uncertainty of better than +/- 0.6% of RTP at full power is achieved using the Leading Edge Flow Meter. 2900 MWt x 1.006 = 2917.4 MWt
2. Design Basis Core Activity for iodines, Noble gases and alkali metals	As provided in S&W reference calculation	FENOC letter ND1MLM:0327 [Table 7], 11/05/02 S&W calculation 10080-UR(B)-483, R0	As provided in Reference	BV1/2 Calculation UR(B)-483	The current design basis composite equilibrium core inventory, which is based on 2918 MWt, an 18 month burnup cycle and initial enrichments from 4.2% to 5%, is appropriate and is not being changed.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

Table 7: Parameters for Calculating Locked Rotor Accident (LRA) Dose Consequences

	AOR [UR(B)-493, R0, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
3. Maximum failed fuel percentage following a LRA	< 20% rods in DNB	FENOC letter ND1MLM:0327 [Table 7], 11/05/02 FENOC letter ND1SGRP:0403, 8/18/03 FENOC letter BV2SGRP:0971, 3/27/14 LTR-PL-13-79, Rev. 1 LTR-TA-13-15, Rev. 0 10080-US(P)-235 Rev 2/A1 (CN-TA-01-051, Rev 0)	≤ 20% rods in DNB	BV1 Calculation US(P)-259 BV2 Calculation US(P)-235 Westinghouse letter FENOC-02-217 BV1 UFSAR Section 14.2.7 BV2 UFSAR Section 15.3.3	Current design basis analysis equates rods in DNB to failed fuel. BV2 Calculation US(P)-235 indicates "Rods in DNB Limit, 25%"; however, Westinghouse letter FENOC-02-217 clarified that the limit was reduced to 20%, which is the current licensing basis. The 20% limit is confirmed via the Reload Safety Analysis Checklist (RSAC) process.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

Table 7: Parameters for Calculating Locked Rotor Accident (LRA) Dose Consequences

	AOR [UR(B)-493, R0, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
4. Maximum melted fuel percentage following a LRA	None	FENOC letter ND1MLM:0327 [Table 7], 11/05/02 FENOC letter ND1SGRP:0403, 8/18/03 FENOC letter BV2SGRP:0971, 3/27/14 LTR-PL-13-79, Rev. 1 LTR-TA-13-15, Rev. 0 10080-US(P)-235 Rev 2/A1 (CN-TA-01-051, Rev 0)	None	BV1 UFSAR Section 14.2.7 Westinghouse letter LTR-PL-13-79	It is assumed that melting will not occur in UO_2 pellets for this accident.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
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Table 7: Parameters for Calculating Locked Rotor Accident (LRA) Dose Consequences

	AOR [UR(B)-493, R0, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
5. Activity available for release	Gap activity in failed fuel	FENOC letter ND1MLM:0327 [Table 7], 11/05/02 RG 1.183, Rev. 0	Gap activity in failed fuel	NRC Regulatory Guide 1.183	Per NRC Regulatory Guide 1.183, Appendix G (LRA), the activity released from the fuel should be assumed to be released instantaneously and homogeneously through the primary coolant. <u>WECTEC Notes:</u> Failed fuel activity is released instantaneously and homogeneously into primary coolant and released to the environment via steam generator Main Steam Safety Valves and Atmospheric Dump Valves due to primary-to secondary SG tube leakage at Technical Specification limits. The implicit assumption is that the portion of activity associated with the release of secondary steam (i.e., activity resulting from primary to secondary leakage due to leakage of primary coolant at the maximum allowable values permitted by the TS for normal operation) is insignificant in comparison with the release of gap activity due to failed fuel.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

Table 7: Parameters for Calculating Locked Rotor Accident (LRA) Dose Consequences

	AOR [UR(B)-493, R0, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
6. Fraction of core activity in the fuel gap for a Locked Rotor Event (refer to the comments)	Noble gases & halogens (except as noted) = 0.05 Kr-85 = 0.1 I-131 = 0.08 Cs, Rb = 0.1	FENOC letter ND1MLM:0327 [Table 7], 11/05/02 RG 1.183, Rev. 0, Table 3	I-131 0.08 I-132 0.23 Kr-85 0.35 Other Noble Gases 0.04 Other Halogens 0.05 Alkali Metals 0.46 Note: Operation is limited to the maximum allowable power operating envelope for PWRs shown in Figure 1 of DG-1199.	NRC Draft Regulatory Guide DG-1199, Table 3 <u>Note</u>: A regulatory commitment to operate under the maximum allowable power operating envelope for PWRs shown in Figure 1 of DG-1199 will be needed. Example: Diablo Canyon Power Plant, Units 1 & 2, Amendments 230 and 232.	NRC Regulatory Guide 1.183 Table 3 provides the gap fractions for Non-LOCA events (with the exception of the CREA) for Alternative Source Term applications. The gap fractions provided in Table 3 of Regulatory Guide 1.183 for Non-LOCA events are contingent upon meeting Note 11 of Regulatory Guide 1.183. Note 11 indicates that the release fractions listed in Table 3 are "acceptable for use with currently approved LWR fuel with a peak burnup of 62,000 MWD/MTU *provided that the maximum linear heat generation rate does not exceed 6.3 kw/ft peak rod average power for burnups exceeding 54 GWD/MTU*." To support flexibility of fuel management with respect to meeting the RG 1.183 criteria for linear heat generation rate, use will be made of gap fractions from DG-1199 Table 3 based on NRC acceptance requirements per other licensing applications / NRC Safety Evaluation Reports (e.g., Diablo Canyon) for fuel rods that exceed the linear heat generation rate criteria.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

Table 7: Parameters for Calculating Locked Rotor Accident (LRA) Dose Consequences

	AOR [UR(B)-493, R0, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
7. Radial peaking factor to be applied to failed fuel	F(ΔH) = 1.75	FENOC letter ND1MLM:0327 [Table 7], 11/05/02 FENOC letter ND1SGRP:0403, 8/18/03 FENOC letter BV2SGRP:0971, 3/27/14	F(ΔH) = 1.70	FENOC Letter ND1MDE:0720 (DIT-BVDM-0081-06 and DIT-BVDM-0061-06)	A higher F(ΔH) value is conservative. An F(ΔH) value of 1.70 was provided for future BV1 & BV2 Full Spectrum LOCA (FSLOCA) calculations. The majority of DBA analyses were performed at a "target" F(ΔH) of 1.75. Core design has been done at a more restrictive F(ΔH) of 1.62 because the Large Break LOCA evaluations addressing thermal conductivity degradation and Small Break LOCA evaluations used an F(ΔH) of 1.62.
8. Chemical form of iodines in failed fuel	95% CsI 4.85% elemental 0.15% organic	FENOC letter ND1MLM:0327 [Table 7], 11/05/02 RG 1.183, Rev. 0	95% CsI 4.85% elemental 0.15% organic	NRC Regulatory Guide 1.183	
9. Chemical composition of iodine released from the Steam Generators to the environment	97% elemental 3% organic	FENOC letter ND1MLM:0327 [Table 7], 11/05/02 RG 1.183, Rev. 0, Appendix G.4	97% elemental 3% organic	NRC Regulatory Guide 1.183	

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

Table 7: Parameters for Calculating Locked Rotor Accident (LRA) Dose Consequences

	AOR [UR(B)-493, R0, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
10. Activity release path	Gap activity from failed fuel is released to the coolant and is assumed to leak into the secondary system at T/S leak rate. Due to assumed loss of offsite power, condenser steam dumps are not available, and steam is released by the MSSVs /ADVs.	FENOC letter ND1MLM:0327 [Table 7], 11/05/02 RG 1.183, Rev. 0	Gap activity from failed fuel is released to the coolant and is assumed to leak into the secondary system at TS leak rate. Due to assumed loss of offsite power, condenser steam dump valves are not available, and steam is released by the Main Steam Safety Valves and Atmospheric Dump Valves.	NRC Regulatory Guide 1.183	NRC Regulatory Guide 1.183, Appendix G, paragraph 5.1 states: "The primary-to-secondary leak rate in the steam generators should be assumed to be the leak-rate-limiting condition for operation specified in the technical specifications. The leakage should be apportioned between the steam generators in such a manner that the calculated dose is maximized."
11. Steam generator (SG) primary-to-secondary leakage rate at T/S levels	150 gallons per day (gpd) (any 1 SG) 450 gpd (all 3 SGs) Leakage density = 1.0 g/cc	FENOC letter ND1MLM:0327 [Table 7], 11/05/02 FENOC letter BV2SGRP:0971, 3/27/14	150 gallons per day (any 1 SG) 450 gpd (all 3 SGs) Leakage density = 1.0 g/cc	BV1/2 TS B 3.4.13 NRC Regulatory Guide 1.183	Per NRC Regulatory Guide 1.183, Appendix G (LRA), the leakage density should be assumed to be 1.0 g/cc in most cases.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

Table 7: Parameters for Calculating Locked Rotor Accident (LRA) Dose Consequences

	AOR [UR(B)-493, R0, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
12. Maximum time period of SG tubes being uncovered	Negligible	FENOC letter ND1MLM:0327 [Table 7], 11/05/02 WCAP-13247, March 1992	Negligible effect	WCAP-13247 NRC letter (3/10/1993)	The scope of WCAP-13247 includes the LRA. The results of the Westinghouse Owners Group program indicate that steam generator tube uncovery does not increase the consequences of Steam Generator Tube Rupture and Non-SGTR events significantly. The current design basis analysis methodologies are adequate and remain valid. NRC letter (3/10/1993) expressed agreement with the position presented in WCAP-13247.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

Table 7: Parameters for Calculating Locked Rotor Accident (LRA) Dose Consequences

	AOR [UR(B)-493, R0, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
13. Partition coefficients in SGs	Tubes submerged Noble gas – released freely with no retention All iodines – 100	FENOC letter ND1MLM:0327 [Table 7], 11/05/02 RG 1.183, Rev. 0	Tubes submerged Noble gas – released freely with no retention All iodines – 100	NRC Regulatory Guide 1.183	Per NRC Regulatory Guide 1.183, Appendix G (LRA), all noble gas radionuclides released from the primary system are assumed to be released to the environment without reduction or mitigation. Also, the transport model described in assumptions 5.5 and 5.6 of Appendix E should be utilized for all iodines and particulates. Per Appendix E (MSLB), the radioactivity in the bulk water is assumed to become a vapor at a rate that is the function of the steaming rate and the partition coefficient. A partition coefficient for iodine of 100 may be assumed. The retention of particulate radionuclides in the steam generators is limited by the moisture carryover from the steam generators.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

Table 7: Parameters for Calculating Locked Rotor Accident (LRA) Dose Consequences

	AOR [UR(B)-493, R0, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
14. Maximum moisture carryover fraction in SGs (carryover of particulates in fuel gap release)	AOR 0.25% EPU / BV2 OSG 0.25% BV2 RSGs ≤0.10%	FENOC letter ND1MLM:0327 [Table 7], 11/05/02 Westinghouse ltr FENOC-01-278, 9/19/01 FENOC letter BV2SGRP:0971, 3/27/14 LTR-PL-13-79, Rev. 1 PCWG 12-6, Feb. 23, 2002	Steam Moisture Fractions are: BV1 RSG 0.0010 BV2 OSG 0.0025 BV2 RSG 0.0010	Westinghouse letter FENOC-01-278 Westinghouse Calculation CN-PCWG-00-17 (PCWG-2793) Westinghouse Calculation CN-PCWG-00-17 (PCWG-2646) BV2 Vendor Calculation 2704.130-000-047 (PCWG-12-6)	

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

Table 7: Parameters for Calculating Locked Rotor Accident (LRA) Dose Consequences

	AOR [UR(B)-493, R0, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
15. Maximum steam release from intact SGs	BV2 OSG 0-2hrs: 348,000 lbm 2-8 hrs: 773,000 lbm BV1 RSG 0-2hrs: 340,000 lbm 2-8 hrs: 778,000 lbm BV2 RSG 0-2hrs: 332,000 lbm 2-8 hrs: 753,000 lbm	FENOC letter ND1MLM:0327 [Table 7], 11/05/02 Westinghouse ltr FENOC-01-278, 9/19/01 FENOC letter ND1SGRP:0403, 8/18/03 FENOC letter BV2SGRP:0971, 3/27/14 CN-CRA-12-12, Rev. 0	BV1 RSG 0 to 2 hours: 340,000 lbm 2 to 8 hours: 778,000 lbm BV2 OSG 0 to 2 hours: 348,000 lbm 2 to 8 hours: 773,000 lbm BV2 RSG 0 to 2 hours: 332,000 lbm 2 to 8 hours: 753,000 lbm	FENOC Letter ND1SGRP:0403 FENOC letter ND1SGRP:0403 Westinghouse Calculation CN-CRA-12-12 FENOC Letter BV2SGRP:0971	
16. Initial & Minimum reactor coolant system (RCS) mass, excluding pressurizer liquid and steam masses	BV2 OSG 341,331 lbm (22% tube plugged) BV1 340,711 lbm BV2 RSG 351,900 lbm (22% tubes plugged)	FENOC letter ND1MLM:0327, [Table 7], 11/05/02 FENOC letter ND1SGRP:0403, 8/18/03 FENOC letter BV2SGRP:0971, 3/27/14	BV1 RSG 345,097 lbm (22% SGTP) BV2 OSG 341,331 lbm (22% SGTP) BV2 RSG 346,381 lbm (22% SGTP)	FENOC letter ND1SGRP:0403 (7790 ft^3) FENOC letter ND1SGRP:0403 (7705 ft^3) Westinghouse Calculations CN-TA-01-33 & CN-TA-12-32 (7819 ft^3)	FENOC-01-278 Note 8 presents a calculation of the mass of the BV1 Reactor Coolant System active water volume (with Original Steam Generators) as an example: 340,711 lbm = 7691 ft^3 X 44.3 lbm/ft^3. Using the same approach, the masses (assuming 22% SGTP) are: 345,097 lbm (BV1 RSGs), 341,331 lbm (BV2 OSGs), and 346,381 lbm (BV2 RSGs).

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

Table 7: Parameters for Calculating Locked Rotor Accident (LRA) Dose Consequences

	AOR [UR(B)-493, R0, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
17. Initial and minimum post-accident mass of secondary coolant per SGs (lbm/SG)	BV2 OSG: 105,076 lbm BV1 RSG: 101,799 lbm BV2 RSG: 103,019 lbm	FENOC letter ND1MLM:0327, [Table 7], 11/05/02 FENOC letter ND1SGRP:0403, 8/18/03 FENOC letter BV2SGRP:0971, 3/27/14 LTR-PL-13-79, Rev. 1 CN-CRA-12-12, Rev. 0	BV1 RSG 101,799 lbm BV2 OSG 105,076 lbm BV2 RSG 103,019 lbm	FENOC Letter ND1SGRP:0403 FENOC Letter ND1SGRP:0403 Westinghouse Calculation CN-CRA-12-12	SG liquid mass would tend to increase following a LRA, so the initial value is the minimum liquid mass during the transient.
18. Termination of environmental release	8 hours	FENOC letter ND1MLM:0327, [Table 7], 11/05/02 Westinghouse ltr FENOC-01-278, 9/19/01 FENOC letter BV2SGRP:0971, 3/27/14 CN-CRA-12-12, Rev. 0	8 hours	BV1 UFSAR Section 14.2.7 FENOC Letter ND1SGRP:0403 BV2 UFSAR Section 15.3.3 Westinghouse Calculation CN-CRA-12-12 NRC Regulatory Guide 1.183	Time of 8 hours reflects when Residual Heat Removal initiation conditions are reached. Per NRC Regulatory Guide 1.183, Appendix G (LRA), the release of radioactivity should be assumed to continue until shutdown cooling is in operation and releases from the steam generators have been terminated.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

Table 7: Parameters for Calculating Locked Rotor Accident (LRA) Dose Consequences

	AOR [UR(B)-493, R0, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
19. Control Room (CR) atmospheric dispersion factors	Release points: U1: N3799 U2: N3841	FENOC letter ND1MLM:0327, [Table 7], 11/05/02 Drawing 8700-RY-1C, R1 X/Qs determined in S&W calculation 10080-EN-ME-105, R0/A1 10080-EN-ME-106, R0/A1	Main Steam Relief Valves (as a Single Riser) Release points: BV1: N3799, E7550 BV2: N3841, E8125	BV1/2 Drawing RY-0001C BV1 Calculation EN-ME-105 BV2 Calculation EN-ME-106	X/Qs determined in BV1 Calculation EN-ME-105 and BV2 Calculation EN-ME-106
Control Room Isolation / Emergency Ventilation (following a LRA)					
20. CR emergency ventilation automatic initiation	CR emergency ventilation is not credited for this event.	FENOC letter ND1MLM:0327, [Table 7], 11/05/02	CR emergency ventilation is not credited for this event.	Conservative Assumption	
21. Initiation of CR purge after environmental release is terminated: time and rate	CR is not purged following this event.	FENOC letter ND1MLM:0327, [Table 7], 11/05/02	CR is not purged following this event.	Conservative Assumption	

References

1. NRC Regulatory Guide 1.183, Rev. 0, Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors
2. NRC Draft Regulatory Guide DG-1199, October 2009, Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors
3. BV1 Renewed Operating License DPR-66
4. BV2 Renewed Operating License NPF-73
5. BV1/2 Technical Specifications, including BV1 Amendment 302 and BV2 Amendment 191
6. BV1/2 Technical Specification Bases, Rev. 35
7. BV1 Licensing Requirements Manual (including Bases), Rev. 101
8. BV2 Licensing Requirements Manual (including Bases), Rev. 92
9. BV1 Updated Final Safety Analysis Report, Rev. 30
10. BV2 Updated Final Safety Analysis Report, Rev. 23
11. BV1/2 Calculation UR(B)-483, Rev. 0, Composite Reactor Core Inventory for BVPS Following Power Uprate (2918 MWth, Initial 4.2% to 5% Enrichment, 18 month Fuel Cycle)
12. BV1 Calculation EN-ME-105, Rev. 0 including Add. 1, Atmospheric Dispersion Factors (X/Qs) at Control Room and ERF Receptors for Unit 1 Accident Releases Using the ARCON96 Methodology
13. BV2 Calculation EN-ME-106, Rev. 0 including Add. 1, Atmospheric Dispersion Factors (X/Qs) at Control Room and ERF Receptors for Unit 2 Accident Releases Using the ARCON96 Methodology
14. BV1 Calculation US(P)-259, Rev. 2 through and including Add. 2, Loss of Flow/Locked Rotor Analyses for Uprating [Westinghouse CN-TA-01-70]
15. BV2 Calculation US(P)-235, Rev. 2 including Add. 1, Loss of Flow/Locked Rotor Analyses for Uprating [Westinghouse CN-TA-01-51]
16. BV2 Vendor Calculation 2704.130-000-047, Rev. A, Best Estimate Performance Parameters [Westinghouse CN-PCWG-12-5]
17. Westinghouse Calculation CN-CRA-12-12, Rev. 0, Steam Releases for Dose for the BV2 Steam Generator Replacement
18. BV1/2 Calculation UR(B)-493, Rev. 0 through and including Add. 2, Site Boundary and Control Room Doses based on Core Uprate and Alternative Source Term Methodology following a) a Locked Rotor Accident b) a Loss of AC Power Accident
19. BV1/2 Drawing RY-0001C, Rev. 2, Site Postulated Release and Receptor Points
20. Westinghouse Owners Group Report WCAP-13247 (3/1992), Report on Methodology for Resolution of the Steam Generator Tube Uncovery Issue
21. Westinghouse letter LTR-PL-13-79, Rev. 4, Update of the Post-Accident Radiological Dose Consequence Analysis Parameter Values in Support of the Beaver Valley Unit 2 RSG Project
22. NRC Letter (3/10/1993), Westinghouse Owners Group-Steam Generator Tube Uncovery Issue (attachment to WOG-93-066) [ML17054C235]
23. FENOC Letter ND1SGRP:0403 (8/18/2003), RSG Project Post-Accident Radiological Input Parameters for Dose Analysis (includes Westinghouse Letter BV1-RSG-03-265)
24. FENOC Letter ND1MDE:0720 (5/22/2018), Beaver Valley Units 1 & 2 FSLOCA Input Parameters, DIT-BVDM-0081-06 and DIT-BVDM-0061-06
25. Diablo Canyon Power Plant, Units 1 and 2, Amendments 230 (DCPP1) and 232 (DCPP2), 4/27/2017, Re: Revise Licensing Bases to Adopt Alternative Source Term [ML17012A246]
26. Westinghouse letter FENOC-02-217 (7/10/2002), Revised Post-Accident Radiological Input Parameters for SGTR and LR Dose Analysis
27. Westinghouse Calculation CN-TA-01-33, Rev. 2, LOFTRAN Base Deck for Beaver Valley Unit 2 (DMW) 9.4% Uprating Program
28. Westinghouse Calculation CN-PCWG-00-17, Rev. 4, PCWG Parameters to Support Staged Implementation of Units 1 and 2 Power Uprate and Unit 1 "Full Replacement" Model 54F Replacement Steam Generators (RSGs)
29. Westinghouse Calculation CN-TA-12-32, Rev. 0, LOFTRAN Base Deck for the Beaver Valley Unit 2 Replacement Steam Generator Program
30. FENOC Letter BV2SGRP:0971 (3/27/2014), Transmittal of DIT-SGR2-0037-00

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CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-493	REVISION: 1

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DESIGN VERIFICATION RECORD

Page 1 of 1

NOP-CC-2001-01 Rev. 00

SECTION I: TO BE COMPLETED BY DESIGN ORIGINATOR

DOCUMENT(S)/ACTIVITY TO BE VERIFIED:

DIT-BVDM-0105-00

☒ SAFETY RELATED ☐ AUGMENTED QUALITY ☐ NONSAFETY RELATED

SUPPORTING/REFERENCE DOCUMENTS

DESIGN ORIGINATOR: *(Print and Sign Name)* K.J. Frederick for M VanPrick — DATE: 7-13-18

SECTION II: TO BE COMPLETED BY VERIFIER

VERIFICATION METHOD *(Check one)*

☒ DESIGN REVIEW *(Complete Design Review Checklist or Calculation Review Checklist)* ☐ ALTERNATE CALCULATION ☐ QUALIFICATION TESTING

JUSTIFICATION FOR SUPERVISOR PERFORMING VERIFICATION:

N/A

APPROVAL: *(Print and Sign Name)* N/A — DATE:

EXTENT OF VERIFICATION:

Design Review checklist performed as a guide for Design Verification.

COMMENTS, ERRORS OR DEFICIENCIES IDENTIFIED? ☐ YES ☒ NO

RESOLUTION: *(For Alternate Calculation or Qualification Testing only)*

N/A

RESOLVED BY: *(Print and Sign Name)* N/A — DATE:

VERIFIER: *(Print and Sign Name)* Douglas T Bloom — DATE: 7-13-18

APPROVED BY: *(Print and Sign Name)* MS Ressler — DATE: 7/13/2018

FirstEnergy

CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-493

REVISION: 1

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DESIGN REVIEW CHECKLIST

NOP-CC-2001-02 Rev. 04

Page 1 of 3

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):

DIT-BVDM-0105-00

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
1. Were the basic functions of each structure, system or component considered?		✓			
2. Have performance requirements such as capacity, rating, and system output been considered?		✓			
3. Are the applicable codes, standards and regulatory requirements including applicable issue and/or addenda properly identified and are their requirements for design and/or material been met or reconciled?		✓			
4. Have design conditions such as pressure, temperature, fluid chemistry, and voltage been specified?		✓			
5. Are loads such as seismic, wind, thermal, dynamic and fatigue factored in the design?		✓			
6. Considering the applicable loading conditions, does an adequate structural margin of safety exist for the strength of components?	✓				
7. Have environmental conditions anticipated during storage, construction and operation such as pressure, temperature, humidity, soil erosion, run-off from storm water, corrosiveness, site elevation, wind direction, nuclear radiation, electromagnetic radiation, and duration of exposure been considered?	✓				
8. Have interface requirements including definition of the functional and physical interfaces involving structures, systems and components been met?		✓			
9. Have the material requirements including such items as compatibility, electrical insulation properties, protective coating, corrosion, and fatigue resistance been considered?	✓				
10. Have mechanical requirements such as vibration, stress, shock and reaction forces been specified?	✓				
11. Have structural requirements covering such items as equipment foundations and pipe supports been identified?	✓				
12. Have hydraulic requirements such as pump net positive suction head (NPSH), allowable pressure drops, and allowable fluid velocities been specified?		✓			
13. Have chemistry requirements such as the provisions for sampling and the limitations on water chemistry been specified?		✓			
14. Have electrical requirements such as source of power, voltage, raceway requirements, electrical insulation and motor requirements been specified?	✓				
15. Have layout and arrangement requirements been considered?		✓			
16. Have operational requirements under various conditions, such as plant startup, normal plant operation, plant shutdown, plant emergency operation, special or infrequent operation, and system abnormal or emergency operation been specified?		✓			

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DESIGN REVIEW CHECKLIST

NOP-CC-2001-02 Rev. 04

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):

DIT-BVDM-0105-00

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
17. Have instrumentation and control requirements including instruments, controls, and alarms required for operation, testing, and maintenance been identified? Other requirements such as the type of instrument, installed spares, range of measurement, and location of indication should also be included.	✓				
18. Have adequate access and administrative controls been planned for plant security?	✓				
19. Have redundancy, diversity, and separation requirements of structures, systems, and components been considered?		✓			
20. Have the failure requirements of structures, systems, and components, including a definition of those events and accidents which they must be designated to withstand been identified?		✓			
21. Have test requirements including in-plant tests, and the conditions under which they will be performed been specified?	✓				
22. Have accessibility, maintenance, repair and in-service inspection requirements for the plant including the conditions under which they will be performed been specified?	✓				
23. Have personnel requirements and limitations including the qualification and number of personnel available for plant operation, maintenance, testing and inspection and permissible personnel radiation exposure for specified areas and conditions been considered?	✓				
24. Have transportability requirements such as size and shipping weight, limitations and Interstate Commerce Commission regulations been considered?	✓				
25. Have fire protection or resistance requirements been specified?	✓				
26. Are adequate handling, storage, cleaning and shipping requirements specified?	✓				
27. Have the safety requirements for preventing undue risk to the health and safety of the public been considered?		✓			
28. Are the specified materials, processes, parts and equipment suitable for the required application?		✓			
29. Have safety requirements for preventing personnel injury including such items as radiation hazards, restricting the use of dangerous materials, escape provisions from enclosures and grounding of electrical equipment been considered?	✓				
30. Were the inputs correctly selected and incorporated into the design?		✓			
31. Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed?		✓			
32. Are the appropriate quality and quality assurance requirements specified?	✓				

FirstEnergy NOP-CC-2001-02 Rev. 04

DESIGN REVIEW CHECKLIST

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.): DIT-BVDM-0105-00

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
33. Have applicable construction and operating experience been considered?		✓			
34. Have the design interface requirements been satisfied?		✓			
35. Was an appropriate design method used?		✓			
36. Is the output reasonable compared to inputs?		✓			
37. Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?	✓				
38. Have adequate maintenance features and requirements been specified?	✓				
39. Has the design properly considered radiation exposure to the public and plant personnel?		✓			
40. Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfied?		✓			
41. Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?	✓				
42. Are adequate identification requirements specified?		✓			
43. Are requirements for record preparation, review, approval, retention, etc., adequately specified?	✓				
44. Have protective coatings qualified for Design Basis Accident (DBA) been specified to structures, equipment and components installed in the containment/drywell?	✓				
45. Are the necessary supporting calculations completed, checked and approved?		✓			
46. Have the equipment heat load changes been reviewed for impact on HVAC systems?	✓				
47. IF a computer program was used to obtain the design by analysis, **THEN** has the program been validated per NOP-SS-1001 and documented to verify the technical adequacy of the computer results contained in the design analysis?	✓				
48. Have Professional Engineer (PE) certification requirements been addressed and documented where required by ASME Code (if applicable).	✓				
49. Does the design involve the installation, removal, or revise software/firmware and have the requirements of NOP-SS-1001 been addressed?	✓				
50. Does the design involve the installation, removal, or change to a digital component(s) and have the requirements of NOP-SS-1201 been addressed?	✓				

COMPLETED BY: *(Print and Sign Name)*	DATE	*IF CHECKLIST IS REVIEWED BY MORE THAN ONE VERIFIER, SIGN BELOW:* ADDITIONAL VERIFIER *(Print and Sign Name)*	DATE
Douglas T Bloom [signature]	7-13-18	N/A	

Attachment 2

FirstEnergy Design Input Transmittal

DIT-BVDM-0106-00 via letter ND1MDE:0726

FENOC
FirstEnergy Nuclear Operating Company

Beaver Valley Power Station
P.O. Box 4
Shippingport, PA 15077

Patrick G. Pauvlinch
Manager, Design Engineering
pauvlinchp@firstenergycorp.com

Phone: 724-682-4982
Fax: 330-315-9717

ND1MDE:0726
July 13, 2018

Sreela Ferguson
WECTEC
720 University Ave.
Norwood, MA 02062

BV1 & BV2 Complete Reanalysis of Dose Consequences for CRE Tracer Gas Testing and Other Acceptance Criteria Changes Design Input Transmittal DIT-BVDM-0106-00 for the Loss of Non-Emergency AC Power Accident Dose

Dear Ms. Ferguson:

Attached is Design Input Transmittal DIT-BVDM-0106-00, which provides information for evaluating the Loss of Non-emergency AC Power Accident.

Should you have any questions about the attached information, please contact Michael Unfried at 724-682-5993 or Mike Ressler at 724-682-7936.

Sincerely,

MSRessler

MSRessler for
Patrick G. Pauvlinch
Manager, Design Engineering

MGU/bls

Attachment

cc: M. G. Unfried
M. S. Ressler
BVRC

FirstEnergy

CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-493	REVISION: 1

Form 1/2-ADM-2097.F01, Rev 0

RTL# A1.105V

DESIGN INPUT TRANSMITTAL

☒ SAFETY RELATED / AUG QUAL ☐ NON-SAFETY RELATED	Originating Organization: ☒ FENOC ☐ Other (Specify)	DIT- BVDM-0106-00 Page __1__ of __1__
Beaver Valley Unit: ☐1 ☐2 ☒Both System Designation: Various Engineering Change Package: N/A		To: Sreela Ferguson Organization: WECTEC

Subject: **Design Input Transmittal for Reanalysis of Dose Consequences For a BV1 or BV2 Loss of Non-emergency AC Power Accident**

Status of Information: ☒Approved for Use ☐Unverified

For Unverified DITs, Notification number tracking verification: ____________________

Description of Information:

Safety Analysis Design Inputs? ☒Yes ☐No

Reconciled to Current Design Basis? ☒Yes ☐N/A

This DIT provides information required for the performance of the Loss of Non-emergency AC Power dose consequence design basis accident calculation. This supports a proposed License Amendment Request (LAR) involving the control room envelope tracer gas testing criteria.

Purpose of Issuance:

This DIT provides information required for the performance of design basis accident dose consequence calculation UR(B)-493.

Source of Information (Reference, Rev, Title, Location): Engineering Judgment Used? ☐Yes ☒No

See attachment to DIT table.

Preparer: Michael G. Unfried	Preparer Signature: *Michael G. Unfried*	Date: 7/12/2018
Reviewer: D. T. Bloom	Reviewer Signature: *[signature]*	Date: 7-13-18
Approver: M. S. Ressler	Approver Signature: *MSRessler*	Date: 7/13/2018

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

Table 6: Parameters for Calculating Loss of AC Power (LACP) Accident Dose Consequences

	AOR [UR(B)-493, R0, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
General Notes: 1. The equipment / parameter values presented in the table below as approved design inputs to be used for the LACP analysis reflect safety related components that can be credited in design bases dose consequence analyses; i.e., the components have the appropriate redundancy, environmental qualification, pedigree, seismic support, etc., applicable to safety related equipment, and the parameter values reflect single failure criteria. 2. The critical input values are: Primary-to-secondary leak rate, Maximum time period of tubes being uncovered, Maximum steam releases, Minimum RCS mass, Initial and minimum post-accident SG mass, Control Room (CR) atmospheric dispersion factors 3. Parameter values provided below reflect the bounding value applicable to Unit 1 and Unit 2					
1. Core Power Level (with power uncertainty) used to establish radiation source terms	2918 MWt	FENOC letter ND1MLM:0327 [Table 6], 11/05/02 FENOC letter BV2SGRP:0971, 3/27/14	2918 MWt	BV1 Renewed Operating License DPR-66 BV2 Renewed Operating License NPF-73 BV1 LRM B 3.3.8 BV2 LRM B 3.3.8 BV1/2 TS 5.6.3	Rated Thermal Power shall not exceed 2900 MWt. Total power measurement uncertainty of better than +/- 0.6% of RTP at full power is achieved using the Leading Edge Flow Meter. 2900 MWt x 1.006 = 2917.4 MWt
2. Design Basis Core Activity for iodines, Noble gases and alkali metals	As provided in S&W reference calculation	FENOC letter ND1MLM:0327 [Table 6], 11/05/02 S&W calculation 10080-UR(B)-483, R0	As provided in Reference	BV1/2 Calculation UR(B)-483	The current design basis composite equilibrium core inventory, which is based on 2918 MWt, an 18 month burnup cycle and initial enrichments from 4.2% to 5%, is appropriate and is not being changed.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

Table 6: Parameters for Calculating Loss of AC Power (LACP) Accident Dose Consequences

	AOR [UR(B)-493, R0, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
3. Maximum failed fuel percentage following a LACP	None	FENOC letter ND1MLM:0327 [Table 6], 11/05/02 FENOC letter ND1SGRP:0403, 8/18/03 FENOC letter BV2SGRP:0971, 3/27/14 LTR-PL-13-79, Rev. 1 LTR-TA-13-15, Rev. 0 10080-US(P)-235 Rev 2/A1 (CN-TA-01-051, Rev 0)	None	BV1 Calculation US(P)-259 BV2 Calculation US(P)-235 Westinghouse letter FENOC-02-217 BV1 UFSAR Section 14.1.11 BV2 UFSAR Section 15.2.6	

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

Table 6: Parameters for Calculating Loss of AC Power (LACP) Accident Dose Consequences

	AOR [UR(B)-493, R0, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
4. Maximum melted fuel percentage following a LACP	None	FENOC letter ND1MLM:0327 [Table 6], 11/05/02 FENOC letter ND1SGRP:0403, 8/18/03 FENOC letter BV2SGRP:0971, 3/27/14 LTR-PL-13-79, Rev. 1 LTR-TA-13-15, Rev. 0 10080-US(P)-235 Rev 2/A1 (CN-TA-01-051, Rev 0)	None	BV1 Calculation US(P)-259 BV2 Calculation US(P)-235 Westinghouse letter FENOC-02-217 BV1 UFSAR Section 14.1.11 BV2 UFSAR Section 15.2.6 Westinghouse letter LTR-PL-13-79	It is assumed that melting will not occur in UO_2 pellets for a LACP event.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

Table 6: Parameters for Calculating Loss of AC Power (LACP) Accident Dose Consequences

	AOR [UR(B)-493, R0, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
5. Activity available for release	Technical Specification RCS activity	FENOC letter ND1MLM:0327 [Table 6], 11/05/02	Technical Specification 3.4.16, RCS Specific Activity	BV1 UFSAR Table 14.1-3, Parameters Used in Control Room Habitability Analysis of the Loss of AC Powered Auxiliaries Accident BV2 UFSAR Table 15.2-2, Parameters Used for the loss of Non-Emergency AC Power to the Station Auxiliaries Accident	Per current licensing basis, the activity available for release as a result of a LACP event is limited to RCS at TS activity concentrations with no iodine spiking. BV1/2 Calculation UR(B)-484 contains the RCS and secondary activity values.
6. Initial RCS Activity (μCi/gm) – Tech Spec Values	Reactor Coolant activity limited to ≤ 0.35 μCi/gm I-131 DE ≤ 100/E_{bar} μCi/gm Isotopic inventory obtained from referenced calculation	FENOC letter ND1MLM:0327 [Table 6], 11/05/02 BV1 TS 3.4.8 BV2 TS 3.4.8 Calc 10080-UR(B)-484, R0	Reactor Coolant Dose Equivalent I-131 specific activity limited to: ≤ 0.35 μCi/gm Reactor Coolant gross specific activity limited to: ≤ 100/E_{bar} μCi/gm Isotopic inventory obtained from referenced calculation	BV1/2 TS 3.4.16 BV1/2 Calculation UR(B)-484	In support of BV2 Original Steam Generators with Alternate Repair Criteria, a License Amendment Request will explain that a bounding value of ≤ 0.35 μCi/gm I-131 DE is used for all BV1 and BV2 accidents with the exception of the BV2 MSLB for OSGs, for which the BV2 specific TS limit of 0.10 μCi/gm I-131 DE is used.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

Table 6: Parameters for Calculating Loss of AC Power (LACP) Accident Dose Consequences

	AOR [UR(B)-493, R0, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
7. Initial TS secondary side Iodine Activity ((µCi/gm)	Secondary Coolant activity limited to ≤ 0.10 µCi/gm I-131 DE	FENOC letter ND1MLM:0327 [Table 6], 11/05/02 BV1 TS 3.7.1.4 BV2 TS 3.7.1.4 Calc 10080-UR(B)-484, R0	Secondary Coolant activity limited to: ≤ 0.10 µCi/gm I-131 DE	BV1/2 TS 3.7.13 BV1/2 Calculation UR(B)-484	In support of BV2 OSGs with ARC, a License Amendment Request will explain that a bounding value of ≤ 0.10 µCi/gm I-131 DE is used for all BV1 and BV2 accidents with the exception of the BV2 MSLB for OSGs, for which the BV2 specific TS limit of 0.05 µCi/gm I-131 DE is used.
8. Iodine Species released from the Steam Generators to the environment	97% elemental 3% organic	FENOC letter ND1MLM:0327 [Table 6], 11/05/02 RG 1.183 R0, Appendix G.4	97% elemental 3% organic	NRC Regulatory Guide 1.183	The iodine species released from the SGs is defined in Appendix F (SGTR). Since there is no appendix specific to a LACP event, it is assumed to be applicable.
9. Activity release path	Reactor coolant is assumed to leak into the secondary system at the TS leak rate. The Main Condenser is assumed unavailable, steam releases through the MSSVs & ADVs during cooldown phase to RHA cut-in.	FENOC letter ND1MLM:0327 [Table 6], 11/05/02 Current design basis	Reactor coolant is assumed to leak into secondary system at the TS leak rate. Steam releases are via the Main Steam Safety Valves and Atmospheric Dump Valves during cooldown phase until Residual Heat Removal initiation conditions are reached.	BV1 UFSAR Section 14.1.11 BV2 UFSAR Section 15.2.6	Main Condenser (including Condenser Steam Dump Valves) is assumed to be unavailable;

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

Table 6: Parameters for Calculating Loss of AC Power (LACP) Accident Dose Consequences

	AOR [UR(B)-493, R0, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
10. Steam generator (SG) primary-to-secondary leakage rate at TS levels	150 gallons per day (gpd) (any 1 SG) 450 gpd (all 3 SGs) Leakage density = 1.0 g/cc	FENOC letter ND1MLM:0327 [Table 6], 11/05/02 FENOC letter BV2SGRP:0971, 3/27/14	150 gallons per day (any 1 SG) 450 gpd (all 3 SGs) Leakage density = 1.0 g/cc	BV1/2 TS B 3.4.13 NRC Regulatory Guide 1.183	Per NRC Regulatory Guide 1.183, Appendix G (LRA), the leakage density should be assumed to be 1.0 g/cc in most cases. Since there is no appendix specific to a LACP event, this density is assumed to be applicable.
11. Maximum time period of SG tubes being uncovered	Negligible	FENOC letter ND1MLM:0327 [Table 6], 11/05/02 WCAP-13247, March 1992	Negligible effect	WCAP-13247 NRC letter (3/10/1993)	The scope of WCAP-13247 includes a Loss Of Offsite Power. The results of the Westinghouse Owners Group program indicate that steam generator tube uncovery does not increase the consequences of Steam Generator Tube Rupture and Non-SGTR events significantly. The current design basis analysis methodologies are adequate and remain valid. NRC letter (3/10/1993) expressed agreement with the position presented in WCAP-13247.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

Table 6: Parameters for Calculating Loss of AC Power (LACP) Accident Dose Consequences

	AOR [UR(B)-493, R0, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
12. Partition coefficients in SGs	Tubes submerged Noble gas – released freely with no retention All iodines – 100	FENOC letter ND1MLM:0327 [Table 6], 11/05/02 RG 1.183, Rev. 0	Tubes submerged Noble gas – released freely with no retention All iodines – 100	NRC Regulatory Guide 1.183	Per NRC Regulatory Guide 1.183, Appendix G (LRA), all noble gas radionuclides released from the primary system are assumed to be released to the environment without reduction or mitigation. Also, the transport model described in assumptions 5.5 and 5.6 of Appendix E should be utilized for all iodines and particulates. Per Appendix E (MSLB), the radioactivity in the bulk water is assumed to become a vapor at a rate that is the function of the steaming rate and the partition coefficient. A partition coefficient for iodine of 100 may be assumed. This partition coefficient is assumed to be applicable to a LACP event.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

Table 6: Parameters for Calculating Loss of AC Power (LACP) Accident Dose Consequences

	AOR [UR(B)-493, R0, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
13. Maximum steam release from intact SGs	BV2 OSG 0-2hrs: 348,000 lbm 2-8 hrs: 773,000 lbm BV1 RSG 0-2hrs: 340,000 lbm 2-8 hrs: 778,000 lbm BV2 RSG 0-2hrs: 332,000 lbm 2-8 hrs: 753,000 lbm	FENOC letter ND1MLM:0327 [Table 6], 11/05/02 Westinghouse ltr FENOC-01-278, 9/19/01 FENOC letter ND1SGRP:0403, 8/18/03 FENOC letter BV2SGRP:0971, 3/27/14 CN-CRA-12-12, Rev. 0	BV1 RSG 0 to 2 hours: 340,000 lbm 2 to 8 hours: 778,000 lbm BV2 OSG 0 to 2 hours: 348,000 lbm 2 to 8 hours: 773,000 lbm BV2 RSG 0 to 2 hours: 332,000 lbm 2 to 8 hours: 753,000 lbm	FENOC Letter ND1SGRP:0403 FENOC Letter ND1SGRP:0403 Westinghouse Calculation CN-CRA-12-12 FENOC Letter BV2SGRP:0971	
14. Initial & Minimum reactor coolant system (RCS) mass, excluding pressurizer liquid and steam masses	BV2 OSG 341,331 lbm (22% tube plugged) BV1 340,711 lbm BV2 RSG 351,900 lbm (22% tubes plugged)	FENOC letter ND1MLM:0327, [Table 6], 11/05/02 FENOC letter ND1SGRP:0403, 8/18/03 FENOC letter BV2SGRP:0971, 3/27/14	BV1 RSG 345,097 lbm (22% SGTP) BV2 OSG 341,331 lbm (22% SGTP) BV2 RSG 346,381 lbm (22% SGTP)	FENOC Letter ND1SGRP:0403 (7790 ft^3) FENOC Letter ND1SGRP:0403 (7705 ft^3) Westinghouse Calculations CN-TA-01-33 & CN-TA-12-32 (7819 ft^3)	Westinghouse letter BV1-RSG-03-265 Note 8 presents a calculation of the mass of the BV1 Reactor Coolant System active water volume (with Original Steam Generators) as an example: 340,711 lbm = 7691 ft^3 X 44.3 lbm/ft^3. Using the same approach, the masses (assuming 22% SGTP) are: 345,097 lbm (BV1 RSGs), 341,331 lbm (BV2 OSGs), and 346,381 lbm (BV2 RSGs).

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

Table 6: Parameters for Calculating Loss of AC Power (LACP) Accident Dose Consequences

	AOR [UR(B)-493, R0, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
15. Initial and minimum post-accident mass of secondary coolant per SGs (lbm/SG)	BV2 OSG: 105,076 lbm BV1 RSG: 101,799 lbm BV2 RSG: 103,019 lbm	FENOC letter ND1MLM:0327, [Table 6], 11/05/02 FENOC letter ND1SGRP:0403, 8/18/03 FENOC letter BV2SGRP:0971, 3/27/14 LTR-PL-13-79, Rev. 1 CN-CRA-12-12, Rev. 0	BV1 RSG 101,799 lbm BV2 OSG 105,076 lbm BV2 RSG 103,019 lbm	FENOC Letter ND1SGRP:0403 FENOC Letter ND1SGRP:0403 Westinghouse Calculation CN-CRA-12-12	SG liquid mass would tend to increase following a LACP event, so the initial value is the minimum liquid mass during the transient.
16. Termination of environmental release	8 hours	FENOC letter ND1MLM:0327, [Table 6], 11/05/02 Westinghouse ltr FENOC-01-278, 9/19/01 FENOC letter BV2SGRP:0971, 3/27/14 CN-CRA-12-12, Rev. 0	8 hours	BV1 UFSAR Section 14.1.11 FENOC Letter ND1SGRP:0403 BV2 UFSAR Section 15.2.6 Westinghouse Calculation CN-CRA-12-12 NRC Regulatory Guide 1.183	Time of 8 hours reflects when Residual Heat Removal initiation conditions are reached. Per NRC Regulatory Guide 1.183, Appendix G (LRA), the release of radioactivity should be assumed to continue until shutdown cooling is in operation and releases from the steam generators have been terminated. This same timeline is assumed for the LACP event.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

Table 6: Parameters for Calculating Loss of AC Power (LACP) Accident Dose Consequences

	AOR [UR(B)-493, R0, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
17. Control Room (CR) atmospheric dispersion factors	Release points: U1: N3799 U2: N3841	FENOC letter ND1MLM:0327, [Table 6], 11/05/02 Drawing 8700-RY-1C, R1 X/Qs determined in S&W calculation 10080-EN-ME-105, R0/A1 10080-EN-ME-106, R0/A1	Main Steam Relief Valves (as a Single Riser) Release points: BV1: N3799, E7550 BV2: N3841, E8125	BV1/2 Drawing RY-0001C BV1 Calculation EN-ME-105 BV2 Calculation EN-ME-106	X/Qs determined in BV1 Calculation EN-ME-105 and BV2 Calculation EN-ME-106
Control Room Isolation / Emergency Ventilation (following a LACP)					
18. CR emergency ventilation automatic initiation	CR emergency ventilation is not credited for this event.	FENOC letter ND1MLM:0327, [Table 6], 11/05/02	CR emergency ventilation is not credited for this event.	Conservative Assumption	
19. Initiation of CR purge after environmental release is terminated: time and rate	CR is not purged following this event.	FENOC letter ND1MLM:0327, [Table 6], 11/05/02	CR is not purged following this event.	Conservative Assumption	

References

1. NRC Regulatory Guide 1.183, Rev. 0, Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors
2. BV1 Renewed Operating License DPR-66
3. BV2 Renewed Operating License NPF-73
4. BV1/2 Technical Specifications, including BV1 Amendment 302 and BV2 Amendment 191
5. BV1/2 Technical Specification Bases, Rev 35
6. BV1 Licensing Requirements Manual (including Bases), Rev. 101
7. BV2 Licensing Requirements Manual (including Bases), Rev. 92
8. BV1 Updated Final Safety Analysis Report, Rev. 30
9. BV2 Updated Final Safety Analysis Report, Rev. 23
10. BV1/2 Calculation UR(B)-483, Rev. 0, Composite Reactor Core Inventory for BVPS Following Power Uprate (2918 MWth, Initial 4.2% to 5% Enrichment, 18 month Fuel Cycle)
11. BV1 Calculation EN-ME-105, Rev. 0 including Add. 1, Atmospheric Dispersion Factors (X/Qs) at Control Room and ERF Receptors for Unit 1 Accident Releases Using the ARCON96 Methodology
12. BV2 Calculation EN-ME-106, Rev. 0 including Add. 1, Atmospheric Dispersion Factors (X/Qs) at Control Room and ERF Receptors for Unit 2 Accident Releases Using the ARCON96 Methodology
13. BV1/2 Calculation UR(B)-484, Rev. 1, Primary and Secondary Coolant Design / Technical Specification Activity Concentrations including Pre-Accident Iodine Spike Concentrations and Equilibrium Iodine Appearance Rates following Power Uprate
14. BV1 Calculation US(P)-259, Rev. 2 through and including Add. 2, Loss of Flow/Locked Rotor Analyses for Uprating [Westinghouse CN-TA-01-70]
15. BV2 Calculation US(P)-235, Rev. 2 including Add. 1, Loss of Flow/Locked Rotor Analyses for Uprating [Westinghouse CN-TA-01-51]
16. Westinghouse Calculation CN-CRA-12-12, Rev. 0, Steam Releases for Dose for the Beaver Valley Unit 2 Steam Generator Replacement
17. BV1/2 Drawing RY-0001C, Rev. 2, Site Postulated Release and Receptor Points
18. Westinghouse Owners Group Report WCAP-13247 (3/1992), Report on Methodology for Resolution of the Steam Generator Tube Uncovery Issue
19. Westinghouse letter LTR-PL-13-79, Rev. 4, Update of the Post-Accident Radiological Dose Consequence Analysis Parameter Values in Support of the Beaver Valley Unit 2 RSG Project
20. NRC Letter (3/10/1993), Westinghouse Owners Group-Steam Generator Tube Uncovery Issue (attachment to WOG-93-066) [ML17054C235]
21. FENOC Letter ND1SGRP:0403 (8/18/2003), RSG Project Post-Accident Radiological Input Parameters for Dose Analysis (includes Westinghouse Letter BV1-RSG-03-265)
22. Westinghouse letter FENOC-02-217 (7/10/2002), Revised Post-Accident Radiological Input Parameters for SGTR and LR Dose Analysis
23. Westinghouse Calculation CN-TA-01-33, Rev. 2, LOFTRAN Base Deck for Beaver Valley Unit 2 (DMW) 9.4% Uprating Program
24. Westinghouse Calculation CN-TA-12-32, Rev. 0, LOFTRAN Base Deck for the Beaver Valley Unit 2 Replacement Steam Generator Program
25. FENOC Letter BV2SGRP:0971 (3/27/2014), Transmittal of DIT-SGR2-0037-00

FirstEnergy

CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-493

REVISION: 1

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DESIGN VERIFICATION RECORD

Page 1 of 1

NOP-CC-2001-01 Rev. 00

SECTION I: TO BE COMPLETED BY DESIGN ORIGINATOR

DOCUMENT(S)/ACTIVITY TO BE VERIFIED:

DIT-BVDM-0106-00

☒ SAFETY RELATED ☐ AUGMENTED QUALITY ☐ NONSAFETY RELATED

SUPPORTING/REFERENCE DOCUMENTS

DESIGN ORIGINATOR: *(Print and Sign Name)* [signature] K. J. Frederick for M Unfried

DATE: 7-13-18

SECTION II: TO BE COMPLETED BY VERIFIER

VERIFICATION METHOD *(Check one)*

☒ DESIGN REVIEW *(Complete Design Review Checklist or Calculation Review Checklist)* ☐ ALTERNATE CALCULATION ☐ QUALIFICATION TESTING

JUSTIFICATION FOR SUPERVISOR PERFORMING VERIFICATION:

N/A

APPROVAL: *(Print and Sign Name)* N/A

DATE

EXTENT OF VERIFICATION:

Design Review Checklist performed as a guide for Design Verification.

COMMENTS, ERRORS OR DEFICIENCIES IDENTIFIED? ☐ YES ☒ NO

RESOLUTION: *(For Alternate Calculation or Qualification Testing only)*

N/A

RESOLVED BY: *(Print and Sign Name)* N/A

DATE

VERIFIER: *(Print and Sign Name)* Douglas T Bloom [signature]

DATE: 7-13-18

APPROVED BY: *(Print and Sign Name)* MSRessler [signature]

DATE: 7/13/2018

FirstEnergy

DESIGN REVIEW CHECKLIST

NOP-CC-2001-02 Rev. 04

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):

DIT-BVDM-0106-00

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
1. Were the basic functions of each structure, system or component considered?		✓			
2. Have performance requirements such as capacity, rating, and system output been considered?		✓			
3. Are the applicable codes, standards and regulatory requirements including applicable issue and/or addenda properly identified and are their requirements for design and/or material been met or reconciled?		✓			
4. Have design conditions such as pressure, temperature, fluid chemistry, and voltage been specified?		✓			
5. Are loads such as seismic, wind, thermal, dynamic and fatigue factored in the design?	✓				
6. Considering the applicable loading conditions, does an adequate structural margin of safety exist for the strength of components?	✓				
7. Have environmental conditions anticipated during storage, construction and operation such as pressure, temperature, humidity, soil erosion, run-off from storm water, corrosiveness, site elevation, wind direction, nuclear radiation, electromagnetic radiation, and duration of exposure been considered?		✓			
8. Have interface requirements including definition of the functional and physical interfaces involving structures, systems and components been met?		✓			
9. Have the material requirements including such items as compatibility, electrical insulation properties, protective coating, corrosion, and fatigue resistance been considered?	✓				
10. Have mechanical requirements such as vibration, stress, shock and reaction forces been specified?	✓				
11. Have structural requirements covering such items as equipment foundations and pipe supports been identified?	✓				
12. Have hydraulic requirements such as pump net positive suction head (NPSH), allowable pressure drops, and allowable fluid velocities been specified?	✓				
13. Have chemistry requirements such as the provisions for sampling and the limitations on water chemistry been specified?		✓			
14. Have electrical requirements such as source of power, voltage, raceway requirements, electrical insulation and motor requirements been specified?	✓				
15. Have layout and arrangement requirements been considered?		✓			
16. Have operational requirements under various conditions, such as plant startup, normal plant operation, plant shutdown, plant emergency operation, special or infrequent operation, and system abnormal or emergency operation been specified?		✓			

DESIGN REVIEW CHECKLIST

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):

DIT-BVDM-0106-00

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
17. Have instrumentation and control requirements including instruments, controls, and alarms required for operation, testing, and maintenance been identified? Other requirements such as the type of instrument, installed spares, range of measurement, and location of indication should also be included.	✓				
18. Have adequate access and administrative controls been planned for plant security?	✓				
19. Have redundancy, diversity, and separation requirements of structures, systems, and components been considered?		✓			
20. Have the failure requirements of structures, systems, and components, including a definition of those events and accidents which they must be designated to withstand been identified?		✓			
21. Have test requirements including in-plant tests, and the conditions under which they will be performed been specified?	✓				
22. Have accessibility, maintenance, repair and in-service inspection requirements for the plant including the conditions under which they will be performed been specified?	✓				
23. Have personnel requirements and limitations including the qualification and number of personnel available for plant operation, maintenance, testing and inspection and permissible personnel radiation exposure for specified areas and conditions been considered?	✓				
24. Have transportability requirements such as size and shipping weight, limitations and Interstate Commerce Commission regulations been considered?	✓				
25. Have fire protection or resistance requirements been specified?	✓				
26. Are adequate handling, storage, cleaning and shipping requirements specified?	✓				
27. Have the safety requirements for preventing undue risk to the health and safety of the public been considered?		✓			
28. Are the specified materials, processes, parts and equipment suitable for the required application?		✓			
29. Have safety requirements for preventing personnel injury including such items as radiation hazards, restricting the use of dangerous materials, escape provisions from enclosures and grounding of electrical equipment been considered?		✓			
30. Were the inputs correctly selected and incorporated into the design?		✓			
31. Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed?		✓			
32. Are the appropriate quality and quality assurance requirements specified?		✓			

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DESIGN REVIEW CHECKLIST

NOP-CC-2001-02 Rev. 04

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.): DIT-BVDM-0106-00

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
33. Have applicable construction and operating experience been considered?		✓			
34. Have the design interface requirements been satisfied?		✓			
35. Was an appropriate design method used?		✓			
36. Is the output reasonable compared to inputs?		✓			
37. Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?	✓				
38. Have adequate maintenance features and requirements been specified?	✓				
39. Has the design properly considered radiation exposure to the public and plant personnel?		✓			
40. Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfied?		✓			
41. Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?	✓				
42. Are adequate identification requirements specified?	✓				
43. Are requirements for record preparation, review, approval, retention, etc., adequately specified?	✓				
44. Have protective coatings qualified for Design Basis Accident (DBA) been specified to structures, equipment and components installed in the containment/drywell?	✓				
45. Are the necessary supporting calculations completed, checked and approved?		✓			
46. Have the equipment heat load changes been reviewed for impact on HVAC systems?	✓				
47. **IF** a computer program was used to obtain the design by analysis, **THEN** has the program been validated per NOP-SS-1001 and documented to verify the technical adequacy of the computer results contained in the design analysis?	✓				
48. Have Professional Engineer (PE) certification requirements been addressed and documented where required by ASME Code (if applicable).	✓				
49. Does the design involve the installation, removal, or revise software/firmware and have the requirements of NOP-SS-1001 been addressed?	✓				
50. Does the design involve the installation, removal, or change to a digital component(s) and have the requirements of NOP-SS-1201 been addressed?	✓				

COMPLETED BY: *(Print and Sign Name)*	DATE	ADDITIONAL VERIFIER *(Print and Sign Name)*	DATE
Douglas T Bloom [signature]	7-13-18	N/A	

IF CHECKLIST IS REVIEWED BY MORE THAN ONE VERIFIER, SIGN BELOW:

FirstEnergy

NOP-CC-3002-01 Rev. 05

CALCULATION COMPUTATION

CALCULATION NO.: 10080-UR(B)-493

REVISION: 1

FirstEnergy	CALCULATION COMPUTATION NOP-CC-3002-01 Rev. 05
CALCULATION NO.: 10080-UR(B)-493	REVISION: 1

Attachment 3

(Partial Copy – excludes CR Shielding Data)

FirstEnergy Design Input Transmittal

DIT-BVDM-0103-03 transmitted via FENOC letter ND1MDE:0738

January 29, 2019

FENOC
FirstEnergy Nuclear Operating Company

Beaver Valley Power Station
P.O. Box 4
Shippingport, PA 15077

Patrick G. Pauvlinch
Manager, Design Engineering
pauvlinchp@firstenergycorp.com

Phone: 724-682-4982
Fax: 330-315-9717

ND1MDE:0738
January 29, 2019

Sreela Ferguson
WECTEC
720 University Ave.
Norwood, MA 02062

BV1 & BV2 Complete Reanalysis of Dose Consequences
For CRE Tracer Gas Testing and Other Acceptance Criteria Changes
<u>Design Input Transmittal DIT-BVDM-0103-03 for Control Room Dose</u>

Dear Ms. Ferguson:

Attached is Design Input Transmittal DIT-BVDM-0103-03 which provides information for evaluating the control room operator dose for various design-basis accidents.

Should you have any questions about the attached information, please contact Doug Bloom at 724-682-5078 or Mike Ressler at 724-682-7936.

Sincerely,

Patrick G. Pauvlinch
Manager, Design Engineering

DTB/bls

Attachment

cc: D. T. Bloom
M. G. Unfried
M. S. Ressler
BVRC

FirstEnergy	CALCULATION COMPUTATION NOP-CC-3002-01 Rev. 05	Page Att3-3 of Att3-26
CALCULATION NO.: 10080-UR(B)-493		REVISION: 1

Form 1/2-ADM-2097.F01, Rev 0 RTL# A1.105V

DESIGN INPUT TRANSMITTAL

☒ SAFETY RELATED / AUG QUAL ☐ NON-SAFETY RELATED	Originating Organization: ☒ FENOC ☐ Other (Specify)	DIT- BVDM-0103-03 Page __1__ of __1__
Beaver Valley Unit: ☐1 ☐2 ☒Both System Designation: Various Engineering Change Package: N/A		To: Sreela Ferguson Organization: WECTEC

Subject: **Design Input Transmittal for Parameter List for Calculating Dose Consequences at the Control Room and Site Boundary**

Status of Information: ☒Approved for Use ☐Unverified

For Unverified DITs, Notification number tracking verification: ____________________

Description of Information:

Safety Analysis Design Inputs? ☒Yes ☐No

Reconciled to Current Design Basis? ☒Yes ☐N/A

This DIT provides information required for the performance of calculating dose consequences at the BV1 and BV2 Control Rooms and Site Boundary.

Purpose of Issuance:

This DIT provides information required for the performance of design basis accident dose consequence calculation UR(B)-487.

Source of Information (Reference, Rev, Title, Location): Engineering Judgment Used? ☐Yes ☒No

See attachment to DIT table.

Preparer: Douglas T Bloom	Preparer Signature: [signature]	Date: 1-29-19
Reviewer: M. G. Unfried	Reviewer Signature: [signature]	Date: 1/29/2019
Approver: M. S. Ressler	Approver Signature: [signature]	Date: 1/29/2019

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE E: Parameter List for Calculating Dose Consequences at the Control Room & Site Boundary

	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
General Notes: 1. As noted in Design Input transmittals provided in support of the BVPS-2 RSGs (e.g., DIT-SGR2-0046-01 for the LOCA) the CR parameters such as shielding configuration, volume, ventilation system parameters (flows, filter efficiency, signals that initiate emergency ventilation, timing of manual action, etc.) have not changed since the Containment Sump modification 2. The <u>critical input values</u> are: CR volume, CR ventilation flows (NOP intake, unfiltered inleakage and filtered intake during pressurization mode), CR filter efficiencies, CREVS initiation times, and atmospheric dispersion factors.					
Control Room (Inhalation / Submersion Dose)					
1. Minimum Control Room (CR) Free Volume	1.73E5 ft^3	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 DQL Calc B-74, Rev. 0. 12/8/81 DLC EM 11578 (NOT IN FILENET RECORDS) Confirmed by DLC EM 116251	1.73E5 ft^3	BV1 Calculations CR-AC-1 & DMC-3171 BV1 UFSAR Table 11.5-8 & Table 14.3-14a BV2 Calculations B-029A & B-074 BV2 Drawing RB-0039A BV2 UFSAR Table 6.4-1 & Table 6.4-1a	BV1 and BV2 share a joint control room inside a single Control Room Envelope. Dimensions used in BV2 Calculation B-074 are consistent with those derived from BV2 Drawing RB-0039A. The net free volume has historically been assumed to be approximately 75% of the gross volume for the radiological dose consequence analyses; it is noted that 30% was used for estimating the occupied volume (resulting in 70% net free volume) in BV2 Calculation B-029A involving refrigerant. The assumption of 75% is adopted here.

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Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
2. Control Room Ventilation Intake Design	Single intake for each unit; same intake used for normal ventilation as well as emergency ventilation.	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 Drawing # 8700-RY-1C, R2 Receptors 2 and 3 for Unit-1, and Unit-2, respectively.	One intake for BV1 and one intake for BV2, which supply the common Control Room. The same intakes are used for normal ventilation as well as emergency ventilation.	BV1/2 Drawing RY-0001C BV1 Drawings RM-0003K & RM-0444A-004 BV2 Drawing RM-0444A-2	There is a single intake for each Unit; the same intake is used for normal ventilation as well as emergency ventilation. The total unfiltered normal operation air intake flow rate is usually unequally divided between the BV1 and BV2 intakes. Receptor 2 represents the BV1 intake, and receptor 3 represents the BV2 intake.
3. Maximum Normal Operation Unfiltered Inflow into Control Room (includes Ventilation Intake Flow Rate and all Unfiltered Inleakage) and postulated Location of referenced Unfiltered Inleakage	Unit 1: Unfiltered: 300 cfm Unit 2: Unfiltered: 200 cfm <u>Total (Unfiltered):</u> <u>500 cfm</u> <u>Filtered: 0 cfm</u> *All NOP ventilation flowrate values include uncertainties.* *Total unfiltered flow includes 10 cfm for ingress/egress.*	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 2DBD-44A2, Rev. 8, para. 2.2, pg. 6 NDINEM:1144 EM:116251	BV1 & BV2 Unfiltered Intake / Inleakage: 1250 cfm maximum (total for both Units) This maximum normal operation ventilation intake flow rate value is an analytical upper bound value that is intended to include: a) flow rate test measurement uncertainties, b) alll unfiltered inleakage, and c) a 10 cfm ingress/ egress allowance	Assumed value - intended to provide operational margin.	<u>Location of Unfiltered Inleakage</u> Component tests performed as part of 2017 tracer gas testing indicated that potential sources of unfiltered inleakage into the Control Room are the normal operation intake dampers – which can be assigned the same χ/Q as the Control Room air intakes. Regarding other potential locations of inleakage, a χ/Q value that reflects the center of the Control Room boundary at roof level as a receptor could be considered the average value applicable to Unfiltered Inleakage locations around the CRE, and thus representative for

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Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
			The above value bounds the test results of BV1/2 Procedure 3BVT 1.44.05 via Order 200699902. All Unfiltered Inleakage (including that associated with ingress/egress) may be assumed to occur at same location as intakes (i.e., receptor points 2 and 3 of BV1/2 Drawing RY-0001C).	Engineering judgement – see comment column for basis BV1/2 Drawing RY-0001C BV1/2 Procedure 3BVT 1.44.05 Order 200699902 Vendor Report, NCS Corporation, Control Room Envelope Inleakage Testing at Beaver Valley Power Station 2017, Final Report	all CR unfiltered leakage locations. Review of BV1/2 Drawing RY-0001C indicates that since the post-accident release points are a) closer to the CR intakes and b) the directions from the release points to the CR center and CR intakes are similar, use of χ/Q values associated with the CR intakes, for CR Unfiltered Inleakage, would be conservative. The 10 cfm allowance for ingress/egress, is assigned to the door leading into the Control Room that is considered the primary point of access. This door (S35-71) is located at grade level on the side of the building facing the BV1 Containment and between the CR air intakes. It is located close enough to the air intakes to allow the assumption that the χ/Q associated with this source of leakage would be reasonably similar to that associated with the air intakes.

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Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
4. CR Emergency Ventilation Intake Design	Filtered emergency intake with recirculation which pressurizes the CRE to +1/8" w.g. above outside air pressure. CREVS provides for 0.35 filtered air changes per hour	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 U-1 T/S SR 4.7.7.1.1.d.3, .2.d.4 U-2 T/S SR 4.7.7.1.1.e.4 UFSAR-2, Table 6.4-1, *Control Room Envelope Ventilation Design Parameters*	CREVS provides for 0.28 filtered air changes per hour (based on 800 cfm minimum filtered intake) and 0.35 filtered air changes per hour (based on 1000 cfm maximum filtered intake).	The number of air changes per hour is based on filtered emergency intake flow rate [parameter 8] and minimum Control Room free volume [parameter 1].	The filtered air intake flow path is normally not in service. With the adoption of tracer gas testing for the Control Room Envelope, the relative pressure comparison is no longer important from a design and licensing basis perspective. It may be used for other purposes, such as ventilation balancing.
5. CREBAPS Design Basis	CREBAPS has been eliminated	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 Amendments 257/139	The Control Room Emergency Bottled Air Pressurization System has been eliminated.	Engineering Change Packages ECP-02-0243-ID-01 through ECP-02-0243-ID-09 & ECP-02-0243-RD NRC Safety Evaluation for Amendments 257 (BV1) & 139 (BV2)	

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	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
6. Maximum control room unfiltered inleakage during CR isolation and emergency pressurization mode and postulated Location of reference Unfiltered Inleakage	<u>Isolation (recirculation) mode</u>: 300 scfm with no pressurization <u>Emergency (pressurization) mode</u>: 30 scfm o Allowance for ingress/egress 10 o Allowance for dampers: 4 o Allowance for doors & seals: 6 o Allowance for degradation: <u>10</u> TOTAL 30 All unfiltered inleakage may be assumed to occur at same location as intakes, i.e. receptor points 2 and 3. These values include measurement uncertainties	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 Control Room Envelope Inleakage Testing at Beaver Valley Power Station; Final Report; NCS Corp. (Lagus) 7/23/01, Table 20, p.69 8700-RY-1C, R2	<u>CR Isolation (recirculation) mode</u>: 450 cfm maximum <u>CR Emergency (pressurization) mode</u>: 165 cfm maximum Each maximum control room unfiltered flow rate value listed above is an upper bound analytical value that includes test measurement uncertainties and a 10 cfm allowance for ingress and egress. All Unfiltered Inleakage (including that associated with ingress/egress) may be assumed to occur at same location as intakes (i.e., receptor points 2 and 3 of BV1/2 Drawing RY-0001C).	Assumed values are intended to provide operational margin. Engineering judgment – see comment column for parameter 3 BV1/2 Drawing RY-0001C	Refer to Comment for parameter 3.

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	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
7. Allowance for Ingress/Egress (all modes)	10 scfm	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 RG 1.78, position C.10 D.G. 1087, 3.4 SRP NuReg-0800, 6.4 SRP NuReg-0800, 6.4.III.3.d.iii	10 cfm	NRC Regulatory Guide 1.197 BV1 Drawing RA-0020A BV2 Drawing RA-0006B Engineering judgment	There are multiple doors that form part of the Control Room Envelope. Door S35-71 on the south wall of the Control Room at grade elevation 735'-6", between the two Control Room air intakes, accounts for most ingress and egress. Although the door for the Control Room south entrance is protected by a vestibule, no reduction in the 10 cfm allowance is credited.
8. Filtered emergency intake flow rate	600 - 1030 cfm range includes allowance for measurement uncertainties	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 T/S-1; 4.7.7.1.2 T/S-2; 4.7.7.1.2 Control Room Envelope Inleakage Testing at BVPS; Final Report; NCS Corp. (Lagus) 7/23/01, Table 7, p.44 and Table 11, p.50	800 to 1000 cfm Control room filtered inleakage ventilation flow rate values are analytical values that include test measurement uncertainties.	BV1/2 TS 5.5.7 BV1 Specification BVS-367 BV2 Specification 2BVS-157	<u>WECTEC Note:</u> A greater filtered emergency intake flow would reduce the CR dose because the greater depletion rate of the existing airborne activity associated with the larger intake eclipses the larger filtered activity intake.

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Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
9. Margin used on all CR ventilation flows	Not required Flows are based on measurements with reported uncertainty included.	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06	CR ventilation flow rates provided in parameters 3, 6, & 8, above, are analytical values that include test measurement uncertainties.		

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	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
10. CR Intake filter iodine removal efficiency DBA analysis values:	a) 99% for particulate b) 98% for elemental and organic	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 G.L. 99-02	99% for particulate	Regulatory Position C.5.c of NRC Regulatory Guide 1.52 BV1/2 TS 5.5.7.a	The inplace dioctyl phthalate (DOP) test of the HEPA filters in accordance with ANSI N510-1980 confirming a penetration and system bypass of less than 0.05% at design flow rate can be considered to warrant a 99% removal efficiency for particulate matter in accident dose evaluations.
			98% for elemental and organic	Per NRC Generic Letter 99-02; to ensure that the efficiency assumed in the accident analysis is still valid at the end of the operating cycle, a minimum safety factor of 2 is to be applied to the laboratory test acceptance criteria. A SF of 2 is assumed. See comment and parameter 11 for additional detail.	<u>WECTEC Notes:</u> The penetration and bypass for the CREVS HEPA Filter per TS 5.5.7.a of < 0.05% warrants the use of an efficiency of 99% in safety analysis. Thus, the current licensing basis value of 99% remains valid. Per parameter 11, the proposed penetration and system bypass acceptance criterion for the CREVS Charcoal Filter (to be documented in updated TS 5.5.7.b) is < 0.5%. Per NRC GL 99-02, safety analyses can assume a charcoal filter efficiency of 100% - [(0.5% + 0.5%) x 2) = 98%. Thus, the current licensing basis value of 98% remains valid.

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Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
11. a) T/S Surveillance Acceptance Criterion for CR charcoal filters	a) ≥ 99 % efficiency acceptance criterion using radioactive methyl iodide.	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 U-1 T/S 4.7.7.1.c.2, T/S 4.7.7.2.c.2 U-2 T/S 4.7.7.1.d	a) ≥ 99.5% removal efficiency acceptance criterion for the <u>charcoal adsorber</u> using methyl iodide (i.e., as demonstrated by a laboratory test of a sample)	***a) Proposed change to BV1/2 TS 5.5.7.c acceptance criteria***	Charcoal adsorber sample is tested in laboratory in accordance with ASTM D3803-1989. System Engineering requested flexibility in charcoal adsorber testing acceptance criteria.
b) T/S Surveillance Acceptance Criterion for CR charcoal filters	b) ≥ 99.95 % efficiency acceptance criterion using R-11 refrigerant.	U-1 T/S 4.7.7.1.c.1, T/S 4.7.7.2.c.1 U-2 T/S 4.7.7.1.c.1	b) < 0.5% penetration and system bypass acceptance criterion for the charcoal adsorber (i.e., as demonstrated by an inplace test)	***b) Proposed change to BV1/2 TS 5.5.7.b acceptance criteria***	Charcoal adsorber is tested inplace in accordance with ANSI N510-1980. <u>WECTEC Note:</u> An efficiency ≥ 99.5% for the charcoal adsorber using R-11 refrigerant means the penetration and system bypass is less than 0.5% for the charcoal adsorber, as demonstrated by an inplace test.
c) T/S Surveillance Acceptance Criterion for CR HEPA filters	c) ≥ 99.95% for particulate using DOP.	U-1 T/S 4.7.7.1.c.1, T/S 4.7.7.2.c.1 U-2 T/S 4.7.7.1.c.2	c) < 0.05% penetration and system bypass for the HEPA filters (i.e., as demonstrated by an inplace test)	c) BV1/2 TS 5.5.7.a	

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Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
12. CR Filtered Recirculation Rate	N/A	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06	The BV1 and BV2 ventilation air-conditioning system recirculates CR air through filters intended for dust removal. BV1 - AC fan 1VS-AC-1A and 1VS-F-40A or the B train - bag type filters - efficiency ~ 90% BV2 - AC fan 2HVC-ACU201A or B - Hi efficiency type filters - efficiency ~ 85% Minimum Flow rate: Based on that available for CR air purge, i.e., 16,200 cfm per unit or 32,400 cfm Duration: t=0 to t-30 days	Location of Recirculation filters with respect to the CR are shown in the BV1 & BV2 sketch attached to this DIT BV1 Vendor Manual 10.001-0644 BV1 Specification BVS-0431 BV2 Vendor Manual 2510.140-179-005 BV2 Stock Code 10008727 BV2 Procedure 3BVT1.44.06 BV1 UFSAR Table 14.3-14a BV2 UFSAR Table 15.6-11	BV licensing basis does not credit / address recirculation filters. Analysis should evaluate if this approach remains conservative *Since the filters are not subject to a maintenance program, the analysis should conservatively assume 50% of the rated efficiency when crediting the filters to estimate the impact of use of the filters on the inhalation / submersion dose, and 100% efficiency when estimating the dose due to direct shine.* Roll Filters have an approximate 20% efficiency based on ASHRAE 52.1 – 1992 Test Method (Reference: Flanders Filter Efficiency Guide). Also reference BV1 Drawing RM-0444A-004, BV2 Drawing RM-0444A-001 and BV2 Drawing RM-0444A-002

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Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
13. Signals that automatically initiate CR emergency Ventilation	- Control Room Area Monitors - CIB signal	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 8700-120-65D S&W 2001-409-001	Signals originate from the Control Room Area Radiation Monitors or as Containment Isolation Phase B	BV1 Drawing LSK-021-001K BV1 UFSAR Section 11.3.5 BV2 UFSAR Section 6.4.2.2	For the purposes of DBA analyses, no credit is taken for CREVS initiation by CR area radiation monitors: BV1 Radiation Monitors RM-1RM-218A & B BV2 Radiation Monitors 2RMC-RQ201 & 202
14. Power supply to safety related instrumentation (i.e., the CIB signal) that initiate CR emergency Ventilation	Uninterrupted power	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 DCP 1302, Rev. 0, Solid State Protection System AC Power	Vital Bus System supplies Class 1E Uninterruptible Power System	BV1 Drawings RE-0001U & RE-0001AA BV2 Drawings RE-0001AY & RE-0001AZ BV1 UFSAR Section 8.5.4 BV2 UFSAR Section 8.3.1.1.17	

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Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
15. CR Emergency Ventilation initiation.	Manual: Yes (see Note 1) Automatic: Yes t = 0 to t = 77 sec: time delay associated with achieving CR isolation; assume normal ventilation (unfiltered) <u>U -1 (bounding)</u> t=77 sec to t = 30 min, CR isolated but not pressurized, t = 30 min to 30 days, CR pressurized/ emergency filtered intake mode	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 Unit 1 T/S 3/4.7.7 SRP 6.4 specifies that a substantial delay be assumed where manual isolation is assumed. ANS 58.8, "Time Response Design Criteria for Safety Related Operations"	The Control Room is automatically isolated within 77 seconds of receipt of a CIB signal; for this time period, normal (unfiltered) ventilation is assumed. Following the CIB signal, the Control Room would remain isolated from 77 seconds to 30 minutes (to bound manual actuation of BV1 CREVS), while on recirculation. From 30 minutes to 30 days, the Control Room will be placed in the emergency filtered intake mode and pressurized via CREVS.	BV1/2 TS 3.7.10 including Bases BV1 LRM Table 3.3.2-1 BV2 LRM Table 3.3.2-1	A CIB from either Unit isolates the Control Room and initiates BV2 CR emergency ventilation. There are three CREVS fan pressurization systems, one at BV1 and two at BV2. Operation with the one BV1 system and one of the two BV2 systems is permitted; a single failure of the operable BV2 system would require manual start of the BV1 system. The 30 minute allowance is for performing manual operator actions outside the Control Room, such as damper manipulations, and bounds the sequencing scheme of automatically starting a BV2 CREV system. The 30 minute allowance is consistent with the current design and licensing basis. For conservatism, all delays are assumed to be sequential.

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Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
16. Radiation monitor alarm set point to initiate CR emergency ventilation (non-1E)	≤ 0.476 mR/hr	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 T/S –1 Table 3.3-6	N/A	N/A	The CREVS initiation function from CR Radiation Monitors (listed in parameter 13) is not credited.
17. Radiation monitor response delay time after CR environment has reached alarm setpoint	≤180 sec following Hi Radiation	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06	N/A	N/A	The CREVS initiation function from CR Radiation Monitors (listed in parameter 13) is not credited.
Control room ventilation isolation delay time on Hi-Hi Containment Pressure (CIB)	≤22.0 sec following CIB signal ≤ 77.0 sec. (including D.G. start and sequencer delays)	Unit -1 & -2 LRM, Table 3.2-1	≤ 22.0 seconds following CIB signal, and ≤ 77.0 seconds following CIB signal and including Emergency Diesel Generator start and EDG load sequencer delays	BV1 LRM Table 3.3.2-1 BV2 LRM Table 3.3.2-1 BV1 Procedure 1BVT1.1.2 BV2 Procedure 2BVT1.1.2	Time response testing demonstrates that the acceptance criteria are satisfied. Actuation times and delays involving the sensor, channel, slave relay, Emergency Diesel Generator (start and coming up to speed), EDG load sequencer, and damper (stroke) are included as appropriate.
18. Radiation monitor accuracy	± 22% of reading	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06	N/A	N/A	The CREVS initiation function from CR Radiation Monitors (listed in parameter 13) is not credited.

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19. CIB signal processing delay time after LOCA	Assumed instantaneous	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06	Assumed instantaneous (see parameter 15)		This parameter is included within the time delay values quoted for parameter 15 (except for the manual actuation at 30 minutes).
20. CR Breathing rate	3.5E-4 m^3/s	R.G. 1.183 Rev 0	3.5E-4 m^3/s	NRC Regulatory Guide 1.183	See RG 1.183 section 4.2.6.
21. Control Room Occupancy Factors	0-24 hr 1.0 1-4 day 0.6 4-30 day 0.4	R.G. 1.183 Rev 0, 4.2.6 SRP, NuReg-0800, 6.4 Appendix A	0 to 24 hours: 1.0 1 to 4 days: 0.6 4 to 30 days: 0.4	NRC Regulatory Guide 1.183	See RG 1.183 section 4.2.6.

Control Room Shielding (General)					
22. Control Room Penetrations	All penetrations in CR walls / ceiling, including CR door have equivalent shielding	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 This will have to be listed as an assumption.	BV1 CR ventilation Intake filters and the air-conditioning recirculation filters are located in the BV1 fan room below the BV1 CR. There are no penetrations between the fan room (ceiling) and CR (floor) BV2 ventilation Intake filters and the air-conditioning recirculation filters are located in the fan room east of the CR (i.e., adjacent to the computer room). There are penetrations in the wall between the fan room and the computer room.	BV1 Drawing 8700-RM-0003M BV1 sketch attached to this DIT BV2 sketch attached to this DIT	

23. Release paths to be addressed for the LOCA analysis	<u>Direct Shine to Control Room</u>: Containment Shine, CR Penetration Shine due to Airborne Activity in the Cable spreading area under Unit 2 CR, CR Penetration Shine due to Airborne Activity in the Cable Tray Mezzanine under Unit 1 CR, Cloud shine due to Containment, ESF, and RWST Leakage, CR filter shine due to containment, ESF and RWST leakage, RWST direct shine	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 U1 UFSAR 14.3.5, U2 UFSAR 15.6.5	<u>Direct Shine to Control Room</u>: 1. Containment Shine, 2. Control Room Penetration Shine due to Airborne Activity in BV2 Cable Spreading Area under BV2 CR, 3. CR Penetration Shine due to Airborne Activity in the Cable Tray Mezzanine under BV1 CR, 4. Cloud shine due to Containment, Engineered Safety Features, and Refueling Water Storage Tank leakage, 5. CR filter shine due to Containment, ESF and RWST leakage, and 6. RWST direct shine	The current design and licensing basis is to be carried forward in BV1/2 Calculation UR(B)-487.	Release paths defined in the current design and licensing basis are applicable.

Control Room Shielding (RWST Direct Shine)					
38. LOCA dose to CR due to direct shine from the RWST	From Reference	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 S&W calc 12241/11700-UR(B)-487, R0 including Addendum 1 and 2	See parameter 24		
Site Boundary Atmospheric Dispersion Factors and Breathing Rates					
39. Offsite atmospheric dispersion factors (s/m^3)	<u>EAB</u> 0-2hrs:1.04E-3 (U1) 0-2hrs:1.25E-3 (U2) <u>LPZ</u> 0-8 hr: 6.04E-5 8-24: 4.33E-5 1-4days: 2.10E-5 4-30 days: 7.44E-6	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 ERS-SFL-96-021	<u>Exclusion Area Boundary</u> 0 to 2 hours: 1.04E-3 (BV1) 1.25E-3 (BV2) <u>Low Population Zone</u> 0 to 8 hours: 6.04E-5 8 to 24 hours: 4.33E-5 1 to 4 days: 2.10E-5 4 to 30 days: 7.44E-6	BV1/2 Calculation ERS-SFL-96-021 BV2 UFSAR Table 15.0-11	
40. Offsite Breathing rates (m^3/sec)	0-8 hrs: 3.5E-4 8-24 hr: 1.8E-4 1-30 days: 2.3E-4	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 RG 1.183 R0	0 to 8 hours: 3.5E-4 8 to 24 hours: 1.8E-4 1 to 30 days: 2.3E-4	NRC Regulatory Guide 1.183	

References for Table E

1. BV1 Updated Final Safety Analysis Report, Rev 30
2. BV1 Licensing Requirements Manual (including Bases), Rev 101
3. BV1 Calculation CR-AC-1, Rev 0, Volume of Control Room Area Air Conditioning Spaces
4. BV1 Calculation DMC-3171, Rev 0, Verification of Control Room Area Volume
5. BV1 Calculation EN-ME-105, Rev 0 including Add 1, Atmospheric Dispersion Factors (X/Qs) at Control Room and ERF Receptors for Unit 1 Accident Releases Using the ARCON96 Methodology
6. BV1 Drawing LSK-021-001K, Rev 5, Logic Diagram – Air Conditioning and Refrigeration – Control Room
7. BV1 Drawing RA-0020A, Rev 10, Floor Plans Main Entrance & Control Room
8. BV1 Drawing RB-0017J, Rev 16, Air Conditioning Plan – Control Room Service Building
9. BV1 Drawing RC-0008C, Rev 13, Slab Plan at Elevation 735'-6" Outline Service Building
10. BV1 Drawing RE-0001U, Rev 39, 120V AC Vital Bus – I One Line Diagram (Red)
11. BV1 Drawing RE-0001AA, Rev 36, 120V AC Vital Bus – II One Line Diagram (White)
12. BV1 Drawing RM-0444A-004, Rev 15, Valve Operating Number Diagram, Control Room Area – Air Conditioning System
13. BV1 Drawing 10.001-0222, Rev B, Control Room Emergency Filter
14. BV1 Procedure 1BVT1.1.2, Rev 25, Engineered Safety Features Time Response Test
15. BV1 Procedure 1CMP-44VS-FL-2-1M, Rev 2, Control Room Emergency Outside Air Filter Replacement
16. BV1 Specification BVS-0367, Rev 3 through and including Add 3, Specification for Primary Ventilation Filter Assemblies
17. BV1 Specification BVS-0431, Rev. 2, Central Station Air Handling Units and Heating and Ventilation Units
18. BV1 Vendor Manual 10.001-0644, Rev. N, Central Station Climate Changers Installation and Maintenance Manual
19. BV2 Updated Final Safety Analysis Report, Rev 23
20. BV2 Licensing Requirements Manual (including Bases), Rev 92
21. BV2 Calculation B-029A, Rev 0, Control Room Ventilation System – Freon-22 Concentration
22. BV2 Calculation B-074, Rev 0, Determination of Control Room Volume
23. BV2 Calculation EN-ME-106, Rev 0 including Add 1, Atmospheric Dispersion Factors (X/Qs) at Control Room and ERF Receptors for Unit 2 Accident Releases Using the ARCON96 Methodology
24. BV2 Drawing RA-0006B, Rev 23, Door Schedule & Details
25. BV2 Drawing RB-0039A, Rev 14, Air Conditioning & Ventilation, Control Building
26. BV2 Drawing RE-0001AY, Rev 13, 120 VAC Vital Bus I One Line Diagram (Red)
27. BV2 Drawing RE-0001AZ, Rev 13, 120 VAC Vital Bus II One Line Diagram (White)
28. BV2 Drawing RM-0444A-001, Rev 8, Valve Operating Number Diagram, Control Building Ventilation System
29. BV2 Drawing RM-0444A-002, Rev 16, Valve Operating Number Diagram, Computer and Control Room Air Conditioning
30. BV2 Drawing 2010.800-157-003, Rev G, Control Room Air Pressurization Filter
31. BV2 Vendor Manual 2510.140-179-005, Rev. F, Installation, Startup and Service Instruments for Carrier 39E Air Handling Units
32. BV2 Vendor Manual 2510.800-157-002, Rev Y, Installation, Operation and Maintenance Manual – Ventilation Filter Assemblies
33. BV2 Procedure 2BVT1.1.2, Rev 15, Safeguards Time Response Test
34. BV2 Specification 2BVS-157, Final Revision (2/2/1988), Specification for Ventilation Filter Assemblies

35. BV1/2 Calculation UR(B)-487, Rev 2 [Pending], Site Boundary, Control Room and Emergency Response Facility Doses following a Loss-Of-Coolant Accident Based on Core Uprate, an Atmospheric Containment and Alternative Source Terms
36. BV1/2 Calculation ERS-SFL-96-021, Rev 0, RG 1.145 Short-Term Accident X/Q Values for EAB and LPZ, based on 1986 – 1995 Observations
37. BV1/2 Drawing RY-0001C, Rev 2, Site Postulated Release and Receptor Points
38. BV1/2 Engineering Change Packages for CREBAPS Deletion and CREVS Modification (i.e., ECP-02-0243-ID-01 Rev 5 through ECP-02-0243-ID-09 Rev 2, plus ECP-02-0243-RD Rev 5)
39. BV1/2 Procedure 3BVT 1.44.05, Rev. 6, Control Room Envelope Air In-Leakage Test
40. BV1/2 Technical Specifications (including Bases), 6/14/2018
41. Order 200699902 (2017), Perform 3BVT-01_44_05
42. Vendor Report, NCS Corporation, Control Room Envelope Inleakage Testing at Beaver Valley Power Station 2017, Final Report (1/31/2018)
43. FENOC Stock Item 9735047, Charcoal Filter Tray
44. FENOC Stock Item 9735717, Charcoal Filter Tray
45. FENOC Stock Item 100075371, Charcoal Filter Tray
46. FENOC Stock Item 10008727, Cambridge Hi-Flo Filter
47. NRC Generic Letter 99-02, Laboratory Testing of Nuclear-Grade Activated Charcoal (6/3/1999), including Errata (8/23/1999)
48. NRC Regulatory Guide 1.52, Rev 2 (3/1978), Design, Testing, and Maintenance Criteria for Post Accident Engineered-Safety-Feature Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants
49. NRC Regulatory Guide 1.183, Rev 0 (7/2000), Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors
50. NRC Regulatory Guide 1.197, Rev 0 (5/2003), Demonstrating Control Room Envelope Integrity at Nuclear Power Reactors
51. NRC Safety Evaluation for Amendments 257 (BV1) & 139 (BV2) for selective implementation of an Alternative Source Term methodology for the Loss-Of-Coolant Accident and the Control Rod Ejection Accident, incorporation of ARCON96 methodology for release points associated with the LOCA and CREA, elimination of the Control Room Emergency Bottled Air Pressurization System changes to the Control Room Emergency Ventilation System, and a change to the BV1 CREVS filter bypass leakage acceptance test criteria

Note: Increasing the current fresh air flow rate (500 cfm) has been requested during normal operation. Unfiltered normal operation air intake flow rates are often stated in the BV1 UFSAR and BV2 UFSAR to be 300 cfm (BV1) and 200 cfm (BV2), or a total of 500 cfm. These UFSAR values are to be changed after the Amendments are received. Other documents showing analogous flow rates are likewise affected.

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CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-493	REVISION: 1

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DESIGN VERIFICATION RECORD

Page 1 of 1

NOP-CC-2001-01 Rev. 00

SECTION I: TO BE COMPLETED BY DESIGN ORIGINATOR

DOCUMENT(S)/ACTIVITY TO BE VERIFIED:

DIT-BVDM-0103-03

☒ SAFETY RELATED ☐ AUGMENTED QUALITY ☐ NONSAFETY RELATED

SUPPORTING/REFERENCE DOCUMENTS

DESIGN ORIGINATOR: *(Print and Sign Name)* Douglas T Bloom [signature]	DATE 1-28-19

SECTION II: TO BE COMPLETED BY VERIFIER

VERIFICATION METHOD *(Check one)*

☒ DESIGN REVIEW *(Complete Design Review Checklist or Calculation Review Checklist)* ☐ ALTERNATE CALCULATION ☐ QUALIFICATION TESTING

JUSTIFICATION FOR SUPERVISOR PERFORMING VERIFICATION:

N/A

APPROVAL: *(Print and Sign Name)* N/A	DATE

EXTENT OF VERIFICATION:

Design Review Checklist completed.

COMMENTS, ERRORS OR DEFICIENCIES IDENTIFIED? ☐ YES ☑ NO

RESOLUTION: *(For Alternate Calculation or Qualification Testing only)*

N/A

RESOLVED BY: *(Print and Sign Name)* N/A	DATE
VERIFIER: *(Print and Sign Name)* Michael G. Unfried [signature]	DATE 1/28/2019
APPROVED BY: *(Print and Sign Name)* M S Ressler [signature]	DATE 1/29/2019

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DESIGN REVIEW CHECKLIST

NOP-CC-2001-02 Rev. 04

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):

DIT-BVDM-0103-03

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
1. Were the basic functions of each structure, system or component considered?		✓			
2. Have performance requirements such as capacity, rating, and system output been considered?		✓			
3. Are the applicable codes, standards and regulatory requirements including applicable issue and/or addenda properly identified and are their requirements for design and/or material been met or reconciled?		✓			
4. Have design conditions such as pressure, temperature, fluid chemistry, and voltage been specified?		✓			
5. Are loads such as seismic, wind, thermal, dynamic and fatigue factored in the design?	✓				
6. Considering the applicable loading conditions, does an adequate structural margin of safety exist for the strength of components?	✓				
7. Have environmental conditions anticipated during storage, construction and operation such as pressure, temperature, humidity, soil erosion, run-off from storm water, corrosiveness, site elevation, wind direction, nuclear radiation, electromagnetic radiation, and duration of exposure been considered?	✓				
8. Have interface requirements including definition of the functional and physical interfaces involving structures, systems and components been met?		✓			
9. Have the material requirements including such items as compatibility, electrical insulation properties, protective coating, corrosion, and fatigue resistance been considered?	✓				
10. Have mechanical requirements such as vibration, stress, shock and reaction forces been specified?	✓				
11. Have structural requirements covering such items as equipment foundations and pipe supports been identified?	✓				
12. Have hydraulic requirements such as pump net positive suction head (NPSH), allowable pressure drops, and allowable fluid velocities been specified?	✓				
13. Have chemistry requirements such as the provisions for sampling and the limitations on water chemistry been specified?	✓				
14. Have electrical requirements such as source of power, voltage, raceway requirements, electrical insulation and motor requirements been specified?	✓				
15. Have layout and arrangement requirements been considered?		✓			
16. Have operational requirements under various conditions, such as plant startup, normal plant operation, plant shutdown, plant emergency operation, special or infrequent operation, and system abnormal or emergency operation been specified?		✓			

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DESIGN REVIEW CHECKLIST

NOP-CC-2001-02 Rev. 04

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):

DIT- BVDM-0103-03

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
17. Have instrumentation and control requirements including instruments, controls, and alarms required for operation, testing, and maintenance been identified? Other requirements such as the type of instrument, installed spares, range of measurement, and location of indication should also be included.	✓				
18. Have adequate access and administrative controls been planned for plant security?	✓				
19. Have redundancy, diversity, and separation requirements of structures, systems, and components been considered?		✓			
20. Have the failure requirements of structures, systems, and components, including a definition of those events and accidents which they must be designated to withstand been identified?	✓				
21. Have test requirements including in-plant tests, and the conditions under which they will be performed been specified?	✓				
22. Have accessibility, maintenance, repair and in-service inspection requirements for the plant including the conditions under which they will be performed been specified?	✓				
23. Have personnel requirements and limitations including the qualification and number of personnel available for plant operation, maintenance, testing and inspection and permissible personnel radiation exposure for specified areas and conditions been considered?	✓				
24. Have transportability requirements such as size and shipping weight, limitations and Interstate Commerce Commission regulations been considered?	✓				
25. Have fire protection or resistance requirements been specified?	✓				
26. Are adequate handling, storage, cleaning and shipping requirements specified?	✓				
27. Have the safety requirements for preventing undue risk to the health and safety of the public been considered?		✓			
28. Are the specified materials, processes, parts and equipment suitable for the required application?	✓				
29. Have safety requirements for preventing personnel injury including such items as radiation hazards, restricting the use of dangerous materials, escape provisions from enclosures and grounding of electrical equipment been considered?	✓				
30. Were the inputs correctly selected and incorporated into the design?		✓			
31. Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed?	✓				
32. Are the appropriate quality and quality assurance requirements specified?	✓				

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CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-493

REVISION: 1

FirstEnergy NOP-CC-2001-02 Rev. 04

DESIGN REVIEW CHECKLIST

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):
01T- BVDM- 0103-03

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
33. Have applicable construction and operating experience been considered?		✓			
34. Have the design interface requirements been satisfied?	✓				
35. Was an appropriate design method used?		✓			
36. Is the output reasonable compared to inputs?		✓			
37. Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?	✓				
38. Have adequate maintenance features and requirements been specified?	✓				
39. Has the design properly considered radiation exposure to the public and plant personnel?		✓			
40. Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfied?	✓				
41. Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?	✓				
42. Are adequate identification requirements specified?	✓				
43. Are requirements for record preparation, review, approval, retention, etc., adequately specified?	✓				
44. Have protective coatings qualified for Design Basis Accident (DBA) been specified to structures, equipment and components installed in the containment/drywell?	✓				
45. Are the necessary supporting calculations completed, checked and approved?	✓				
46. Have the equipment heat load changes been reviewed for impact on HVAC systems?	✓				
47. **IF** a computer program was used to obtain the design by analysis, **THEN** has the program been validated per NOP-SS-1001 and documented to verify the technical adequacy of the computer results contained in the design analysis?	✓				
48. Have Professional Engineer (PE) certification requirements been addressed and documented where required by ASME Code (if applicable).	✓				
49. Does the design involve the installation, removal, or revise software/firmware and have the requirements of NOP-SS-1001 been addressed?	✓				
50. Does the design involve the installation, removal, or change to a digital component(s) and have the requirements of NOP-SS-1201 been addressed?	✓				

COMPLETED BY: *(Print and Sign Name)*	DATE	ADDITIONAL VERIFIER *(Print and Sign Name)*	DATE
M. G. Unfried [signature]	1/28/2019	N/A	

IF CHECKLIST IS REVIEWED BY MORE THAN ONE VERIFIER, SIGN BELOW:

Enclosure E
L-20-161

L-SHW-BV2-000240 NP-Attachment 4 Calculation 10080-UR(B)-496, Revision 3, “Site Boundary and Control Room Doses following a Steam Generator Tube Rupture based on Core Uprate and Alternative Source Term Methodology”
(Nonproprietary Version)

(95 pages follow)

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CALCULATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.	VENDOR CALCULATION NO.
10080-UR(B)-496	N/A

☐ BV1 ☒ BV2 ☐ BV1/2 ☐ BV3 ☐ BVSWT | ☐ DB | ☐ PY

Title/Subject: Site Boundary and Control Room Doses following a Steam Generator Tube Rupture based on Core Uprate and Alternative Source Term Methodology

Category:	☒ Active ☐ Historical ☐ Study — **Vendor Calc Summary:** Yes ☐ No ☒
Classification:	☒ Tier 1 Calculation ☒ Safety-Related/Augmented Quality ☐ Non-safety-Related
Open Assumptions?:	☐ Yes ☒ No If Yes, Enter Tracking Number
System Number:	N/A
Functional Location :	N/A
Commitments:	None
Initiating Documents:	CR-2017-10857

(PY) Calculation Type:

(PY) Referenced In USAR Validation Database ☐ Yes ☐ No | (PY) Referenced In Atlas? ☐ Yes ☐ No

Computer Program(s)

Program Name	Version / Revision	Category	Status	Description
PERC2	V00 / L02	B	Active	Activity Transport and Consequence

Revision Record

Rev.	Affected Pages	Originator *(Print, Sign & Date)*	Reviewer/Design Verifier *(Print, Sign & Date)*	Approver *(Print, Sign & Date)*
3	N/A	Keith Ferguson 02/04/2019	Joseph Baron 02/04/2019	Sreela Ferguson 02/04/2019
	Description of Change: As part of a Long Term Objective, the dose consequences at the Site Boundary and Control Room following a Steam Generator Tube rupture has been updated to facilitate relaxation of operational limits that currently affect plant operation; specifically to allow an increase in the allowable unfiltered inleakage into the Control room Envelope. Also included is a review / update of all design input parameter values / references to reflect current plant design.			
	Describe where the calculation will be evaluated for 10CFR50.59 and/or 10CFR72.48 applicability. Regulatory Applicability Determination and 10CFR50.59 Screen 18-01778 is attached to this calculation			
Rev.	Affected Pages	Originator *(Print, Sign & Date)*	Reviewer/Design Verifier *(Print, Sign & Date)*	Approver *(Print, Sign & Date)*
2	NA	Yi Yu (9/28/2015)	Wu-Hung Peng 9/28/2015	Sreela Ferguson 9/28/2105
	Description of Change:			
	Describe where the calculation will be evaluated for 10CFR50.59 and/or 10CFR72.48 applicability.			

~~PROPRIETARY~~

FirstEnergy NOP-CC-3002-01 Rev. 05	**CALCULATION**	Page ii
CALCULATION NO. 10080-UR(B)-496, Revision 3	**[ ] VENDOR CALC SUMMARY VENDOR CALCULATION NO. N/A**	

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CALCULATION NO. **10080-UR(B)-496, Revision 3**	**[ ] VENDOR CALC SUMMARY** **VENDOR CALCULATION NO. N/A**

OBJECTIVE OR PURPOSE:

The objective of this calculation is to determine the airborne dose at the Exclusion Area Boundary (EAB), Low Population Zone (LPZ) and Control Room (CR) at Beaver Valley Power Station (BVPS) Unit 2 following a postulated Steam Generator Tube Rupture (SGTR) Accident. The analysis is based on a core power level of 2918 MWt (i.e., the uprated core thermal power level with margin for power uncertainty).

The calculated dose is based on "Alternative Source Terms" per Regulatory Guide (RG) 1.183, Revision 0, increased allowable unfiltered inleakage into the Control Room Envelope (CRE), and current design input parameter values as provided by First Energy Nuclear Operating Company (FENOC) via DIN# 1 and 11, and included as Attachments 1 and 2 of this calculation.

SCOPE OF CALCULATION:

As part of a Long Term Objective, and with the intent of providing operational margin, the BVPS design basis site boundary and control room dose consequence analyses are being updated to facilitate relaxation of certain operational limits that have significant effect on plant operation. To that end, Revision 3 herein investigates the impact of a proposed increase in the allowable unfiltered inleakage into the Control Room Envelope (CRE), on the dose consequences following a SGTR accident at Unit 2.

The objective of Revision 3 is to demonstrate continued compliance with the dose acceptance criteria of 10CFR50.67 (as modified by Table 6 of RG 1.183 R0) after taking into consideration the following:

a) An increase in allowable unfiltered inleakage into the CRE (inclusive of that associated with ingress /egress) from 30 cfm to 165 cfm.

b) Review / Update (as needed) of all design input parameter values / references to reflect current plant design.

SUMMARY OF RESULTS/CONCLUSIONS:

The BVPS Site Boundary and Control Room doses due to airborne radioactive material released following a SGTR at U2 will remain within the regulatory limits set by 10CFR50.67 and Regulatory Guide 1.183.

In accordance with regulatory guidance, two scenarios are evaluated, i.e., a Pre-accident Iodine Spike and a Concurrent Iodine spike. As noted in Section 8, the pre-accident iodine spike scenario is bounding.

Control Room

The 30-day integrated dose to the Control Room (CR) operator is 0.4 rem TEDE. This value is below the regulatory limit of 5 rem TEDE.

Note: *In accordance with current licensing basis, the CR dose estimates following a SGTR at Unit 2 is based on the assumption that the CR ventilation system remains in normal operation mode, and that the CR is purged at a minimum flow rate of 16,200 cfm between t=8 hrs and t=8.5 hrs after which it reverts to the normal operation mode.*

Site Boundary

The limiting integrated dose to an individual located at any point on the boundary of the exclusion area for any 2-hour period following the onset of the event is 1.3 rem TEDE (t=0 hr to t=2 hour time window). This dose is less than the regulatory limit of 25 rem TEDE for the pre-accident iodine spike.

The limiting integrated dose to an individual located at LPZ following the onset of the event is 0.08 rem TEDE. This dose is also less than the regulatory limit of 25 rem TEDE for the pre-accident iodine spike.

It is noted however that although the estimated doses at the EAB and LPZ due to a concurrent iodine spike are bounded by the estimated doses reported above due to the pre-accident iodine spike, the margin to the regulatory limit for the concurrent iodine spike (i.e., 2.5 rem TEDE), is less. (See Section 8 for detail).

LIMITATIONS OR RESTRICTIONS ON CALCULATION APPLICABILITY:

NRC approval of the increase in the maximum allowable unfiltered inleakage into the CRE (inclusive of that associated with ingress /egress) from 30 cfm to 165 cfm.

IMPACT ON OUTPUT DOCUMENTS:

Unit 2 UFSAR Section 15.6.3.4 and associated tables, as needed.

FirstEnergy	NOP-CC-3002-01 Rev. 05	**CALCULATION**	Page v
CALCULATION NO. **10080-UR(B)-496, Revision 3**		**[ ] VENDOR CALC SUMMARY** **VENDOR CALCULATION NO. N/A**	

DESIGN VERIFICATION FORM

Project Name:	**BVPS Control Room Dose Consequence Analyses Update**	**Job Number:**	**7001041**
Verified Document No.:	**10080-UR(B)-496**	**Revision:**	**3**
Verified Document Title:	**Site Boundary and Control Room Doses following a Steam Generator Tube Rupture based on Core Uprate and Alternative Source Term Methodology**	**Date Verified:**	**02/04/2019**
Verifier's Name/Signature:	**Joseph S. Baron** [signature]		**02/04/2019**
Lead Engr. Concurrence Name/Signature/ Date	**Sreela Ferguson** [signature]		**02/04/2019**
Extent of Review: (entire document or not)	Full ☒ Partial ☐	If partial, specify what was reviewed:	
Method of Review	Design Review ☒ Alternate Calculation/Analysis ☐ Qualification Testing ☐		
Incomplete or unverified portions of design:	NA		
Consideration of known problems affecting the standard or previously proven design document:	NA		

THE FOLLOWING QUESTIONS ARE SUMMARIZED. REFER TO NEPP 4-43 FOR COMPLETE REVIEW REQUIREMENTS. ADDRESS ADDITIONAL APPLICABLE REVIEWS IN COMMENT/JUSTIFICATION BLOCK AS NECESSARY.

Design Reviews	Inputs have been properly selected?	Yes ☒ No ☐
	Assumptions are adequately described and reasonable?	Yes ☒ No ☐
	Methodology, including computer programs, to assure the appropriateness of the overall approach, its implementation, and the correctness of the specific information and correlations utilized?	Yes ☒ No ☐
	Inputs are correctly used in the document, including validity of references identified?	Yes ☒ No ☐
	Design Output is reasonable compared to the inputs used?	Yes ☒ No ☐
	Design Input and Verification Requirements for interfacing organizations are specified in design documents or in supporting procedures?	Yes ☒ No ☐
Administrative Check Of Format And Content		Yes ☒ No ☐

Comments/Justification (Identify comment subject and associated response.)
The results of this calculation are based on the design input provided by FENOC

CALCULATION NO. **10080-UR(B)-496, Revision 3**	**[ ] VENDOR CALC SUMMARY** **VENDOR CALCULATION NO. N/A**

DOCUMENT INDEX

DIN No.	Document Number/Title	Revision, Edition, Date	Reference	Input	Output
1	FENOC Letter ND1MDE:0732: BV2 Complete Reanalysis of Dose Consequences for CRE Tracer Gas Testing and other Acceptance Criteria Changes: Design Input Transmittal DIT-BVDM-0112-00 for Steam Generator Tube Rupture	September 11, 2018	☒	☒	☐
2	Reg. Guide 1.183, “Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors”	July 2000	☒	☐	☐
3	10CFR50.67, “Accident Source Term”	N/A	☒	☐	☐
4	Radiological Engineering & Waste Management Generic Library Data Volume I, Average β/γEnergies and Inhalation Dose Conversion Factors	September 26 1996	☒	☐	☐
5	EPA-520/1-88-020, Federal Guidance Report No.11, “Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion and Ingestion.”	September 1988	☒	☐	☐
6	WECTEC Calculation 10080-UR(B)-484, “Primary and Secondary Coolant Design/Technical Specification Activity Concentrations including Pre-Accident Iodine Spike concentrations and Equilibrium Iodine Appearance Rates”	Rev 1	☒	☒	☐
7	ANSI/ANS 6.1.1-1991, “Neutron and Gamma-ray Fluence-to-dose Factors”	1991	☒	☐	☐
8	DOE/TIC-11026, “Radioactive Decay Data Tables - A Handbook of Decay Data for Application to Radiation Dosimetry and Radiological Assessments”,	Kocher, 1981	☒	☐	☐
9	WECTEC Calculation 10080-EN-ME-106, “Atmospheric Dispersion Factors (χ/Qs) at Control Room and ERF Receptors for Unit 2 Accident Releases Using the ARCON96 Methodology”	Rev 0, including all Addenda	☒	☒	☐

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CALCULATION NO. **10080-UR(B)-496, Revision 3**		**[ ] VENDOR CALC SUMMARY** **VENDOR CALCULATION NO. N/A**	

DIN No.	Document Number/Title	Revision, Edition, Date	Reference	Input	Output
10	WECTEC Computer Program NU-226, Ver. 00, Lev. 02, PERC2, “Passive/Evolutionary Regulatory Consequence Code”	September 22, 2006	☒	☒	☐
11	FENOC Letter ND1MDE:0738, BV1 & BV2 Complete Reanalysis of Dose Consequences for CRE Tracer Gas Testing and Other Acceptance Criteria Changes - Design input Transmittal DIT-BVDM-0103-03 for Control Room Dose	January 29, 2019	☒	☒	☐
12	Lawrence Berkeley Laboratory, University of California, Berkeley, “Table of Isotopes”	7th Edition	☒	☐	☐
13	TID-24190, Air Resources Laboratories, “Meteorology and Atomic Energy”	July 1968	☒	☒	☐
14	WECTEC Calculation 10080-UR(B)-514, Confirm Continued Validity of the Current Licensing Basis 4-hour Duration of the BVPS Post-Accident Concurrent Iodine Spike assuming Alternate Source Terms and Gap Fractions based on Draft Guide 1199	Rev 0	☒	☐	☐
15	BV Condition Report CR-2017-10857, 3BVT1.44.5 testing 1VS-D-40-1D Component Test Results	October 28, 2017	☒	☐	☐

CALCULATION NO. 10080-UR(B)-496, Revision 3	[ ] VENDOR CALC SUMMARY VENDOR CALCULATION NO. N/A

REVISION STATUS

Revision Number	Affected Sections	Description of Revision
0	N/A	Original Issue
Rev 0, Addendum 1	Section 3 Item 14, Section 5, Section 9 and Section 10 of Revision 0.	The Addendum determined the impact on the Unit 2 SGTR site boundary and control room dose estimates resulting from use of an updated Westinghouse design input value for the time at which break flow flashing is terminated. In the original analysis break flow flashing occurred until the break flow terminated at 3160 seconds after the SGTR. For this addendum, based on DIN# 1, break blow flashing ends at 1742.5 seconds after the accident. All other data and assumptions remain the same as Rev.0.
Rev 1	ALL	The scope of this Revision is to replace Rev.0 (& Addendum 1) in its entirety, incorporating the updated Westinghouse thermal-hydraulic input data which reflects change of break flow that flashes and an increase in the operator action time to close the stuck open ADV from 6.5 minutes to 10 minutes.
Rev 1 Addendum 1	Design Input Section: Items 12, 14, 16, and 17	The Addendum determined the impact on the Unit 2 SGTR site boundary and control room dose estimates resulting from the reduced capacity of the atmospheric dump valves and associated changes in the SGTR environmental releases. The addendum concludes that the site boundary and control room doses documented in Rev. 1 remain bounding.
Rev 2	All	The scope of this Revision is to replace Rev.1 and Addendum 1 of Rev.1 in its entirety, incorporating the updated Westinghouse thermal-hydraulic input data that reflect the Unit 2 RSGs.
Rev.3	All	Complete update to address: 1) An increase in allowable unfiltered inleakage into the Control Room Envelope from 30 cfm to 165 cfm. 2) Review / Update (as needed) of all design input parameter values / references to reflect current plant design.

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CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-496	REVISION: 3

BACKGROUND / APPROACH

1.1 Background

Beaver Valley Power Station (BVPS) has implemented Alternative Source terms (AST) in accordance with Regulatory Guide (RG) 1.183, Revision 0. The dose consequences at the Exclusion Area Boundary (EAB), Low Population Zone (LPZ) and Control Room (CR) for a postulated Steam Generator Tube Rupture (SGTR), at BVPS Unit 2, based on AST methodology and Extended Power Uprate (EPU) is currently documented in Revision 1.

Revision 2 of this analysis was developed to address the Unit 2 Replacement Steam Generators (RSGs). However, since implementation of BVPS 2 RSGs has been delayed, Revision 3 herein, is based on the Original Steam Generators (OSGs).

As part of a Long Term Objective, and with the intent of providing operational margin, the BVPS design basis site boundary and control room dose consequence analyses are being updated to facilitate relaxation of certain operational limits that have significant effect on plant operation. To that end, Revision 3 investigates the impact of a proposed increase in the allowable unfiltered inleakage into the Control Room Envelope (CRE), on the dose consequences following a Steam Generator Tube Rupture (SGTR) at Unit 2.

In addition, since the installation of the BVPS-2 RSGs have been delayed, two sets of Technical Specification activities are planned - one for BVPS-1 (based on the current T/S coolant activity limits) and the other for BVPS-2 (based on a proposed “reduced” T/S coolant activity limit).

The BVPS-2 T/S activity limits will be used to assess the dose consequences of a BVPS-2 Main Steam Line Break (MSLB). The BVPS-1 T/S activity limits will be used to assess the dose consequences of all postulated BVPS-1 design basis accidents (DBAs), and to conservatively assess the dose consequences of the remaining BVPS-2 DBAs, which includes the SGTR.

In summary, the objective of Revision 3 is to demonstrate continued compliance with the dose acceptance criteria of 10CFR50.67, as modified by Table 6 of RG 1.183 R0, based on the following:

a) An increase in allowable unfiltered inleakage into the CRE (inclusive of that associated with ingress/egress) from 30 cfm to 165 cfm. This is intended to address the fact that recent CRE Tracer Gas Tests indicate unfiltered CRE inleakage that are in excess of the values used in the design basis dose consequence analyses.

b) Review / Update (as needed) of all design input parameter values / references to reflect current plant design.

c) Use of BVPS-1 T/S activity limits.

1.2 Approach

This event assumes the instantaneous rupture of one steam generator (SG) tube with a resultant release of primary coolant into the lower pressure secondary system. Based on an assumption of a Loss of Offsite Power (simultaneous with reactor trip), the condenser is assumed to be unavailable, and environmental steam releases via the Main Steam Safety Valves (MSSVs) and Atmospheric Dump Valves (ADVs) of the intact steam generators are used to cool down the reactor until initiation of shutdown cooling via the RHR system. A portion of the primary coolant break flow into the ruptured SG flashes and is released a) to the condenser before reactor trip and b) directly to the environment after reactor trip, via the MSSVs / ADVs. The remaining break flow mixes with the secondary side liquid, and is released to the environment via steam releases through MSSVs and ADVs. The activity in the RCS also leaks into the intact steam generators via SG tube leakage and is released to the environment from the MSSVs / ADVs.

Regulatory guidance provided in Regulatory Guide 1.183 Appendix F (DIN# 2) is used to develop the dose consequence model. The key assumptions / parameters utilized to develop the radiological consequences following a SGTR are listed in DIN# 1.

Per DIN# 1, no melt or clad breach is postulated for the U1 BVPS SGTR event. Thus, and in accordance with RG 1.183, the activity released is based on the maximum coolant activity allowed by the plant Technical Specifications. In addition, and per RG 1.183, two scenarios are addressed, i.e., a) a pre-accident iodine spike which reflects the maximum allowable iodine spike activity level per the Plant Technical Specifications and b) an accident-initiated iodine spike (also called a concurrent iodine spike) which results in an increase in the iodine appearance rate from the fuel to the RCS by 335 times.

Activity Transport

WECTEC computer program PERC2 (DIN# 10) is used to calculate the Committed Effective Dose Equivalent (CEDE) from inhalation and the Deep Dose Equivalent (DDE) from submersion due to halogens and noble gases at the offsite locations and in the control room. PERC2 is a multiple compartment activity transport code with the dose model consistent with the regulatory guidance. The decay and daughter build-up during the activity transport among compartments and the various cleanup mechanisms are included.

The BVPS design input parameters utilized in the Unit 2 SGTR analysis are provided via DIN# 1 and 11.

The thermo-hydraulic transient analysis of a postulated SGTR at Unit 2 and other input parameters that are required to determine the dose consequences at the control room and offsite locations, are summarized in DIN# 1.

Based on DIN# 1 the radiological model used for the SGTR analysis conservatively assumes, reactor trip occurs at 116 seconds after the tube rupture. Due to the tube rupture the primary coolant with elevated iodine concentrations (pre-accident or concurrent iodine spike) flows to the ruptured steam generator and the associated activities are released to the environment due to secondary side steam releases. Before the reactor trip, the activities are released from the air ejector. After the reactor trip the steam release is from both the ruptured and intact SGs via the MSSVs/ADVs. The primary coolant activities due to the iodine spike is leaked into the intact steam generator at the maximum allowable primary-to-secondary leakage value and are also released to the environment via secondary steam releases.

The steam releases from the intact SGs, continue until shutdown cooling is initiated via operation of the RHR system at T= 8 hrs, resulting in the termination of environmental releases via this pathway. Releases from the ruptured SG are assumed to stop when the SG is isolated. The ruptured SG break flow termination time is 4076 seconds.

EAB Worst Case 2-hr Window

AST methodology requires that the worst case dose to an individual located at any point on the boundary at the EAB, for any 2-hour period following the onset of the accident be reported as the EAB dose. It is noted that regardless of the starting point of the worst 2 hr window, the 0-2 hr EAB χ/Q (limiting) is utilized.

The major source radioactivity release following a SGTR, and thus dose consequences, is the flashed portion of the RCS break flow, which is released from condenser/air ejector before reactor trip and from MSSVs/ ADVs after reactor trip until it is terminated at T = 1932.5 seconds. Therefore, the worst 2-hr window dose occurs during T = 0 to 2 hours after the accident. To ensure the maximum 2-hour window dose is calculated, the brief depressurization steam release from the ruptured steam generator is conservatively modeled as a release during the time period T= 119 minutes to 120 minutes.

Source Terms

Since there is no fuel damage during the course of the accident, the main source of release of radioactivity are the primary and secondary coolant systems. For the primary coolant, two spiking cases are addressed: a pre-accident iodine spike and a concurrent iodine spike. The resultant RCS activity leaks into the ruptured and intact SGs via SG tube leakage, and is released to the environment from the break point, and from the MSSVs / ADVs, respectively.

a) Pre-accident iodine spike - the initial primary coolant iodine activity is based on a maximum allowable pre-accident iodine spike activity level per the Plant Technical Specifications of 60 times the equilibrium Technical Specification iodine activity concentration of 0.35 µCi/gm DE I-131 (DIN# 1) or 21 µCi/gm of DE I-131 (transient Technical Specification limit for full power operation). The initial primary coolant noble gas activity is consistent with the design basis relative mix and activity levels associated with the Tech Spec iodine concentrations in the coolant.

b) Concurrent iodine spike - the initial primary coolant iodine activity is assumed to be at the equilibrium Technical Specification iodine activity concentration of 0.35 µCi/gm DE I-131. Immediately following the accident the iodine appearance rate from the fuel to the primary coolant is assumed to increase to 335 times (per DIN# 2) the equilibrium appearance rate corresponding to the 0.35 µCi/gm DE I-131 coolant concentration allowed by the plant Technical Specifications. The duration of the assumed spike is 4 hours (DIN# 1). The initial primary coolant noble gas activity is assumed to be at Tech Spec levels. (See discussion under item a).

The secondary coolant iodine activity, just prior to the accident, is also assumed to be at the Technical Specification limit of 0.1 µCi/gm DE I-131.

Activity Release Model

Ruptured SG Release

A postulated SGTR will result in a large amount of primary coolant being released to the ruptured steam generator via the ruptured tube with a significant portion of it flashed to the steam space. The noble gases in the entire break flow and the iodine in the flashed flow are assumed immediately available for release from the steam generator. The iodine in the non-flashed portion of the break flow mixes uniformly with the steam generator liquid mass and is released into the steam space in proportion to the steaming rate and partition factor. To maximize the calculated offsite doses it is assumed that offsite power is lost (LOOP) so that the main condensers are not available. Before the reactor trip at 116 seconds, the radioactivity in the steam is released to the environment from the air ejector/ condenser. The noble gases and organic iodine in the steam are released directly to the environment. Only a portion of the elemental iodine carried with the steam is partitioned to the air ejector and released to the environment. The rest is partitioned to the condensate, returned to all three steam generators and assumed to be available for future steaming release. After the reactor trip, the break flow continues until the primary system is fully depressurized and the break flow terminates at 4076 seconds after the accident. The steam is released from the MSSVs/ADVs. The steam release from the ruptured steam generator including release from the failed- open ADV continues until it is isolated. Additionally, there is also a brief period of steam release from the ruptured SG when it is manually depressurized between T= 2 hours and T = 8 hours in preparation for RHR operation.

Intact SG release

The activity release from the intact steam generator is due to normal primary-to-secondary leakage and steam release from the secondary side. The primary to secondary coolant leak rate is assumed to be at the maximum Tech Spec allowable value. All leaked primary coolant iodine activities are assumed to mix uniformly with the steam generator liquid and are released in proportion to the steaming rate and the partition factor. Before the reactor trip, the main steam is released from the air ejector/ condenser. After the reactor trip, the steam is released from the MSSVs/ADVs. The reactor coolant noble gases that enter the intact steam generator are released directly to the environment without holdup. Because the intact steam generator is used to cool down the reactor until the shutdown cooling starts, the steam release from intact steam generators continues until 8 hours after the accident.

Per DIN# 1, the effect of SG tube uncovery in intact SGs (for SGTR and non-SGTR events), has been evaluated for potential impact on dose consequences as part of a Westinghouse Owners Group (WOG) Program and demonstrated to be insignificant; therefore, and per RG 1.183, R0, the iodines are assumed to have a partition coefficient of 100 in the SG and released to the environment in proportion to the steaming rate and the partition coefficient. In accordance with RG 1.183, R0, the iodine releases to the environment from the SG are assumed to be 97% elemental and 3% organic. The noble gases are released freely to the environment without retention in the SG.

Release of Initial SG Liquid Activity

The initial iodine inventory in the steam generator liquid at Tech. Spec. level (0.1 µCi/gm DE I-131) is released to the environment due to steam releases, via the condenser/air ejector before reactor trip and via the MSSVs/ADVs after reactor trip. The release from the ruptured SG stops when it is isolated except for a brief period between T= 2 to 8 hrs when it is manually depressurized. The release from intact steam generators continues until 8 hours after the accident.

Control Room Design/Operation/Transport Modeling

Control Room Design / Operation

Beaver Valley Power Station is served by a single control room that supports both Units. The joint control room is serviced by two ventilation intakes, one assigned to BVPS-1 and the other to BVPS-2. These air intakes are utilized for both the normal as well as the accident mode.

During normal plant operation, both ventilation intakes are operable providing a total supply of 1250 cfm of unfiltered outside air makeup which includes all potential inleakage and uncertainties (Note: this value is the total for both U1 and U2 intakes with margin; it includes the intake flow and all unfiltered inleakage (including that associated with ingress / egress and all potential inleakage) with uncertainties). (DIN# 11)

The containment high-high pressure signal (CIB) signals from either unit initiate the BVPS-2 control room emergency ventilation system. In the event one of the BVPS-2 trains is out of service, and the second train fails to start, operator action will be utilized to initiate the BVPS-1 control room emergency pressurization system.

The CR emergency pressurization intake filter has an efficiency of 99% for particulates, and 98% for elemental and organic iodine (DIN# 11).

Filtration of the Control Room ventilation recirculation flows during all modes of operation, by particulate air filters (intended for dust removal) in the CRVS recirculation air-conditioning system, is not credited.

The control room emergency filtered ventilation intake flow varies between 800 to 1000 cfm, which includes allowance for measurement uncertainties (DIN# 11). The control room unfiltered inleakage during the emergency pressurization mode is conservatively assumed to be 165 cfm (includes 10 cfm unfiltered inleakage due to ingress / egress) to reflect the results of tracer gas testing in the pressurized mode, and to also accommodate margin for potential future deterioration.

Control Room Transport Model

Since the BVPS control rooms (CR) are contained in a single control room envelope, they are modeled as a single region. Isotopic concentrations in areas outside the control room envelope are assumed to be comparable to the isotopic concentrations at the control room intake locations. To support development of bounding control room doses, the most limiting χ/Q associated with the release point / receptor for an event in either unit, is utilized.

The control room post-accident ventilation model utilized in the dose analysis corresponds to an assumed "single intake" which utilizes the worst case atmospheric dispersion factor (χ/Q) from release points to the limiting control room intake. The atmospheric dispersion factors are provided in Section 2.

Based on DIN# 11, the atmospheric dispersion factors associated with control room inleakage are assumed to be the same as those utilized for the control room intake. (Also, see Assumption 5)

To provide operational margin, and in accordance with DIN# 11, the analysis herein assumes that during normal plant operation, the BVPS-1 & BVPS-2 unfiltered intake plus inleakage is a maximum of 1250 cfm (total for both Units). This maximum normal operation unfiltered inflow to the CR is an analytical upper bound value that is intended to include a) the CR intake flow rate (including test measurements uncertainties), b) all unfiltered inleakage and c) a 10 cfm allowance for ingress / egress. The above value bounds the test results of BV1/2 Procedure 3BVT 1.44.05 via Order 200699902. See Section 3, Assumption 4 for additional details.

Based on DIN# 1, the control room emergency ventilation is not automatically initiated, and the unfiltered intake flow into the control room remains at the normal operation flow of 1250 cfm. Eight (8) hours after a postulated SGTR at BVPS Unit 2, the CR free volume is purged at 16,200 cfm for 30 minutes. After purging the vent system is returned to the normal mode of operation. Also see Section 6.3.

Dose Calculation Model

WECTEC radiological consequence program PERC2 is used to calculate the Committed Effective Dose Equivalent (CEDE) from inhalation and the Deep Dose Equivalent (DDE) from submersion due to halogens and noble gases transported to offsite locations and in the control room. The CEDE is calculated with dose conversion factors from DIN# 5, which uses the methodology provided in ICRP-30. The committed doses to other organs due to inhalation of halogens, particulates and noble gas daughters are also calculated. PERC2 is a multiple compartment activity transport code with the dose model consistent with the regulatory guidance. The decay and daughter build-up during the activity transport among compartments and the various cleanup mechanisms are included.

The PERC2 activity transport model, first calculates the integrated activity (using a closed form integration solution) at the offsite locations and in the control room air region, and then calculates the cumulative doses as described below:

Committed Effective Dose Equivalent (CEDE) Inhalation Dose - The dose conversion factors by isotope and internal organ type are applied to the activity in the air space of the control room, or at the EAB/LPZ. The exposure is adjusted by the appropriate respiration rate and occupancy factors for the CR dose at each integration interval as follows:

$$Dh(j) = A(j) \times h(j) \times C2 \times C3 \times CB \times CO$$

Where:

Dh(j) = Committed Effective Dose Equivalent (rem) from isotope j

A(j) = Integrated Activity (Ci-s/m^3)

h(j) = Isotope j Committed Effective Dose Equivalent (CEDE) dose conversion factor (mrem/pCi) based on Fed. Guidance Report No.11, Sept. 1988 (DIN# 5)

C2 = Unit conversion of 1×10^{12} pCi/Ci

C3 = Unit conversion of 1×10^{-3} rem/mrem

CB = Breathing rate (m^3/s)
CO = Occupancy factor

Deep Dose Equivalent (DDE) from External Exposure - According to the guidance provided in Section 4.1.4 and Section 4.2.7 of RG 1.1.83, R0 (DIN# 2), the Effective Dose Equivalent (EDE) may be used in lieu of DDE in determining the contribution of external dose to the TEDE if the whole body is irradiated uniformly. The EDE in the control room is based on a finite cloud model that addresses buildup and attenuation in air. The dose equation is based on the assumption that the dose point is at the center of a hemisphere of the same volume as the control room. The dose rate at that point is calculated as the sum of typical differential shell elements at a radius R. The equation utilizes, the integrated activity in the control room air space, the photon energy release rates per energy group from activity airborne in the control room based on using the isotopic gamma energy library data developed in DIN# 4 based on DIN#s 12 and 8, and the ANSI/ANS 6.1.1-1991 "Neutron and Gamma-ray Fluence-to-dose Factors", DIN# 7.

The Deep Dose Equivalent at the EAB and LPZ locations is very conservatively calculated using the semi-infinite cloud model outlined in TID-24190 (DIN# 13), Section 7-5.2, Equation 7.36, where 1 rad is assumed to be equal to 1 rem.

$\gamma D\infty$ (x,y,0) rad = $0.25\ E\gamma_{BAR}\ \psi$ (x,y,0)
$E\gamma_{BAR}$ = average gamma energy released per disintegration (Mev/dis)
is based on the isotopic gamma energy data developed in DIN# 4
ψ (x,y,0) = concentration time integral (Ci-sec/m^3)
0.25 = $[1.11 \bullet 1.6\text{x}10^{-6} \bullet 3.7\text{x}10^{10}] / [1293 \bullet 100 \bullet 2]$

Where:
1.11 = ratio of electron densities per gm of tissue to per gm of air
$1.6\text{x}10^{-6}$ (erg/Mev) = number of ergs per Mev
$3.7\text{x}10^{10}$ (dis/sec-Ci) = disintegration rate per curie
1293 (g/m^3) = density of air at S.T.P.
100 = ergs per gram per rad
2 = factor for converting an infinite to a semi-infinite cloud

2.0 DESIGN INPUTS

All input parameters values associated with BVPS design used in this analysis including identification of the source documents from which the parameter values were obtained, have been verified / approved for use by FENOC and provided to WECTEC via DIN# 1 and 11 (included herein as Attachments 1 and 2). Comments / explanations associated with the parameter values presented below are provided in DIN# 1 and 11 under the "Comment" column, and provide additional information that may be useful to the user.

General Comment (Per DIN# 1 & 11)
The equipment / parameter values presented below as approved design input reflect safety related components that can be credited in design bases dose consequence analyses; i.e., the components have the appropriate redundancy, environmental qualification, pedigree, seismic support etc. applicable to safety related equipment, and the parameter values reflect single failure criteria.

Design Input Parameter / Value **DIN#**

1. Reactor Core thermal power – 2918 MW (100.6% of uprate power level of 2900 MW) [1]
2. Failed Fuel Percentage – 0% [1]
3. Melted fuel percentage – 0% [1]
4. Primary Coolant and Secondary Side Halogen and Noble Gas Concentrations at Technical Spec Limits (0.35 μCi/gm DE I-131 for primary coolant, 0.1 μCi/gm DE I-131 for the secondary side - conservatively based on BV-1) in μCi/gm [1] [6]

Nuclide		Reactor Coolant (μCi/gm)		Secondary Liquid (μCi/gm)
KR 83M		4.09E-02		
KR 85M		1.48E-01		
KR 85		1.30E+01		
KR 87		9.68E-02		
KR 88		2.74E-01		
KR 89		7.80E-03		
XE131M		5.54E-01		
XE133M		4.59E-01		
XE133		3.34E+01		
XE135M		9.87E-02		
XE135		1.02E+00		
XE137		2.03E-02		
XE138		6.86E-02		

		Reactor		Secondary
		Coolant		Liquid
Nuclide		(µCi/gm)		(µCi/gm)
BR83		7.64E-03		
BR84		3.84E-03		
BR85		4.07E-04		
BR87		2.11E-04		
I129		1.04E-08		3.34E-09
I130		4.52E-03		8.38E-04
I131		2.73E-01		8.34E-02
I132		1.13E-01		1.39E-02
I133		4.17E-01		9.32E-02
I134		6.47E-02		1.90E-03
I135		2.46E-01		3.34E-02
I136		7.07E-04		5.79E-07

5. Primary Coolant Iodine Concentrations with Pre-accident Spike (21 µCi/gm DE I-131, conservatively based on BV-1) [1] [6]

Nuclide			
I131		1.64E+01	µCi/gm
I132		6.77E+00	µCi/gm
I133		2.50E+01	µCi/gm
I134		3.88E+00	µCi/gm
I135		1.48E+01	µCi/gm

6. Iodine Appearance Rate at Equilibrium Technical Spec Concentrations (based on 0.35 µCi/gm DE I-131; conservatively based on BV-1) [1] [6]

Nuclide			
I131		2.27E+03	µCi/sec
I132		2.83E+03	µCi/sec
I133		4.17E+03	µCi/sec
I134		3.39E+03	µCi/sec
I135		3.44E+03	µCi/sec

7. Iodine Appearance Rate with Concurrent Spike = 335 x Design Input 6 values [1] [2]
8. Duration of Iodine Concurrent Spike = 4 hours [1] [14]
9. Chemical form of halogens released via steam generators [1] [2]

97% elemental, 3% organic

10. Primary to Secondary Coolant leakage rate in Intact SGs [1]

    150 gpd @ STP per SG, leakage density 1g/cc

11. Initial & Minimum post-accident reactor coolant mass [1]

    368,000 lbm

12. Time Till Reactor Trip – 116 seconds [1]

13. Activity Release Path [1] [2]

    Before reactor trip – Condenser/ air ejector effluent

    After reactor trip – MSSVs/ADVs

14. Break Flow from RCS to Ruptured SG and the portion that flashes [1]

Time (sec)	Break Flow (lbm)	Break Flow that Flash (lbm)
0 to 116	9,200	1730.2
116 to 1932.5	-----	6814.5
116 to 4076	197,400	-----

15. Maximum main steam flow to condenser before reactor trip [1]

    Ruptured SG - 142,300 lbm

    Intact SGs - 281,900 lbm

16. Maximum Steam Releases from ruptured SG via MSSVs/ADVs [1]

Time	MSSVs/ADVs Release
(sec)	(lbm)
116 – 4076	67,300
4076 - 7200	0.0
7200 – 28,800*	46,800

* A brief depressurization release in preparation of shutdown cooling

17. Maximum Steam Releases from intact SGs via MSSVs/ADVs [1]

Time	MSSVs/ADVs Release
(sec)	(lbm)
116 – 4076	163,500
4076 – 7200	216,800
7200 – 28,800	798,500

18. Time period of tube uncovery – negligible [1]

20. Partition Coefficient in Steam Generators [1] [2]

Flashed portion of the rupture flow:

Noble Gas & iodine – released freely with no retention

Non-flashed portion of the rupture flow and leakage flow in intact SGs:

Noble Gas – released freely with no retention

Iodine – 100

Partition Coefficient = $\frac{\text{mass of iodine per unit mass of liquid}}{\text{mass of iodine per unit mass of steam}}$

21. Partition Factor in Condenser/ Air Ejector [1]

Noble Gas – 1 (all released)

Organic iodine – 1 (all released)

Elemental iodine – 100 (1/100th released)

22. Minimum post-accident Steam Generator Liquid Mass [1]

95,150 lbm for each SG (ruptured and intact SGs)

23. Initial Steam Generator Liquid Mass [1]

95,150 lbm for each SG

24. Control Room Breathing Rate [2] [11]

0-30 day - 3.5E-04 m^3/sec

25. Control Room Occupancy Factors [2] [11]

0-1 day	1.0
1-4 day	0.6
4-30 day	0.4

26. Minimum Control Room Envelope Free Volume [11]

173,000 ft^3

27. Maximum unfiltered normal operation ventilation air intake into the CR [11]

1250 cfm

(Total for both U1 and U2 intakes with margin, includes intake and all unfiltered inleakage, including that associated with ingress / egress)

This is an assumed value intended to provide operational margin – see Assumption 4.

28. Post-accident control room purge [1]

16,200 cfm from 8 hr to 8.5 hr

29. Dispersion factor from MSSV/ADV and Air Ejector (T.B. NW corner) to the control room (Unit 2 intake value is more limiting) [1] [9]

Time	MSSV/ADV	T.B. NW Corner
0-2hr	5.01E-04 s/m^3	1.03E-03 s/m^3
2-8hr	3.58E-04 s/m^3	7.84E-04 s/m^3

30. Exclusion Area Boundary χ/Q [11]

0-2 hr - 1.25E-03 sec/m^3

31. Low Population Zone χ/Q [11]

0-8 hr - 6.04E-05 sec/m^3

32. Offsite Breathing Rate [2] [11]

0-8 hr	3.5E-04 m^3/sec
8-24 hr	1.8E-04 m^3/sec
1-30 day	2.3E-04 m^3/sec

3.0 ASSUMPTIONS

Assumptions utilized in this assessment have been approved by FENOC and were provided to WECTEC via DIN# 1 and 11. None of these assumptions need further verification. Discussions regarding the bases of these assumptions are also included in DIN# 1 and 11. Summarized below are some of the salient assumptions, including those made by the author when developing the transport models:

1. Assumptions used in the SGTR dose consequence transport model that are listed as Design Input No. 7, 9, 13, 19, 23, 24, 31 are based on the guidance provided in RG 1.183, Revision 0. The partition factor in the condenser listed under Design Input No. 20 is based on guidance provided in NUREG 0017, R1.
2. As accordance with DIN# 14, the concurrent iodine spike is assumed to last 4 hours.
3. In accordance with DIN# 1, the analysis herein assumes manual operator action to purge the CR free volume at 16,200 cfm for 30 minutes, eight (8) hours after a postulated SGTR.
4. To provide operational margin, and in accordance with DIN# 11, the analysis herein assumes that during normal plant operation, the BVPS-1 & BVPS-2 unfiltered intake plus inleakage is a maximum of 1250 cfm (total for both Units). This maximum normal operation unfiltered inflow to the CR is an analytical upper bound value that is intended to include a) the CR intake flow rate (including test measurements uncertainties), b) all unfiltered inleakage and c) a 10 cfm allowance for ingress / egress. The above value bounds the test results of BV1/2 Procedure 3BVT 1.44.05 via Order 200699902.
5. As noted in DIN# 11, due to the following reasons, the CR air intake χ/Q values are assumed to be representative / applicable for unfiltered in-leakage (including CR ingress / egress).
   - Component tests performed as part of the 2017 CR Inleakage Tracer Gas Test indicated that a potential source of unfiltered inleakage into the Control Room are the normal operation intake dampers - which can be assigned the same χ/Q as the Control Room air intakes.
   - Regarding other potential locations of inleakage, a χ/Q value that reflects the center of the Control Room boundary at roof level as a receptor could be considered the average value applicable to Unfiltered Inleakage locations around the CRE, and thus representative for all CR unfiltered leakage locations.
   - Review of dwg 8700-RY-1C, R2 indicates that since the post-accident release points are a) closer to the CR intakes and b) the directions from the release points to the CR center and CR intakes are similar, use of χ/Q values associated with the CR intakes, for CR unfiltered inleakage, would be conservative.
   - The 10 cfm allowance for ingress/egress, is assigned to the door leading into the Control Room that is considered the primary point of access. This door (S35-71) is located at grade level on the side of the building facing the BV1 Containment and between the CR air intakes. It is located close enough to the air intakes to allow the assumption that the χ/Q associated with this source of leakage would be reasonably similar to that associated with the air intakes.

6. Isotopes addressed herein are consistent with the AST LAR, Power Uprate analysis, and those addressed in the current analysis of record. All isotope values used are from DIN# 6.
7. In accordance with RG 1.183 R0, the condenser is assumed unavailable due to a coincident loss of offsite power. Consequently, the radioactivity release from the intact SGs resulting from a SGTR is discharged to the environment via the MSSVs and the ADVs.

4.0 ACCEPTANCE CRITERIA

EAB and LPZ Dose Criteria for a SGTR (per 10 CFR Part 50.67, and Section 4.4 Table 6 of RG 1.183).

(i) An individual located at any point on the boundary of the exclusion area for any 2-hour period following the onset of the postulated accident, should not receive a radiation dose in excess of 0.25 Sv (25 rem) total effective dose equivalent (TEDE) for the Pre-incident Spike Case and 0.025 Sv (2.5 rem) TEDE for the Coincident Spike Case.

(ii) An individual located at any point on the outer boundary of the low population zone, who is exposed to the radioactive cloud resulting from the postulated accident (during the entire period of its passage), should not receive a radiation dose in excess of 0.25 Sv (25 rem) TEDE for the Pre-incident Spike Case and 0.025 Sv (2.5 rem) TEDE for the Coincident Spike Case.

Control Room Dose Criteria (10 CFR Part 50 & 50.67)

Adequate radiation protection is provided to permit occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 0.05 Sv (5 rem) total effective dose equivalent (TEDE) for the duration of the accident.

5.0 LIST OF COMPUTER PROGRAMS AND OUTPUT FILES

IDENTIFICATION OF COMPUTER HARDWARE

Dell Precision T1700 PC, Intel Core i5-4570, Windows 7 Professional Version 2009, Service Pack 1, WECTEC Serial/ID number: 154LH02

IDENTIFICATION OF COMPUTER PROGRAMS

PERC2, NU-226, Ver.00, Lev.02, QA Cat. I, “PERC2 - Passive Evolutionary Regulatory Consequence Code”, created September 22, 2006

There are no outstanding error releases associated with PERC2 that would affect the results of this analysis.

LIST OF COMPUTER OUTPUT FILES

File Name[(2)]	Run Date	Run Time	Description
Pre-accident Iodine Spike Source			
BV219LB01P,C	10/23/18	17:09:22	Ruptured flow, halogen source, control room & LPZ
BV219LB02P	10/23/18	17:09:35	Ruptured flow, halogen source, EAB
BV219LB03P,C	10/23/18	17:09:45	Ruptured flow, noble gas & daughters, control room & LPZ
BV219LB04P	10/23/18	17:09:56	Ruptured flow, noble gas & daughters, EAB
BV219LB05P,C	10/23/18	17:10:06	Intact SG leakage, N.G. & halogen source, control room & LPZ
BV219LB06P	10/23/18	17:10:16	Intact SG leakage, N.G. & halogen source, EAB
Iodine Inventory in Steam Generator Liquid			
BV219LB07P,C	10/23/18	17:10:29	Ruptured steam generator, control room & LPZ
BV219LB08P	10/23/18	17:10:40	Ruptured steam generator, EAB
BV219LB09P,C	10/23/18	17:10:51	Intact steam generators, control room & LPZ
BV219LB10P	10/23/18	17:11:00	Intact steam generators, EAB
Concurrent Iodine Spike Source			
BV219LB11P,C	10/23/18	17:11:14	Ruptured flow, halogen source, control room & LPZ
BV219LB12P	10/23/18	17:11:31	Ruptured flow, halogen source, EAB
BV219LB13P,C	10/23/18	17:11:43	Ruptured flow, noble gas & daughters, control room & LPZ
BV219LB14P	10/23/18	17:11:59	Ruptured flow, noble gas & daughters, EAB
BV219LB15P,C	10/23/18	17:12:13	Intact SG leakage, N.G. & halogen source, control room & LPZ
BV219LB16P	10/23/18	17:12:31	Intact SG leakage, N.G. & halogen source, EAB

Computer run files are retained in the WECTEC Offices.

6.0 COMPUTATION

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CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-496	REVISION: 3

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CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-496	REVISION: 3

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CALCULATION NO.: 10080-UR(B)-496	REVISION: 3

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CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-496	REVISION: 3

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7.0 RESULTS

Presented in Table 7-1 and Table 7-2 below are the airborne doses at the EAB, LPZ and Control Room following a postulated SGTR at Unit 2 from each pathway for the pre-accident iodine spike scenario and the concurrent iodine spike scenario, respectively. As discussed earlier, the "worst" 2-hour EAB dose following a SGTR is the 0-2 hour period.

Table 7-1
Pre-Accident Iodine Spike Scenario

Site Boundary Doses (rem)

	2 hr- EAB			30 day LPZ		
CONTRIBUTOR	**CEDE**	**DDE**	**TEDE**	**CEDE**	**DDE**	**TEDE**
Ruptured SG – Halogens	1.021E+00	6.618E-02	1.09E+00	4.963E-02	3.209E-03	5.28E-02
Ruptured SG - NG & Halogen Daughters	4.295E-04	1.494E-01	1.50E-01	2.075E-05	1.883E-02	1.89E-02
Intact SGs - Halogen, NG & Daughters	3.267E-04	1.922E-04	5.19E-04	1.517E-04	6.335E-05	2.15E-04
T.S. Iodine in Ruptured SG Sec. Coolant	7.811E-04	2.732E-05	8.08E-04	3.774E-05	1.320E-06	3.91E-05
T.S. Iodine in Intact SGs Sec. Coolant	2.541E-03	8.869E-05	2.63E-03	3.570E-04	1.076E-05	3.68E-04
Totals	1.025E+00	2.159E-01	**1.241**	5.020E-02	2.211E-02	**0.072**

Control Room Operator Dose (rem)

	30-day CONTROL ROOM		
CONTRIBUTOR	**CEDE**	**DDE**	**TEDE**
Ruptured SG – Halogens	3.906E-01	6.578E-04	3.91E-01
Ruptured SG - NG & Halogen Daughters	1.790E-04	1.326E-03	1.51E-03
Intact SGs - Halogen, NG & Daughters	6.169E-04	4.539E-06	6.21E-04
T.S. Iodine in Ruptured SG Sec. Coolant	3.084E-04	3.100E-07	3.09E-04
T.S. Iodine in Intact SGs Sec. Coolant	1.941E-03	1.805E-06	1.94E-03
Totals	3.936E-01	1.990E-03	**0.396**

Notes: General

[1] The control room doses are taken from output file "CNTLROOM.OUT". The EAB and LPZ doses are taken from output file "PERC.OUT".

[2] Noble gas daughter products as particulates are included in files 496R2-03, 04, 05 and 06. They exist in the runs because the models are conservative. The model does not account for the fact that the particulates will largely remain in the secondary coolant. Even though the particulate contribution is overestimated the dose values due to the addition of these particulates is inconsequential.

Table 7-2
Concurrent Accident Iodine Spike Scenario

Site Boundary Doses (rem)

CONTRIBUTOR	2 hr- EAB CEDE	2 hr- EAB DDE	2 hr- EAB TEDE	30 day LPZ CEDE	30 day LPZ DDE	30 day LPZ TEDE
Ruptured SG – Halogens	3.767E-01	7.635E-02	4.53E-01	1.821E-02	3.690E-03	2.19E-02
Ruptured SG - NG & Halogen Daughters	4.296E-04	1.561E-01	1.57E-01	2.076E-05	2.051E-02	2.05E-02
Intact SGs - Halogen, NG & Daughters	2.514E-04	2.439E-04	4.95E-04	3.664E-04	2.273E-04	5.94E-04
T.S. Iodine (0.35 uCi/g DEI-131) in RCS	1.702E-02	1.103E-03	1.81E-02	8.297E-04	5.348E-05	8.83E-04
T.S. Iodine in Ruptured SG Sec. Coolant	7.811E-04	2.732E-05	8.08E-04	3.774E-05	1.320E-06	3.91E-05
T.S. Iodine in Intact SGs Sec. Coolant	2.541E-03	8.869E-05	2.63E-03	3.570E-04	1.076E-05	3.68E-04
Totals	3.98E-01	2.34E-01	**0.632**	1.98E-02	2.45E-02	**0.044**

Control Room Operator Dose (rem)

CONTRIBUTOR	30-day CONTROL ROOM CEDE	30-day CONTROL ROOM DDE	30-day CONTROL ROOM TEDE
Ruptured SG - Halogens	1.401E-01	5.599E-04	1.41E-01
Ruptured SG - NG & Halogen Daughters	1.791E-04	1.381E-03	1.56E-03
Intact SGs - Halogen, NG & Daughters	1.295E-03	1.164E-05	1.31E-03
T.S. Iodine (0.35 uCi/g DEI-131) in RCS	6.520E-03	1.096E-05	6.53E-03
T.S. Iodine in Ruptured SG Sec. Coolant	3.084E-04	3.100E-07	3.09E-04
T.S. Iodine in Intact SGs Sec. Coolant	1.941E-03	1.805E-06	1.94E-03
Totals	1.50E-01	1.97E-03	**0.152**

Notes: General

[1] The control room doses are taken from output file “CNTLROOM.OUT”. The EAB and LPZ doses are taken from output file “PERC.OUT”.

[2] Noble gas daughter products as particulates are included in files 496R2-13, 14, 15 and 16. They exist in the runs because the models are conservative. The model does not account for the fact that the particulates will largely remain in the secondary coolant. Even though the particulate contribution is overestimated the dose values due to the addition of these particulates is inconsequential.

8.0 CONCLUSIONS

The BVPS Site Boundary and Control Room doses due to airborne radioactive material released following a SGTR at Unit 2 will remain within the regulatory limits set by 10CFR50.67 and Regulatory Guide 1.183. These doses were calculated by using Alternative Source Terms and BVPS Unit 2 design input parameter values provided by FENOC via DIN#s 1 and 11 (see Attachment 1 and 2).

In accordance with regulatory guidance, two scenarios were evaluated, i.e., a Pre-accident Iodine Spike and a Concurrent Iodine spike. As noted in Section 7, Results, the pre-accident iodine spike scenario is bounding:

Pre-accident Iodine Spike Case

EAB (maximum 2 hours)	1.3 rem	limit 25 rem
LPZ (course of accident)	0.08 rem	limit 25 rem
Control Room (30 days)	0.4 rem	limit 5 rem

Concurrent Iodine Spike Case

EAB (maximum 2 hours)	0.64 rem	limit 2.5 rem
LPZ (course of accident)	0.05 rem	limit 2.5 rem
Control Room (30 days)	0.16 rem	limit 5 rem

In summary:

Control Room
The limiting 30-day integrated dose to the Control Room (CR) operator is 0.4 rem TEDE. This value is below the regulatory limit of 5 rem TEDE.

Note: In accordance with current licensing basis, the CR dose estimates following a SGTR at Unit 2 is based on the assumption that the CR ventilation system remains in normal operation mode, and that the CR is purged at a minimum flow rate of 16,200 cfm between t=8 hrs and t=8.5 hrs after which it reverts to the normal operation mode.

Site Boundary
The limiting integrated dose to an individual located at any point on the boundary of the exclusion area (EAB) for any 2-hour period following the onset of the event is 1.3 rem TEDE (t=0 hr to t=2 hour time window). This dose is less than the regulatory limit of 25 rem TEDE for the pre-accident iodine spike.

The limiting integrated dose to an individual located at LPZ following the onset of the event with a concurrent iodine spike is 0.08 rem TEDE, which is less than the regulatory limit of 25 rem TEDE for the pre-accident iodine spike.

It is noted however that although the estimated doses at the EAB and LPZ due to a concurrent iodine spike are bounded by the estimated doses reported above due to the pre-accident iodine spike, the margin to the regulatory limit for the concurrent iodine spike (i.e., 2.5 rem TEDE), is less.

Attachment 1

FirstEnergy Design Input Transmittal

DIT-BVDM-0112-00 transmitted via Letter ND1MDE:0732

September 11, 2018

FENOC
FirstEnergy Nuclear Operating Company

Beaver Valley Power Station
P.O. Box 4
Shippingport, PA 15077

Patrick G. Pauvlinch
Manager, Design Engineering
pauvlinchp@firstenergycorp.com

Phone: 724-682-4982
Fax: 330-315-9717

ND1MDE:0732
September 11, 2018

Sreela Ferguson
WECTEC
720 University Ave.
Norwood, MA 02062

BV2 Complete Reanalysis of Dose Consequences
For CRE Tracer Gas Testing and Other Acceptance Criteria Changes
Design Input Transmittal DIT-BVDM-0112-00 for Steam Generator Tube Rupture

Dear Ms. Ferguson:

Attached is Design Input Transmittal DIT-BVDM-0112-00 which provides information for evaluating the control room operator dose for a BV2 Steam Generator Tube Rupture Design Basis Accident.

Should you have any questions about the attached information, please contact Douglas Bloom at 724-682-5078 or Mike Ressler at 724-682-7936.

Sincerely,

Patrick G. Pauvlinch
Manager, Design Engineering

DTB/bls

Attachment

cc: D. T. Bloom
M. G. Unfried
MSR M. S. Ressler
BVRC

Form 1/2-ADM-2097.F01, Rev 0 RTL# A1.105V

DESIGN INPUT TRANSMITTAL

☒ SAFETY RELATED / AUG QUAL ☐ NON-SAFETY RELATED	Originating Organization: ☒ FENOC ☐ Other (Specify)	DIT- BVDM-0112-00 Page 1 of 1
Beaver Valley Unit: ☐1 ☐2 ☒Both System Designation: Various Engineering Change Package: N/A		To: Sreela Ferguson Organization: WECTEC

Subject: **Design Input Transmittal for Reanalysis of Dose Consequences for a BV2 Steam Generator Tube Rupture**

Status of Information: ☒Approved for Use ☐Unverified

For Unverified DITs, Notification number tracking verification: ____________

Description of Information:

Safety Analysis Design Inputs? ☒Yes ☐No
Reconciled to Current Design Basis? ☒Yes ☐N/A

This DIT provides information required for the performance of the BV2 Steam Generator Tube Rupture dose consequence design basis accident calculation. This supports a proposed License Amendment Request (LAR) involving the control room envelope tracer gas testing criteria.

Purpose of Issuance:
This DIT provides information required for the performance of design basis accident dose consequence calculation UR(B)-496.

Source of Information (Reference, Rev, Title, Location): Engineering Judgment Used? ☐Yes ☒No

See attachment to DIT table.

Preparer: Douglas T. Bloom	Preparer Signature: [signature]	Date: 9-6-18
Reviewer: K. J. Frederick	Reviewer Signature: [signature]	Date: 9-6-18
Approver: M. S. Ressler	Approver Signature: [signature]	Date: 9/11/2018

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3B: Parameters for Calculating BVPS Unit 2 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-496, R1, A1 & R2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
General Notes: 1. The equipment / parameter values presented in the table below as approved design inputs to be used for the U2 SGTR analysis reflect safety related components that can be credited in design bases dose consequence analyses; i.e., the components have the appropriate redundancy, environmental qualification, pedigree, seismic support, etc., applicable to safety related equipment, and the parameter values reflect single failure criteria. 2. The critical input values are: Initial RCS T/S activity concentrations, Time of reactor trip, Maximum break flow from RCS into the ruptured SG, Maximum break flow that flashes (ruptured SG), Termination of environmental releases from the ruptured SG, Maximum time period of tubes being uncovered, Maximum steam release to atmosphere from the ruptured SG, Initial and post-accident liquid mass per SG, Minimum RCS mass, Control Room (CR) atmospheric dispersion factors					
1. Core Power Level (with power uncertainty) used to establish radiation source terms	2918 MWt	FENOC letter ND1MLM:0327, Table 3b, 11/5/02	2918 MWt	BV2 Renewed Operating License NPF-73 BV2 LRM B 3.3.8 BV1/2 TS 5.6.3 BV2 UFSAR Table 15.6-5b	Rated Thermal Power shall not exceed 2900 MWt. Total power measurement uncertainty of better than +/- 0.6% of RTP at full power is achieved using the Leading Edge Flow Meter. 2900 MWt x 1.006 = 2917.4 MWt
2. Design Basis Core Activity for iodines and Noble gases	As provided in reference calculation	FENOC letter ND1MLM:0327, Table 3b, 11/5/02; Calculation 10080-UR(B)-483, R0	As provided in Reference	BV1/2 Calculation UR(B)-483	The current design basis composite equilibrium core inventory, which is based on 2918 MWt, an 18 month burnup cycle and initial enrichments from 4.2% to 5%, is appropriate and is not being changed.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3B: Parameters for Calculating BVPS Unit 2 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-496, R1, A1 & R2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
3. Maximum failed fuel percentage following a SGTR	None	FENOC letter ND1MLM:0327, Table 3b, 11/5/02 FENOC letter ND1MDE:0328, 12/15/05 FENOC letter BV2SGRP:1300, 9/24/14 LTR-PL-13-79, R3	None	FENOC Letter ND1MLM:0327 FENOC Letter ND1MDE:0328 BV2 Calculation UR(B)-496 BV2 UFSAR Section 15.6.3.4	Per NRC Regulatory Guide 1.183, Appendix F (SGTR) states, in part: "If no or minimal fuel damage is postulated for the limiting event, the activity released should be the maximum coolant activity allowed by technical specification. Two cases of iodine spiking should be assumed." UFSAR Section 15.6.3.4 states: "Since there is no postulated fuel damage associated with this accident, the main radiation source is the activity in the primary coolant system and the two iodine spiking cases addressed, i.e, a) a pre-accident iodine spike and, b) a concurrent iodine spike."

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3B: Parameters for Calculating BVPS Unit 2 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-496, R1, A1 & R2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
4. Maximum melted fuel percentage following a SGTR	None	FENOC letter ND1MLM:0327, Table 3b, 11/5/02 FENOC letter ND1MDE:0328, 12/15/05 FENOC letter BV2SGRP:1300, 09/24/14 LTR-PL-13-79, R3	None	FENOC Letter ND1MLM:0327 FENOC Letter ND1MDE:0328 BV2 Calculation UR(B)-496 BV2 UFSAR Section 15.6.3.4	See Parameter 3

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3B: Parameters for Calculating BVPS Unit 2 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-496, R1, A1 & R2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
5. Activity available for release	- Technical Specification (T/S) Reactor Coolant System (RCS) concentrations - T/S secondary side concentrations - Pre-accident iodine spike activity - Concurrent iodine spike activity	FENOC letter ND1MLM:0327, Table 3b, 11/5/02 FENOC letter BV2SGRP:1300, 09/24/14 RG 1.183 R0	- Technical Specification (T/S) Reactor Coolant System (RCS) concentrations - T/S secondary side concentrations - Pre-accident iodine spike activity - Concurrent iodine spike activity	NRC Regulatory Guide 1.183 BV2 Calculation UR(B)-496 BV1/2 Calculation UR(B)-484 BV2 UFSAR Section 15.6.3.4	Per NRC Regulatory Guide 1.183, Appendix F (SGTR) states, in part: "If no or minimal fuel damage is postulated for the limiting event, the activity released should be the maximum coolant activity allowed by technical specification. Two cases of iodine spiking should be assumed…(i.e., a preaccident iodine spike case…concurrent iodine spike case)." RCS activity is released into the ruptured SG via the tube rupture, and into the intact SGs due to primary-to-secondary leakage; the activity is released to the environment via the MSSVs and ADVs. Secondary side activity is released due to steam release from all SGs.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3B: Parameters for Calculating BVPS Unit 2 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-496, R1, A1 & R2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
6. Initial RCS activity concentrations (µCi/gm) T/S values	RCS activity limited to ≤ 0.35 µCi/gm Dose Equivalent (DE) I-131 ≤ 100 E_{BAR} µCi/gm Isotopic inventory obtained from referenced calculation	FENOC letter ND1MLM:0327, Table 3b, 11/5/02 BVPS-2 T/S Sec. 3.4.8 Calculation UR(B)-484, R0/A1	Reactor Coolant Dose Equivalent I-131 specific activity limited to: ≤ 0.35 µCi/gm Reactor Coolant gross specific activity limited to: ≤ 100/E_{bar} µCi/gm Isotopic inventory obtained from referenced calculation	BV1/2 TS 3.4.16 BV1/2 Calculation UR(B)-484	In support of BV2 Original Steam Generators with Alternate Repair Criteria, a License Amendment Request will explain that a bounding value of ≤ 0.35 µCi/gm I-131 DE is used for all BV1 and BV2 accidents with the exception of the BV2 MSLB for OSGs, for which the BV2 specific TS limit of 0.10 µCi/gm I-131 DE is used.
7. Initial T/S secondary side liquid iodine concentrations (µCi/gm)	Steam generator (SG) coolant activity limited to ≤ 0.10 µCi/gm DE I-131 Isotopic inventory obtained from referenced calculation	BVPS-1 T/S Sec. 3.7.1.4 BVPS-1 T/S Amendment No. 244 Calculation UR(B)-484, R0 / A1	Secondary Coolant activity limited to: ≤ 0.10 µCi/gm I-131 DE Isotopic inventory obtained from referenced calculation	BV1/2 TS 3.7.13 BV1/2 Calculation UR(B)-484	In support of BV2 Original Steam Generators with Alternate Repair Criteria, a License Amendment Request will explain that a bounding value of ≤ 0.10 µCi/gm I-131 DE is used for all BV1 and BV2 accidents with the exception of the BV2 MSLB for OSGs, for which the BV2 specific TS limit of 0.05 µCi/gm I-131 DE is used.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3B: Parameters for Calculating BVPS Unit 2 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-496, R1, A1 & R2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
8. Concurrent iodine spike appearance rate (Ci/sec)	335 times T/S equilibrium appearance rate T/S equilibrium appearance rate provided in referenced calculation	FENOC letter ND1MLM:0327, Table 3b, 11/5/02 RG 1.183 Rev.0 Calculation UR(B)-484, R0/A1	335 times TS equilibrium appearance rate TS equilibrium appearance rate provided in referenced calculation	NRC Regulatory Guide 1.183 BV2 Calculation UR(B)-496 BV1/2 Calculation UR(B)-484 BV2 UFSAR Table 15.0-10 BV2 UFSAR Table 15.6-5b	Per NRC Regulatory Guide 1.183, Appendix F (SGTR) states, in part: "The primary system transient associated with the SGTR causes an iodine spike in the primary system. The increase in primary coolant iodine concentration is estimated using a spiking model that assumes that the iodine release rate from the fuel rods to the primary coolant (expressed in curies per unit time) increases to a value 335 times greater than the release rate corresponding to the iodine concentration at the equilibrium value (typically 1.0 µCi/gm DE I-131) specified in technical specifications (i.e., concurrent iodine spike case)."

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3B: Parameters for Calculating BVPS Unit 2 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-496, R1, A1 & R2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
9. Duration of concurrent iodine spike	4 hours	FENOC letter ND1MLM:0327, Table 3b, 11/5/02 Current licensing basis Calc 10080-UR(B)-496, R1, A1	4 hours	BV2 Calculation UR(B)-496 BV2 UFSAR Table 15.6-5b	Per NRC Regulatory Guide 1.183, Appendix F (SGTR) states, in part: "The assumed iodine spike duration should be 8 hours. Shorter spike durations may be considered on a case-by-case basis if it can be shown that the activity released by the 8-hour spike exceeds that available for release from the fuel gap of all fuel pins." Basis for acceptability of the 4-hour duration was provided to NRC via response to Request for Additional Information. NRC acknowledged 4-hour duration in Safety Evaluation for BV2 Amendment 156.
10. Pre-accident iodine spike	21 µCi/gm DE I-131 Values provided in referenced calculation	FENOC letter ND1MLM:0327, Table 3b, 11/5/02 BVPS-2 T/S Figure 3.4-1 S&W calculation UR(B)-484, R0/A1	21 µCi/gm DE I-131 Values provided in referenced calculation	BV1/2 TS B 3.4.16 BV1/2 Calculation UR(B)-484 BV2 UFSAR Section 15.0.9.4	Value is 60 times the 0.35 µCi/gm DE I-131 TS limit. Value is the threshold iodine concentration to shut down the plant.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3B: Parameters for Calculating BVPS Unit 2 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-496, R1, A1 & R2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
11. Iodine species released from SGs to the environment	97% elemental 3% organic	FENOC letter ND1MLM:0327, Table 3b, 11/5/02 RG 1.183 Rev.0	97% elemental 3% organic	NRC Regulatory Guide 1.183 BV2 Calculation UR(B)-496 BV2 UFSAR Table 15.6-5b	Per NRC Regulatory Guide 1.183, Appendix F (SGTR) states, in part: "Iodine releases from the steam generators to the environment should be assumed to be 97% elemental and 3% organic."
12. Activity release path	Prior to trip, both intact and ruptured SGs release steam to the condenser; environmental release occurs from the condenser via the air ejectors. After reactor trip, due to the loss of offsite power, the main condenser is not available. Steam releases occur from both the ruptured and intact SGs via the MSSVs and ADVs.	FENOC letter ND1MLM:0327, Table 3b, 11/5/02 Westinghouse letter FENOC-01-278, 9/19/01 RG 1.183, Rev. 0	Prior to trip, both intact and ruptured SGs release steam to the condenser; environmental release occurs from the condenser via the air ejectors. After reactor trip, due to assumed loss of offsite power, condenser steam dump valves are not available. Steam releases occur from both the ruptured and intact SGs via the Main Steam Safety Valves and Atmospheric Dump Valves.	NRC Regulatory Guide 1.183 BV2 Calculation UR(B)-496 BV2 UFSAR Section 15.6.3.2	

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3B: Parameters for Calculating BVPS Unit 2 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-496, R1, A1 & R2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
13. Time of reactor trip	EPU / BV2 OSG t=116 second BV2 RSGs - *Case 3a (0% SGTP)* t=112 seconds - Case 4a (22% SGTP) t=107 seconds	CN-CRA-01-50, R6, pg 6 FENOC letter BV2SGRP:1300, 09/24/14 CN-CRA-14-3, R0 (Tables 2.0-1 and 2.0-2)	116 seconds	BV2 Calculation UR(B)-496 BV2 UFSAR Table 15.6-5b Westinghouse Calculation CN-CRA-01-50	
14. Break flow termination time	EPU / BV2 OSG t=4076 secs BV2 RSG - *Case 3a (0% SGTP)* t=3532 seconds - *Case 4a (22% SGTP)* t=3526 seconds	CN-CRA-01-50, R6, pg 6 FENOC letter BV2SGRP:1300, 09/24/14 CN-CRA-14-3, R0 (Tables 2.0-1 and 2.0-2)	4076 seconds	BV2 Calculation UR(B)-496 Westinghouse Calculation CN-CRA-01-50	

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3B: Parameters for Calculating BVPS Unit 2 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-496, R1, A1 & R2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
15. Maximum break flow from RCS into ruptured SG	<u>EPU / BV2 OSG</u> 0-116 sec: 9200 lbm 116-4076 sec: 197,400 lbm <u>BV2 RSG</u> - *<u>Case 3a</u> (0% SGTP)* 0-112 sec: 8,900 lbm 112 – 3532 sec: 165,000 lbm - *<u>Case 4a</u> (22% SGTP)* 0-107 sec: 8,700 lbm 107 – 3526 sec: 166,200 lbm	CN-CRA-01-50, R6, pg 6 FENOC letter BV2SGRP:1300, 09/24/14 CN-CRA-14-3, R0 (Tables 2.0-1 and 2.0-2) LTR-PL-13-79, Rev. 3	0 sec to 116 sec: 9200 lbm 116 sec to 4076 sec: 197,400 lbm	BV2 Calculation UR(B)-496 Westinghouse Calculation CN-CRA-01-50 BV2 UFSAR Table 15.6-5b	

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3B: Parameters for Calculating BVPS Unit 2 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-496, R1, A1 & R2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
16. Maximum break flow that flashes (defective SG)	EPU / BV2 OSG 0-116 sec: 1730.2 lbm 116-1932.5 sec: 6814.5 lbm BV2 RSG - *Case 3a (0% SGTP)* 0-112 sec: 1706.9 lbm 112 – 2032.5 sec: 7542.7 lbm - *Case 4a (22% SGTP)* 0-107 sec: 1788.9 lbm 112 – 2020.5 sec: 7623.4 lbm	CN-CRA-01-50, R6, pg 6 FENOC letter BV2SGRP:1300, 09/24/14 CN-CRA-14-3, R0 (Tables 2.0-1 and 2.0-2) LTR-PL-13-79, Rev. 3	0 sec to 116 sec: 1730.2 lbm 116 sec to 1932.5 sec: 6814.5 lbm	BV2 Calculation UR(B)-496 Westinghouse Calculation CN-CRA-01-50	
17. Steam generator (SG) primary-to-secondary leakage rate at T/S levels in intact SG	150 gallons per day (gpd) (any one SG) Leakage density = 1.0 g/cc	FENOC letter ND1MLM:0327, Table 3b, 11/5/02 BVPS-2 T/S 3.4.6.2	150 gallons per day (any 1 SG) 450 gpd (all 3 SGs) Leakage density = 1.0 g/cc	BV1/2 TS B 3.4.13 NRC Regulatory Guide 1.183	Per NRC Regulatory Guide 1.183, Appendix F (SGTR) states, in part: "In most cases, the density should be assumed to be 1.0 gm/cc (62.4 lbm/ft³)."
18. Termination of environmental releases	EPU / BV2 OSG *Intact SGs*: 8 hours *Defective SG*:	CN-CRA-01-50, R6, pg 6	*Intact SGs*: 8 hours *Defective SG*: Break flow terminated at 4076 sec. {with a release later on	NRC Regulatory Guide 1.183 BV1 Calculation UR(B)-496	Per NRC Regulatory Guide 1.183, Appendix F (SGTR) states, in part: "The primary-to-secondary leakage should be assumed to continue until the primary system pressure is less than the secondary

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3B: Parameters for Calculating BVPS Unit 2 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-496, R1, A1 & R2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
	Break flow terminated at 4076 sec. {with a release later on (before t = 8 hrs.) to depressurize the isolated SG} BV2 RSG *Intact SGs*: 8 hours *Defective SG*: - Case 3a: *(0% SGTP)* Break flow terminated at 3532 sec. {with a release later on (before t = 8 hrs.) to depressurize the isolated SG} - Case 4a: *(22% SGTP)* Break flow terminated at 3526 sec. {with a release later on (before t = 8 hrs.) to depressurize the isolated SG}	 FENOC letter BV2SGRP:1300, 09/24/14 CN-CRA-14-3, R0 (Tables 2.0-1 and 2.0-2) LTR-PL-13-79, Rev. 3	(before t = 8 hrs.) to depressurize the isolated SG}	Westinghouse Calculation CN-CRA-01-50	system pressure, or until the temperature of the leakage is less than 100°C (212°F). The release of radioactivity from the unaffected steam generators should be assumed to continue until shutdown cooling is in operation and releases from the steam generators have been terminated." Releases via the intact SGs are assumed to stop once the Residual Heat Removal system starts operation for shutdown cooling and there are no more releases from the MSSVs and ADVs. Releases from the ruptured SG are assumed to stop after the SG is isolated.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3B: Parameters for Calculating BVPS Unit 2 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-496, R1, A1 & R2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
19. Maximum time period of tubes being uncovered	Negligible	FENOC letter ND1MLM:0327, Table 3b, 11/5/02 FENOC letter BV2SGRP:1300, 09/24/14 LTR-PL-13-79, Rev. 3	Negligible effect	WCAP-13247, NRC letter (3/10/93)	The scope of WCAP-13247 includes the Steam Generator Tube Rupture. The results of the Westinghouse Owners Group program indicate that steam generator tube uncovery does not increase the consequences of Steam Generator Tube Rupture and Non-SGTR events significantly. The current design basis analysis methodologies are adequate and remain valid. NRC letter (3/10/1993) expressed agreement with the position presented in WCAP-13247.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3B: Parameters for Calculating BVPS Unit 2 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-496, R1, A1 & R2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
20. Partition coefficient in SGs when tubes are totally submerged	Flashed portion of rupture flow: Noble gases – released freely with no retention; All iodines – released freely with no retention Non-flashed portion of rupture flow and T/S leakage in intact SG: Noble gases – released freely with no retention All iodines – 100	FENOC letter ND1MLM:0327, Table 3b, 11/5/02 RG 1.183, Rev. 0	Flashed portion of rupture flow: Noble gases – released freely with no retention; All iodines – released freely with no retention Non-flashed portion of rupture flow and T/S leakage in intact SG: Noble gases – released freely with no retention All iodines – 100	NRC Regulatory Guide 1.183 BV2 Calculation UR(B)-496 BV2 UFSAR Table 15.6-5b	Per NRC Regulatory Guide 1.183, Appendix F (SGTR) states: "All noble gas radionuclides released from the primary system are assumed to be released to the environment without reduction or mitigation." No credit for scrubbing of the flashed elemental iodine is a conservative assumption. Per NRC Regulatory Guide 1.183, Appendix F (SGTR) states: "The transport model described in Regulatory Positions 5.5 and 5.6 of Appendix E should be utilized for iodine and particulates." Per NRC Regulatory Guide 1.183, Appendix E (MSLB) position 5.5.4 states, in part: "A partition coefficient for iodine of 100 may be assumed."

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3B: Parameters for Calculating BVPS Unit 2 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-496, R1, A1 & R2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
21. Partition coefficient in the ruptured and intact SGs during periods when tubes are uncovered	Noble gases: released freely with no retention All iodines : released freely with no retention	FENOC letter ND1MLM:0327, Table 3b, 11/5/02 RG 1.183, Rev. 0	Noble gases: released freely with no retention All iodines: released freely with no retention	NRC Regulatory Guide 1.183 BV2 Calculation UR(B)-496 BV2 UFSAR Table 15.6-5b	Per NRC Regulatory Guide 1.183, Appendix F (SGTR) states: "The transport model described in Regulatory Positions 5.5 and 5.6 of Appendix E should be utilized for iodine and particulates." Per NRC Regulatory Guide 1.183, Appendix E (MSLB) position 5.5.1 states, in part: "During periods of steam generator dryout, all of the primary-to-secondary leakage is assumed to flash to vapor and be released to the environment with no mitigation."
22. Partition factor in condenser/air ejector	Noble gas: 1 Organic iodine: 1 Elemental iodine: 0.01	FENOC letter ND1MLM:0327, Table 3b, 11/5/02 NUREG-0017, R1	Noble gas: 1 Organic iodine: 1 Elemental iodine: 0.01	NUREG-0017 BV2 Calculation UR(B)-496 BV2 UFSAR Table 15.6-5b	

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE 3B: Parameters for Calculating BVPS Unit 2 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-496, R1, A1 & R2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
23. Maximum steam release to atmosphere from the ruptured SG via the MSSVs/ADVs	EPU / BV2 OSG 116-4076 sec: 67,300 lbm 4076- 7200 sec: 0 lbm 7200 – 28,800 sec: 46,800 lbm BV2 RSG *- Case 3a (0% SGTP)* 112 - 3532 sec: 81,300 lbm 3532- 7200 sec: 0 lbm 7200 – 28,800 sec: 41,300 lbm *- Case 4a (22% SGTP)* 107 - 3526 sec: 78,400 lbm 3526 - 7200 sec: 0 lbm 7200 – 28,800 sec: 41,700 lbm	CN-CRA-01-50, R6, pg 6 FENOC letter BV2SGRP:1300, 09/24/14 CN-CRA-14-3, R0 (Tables 2.0-1 and 2.0-2) LTR-PL-13-79, Rev. 3	116 sec to 4076 sec: 67,300 lbm 4076 sec to 7200 sec: 0 lbm 7200 sec to 28,800 sec: 46,800 lbm	BV2 Calculation UR(B)-496 Westinghouse Calculation CN-CRA-01-50	

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TABLE 3B: Parameters for Calculating BVPS Unit 2 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-496, R1, A1 & R2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
24. Maximum steam release to atmosphere from intact SGs via MSSVs/ADVs	EPU / BV2 OSG 116-4076 sec: 163,500 lbm 4076- 7200 sec: 216,800 lbm 7200 – 28,800 sec: 798,500 lbm BV2 RSG - *Case 3a (0% SGTP)* 112 - 3532 sec: 163,200 lbm 3532- 7200 sec: 259,900lbm 7200 – 28,800 sec: 776,600 lbm - *Case 4a (22% SGTP)* 107 - 3526 sec: 157,800 lbm 3526 - 7200 sec: 259,000 lbm 7200 – 28,800 sec: 774,800 lbm	CN-CRA-01-50, R6, pg 6 FENOC letter BV2SGRP:1300, 09/24/14 CN-CRA-14-3, R0 (Tables 2.0-1 and 2.0-2) LTR-PL-13-79, Rev. 3	116 sec to 4076 sec: 163,500 lbm 4076 sec to 7200 sec: 216,800 lbm 7200 sec to 28,800 sec: 798,500 lbm	BV2 Calculation UR(B)-496 Westinghouse Calculation CN-CRA-01-50	

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
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TABLE 3B: Parameters for Calculating BVPS Unit 2 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-496, R1, A1 & R2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
25. Main steam flow to the condenser before reactor trip	EPU / BV2 OSG Ruptured SG: 142,300 lbm Intact SGs 281,900 lbm BV2 RSG *- Case 3a (0% SGTP)* Ruptured SG: 127,700 lbm Intact SGs 251,800 lbm *- Case 4a (22% SGTP)* Ruptured SG: 121,800 lbm Intact SGs 240,000 lbm	CN-CRA-01-50, R6, pg 6 FENOC letter BV2SGRP:1300, 09/24/14 CN-CRA-14-3, R0 (Tables 2.0-1 and 2.0-2) LTR-PL-13-79, Rev. 3	Ruptured SG: 142,300 lbm Intact SGs: 281,900 lbm	BV2 Calculation UR(B)-496 Westinghouse Calculation CN-CRA-01-50	

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
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TABLE 3B: Parameters for Calculating BVPS Unit 2 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-496, R1, A1 & R2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
26. Initial and minimum post-accident mass of secondary coolant per SGs (lbm/SG)	<u>BV2 OSG</u>: 95,150 lbm <u>BV2 RSG</u> *- Case 3a (0% SGTP)* 92,695 lbm *- Case 4a (22% SGTP)* 90,793 lbm	FENOC letter ND1MLM:0327, Table 3b, 11/5/02 WEC ltr FENOC-01-278, 9/19/01 FENOC letter BV2SGRP:1300, 09/24/14 CN-CRA-14-3, R0 LTR-PL-13-79, Rev. 3	95,150 lbm	FENOC Letter ND1MDE:0328 BV2 Calculation UR(B)-496 BV2 UFSAR Table 15.6-5b	SG liquid mass increases following a SGTR, so the initial value is the minimum liquid mass during the transient. The *minimum* SG liquid mass is used to determine the activity release rate during the accident. The *initial* SG liquid mass is used to determine the total iodine activity in the SG liquid.
27. Initial & Minimum RCS mass not including pressurizer liquid and steam masses.	<u>BV2 OSG</u>: 368,000 <u>BV2 RSG</u> *- Case 3a (0% SGTP)* 375,000 lbm (approx.) *- Case 4a (22% SGTP)* 350,000 lbm (approx.)	FENOC letter ND1MLM:0327, Table 3b, 11/5/02 WEC ltr FENOC-01-278, 9/19/01 FENOC letter BV2SGRP:1300, 09/24/14 CN-CRA-14-3, R0 LTR-PL-13-79, Rev. 3	368,000 lbm	FENOC Letter ND1MDE:0328 BV2 Calculation UR(B)-496 BV2 UFSAR Table 15.6-5b	RCS liquid mass tends to increase following a trip, so the minimum is represented by the initial value.

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TABLE 3B: Parameters for Calculating BVPS Unit 2 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-496, R1, A1 & R2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
28. Control Room (CR) atmospheric dispersion factors	Release points: MSSVs & ADVS: N3841 Condenser/Air ejector: N3755.33	FENOC letter ND1MLM:0327, Table 3b, 11/5/02 Drawing 8700-RY-1C, R2 X/Qs determined in Calculation 8700-EN-ME-106, R0/A1	MSSVs & ADVS: N3841, E8125 Condenser/Air ejector: N3755.33, E7951.67	BV1/2 Drawing RY-0001C BV2 Calculation EN-ME-106	The atmospheric dispersion factors at the CR intake are representative for inleakage. X/Qs are determined in BV2 Calculation EN-ME-106. Condenser and Air Ejector are located in the Turbine Building. Main Steam Relief Valves release point is for MSSVs and ADVs.
Control Room Isolation / Emergency Ventilation (following a SGTR)					
29. CR emergency ventilation initiation:	CR emergency ventilation is not automatically initiated	FENOC letter ND1MLM:0327, Table 3b, 11/5/02 Conservative assumption	CR emergency ventilation is not automatically initiated	BV2 Calculation UR(B)-496 FENOC Letter ND1MDE:0328	SGTR does not result in high containment pressure; no Containment Isolation Phase B signal is generated.

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TABLE 3B: Parameters for Calculating BVPS Unit 2 Steam Generator Tube Rupture (SGTR) Dose Consequences

	AOR [UR(B)-496, R1, A1 & R2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
30. Initiation of CR purge after environmental release is terminated : time & rate	t = 8 hrs. 16,200 cfm for 30 min.	FENOC letter ND1MLM:0327, Table 3b, 11/5/02 FENOC letter BV2SGRP:1300, 09/24/14 1/2 OM-44A.4A.A, Rev 17, page 13, para 13.	Maximum Time: 8 hours Minimum Purge Rate: 16,200 cfm for 30 minutes	BV2 Calculation UR(B)-496 BV2 UFSAR Table 15.6-5b	Fans 1VS-F-40A&B are rated for 33,200 cfm per BV1 Specification BVS-430, while fans 2HVC-ACU201A&B are rated for 20,000 cfm per BV2 Specification 2BVS-179. The BV2 Fan, which is conservative compared to BV1, is credited for producing 16,200 cfm.

References:

1. NRC Regulatory Guide 1.183, Rev. 0, Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors
2. BV2 Renewed Operating License DPR-73
3. BV1/2 Technical Specifications, including BV1 Amendment 302 and BV2 Amendment 191
4. BV1/2 Technical Specification Bases, Rev. 35
5. BV2 Licensing Requirements Manual (including Bases), Rev. 92
6. BV2 Updated Final Safety Analysis Report, Rev. 23
7. BV1/2 Calculation UR(B)-483, Rev. 0, Composite Reactor Core Inventory for BVPS Following Power Uprate (2918 MWth, Initial 4.2% to 5% Enrichment, 18-month Fuel Cycle)
8. BV1/2 Calculation UR(B)-484, Rev. 0 including Add. 1, Primary and Secondary Coolant Design/Technical Specification Activity Concentrations including Pre-Accident Iodine Spike Concentrations and Equilibrium Iodine Appearance Rates following Power Uprate
9. BV2 Calculation EN-ME-106, Rev. 0 including Add. 1, Atmospheric Dispersion Factors (X/Qs) at Control Room and ERF Receptors for Unit 2 Accident Releases using the ARCON96 Methodology
10. BV2 Calculation UR(B)-496, Rev. 1 including Add. 1, Site Boundary and Control Room Doses Following a Steam Generator Tube Rupture Based on Core Uprate and Alternative Source Term Methodology
11. BV1/2 Drawing RY-0001C, Rev. 2, Site Postulated Release and Receptor Points
12. Westinghouse Owners Group Report WCAP-13247 (3/1992), Report on Methodology for Resolution of the Steam Generator Tube Uncovery Issue
13. NRC Letter (3/10/1993), Westinghouse Owners Group – Steam Generator Tube Uncovery Issue (attachment to WOG-93-066) [ML17054C235]
14. Westinghouse Letter FENOC-01-278, 09/19/2001, Post Accident Radiological Input Parameters for Dose Analysis
15. FENOC Letter ND1MLM:0327, 11/05/2002, Extended Power Uprate DBA Radiological Analysis Revised Methods, Inputs and Assumptions
16. FENOC Letter ND1MDE:0328, 12/15/2005, Transmittal of DIT-FPP-0025-01
17. Westinghouse Calculation CN-CRA-01-50, Rev. 7, Beaver Valley Unit 2 (DMW) Steam Generator Tube Rupture Analysis – for Overfill and Mass Release for 9.4% Uprate
18. NUREG-0017, Rev. 1, Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors: PWR-GALE Code

Note: BV1/2 Calculation UR(B)-484 has been revised and submitted to FENOC for Owner Acceptance Review. The concentrations from Rev. 1 of this calculation will be used for the radiological dose consequence analyses.

FirstEnergy	CALCULATION COMPUTATION NOP-CC-3002-01 Rev. 05	Page Att1-26 of Att1-29
CALCULATION NO.: 10080-UR(B)-496		REVISION: 3

FirstEnergy

DESIGN VERIFICATION RECORD

Page 1 of 1

NOP-CC-2001-01 Rev. 00

SECTION I: TO BE COMPLETED BY DESIGN ORIGINATOR		
DOCUMENT(S)/ACTIVITY TO BE VERIFIED: DIT-BVDM-0112-00		
☒ SAFETY RELATED	☐ AUGMENTED QUALITY	☐ NONSAFETY RELATED
SUPPORTING/REFERENCE DOCUMENTS		
DESIGN ORIGINATOR: *(Print and Sign Name)* Douglas T Bloom [signature]		DATE 9-6-18
SECTION II: TO BE COMPLETED BY VERIFIER		
VERIFICATION METHOD *(Check one)*		
☑ DESIGN REVIEW *(Complete Design Review Checklist or Calculation Review Checklist)*	☐ ALTERNATE CALCULATION	☐ QUALIFICATION TESTING
JUSTIFICATION FOR SUPERVISOR PERFORMING VERIFICATION: NA		
APPROVAL: *(Print and Sign Name)* NA		DATE
EXTENT OF VERIFICATION: Design Review Checklist		
COMMENTS, ERRORS OR DEFICIENCIES IDENTIFIED? ☐ YES ☑ NO		
RESOLUTION: *(For Alternate Calculation or Qualification Testing only)* NA		
RESOLVED BY: *(Print and Sign Name)* NA		DATE
VERIFIER: *(Print and Sign Name)* K. J. Frederick [signature]		DATE 9-6-18
APPROVED BY: *(Print and Sign Name)* MSRessler [signature]		DATE 9/11/2018

FirstEnergy

NOP-CC-2001-02 Rev. 04

DESIGN REVIEW CHECKLIST

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):

DIT-BVOM-0112-00

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
1. Were the basic functions of each structure, system or component considered?		✓			
2. Have performance requirements such as capacity, rating, and system output been considered?		✓			
3. Are the applicable codes, standards and regulatory requirements including applicable issue and/or addenda properly identified and are their requirements for design and/or material been met or reconciled?		✓			
4. Have design conditions such as pressure, temperature, fluid chemistry, and voltage been specified?		✓			
5. Are loads such as seismic, wind, thermal, dynamic and fatigue factored in the design?	✓				
6. Considering the applicable loading conditions, does an adequate structural margin of safety exist for the strength of components?	✓				
7. Have environmental conditions anticipated during storage, construction and operation such as pressure, temperature, humidity, soil erosion, run-off from storm water, corrosiveness, site elevation, wind direction, nuclear radiation, electromagnetic radiation, and duration of exposure been considered?	✓				
8. Have interface requirements including definition of the functional and physical interfaces involving structures, systems and components been met?		✓			
9. Have the material requirements including such items as compatibility, electrical insulation properties, protective coating, corrosion, and fatigue resistance been considered?	✓				
10. Have mechanical requirements such as vibration, stress, shock and reaction forces been specified?	✓				
11. Have structural requirements covering such items as equipment foundations and pipe supports been identified?	✓				
12. Have hydraulic requirements such as pump net positive suction head (NPSH), allowable pressure drops, and allowable fluid velocities been specified?	✓				
13. Have chemistry requirements such as the provisions for sampling and the limitations on water chemistry been specified?	✓				
14. Have electrical requirements such as source of power, voltage, raceway requirements, electrical insulation and motor requirements been specified?	✓				
15. Have layout and arrangement requirements been considered?		✓			
16. Have operational requirements under various conditions, such as plant startup, normal plant operation, plant shutdown, plant emergency operation, special or infrequent operation, and system abnormal or emergency operation been specified?		✓			

DESIGN REVIEW CHECKLIST

NOP-CC-2001-02 Rev. 04

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):

DIT-BVDM-0112-00

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
17. Have instrumentation and control requirements including instruments, controls, and alarms required for operation, testing, and maintenance been identified? Other requirements such as the type of instrument, installed spares, range of measurement, and location of indication should also be included.	✓				
18. Have adequate access and administrative controls been planned for plant security?	✓				
19. Have redundancy, diversity, and separation requirements of structures, systems, and components been considered?		✓			
20. Have the failure requirements of structures, systems, and components, including a definition of those events and accidents which they must be designated to withstand been identified?		✓			
21. Have test requirements including in-plant tests, and the conditions under which they will be performed been specified?	✓				
22. Have accessibility, maintenance, repair and in-service inspection requirements for the plant including the conditions under which they will be performed been specified?	✓				
23. Have personnel requirements and limitations including the qualification and number of personnel available for plant operation, maintenance, testing and inspection and permissible personnel radiation exposure for specified areas and conditions been considered?		✓			
24. Have transportability requirements such as size and shipping weight, limitations and Interstate Commerce Commission regulations been considered?	✓				
25. Have fire protection or resistance requirements been specified?	✓				
26. Are adequate handling, storage, cleaning and shipping requirements specified?	✓				
27. Have the safety requirements for preventing undue risk to the health and safety of the public been considered?		✓			
28. Are the specified materials, processes, parts and equipment suitable for the required application?	✓				
29. Have safety requirements for preventing personnel injury including such items as radiation hazards, restricting the use of dangerous materials, escape provisions from enclosures and grounding of electrical equipment been considered?	✓				
30. Were the inputs correctly selected and incorporated into the design?		✓			
31. Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed?		✓			
32. Are the appropriate quality and quality assurance requirements specified?		✓			

FirstEnergy

NOP-CC-2001-02 Rev. 04

DESIGN REVIEW CHECKLIST

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):

DIT-BV0M-0112-00

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
33. Have applicable construction and operating experience been considered?		✓			
34. Have the design interface requirements been satisfied?		✓			
35. Was an appropriate design method used?		✓			
36. Is the output reasonable compared to inputs?	✓				
37. Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?	✓				
38. Have adequate maintenance features and requirements been specified?	✓				
39. Has the design properly considered radiation exposure to the public and plant personnel?		✓			
40. Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfied?		✓			
41. Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?	✓				
42. Are adequate identification requirements specified?	✓				
43. Are requirements for record preparation, review, approval, retention, etc., adequately specified?	✓				
44. Have protective coatings qualified for Design Basis Accident (DBA) been specified to structures, equipment and components installed in the containment/drywell?	✓				
45. Are the necessary supporting calculations completed, checked and approved?		✓			
46. Have the equipment heat load changes been reviewed for impact on HVAC systems?	✓				
47. **IF** a computer program was used to obtain the design by analysis, **THEN** has the program been validated per NOP-SS-1001 and documented to verify the technical adequacy of the computer results contained in the design analysis?	✓				
48. Have Professional Engineer (PE) certification requirements been addressed and documented where required by ASME Code (if applicable).	✓				
49. Does the design involve the installation, removal, or revise software/firmware and have the requirements of NOP-SS-1001 been addressed?			✓		
50. Does the design involve the installation, removal, or change to a digital component(s) and have the requirements of NOP-SS-1201 been addressed?			✓		

COMPLETED BY: *(Print and Sign Name)* K.J. Frederick [signature] DATE 9-6-18

IF CHECKLIST IS REVIEWED BY MORE THAN ONE VERIFIER, SIGN BELOW:

ADDITIONAL VERIFIER *(Print and Sign Name)* N/A DATE

FirstEnergy	CALCULATION COMPUTATION NOP-CC-3002-01 Rev. 05
CALCULATION NO.: 10080-UR(B)-496	REVISION: 3

Attachment 2

(Partial Copy – excludes CR Shielding Data)

FirstEnergy Design Input Transmittal

DIT-BVDM-0103-03 transmitted via FENOC letter ND1MDE:0738

January 29, 2019

FENOC

FirstEnergy Nuclear Operating Company

Beaver Valley Power Station
P.O. Box 4
Shippingport, PA 15077

Patrick G. Pauvlinch
Manager, Design Engineering
pauvlinchp@firstenergycorp.com

Phone: 724-682-4982
Fax: 330-315-9717

ND1MDE:0738
January 29, 2019

Sreela Ferguson
WECTEC
720 University Ave.
Norwood, MA 02062

BV1 & BV2 Complete Reanalysis of Dose Consequences
For CRE Tracer Gas Testing and Other Acceptance Criteria Changes
Design Input Transmittal DIT-BVDM-0103-03 for Control Room Dose

Dear Ms. Ferguson:

Attached is Design Input Transmittal DIT-BVDM-0103-03 which provides information for evaluating the control room operator dose for various design-basis accidents.

Should you have any questions about the attached information, please contact Doug Bloom at 724-682-5078 or Mike Ressler at 724-682-7936.

Sincerely,

Patrick G. Pauvlinch
Manager, Design Engineering

DTB/bls

Attachment

cc: D. T. Bloom
M. G. Unfried
M. S. Ressler
BVRC

FirstEnergy	CALCULATION COMPUTATION NOP-CC-3002-01 Rev. 05	Page Att2-3 of Att2-26
CALCULATION NO.: 10080-UR(B)-496		REVISION: 3

Form 1/2-ADM-2097.F01, Rev 0 RTL# A1.105V

DESIGN INPUT TRANSMITTAL

☒ SAFETY RELATED / AUG QUAL ☐ NON-SAFETY RELATED	Originating Organization: ☒ FENOC ☐ Other (Specify)	DIT- BVDM-0103-03 Page __1__ of __1__
Beaver Valley Unit: ☐1 ☐2 ☒Both System Designation: Various Engineering Change Package: N/A		To: Sreela Ferguson Organization: WECTEC

Subject: **Design Input Transmittal for Parameter List for Calculating Dose Consequences at the Control Room and Site Boundary**

Status of Information: ☒Approved for Use ☐Unverified

For Unverified DITs, Notification number tracking verification: ____________________

Description of Information:

Safety Analysis Design Inputs? ☒Yes ☐No

Reconciled to Current Design Basis? ☒Yes ☐N/A

This DIT provides information required for the performance of calculating dose consequences at the BV1 and BV2 Control Rooms and Site Boundary.

Purpose of Issuance:

This DIT provides information required for the performance of design basis accident dose consequence calculation UR(B)-487.

Source of Information (Reference, Rev, Title, Location): Engineering Judgment Used? ☐Yes ☒No

See attachment to DIT table.

Preparer: Douglas T Bloom	Preparer Signature: [signature]	Date: 1-29-19
Reviewer: M. G. Unfried	Reviewer Signature: [signature]	Date: 1/29/2019
Approver: M. S. Ressler	Approver Signature: [signature]	Date: 1/29/2019

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE E: Parameter List for Calculating Dose Consequences at the Control Room & Site Boundary

	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
General Notes: 1. As noted in Design Input transmittals provided in support of the BVPS-2 RSGs (e.g., DIT-SGR2-0046-01 for the LOCA) the CR parameters such as shielding configuration, volume, ventilation system parameters (flows, filter efficiency, signals that initiate emergency ventilation, timing of manual action, etc.) have not changed since the Containment Sump modification 2. The critical input values are: CR volume, CR ventilation flows (NOP intake, unfiltered inleakage and filtered intake during pressurization mode), CR filter efficiencies, CREVS initiation times, and atmospheric dispersion factors.					
Control Room (Inhalation / Submersion Dose)					
1. Minimum Control Room (CR) Free Volume	1.73E5 ft^3	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 DQL Calc B-74, Rev. 0. 12/8/81 DLC EM 11578 (NOT IN FILENET RECORDS) Confirmed by DLC EM 116251	1.73E5 ft^3	BV1 Calculations CR-AC-1 & DMC-3171 BV1 UFSAR Table 11.5-8 & Table 14.3-14a BV2 Calculations B-029A & B-074 BV2 Drawing RB-0039A BV2 UFSAR Table 6.4-1 & Table 6.4-1a	BV1 and BV2 share a joint control room inside a single Control Room Envelope. Dimensions used in BV2 Calculation B-074 are consistent with those derived from BV2 Drawing RB-0039A. The net free volume has historically been assumed to be approximately 75% of the gross volume for the radiological dose consequence analyses; it is noted that 30% was used for estimating the occupied volume (resulting in 70% net free volume) in BV2 Calculation B-029A involving refrigerant. The assumption of 75% is adopted here.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE E: Parameter List for Calculating Dose Consequences at the Control Room & Site Boundary

	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
2. Control Room Ventilation Intake Design	Single intake for each unit; same intake used for normal ventilation as well as emergency ventilation.	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 Drawing # 8700-RY-1C, R2 Receptors 2 and 3 for Unit-1, and Unit-2, respectively.	One intake for BV1 and one intake for BV2, which supply the common Control Room. The same intakes are used for normal ventilation as well as emergency ventilation.	BV1/2 Drawing RY-0001C BV1 Drawings RM-0003K & RM-0444A-004 BV2 Drawing RM-0444A-2	There is a single intake for each Unit; the same intake is used for normal ventilation as well as emergency ventilation. The total unfiltered normal operation air intake flow rate is usually unequally divided between the BV1 and BV2 intakes. Receptor 2 represents the BV1 intake, and receptor 3 represents the BV2 intake.
3. Maximum Normal Operation Unfiltered Inflow into Control Room (includes Ventilation Intake Flow Rate and all Unfiltered Inleakage) and postulated Location of referenced Unfiltered Inleakage	Unit 1: Unfiltered: 300 cfm Unit 2: Unfiltered: 200 cfm <u>Total (Unfiltered): 500 cfm</u> <u>Filtered: 0 cfm</u> *All NOP ventilation flowrate values include uncertainties.* *Total unfiltered flow includes 10 cfm for ingress/egress.*	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 2DBD-44A2, Rev. 8, para. 2.2, pg. 6 NDINEM:1144 EM:116251	BV1 & BV2 Unfiltered Intake / Inleakage: 1250 cfm maximum (total for both Units) This maximum normal operation ventilation intake flow rate value is an analytical upper bound value that is intended to include: a) flow rate test measurement uncertainties, b) alll unfiltered inleakage, and c) a 10 cfm ingress/ egress allowance	Assumed value - intended to provide operational margin.	<u>Location of Unfiltered Inleakage</u> Component tests performed as part of 2017 tracer gas testing indicated that potential sources of unfiltered inleakage into the Control Room are the normal operation intake dampers – which can be assigned the same χ/Q as the Control Room air intakes. Regarding other potential locations of inleakage, a χ/Q value that reflects the center of the Control Room boundary at roof level as a receptor could be considered the average value applicable to Unfiltered Inleakage locations around the CRE, and thus representative for

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE E: Parameter List for Calculating Dose Consequences at the Control Room & Site Boundary

	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
			The above value bounds the test results of BV1/2 Procedure 3BVT 1.44.05 via Order 200699902. All Unfiltered Inleakage (including that associated with ingress/egress) may be assumed to occur at same location as intakes (i.e., receptor points 2 and 3 of BV1/2 Drawing RY-0001C).	Engineering judgement – see comment column for basis BV1/2 Drawing RY-0001C BV1/2 Procedure 3BVT 1.44.05 Order 200699902 Vendor Report, NCS Corporation, Control Room Envelope Inleakage Testing at Beaver Valley Power Station 2017, Final Report	all CR unfiltered leakage locations. Review of BV1/2 Drawing RY-0001C indicates that since the post-accident release points are a) closer to the CR intakes and b) the directions from the release points to the CR center and CR intakes are similar, use of χ/Q values associated with the CR intakes, for CR Unfiltered Inleakage, would be conservative. The 10 cfm allowance for ingress/egress, is assigned to the door leading into the Control Room that is considered the primary point of access. This door (S35-71) is located at grade level on the side of the building facing the BV1 Containment and between the CR air intakes. It is located close enough to the air intakes to allow the assumption that the χ/Q associated with this source of leakage would be reasonably similar to that associated with the air intakes.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE E: Parameter List for Calculating Dose Consequences at the Control Room & Site Boundary

	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
4. CR Emergency Ventilation Intake Design	Filtered emergency intake with recirculation which pressurizes the CRE to +1/8" w.g. above outside air pressure. CREVS provides for 0.35 filtered air changes per hour	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 U-1 T/S SR 4.7.7.1.1.d.3, .2.d.4 U-2 T/S SR 4.7.7.1.1.e.4 UFSAR-2, Table 6.4-1, *Control Room Envelope Ventilation Design Parameters*	CREVS provides for 0.28 filtered air changes per hour (based on 800 cfm minimum filtered intake) and 0.35 filtered air changes per hour (based on 1000 cfm maximum filtered intake).	The number of air changes per hour is based on filtered emergency intake flow rate [parameter 8] and minimum Control Room free volume [parameter 1].	The filtered air intake flow path is normally not in service. With the adoption of tracer gas testing for the Control Room Envelope, the relative pressure comparison is no longer important from a design and licensing basis perspective. It may be used for other purposes, such as ventilation balancing.
5. CREBAPS Design Basis	CREBAPS has been eliminated	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 Amendments 257/139	The Control Room Emergency Bottled Air Pressurization System has been eliminated.	Engineering Change Packages ECP-02-0243-ID-01 through ECP-02-0243-ID-09 & ECP-02-0243-RD NRC Safety Evaluation for Amendments 257 (BV1) & 139 (BV2)	

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
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TABLE E: Parameter List for Calculating Dose Consequences at the Control Room & Site Boundary

	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
6. Maximum control room unfiltered inleakage during CR isolation and emergency pressurization mode and postulated Location of reference Unfiltered Inleakage	<u>Isolation (recirculation) mode</u>: 300 scfm with no pressurization <u>Emergency (pressurization) mode</u>: 30 scfm ○ Allowance for ingress/egress 10 ○ Allowance for dampers: 4 ○ Allowance for doors & seals: 6 ○ Allowance for degradation: <u>10</u> TOTAL 30 All unfiltered inleakage may be assumed to occur at same location as intakes, i.e. receptor points 2 and 3. These values include measurement uncertainties	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 Control Room Envelope Inleakage Testing at Beaver Valley Power Station; Final Report; NCS Corp. (Lagus) 7/23/01, Table 20, p.69 8700-RY-1C, R2	<u>CR Isolation (recirculation) mode</u>: 450 cfm maximum <u>CR Emergency (pressurization) mode</u>: 165 cfm maximum Each maximum control room unfiltered flow rate value listed above is an upper bound analytical value that includes test measurement uncertainties and a 10 cfm allowance for ingress and egress. All Unfiltered Inleakage (including that associated with ingress/egress) may be assumed to occur at same location as intakes (i.e., receptor points 2 and 3 of BV1/2 Drawing RY-0001C).	Assumed values are intended to provide operational margin. Engineering judgment – see comment column for parameter 3 BV1/2 Drawing RY-0001C	Refer to Comment for parameter 3.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE E: Parameter List for Calculating Dose Consequences at the Control Room & Site Boundary

	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
7. Allowance for Ingress/Egress (all modes)	10 scfm	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 RG 1.78, position C.10 D.G. 1087, 3.4 SRP NuReg-0800, 6.4 SRP NuReg-0800, 6.4.III.3.d.iii	10 cfm	NRC Regulatory Guide 1.197 BV1 Drawing RA-0020A BV2 Drawing RA-0006B Engineering judgment	There are multiple doors that form part of the Control Room Envelope. Door S35-71 on the south wall of the Control Room at grade elevation 735'-6", between the two Control Room air intakes, accounts for most ingress and egress. Although the door for the Control Room south entrance is protected by a vestibule, no reduction in the 10 cfm allowance is credited.
8. Filtered emergency intake flow rate	600 - 1030 cfm range includes allowance for measurement uncertainties	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 T/S-1; 4.7.7.1.2 T/S-2; 4.7.7.1.2 Control Room Envelope Inleakage Testing at BVPS; Final Report; NCS Corp. (Lagus) 7/23/01, Table 7, p.44 and Table 11, p.50	800 to 1000 cfm Control room filtered inleakage ventilation flow rate values are analytical values that include test measurement uncertainties.	BV1/2 TS 5.5.7 BV1 Specification BVS-367 BV2 Specification 2BVS-157	<u>WECTEC Note:</u> A greater filtered emergency intake flow would reduce the CR dose because the greater depletion rate of the existing airborne activity associated with the larger intake eclipses the larger filtered activity intake.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE E: Parameter List for Calculating Dose Consequences at the Control Room & Site Boundary

	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
9. Margin used on all CR ventilation flows	Not required Flows are based on measurements with reported uncertainty included.	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06	CR ventilation flow rates provided in parameters 3, 6, & 8, above, are analytical values that include test measurement uncertainties.		

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
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TABLE E: Parameter List for Calculating Dose Consequences at the Control Room & Site Boundary

	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
10. CR Intake filter iodine removal efficiency DBA analysis values:	a) 99% for particulate b) 98% for elemental and organic	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 G.L. 99-02	99% for particulate	Regulatory Position C.5.c of NRC Regulatory Guide 1.52 BV1/2 TS 5.5.7.a	The inplace dioctyl phthalate (DOP) test of the HEPA filters in accordance with ANSI N510-1980 confirming a penetration and system bypass of less than 0.05% at design flow rate can be considered to warrant a 99% removal efficiency for particulate matter in accident dose evaluations.
			98% for elemental and organic	Per NRC Generic Letter 99-02; to ensure that the efficiency assumed in the accident analysis is still valid at the end of the operating cycle, a minimum safety factor of 2 is to be applied to the laboratory test acceptance criteria. A SF of 2 is assumed. See comment and parameter 11 for additional detail.	WECTEC Notes: The penetration and bypass for the CREVS HEPA Filter per TS 5.5.7.a of < 0.05% warrants the use of an efficiency of 99% in safety analysis. Thus, the current licensing basis value of 99% remains valid. Per parameter 11, the proposed penetration and system bypass acceptance criterion for the CREVS Charcoal Filter (to be documented in updated TS 5.5.7.b) is < 0.5%. Per NRC GL 99-02, safety analyses can assume a charcoal filter efficiency of 100% - [(0.5% + 0.5%) x 2) = 98%. Thus, the current licensing basis value of 98% remains valid.

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TABLE E: Parameter List for Calculating Dose Consequences at the Control Room & Site Boundary

	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
11. a) T/S Surveillance Acceptance Criterion for CR charcoal filters	a) ≥ 99 % efficiency acceptance criterion using radioactive methyl iodide.	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 U-1 T/S 4.7.7.1.c.2, T/S 4.7.7.2.c.2 U-2 T/S 4.7.7.1.d	a) ≥ 99.5% removal efficiency acceptance criterion for the charcoal adsorber using methyl iodide (i.e., as demonstrated by a laboratory test of a sample)	***a) Proposed change to BV1/2 TS 5.5.7.c acceptance criteria***	Charcoal adsorber sample is tested in laboratory in accordance with ASTM D3803-1989. System Engineering requested flexibility in charcoal adsorber testing acceptance criteria.
b) T/S Surveillance Acceptance Criterion for CR charcoal filters	b) ≥ 99.95 % efficiency acceptance criterion using R-11 refrigerant.	U-1 T/S 4.7.7.1.c.1, T/S 4.7.7.2.c.1 U-2 T/S 4.7.7.1.c.1	b) < 0.5% penetration and system bypass acceptance criterion for the charcoal adsorber (i.e., as demonstrated by an inplace test)	***b) Proposed change to BV1/2 TS 5.5.7.b acceptance criteria***	Charcoal adsorber is tested inplace in accordance with ANSI N510-1980. WECTEC Note: An efficiency ≥ 99.5% for the charcoal adsorber using R-11 refrigerant means the penetration and system bypass is less than 0.5% for the charcoal adsorber, as demonstrated by an inplace test.
c) T/S Surveillance Acceptance Criterion for CR HEPA filters	c) ≥ 99.95% for particulate using DOP.	U-1 T/S 4.7.7.1.c.1, T/S 4.7.7.2.c.1 U-2 T/S 4.7.7.1.c.2	c) < 0.05% penetration and system bypass for the HEPA filters (i.e., as demonstrated by an inplace test)	c) BV1/2 TS 5.5.7.a	

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	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
12. CR Filtered Recirculation Rate	N/A	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06	The BV1 and BV2 ventilation air-conditioning system recirculates CR air through filters intended for dust removal. <u>BV1</u> - AC fan 1VS-AC-1A and 1VS-F-40A or the B train - bag type filters - efficiency ~ 90% <u>BV2</u> - AC fan 2HVC-ACU201A or B - Hi efficiency type filters - efficiency ~ 85% <u>Minimum Flow rate</u>: Based on that available for CR air purge, i.e., 16,200 cfm per unit or 32,400 cfm <u>Duration</u>: t=0 to t-30 days	Location of Recirculation filters with respect to the CR are shown in the BV1 & BV2 sketch attached to this DIT BV1 Vendor Manual 10.001-0644 BV1 Specification BVS-0431 BV2 Vendor Manual 2510.140-179-005 BV2 Stock Code 10008727 BV2 Procedure 3BVT1.44.06 BV1 UFSAR Table 14.3-14a BV2 UFSAR Table 15.6-11	BV licensing basis does not credit / address recirculation filters. Analysis should evaluate if this approach remains conservative *Since the filters are not subject to a maintenance program, the analysis should conservatively assume 50% of the rated efficiency when crediting the filters to estimate the impact of use of the filters on the inhalation / submersion dose, and 100% efficiency when estimating the dose due to direct shine.* Roll Filters have an approximate 20% efficiency based on ASHRAE 52.1 – 1992 Test Method (Reference: Flanders Filter Efficiency Guide). Also reference BV1 Drawing RM-0444A-004, BV2 Drawing RM-0444A-001 and BV2 Drawing RM-0444A-002

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
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TABLE E: Parameter List for Calculating Dose Consequences at the Control Room & Site Boundary

	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
13. Signals that automatically initiate CR emergency Ventilation	- Control Room Area Monitors - CIB signal	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 8700-120-65D S&W 2001-409-001	Signals originate from the Control Room Area Radiation Monitors or as Containment Isolation Phase B	BV1 Drawing LSK-021-001K BV1 UFSAR Section 11.3.5 BV2 UFSAR Section 6.4.2.2	For the purposes of DBA analyses, no credit is taken for CREVS initiation by CR area radiation monitors: BV1 Radiation Monitors RM-1RM-218A & B BV2 Radiation Monitors 2RMC-RQ201 & 202
14. Power supply to safety related instrumentation (i.e., the CIB signal) that initiate CR emergency Ventilation	Uninterrupted power	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 DCP 1302, Rev. 0, Solid State Protection System AC Power	Vital Bus System supplies Class 1E Uninterruptible Power System	BV1 Drawings RE-0001U & RE-0001AA BV2 Drawings RE-0001AY & RE-0001AZ BV1 UFSAR Section 8.5.4 BV2 UFSAR Section 8.3.1.1.17	

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
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TABLE E: Parameter List for Calculating Dose Consequences at the Control Room & Site Boundary

	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
15. CR Emergency Ventilation initiation.	Manual: Yes (see Note 1) Automatic: Yes t = 0 to t = 77 sec: time delay associated with achieving CR isolation; assume normal ventilation (unfiltered) <u>U -1 (bounding)</u> t=77 sec to t = 30 min, CR isolated but not pressurized, t = 30 min to 30 days, CR pressurized/ emergency filtered intake mode	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 Unit 1 T/S 3/4.7.7 SRP 6.4 specifies that a substantial delay be assumed where manual isolation is assumed. ANS 58.8, "Time Response Design Criteria for Safety Related Operations"	The Control Room is automatically isolated within 77 seconds of receipt of a CIB signal; for this time period, normal (unfiltered) ventilation is assumed. Following the CIB signal, the Control Room would remain isolated from 77 seconds to 30 minutes (to bound manual actuation of BV1 CREVS), while on recirculation. From 30 minutes to 30 days, the Control Room will be placed in the emergency filtered intake mode and pressurized via CREVS.	BV1/2 TS 3.7.10 including Bases BV1 LRM Table 3.3.2-1 BV2 LRM Table 3.3.2-1	A CIB from either Unit isolates the Control Room and initiates BV2 CR emergency ventilation. There are three CREVS fan pressurization systems, one at BV1 and two at BV2. Operation with the one BV1 system and one of the two BV2 systems is permitted; a single failure of the operable BV2 system would require manual start of the BV1 system. The 30 minute allowance is for performing manual operator actions outside the Control Room, such as damper manipulations, and bounds the sequencing scheme of automatically starting a BV2 CREV system. The 30 minute allowance is consistent with the current design and licensing basis. For conservatism, all delays are assumed to be sequential.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
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	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
16. Radiation monitor alarm set point to initiate CR emergency ventilation (non-1E)	≤ 0.476 mR/hr	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 T/S –1 Table 3.3-6	N/A	N/A	The CREVS initiation function from CR Radiation Monitors (listed in parameter 13) is not credited.
17. Radiation monitor response delay time after CR environment has reached alarm setpoint	≤180 sec following Hi Radiation	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06	N/A	N/A	The CREVS initiation function from CR Radiation Monitors (listed in parameter 13) is not credited.
Control room ventilation isolation delay time on Hi-Hi Containment Pressure (CIB)	≤22.0 sec following CIB signal ≤ 77.0 sec. (including D.G. start and sequencer delays)	Unit -1 & -2 LRM, Table 3.2-1	≤ 22.0 seconds following CIB signal, and ≤ 77.0 seconds following CIB signal and including Emergency Diesel Generator start and EDG load sequencer delays	BV1 LRM Table 3.3.2-1 BV2 LRM Table 3.3.2-1 BV1 Procedure 1BVT1.1.2 BV2 Procedure 2BVT1.1.2	Time response testing demonstrates that the acceptance criteria are satisfied. Actuation times and delays involving the sensor, channel, slave relay, Emergency Diesel Generator (start and coming up to speed), EDG load sequencer, and damper (stroke) are included as appropriate.
18. Radiation monitor accuracy	± 22% of reading	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06	N/A	N/A	The CREVS initiation function from CR Radiation Monitors (listed in parameter 13) is not credited.

DESIGN INPUT REQUEST FOR UPDATE OF RADIOLOGICAL DOSE CONSEQUENCE ANALYSES
BEAVER VALLEY POWER STATION

TABLE E: Parameter List for Calculating Dose Consequences at the Control Room & Site Boundary

	AOR [UR(B)-487 R1, A1 & A2]		LAR – Increase in CR Inleakage		
Parameter	**Value**	**Reference**	**Value**	**Reference**	**Comment**
19. CIB signal processing delay time after LOCA	Assumed instantaneous	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06	Assumed instantaneous (see parameter 15)		This parameter is included within the time delay values quoted for parameter 15 (except for the manual actuation at 30 minutes).
20. CR Breathing rate	3.5E-4 m^3/s	R.G. 1.183 Rev 0	3.5E-4 m^3/s	NRC Regulatory Guide 1.183	See RG 1.183 section 4.2.6.
21. Control Room Occupancy Factors	0-24 hr 1.0 1-4 day 0.6 4-30 day 0.4	R.G. 1.183 Rev 0, 4.2.6 SRP, NuReg-0800, 6.4 Appendix A	0 to 24 hours: 1.0 1 to 4 days: 0.6 4 to 30 days: 0.4	NRC Regulatory Guide 1.183	See RG 1.183 section 4.2.6.

Control Room Shielding (General)					
22. Control Room Penetrations	All penetrations in CR walls / ceiling, including CR door have equivalent shielding	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 This will have to be listed as an assumption.	BV1 CR ventilation Intake filters and the air-conditioning recirculation filters are located in the BV1 fan room below the BV1 CR. There are no penetrations between the fan room (ceiling) and CR (floor) BV2 ventilation Intake filters and the air-conditioning recirculation filters are located in the fan room east of the CR (i.e., adjacent to the computer room). There are penetrations in the wall between the fan room and the computer room.	BV1 Drawing 8700-RM-0003M BV1 sketch attached to this DIT BV2 sketch attached to this DIT	

23. Release paths to be addressed for the LOCA analysis	<u>Direct Shine to Control Room</u>: Containment Shine, CR Penetration Shine due to Airborne Activity in the Cable spreading area under Unit 2 CR, CR Penetration Shine due to Airborne Activity in the Cable Tray Mezzanine under Unit 1 CR, Cloud shine due to Containment, ESF, and RWST Leakage, CR filter shine due to containment, ESF and RWST leakage, RWST direct shine	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 U1 UFSAR 14.3.5, U2 UFSAR 15.6.5	<u>Direct Shine to Control Room</u>: 1. Containment Shine, 2. Control Room Penetration Shine due to Airborne Activity in BV2 Cable Spreading Area under BV2 CR, 3. CR Penetration Shine due to Airborne Activity in the Cable Tray Mezzanine under BV1 CR, 4. Cloud shine due to Containment, Engineered Safety Features, and Refueling Water Storage Tank leakage, 5. CR filter shine due to Containment, ESF and RWST leakage, and 6. RWST direct shine	The current design and licensing basis is to be carried forward in BV1/2 Calculation UR(B)-487.	Release paths defined in the current design and licensing basis are applicable.

Control Room Shielding (RWST Direct Shine)					
38. LOCA dose to CR due to direct shine from the RWST	From Reference	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 S&W calc 12241/11700-UR(B)-487, R0 including Addendum 1 and 2	See parameter 24		
Site Boundary Atmospheric Dispersion Factors and Breathing Rates					
39. Offsite atmospheric dispersion factors (s/m^3)	<u>EAB</u> 0-2hrs:1.04E-3 (U1) 0-2hrs:1.25E-3 (U2) <u>LPZ</u> 0-8 hr: 6.04E-5 8-24: 4.33E-5 1-4days: 2.10E-5 4-30 days: 7.44E-6	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 ERS-SFL-96-021	<u>Exclusion Area Boundary</u> 0 to 2 hours: 1.04E-3 (BV1) 1.25E-3 (BV2) <u>Low Population Zone</u> 0 to 8 hours: 6.04E-5 8 to 24 hours: 4.33E-5 1 to 4 days: 2.10E-5 4 to 30 days: 7.44E-6	BV1/2 Calculation ERS-SFL-96-021 BV2 UFSAR Table 15.0-11	
40. Offsite Breathing rates (m^3/sec)	0-8 hrs: 3.5E-4 8-24 hr: 1.8E-4 1-30 days: 2.3E-4	FENOC letter ND1MDE:0379, [DIT-FPP-0045-00]; 10/20/06 RG 1.183 R0	0 to 8 hours: 3.5E-4 8 to 24 hours: 1.8E-4 1 to 30 days: 2.3E-4	NRC Regulatory Guide 1.183	

References for Table E

1. BV1 Updated Final Safety Analysis Report, Rev 30
2. BV1 Licensing Requirements Manual (including Bases), Rev 101
3. BV1 Calculation CR-AC-1, Rev 0, Volume of Control Room Area Air Conditioning Spaces
4. BV1 Calculation DMC-3171, Rev 0, Verification of Control Room Area Volume
5. BV1 Calculation EN-ME-105, Rev 0 including Add 1, Atmospheric Dispersion Factors (X/Qs) at Control Room and ERF Receptors for Unit 1 Accident Releases Using the ARCON96 Methodology
6. BV1 Drawing LSK-021-001K, Rev 5, Logic Diagram – Air Conditioning and Refrigeration – Control Room
7. BV1 Drawing RA-0020A, Rev 10, Floor Plans Main Entrance & Control Room
8. BV1 Drawing RB-0017J, Rev 16, Air Conditioning Plan – Control Room Service Building
9. BV1 Drawing RC-0008C, Rev 13, Slab Plan at Elevation 735'-6" Outline Service Building
10. BV1 Drawing RE-0001U, Rev 39, 120V AC Vital Bus – I One Line Diagram (Red)
11. BV1 Drawing RE-0001AA, Rev 36, 120V AC Vital Bus – II One Line Diagram (White)
12. BV1 Drawing RM-0444A-004, Rev 15, Valve Operating Number Diagram, Control Room Area – Air Conditioning System
13. BV1 Drawing 10.001-0222, Rev B, Control Room Emergency Filter
14. BV1 Procedure 1BVT1.1.2, Rev 25, Engineered Safety Features Time Response Test
15. BV1 Procedure 1CMP-44VS-FL-2-1M, Rev 2, Control Room Emergency Outside Air Filter Replacement
16. BV1 Specification BVS-0367, Rev 3 through and including Add 3, Specification for Primary Ventilation Filter Assemblies
17. BV1 Specification BVS-0431, Rev. 2, Central Station Air Handling Units and Heating and Ventilation Units
18. BV1 Vendor Manual 10.001-0644, Rev. N, Central Station Climate Changers Installation and Maintenance Manual
19. BV2 Updated Final Safety Analysis Report, Rev 23
20. BV2 Licensing Requirements Manual (including Bases), Rev 92
21. BV2 Calculation B-029A, Rev 0, Control Room Ventilation System – Freon-22 Concentration
22. BV2 Calculation B-074, Rev 0, Determination of Control Room Volume
23. BV2 Calculation EN-ME-106, Rev 0 including Add 1, Atmospheric Dispersion Factors (X/Qs) at Control Room and ERF Receptors for Unit 2 Accident Releases Using the ARCON96 Methodology
24. BV2 Drawing RA-0006B, Rev 23, Door Schedule & Details
25. BV2 Drawing RB-0039A, Rev 14, Air Conditioning & Ventilation, Control Building
26. BV2 Drawing RE-0001AY, Rev 13, 120 VAC Vital Bus I One Line Diagram (Red)
27. BV2 Drawing RE-0001AZ, Rev 13, 120 VAC Vital Bus II One Line Diagram (White)
28. BV2 Drawing RM-0444A-001, Rev 8, Valve Operating Number Diagram, Control Building Ventilation System
29. BV2 Drawing RM-0444A-002, Rev 16, Valve Operating Number Diagram, Computer and Control Room Air Conditioning
30. BV2 Drawing 2010.800-157-003, Rev G, Control Room Air Pressurization Filter
31. BV2 Vendor Manual 2510.140-179-005, Rev. F, Installation, Startup and Service Instruments for Carrier 39E Air Handling Units
32. BV2 Vendor Manual 2510.800-157-002, Rev Y, Installation, Operation and Maintenance Manual – Ventilation Filter Assemblies
33. BV2 Procedure 2BVT1.1.2, Rev 15, Safeguards Time Response Test
34. BV2 Specification 2BVS-157, Final Revision (2/2/1988), Specification for Ventilation Filter Assemblies

35. BV1/2 Calculation UR(B)-487, Rev 2 [Pending], Site Boundary, Control Room and Emergency Response Facility Doses following a Loss-Of-Coolant Accident Based on Core Uprate, an Atmospheric Containment and Alternative Source Terms
36. BV1/2 Calculation ERS-SFL-96-021, Rev 0, RG 1.145 Short-Term Accident X/Q Values for EAB and LPZ, based on 1986 – 1995 Observations
37. BV1/2 Drawing RY-0001C, Rev 2, Site Postulated Release and Receptor Points
38. BV1/2 Engineering Change Packages for CREBAPS Deletion and CREVS Modification (i.e., ECP-02-0243-ID-01 Rev 5 through ECP-02-0243-ID-09 Rev 2, plus ECP-02-0243-RD Rev 5)
39. BV1/2 Procedure 3BVT 1.44.05, Rev. 6, Control Room Envelope Air In-Leakage Test
40. BV1/2 Technical Specifications (including Bases), 6/14/2018
41. Order 200699902 (2017), Perform 3BVT-01_44_05
42. Vendor Report, NCS Corporation, Control Room Envelope Inleakage Testing at Beaver Valley Power Station 2017, Final Report (1/31/2018)
43. FENOC Stock Item 9735047, Charcoal Filter Tray
44. FENOC Stock Item 9735717, Charcoal Filter Tray
45. FENOC Stock Item 100075371, Charcoal Filter Tray
46. FENOC Stock Item 10008727, Cambridge Hi-Flo Filter
47. NRC Generic Letter 99-02, Laboratory Testing of Nuclear-Grade Activated Charcoal (6/3/1999), including Errata (8/23/1999)
48. NRC Regulatory Guide 1.52, Rev 2 (3/1978), Design, Testing, and Maintenance Criteria for Post Accident Engineered-Safety-Feature Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants
49. NRC Regulatory Guide 1.183, Rev 0 (7/2000), Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors
50. NRC Regulatory Guide 1.197, Rev 0 (5/2003), Demonstrating Control Room Envelope Integrity at Nuclear Power Reactors
51. NRC Safety Evaluation for Amendments 257 (BV1) & 139 (BV2) for selective implementation of an Alternative Source Term methodology for the Loss-Of-Coolant Accident and the Control Rod Ejection Accident, incorporation of ARCON96 methodology for release points associated with the LOCA and CREA, elimination of the Control Room Emergency Bottled Air Pressurization System changes to the Control Room Emergency Ventilation System, and a change to the BV1 CREVS filter bypass leakage acceptance test criteria

Note: Increasing the current fresh air flow rate (500 cfm) has been requested during normal operation. Unfiltered normal operation air intake flow rates are often stated in the BV1 UFSAR and BV2 UFSAR to be 300 cfm (BV1) and 200 cfm (BV2), or a total of 500 cfm. These UFSAR values are to be changed after the Amendments are received. Other documents showing analogous flow rates are likewise affected.

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CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-496	REVISION: 3

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DESIGN VERIFICATION RECORD

Page 1 of 1

NOP-CC-2001-01 Rev. 00

SECTION I: TO BE COMPLETED BY DESIGN ORIGINATOR

DOCUMENT(S)/ACTIVITY TO BE VERIFIED:

DIT-BVDM-0103-03

☒ SAFETY RELATED ☐ AUGMENTED QUALITY ☐ NONSAFETY RELATED

SUPPORTING/REFERENCE DOCUMENTS

DESIGN ORIGINATOR: *(Print and Sign Name)* Douglas T Bloom [signature]	DATE 1-28-19

SECTION II: TO BE COMPLETED BY VERIFIER

VERIFICATION METHOD *(Check one)*

☒ DESIGN REVIEW *(Complete Design Review Checklist or Calculation Review Checklist)* ☐ ALTERNATE CALCULATION ☐ QUALIFICATION TESTING

JUSTIFICATION FOR SUPERVISOR PERFORMING VERIFICATION:

N/A

APPROVAL: *(Print and Sign Name)* N/A	DATE

EXTENT OF VERIFICATION:

Design Review Checklist completed.

COMMENTS, ERRORS OR DEFICIENCIES IDENTIFIED? ☐ YES ☒ NO

RESOLUTION: *(For Alternate Calculation or Qualification Testing only)*

N/A

RESOLVED BY: *(Print and Sign Name)* N/A	DATE
VERIFIER: *(Print and Sign Name)* Michael G. Unfried [signature]	DATE 1/28/2019
APPROVED BY: *(Print and Sign Name)* M S Ressler [signature]	DATE 1/29/2019

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DESIGN REVIEW CHECKLIST

NOP-CC-2001-02 Rev. 04

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):

DIT-BVDM-0103-03

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
1. Were the basic functions of each structure, system or component considered?		✓			
2. Have performance requirements such as capacity, rating, and system output been considered?		✓			
3. Are the applicable codes, standards and regulatory requirements including applicable issue and/or addenda properly identified and are their requirements for design and/or material been met or reconciled?		✓			
4. Have design conditions such as pressure, temperature, fluid chemistry, and voltage been specified?		✓			
5. Are loads such as seismic, wind, thermal, dynamic and fatigue factored in the design?	✓				
6. Considering the applicable loading conditions, does an adequate structural margin of safety exist for the strength of components?	✓				
7. Have environmental conditions anticipated during storage, construction and operation such as pressure, temperature, humidity, soil erosion, run-off from storm water, corrosiveness, site elevation, wind direction, nuclear radiation, electromagnetic radiation, and duration of exposure been considered?	✓				
8. Have interface requirements including definition of the functional and physical interfaces involving structures, systems and components been met?		✓			
9. Have the material requirements including such items as compatibility, electrical insulation properties, protective coating, corrosion, and fatigue resistance been considered?	✓				
10. Have mechanical requirements such as vibration, stress, shock and reaction forces been specified?	✓				
11. Have structural requirements covering such items as equipment foundations and pipe supports been identified?	✓				
12. Have hydraulic requirements such as pump net positive suction head (NPSH), allowable pressure drops, and allowable fluid velocities been specified?	✓				
13. Have chemistry requirements such as the provisions for sampling and the limitations on water chemistry been specified?	✓				
14. Have electrical requirements such as source of power, voltage, raceway requirements, electrical insulation and motor requirements been specified?	✓				
15. Have layout and arrangement requirements been considered?		✓			
16. Have operational requirements under various conditions, such as plant startup, normal plant operation, plant shutdown, plant emergency operation, special or infrequent operation, and system abnormal or emergency operation been specified?		✓			

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DESIGN REVIEW CHECKLIST

NOP-CC-2001-02 Rev. 04

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):

DIT-BVDM-0103-03

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
17. Have instrumentation and control requirements including instruments, controls, and alarms required for operation, testing, and maintenance been identified? Other requirements such as the type of instrument, installed spares, range of measurement, and location of indication should also be included.	✓				
18. Have adequate access and administrative controls been planned for plant security?	✓				
19. Have redundancy, diversity, and separation requirements of structures, systems, and components been considered?		✓			
20. Have the failure requirements of structures, systems, and components, including a definition of those events and accidents which they must be designated to withstand been identified?	✓				
21. Have test requirements including in-plant tests, and the conditions under which they will be performed been specified?	✓				
22. Have accessibility, maintenance, repair and in-service inspection requirements for the plant including the conditions under which they will be performed been specified?	✓				
23. Have personnel requirements and limitations including the qualification and number of personnel available for plant operation, maintenance, testing and inspection and permissible personnel radiation exposure for specified areas and conditions been considered?	✓				
24. Have transportability requirements such as size and shipping weight, limitations and Interstate Commerce Commission regulations been considered?	✓				
25. Have fire protection or resistance requirements been specified?	✓				
26. Are adequate handling, storage, cleaning and shipping requirements specified?	✓				
27. Have the safety requirements for preventing undue risk to the health and safety of the public been considered?		✓			
28. Are the specified materials, processes, parts and equipment suitable for the required application?	✓				
29. Have safety requirements for preventing personnel injury including such items as radiation hazards, restricting the use of dangerous materials, escape provisions from enclosures and grounding of electrical equipment been considered?	✓				
30. Were the inputs correctly selected and incorporated into the design?		✓			
31. Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed?	✓				
32. Are the appropriate quality and quality assurance requirements specified?	✓				

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CALCULATION COMPUTATION

NOP-CC-3002-01 Rev. 05

CALCULATION NO.: 10080-UR(B)-496

REVISION: 3

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DESIGN REVIEW CHECKLIST

NOP-CC-2001-02 Rev. 04

DOCUMENT(S) TO BE VERIFIED (including document revision and, if applicable, unit No.):
DIT- BVDM- 0103-03

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
33. Have applicable construction and operating experience been considered?		✓			
34. Have the design interface requirements been satisfied?	✓				
35. Was an appropriate design method used?		✓			
36. Is the output reasonable compared to inputs?		✓			
37. Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?	✓				
38. Have adequate maintenance features and requirements been specified?	✓				
39. Has the design properly considered radiation exposure to the public and plant personnel?		✓			
40. Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfied?	✓				
41. Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?	✓				
42. Are adequate identification requirements specified?	✓				
43. Are requirements for record preparation, review, approval, retention, etc., adequately specified?	✓				
44. Have protective coatings qualified for Design Basis Accident (DBA) been specified to structures, equipment and components installed in the containment/drywell?	✓				
45. Are the necessary supporting calculations completed, checked and approved?	✓				
46. Have the equipment heat load changes been reviewed for impact on HVAC systems?	✓				
47. **IF** a computer program was used to obtain the design by analysis, **THEN** has the program been validated per NOP-SS-1001 and documented to verify the technical adequacy of the computer results contained in the design analysis?	✓				
48. Have Professional Engineer (PE) certification requirements been addressed and documented where required by ASME Code (if applicable).	✓				
49. Does the design involve the installation, removal, or revise software/firmware and have the requirements of NOP-SS-1001 been addressed?	✓				
50. Does the design involve the installation, removal, or change to a digital component(s) and have the requirements of NOP-SS-1201 been addressed?	✓				

COMPLETED BY: *(Print and Sign Name)*	DATE	ADDITIONAL VERIFIER *(Print and Sign Name)*	DATE
M. G. Unfried [signature]	1/28/2019	N/A	

IF CHECKLIST IS REVIEWED BY MORE THAN ONE VERIFIER, SIGN BELOW: