WOLF CREEK
NUCLEAR OPERATING CORPORATION

Stephen L. Smith
Vice President Engineering

December 6, 2018

ET 18-0035

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

Reference:
1) Letter ET 17-0001, dated January 17, 2017, from J. H. McCoy, WCNOC, to USNRC
2) Letter dated December 4, 2017, from B. K. Singal, USNRC, to A. C. Heflin, WCNOC, "Wolf Creek Generating Station, Unit 1 – Request for Additional Information Re: Licensing Amendment Request for Transition to Westinghouse Methodology for Selected Accident and Transient Analyses (CAC No. MF9307, EPID L-2017-LLA-0211)"
3) Letter dated November 5, 2018, from B. K. Singal, USNRC, to A. C. Heflin, WCNOC, "Wolf Creek Generating Station, Unit 1– Request for Additional Information Re: Licensing Amendment Request for Transition to Westinghouse Methodology for Selected Accident and Transient Analyses (CAC No. MF9307, EPID L-2017-LLA-0211)"

Subject: Docket No. 50-482: Supplemental Response to RAI for License Amendment Request to Revise Technical Specifications to Transition to Westinghouse Core Design and Safety Analysis Including Adoption of Alternative Source Term

To Whom It May Concern:

Reference 1 provided the Wolf Creek Nuclear Operating Corporation (WCNOC) application to revise the Wolf Creek Generating Station (WCGS) Technical Specifications (TS). The proposed amendment would support transition to the Westinghouse Core Design and Safety Analysis methodologies. In addition, the amendment request included revising the WCGS licensing basis by adopting the Alternative Source Term radiological analysis methodology in accordance with 10 CFR 50.67, "Accident Source Term." Reference 2 provided a request for additional information (RAI) related to the application. Reference 3 is a request for supplemental additional information based on the original RAI transmitted in Reference 2.

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The additional information provided in this submittal does not expand the scope of the application and does not impact the no significant hazards consideration determination presented in Reference 1.

In accordance with 10 CFR 50.91, "Notice for public comment; State consultation," a copy of this submittal is being provided to the designated Kansas State official.

This letter contains no commitments. If you have any questions concerning this matter, please contact me at (620) 364-4093, or Cynthia R. Hafenstine at (620) 364-4204.

Sincerely,

Stephen L. Smith

SLS/rlt

Attachment: Supplemental Response to Request for Additional Information

cc: K. M. Kennedy (NRC), w/a
B. K. Singal (NRC), w/a
K. S. Steves (KDHE), w/a
N. H. Taylor (NRC), w/a
Senior Resident Inspector (NRC), w/a

STATE OF KANSAS)
) SS
COUNTY OF COFFEY)

Stephen L. Smith, of lawful age, being first duly sworn upon oath says that he is Vice President Engineering of Wolf Creek Nuclear Operating Corporation; that he has read the foregoing document and knows the contents thereof; that he has executed the same for and on behalf of said Corporation with full power and authority to do so; and that the facts therein stated are true and correct to the best of his knowledge, information and belief.

By______________________________
Stephen L. Smith
Vice President Engineering

SUBSCRIBED and sworn to before me this 6th day of December, 2018.

CINDY NOVINGER
Notary Public - State of Kansas
My Appt. Expires 7/8/2022

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Notary Public

Expiration Date 7/8/2022

Supplemental Response to Request for Additional Information

During phone calls held on October 4, 2018 and October 11, 2018, between Nuclear Regulatory Commission (NRC) staff and Wolf Creek Nuclear Operating Corporation (WCNOC) personnel, several follow-up questions were discussed related to the set of questions from the request for additional information (RAI) provided in a letter dated December 4, 2017. Some of these follow-up questions were formalized into an RAI transmitted to WCNOC in a letter dated November 5, 2018. This attachment provides WCNOC's response to that RAI. NRC questions are in italics while WCNOC responses are in plain text.

RAI ARCB1-CONTROL ROOM-3

Please provide a justification for the proposed change to the licensing basis analysis to include the deposition factors from NUREG/CR-3332.

As stated in the request, the addition of the deposition factors from NUREG/CR-3332 are a change to the licensing basis analysis; however, this is due to the fact that the operator dose due to ingress and egress has not been calculated as part of the current licensing basis. Despite paragraph 50.67(b)(2)(iii) of 10 CFR requiring that the licensee's analysis demonstrates with reasonable assurance that "[a]dequate radiation protection is provided to permit access to and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 0.05 Sv [sievert] (5 rem [roentgen equivalent man]) total effective dose equivalent (TEDE) for the duration of the accident", no guidance could be located within Regulatory Guide 1.183 associated with analyzing an operator dose due to ingress and egress. For this reason, a need for a new licensing basis was not identified in the initial license amendment request. Therefore, the following guidance could not be met: Section 8 of Enclosure IV to letter dated January 17, 2017, "NRC Regulatory Issue Summary 2006-04 Comparison," which states that the analysis conforms to Issue 1, which states that the amendment should identify and justify each change to the accident analysis.

In order to be consistent with precedent, previously approved Alternative Source Term license amendments were reviewed to determine how other utilities had accounted for deposition. When reviewing recent submittals, no details on deposition velocities could be located. Specifically, within Section 7.2.6 of Attachment 1 of the Diablo Canyon response to an NRC RAI (response letter dated October 6, 2016, ADAMS Accession No. ML16287A755), it is stated that radiation exposures to personnel during egress and ingress are limited to (**emphasis** added):

1) **Airborne** activity in the containment leakage plume
2) Direct gamma radiation from fission products in the containment structure

Thus, from the docketed information, it appears that the impact of deposition was neglected. Regarding other submittals, Assumption 10 of SNC Response to RAI No. 40 of the Farley response to an NRC RAI (response letter dated June 8, 2017, ADAMS Accession No. ML17159A847) states the following:

> For the ground shine dose, 100% of the non-noble gas released activity is deposited on the ground of the plant site.

While it is stated that 100% of the non-noble gas released activity is deposited on the ground, the specific details associated with this model could not be ascertained based upon the information available on the docket and as a result, no comparison could be made.

As WCNOC has not analyzed an operator ingress/egress dose as part of its current licensing basis, as there is no guidance contained within Regulatory Guide 1.183, and as no precedent could be located (in regards to deposition velocities), new values had to be utilized/developed for use.

The NUREG library was utilized to obtain values, specifically, NUREG/CR-3332. While the request contained within the RAI discusses that the velocities appear to be derived for "relatively short term" use, it is worth noting that the values documented are relatively consistent with corresponding representative values utilized for other applications. For example, Section 4.2.2.1 of HPA-RPD-058[1] (used for routine releases) documents the following:

> A single value of 10^{-3} m s^{-1}, which is representative of 1 μm particles, is used in this methodology for all radionuclides, except for noble gases (which are assumed not to deposit) and iodine. The deposition velocity for organic iodine is much lower, for which a representative value of 10^{-5} m s^{-1} is adopted whilst the value for inorganic iodine is higher, for which a value of 10^{-2} m s^{-1} is used.

Also, the following is stated in Section 4.2.2.1 of Chapter 1 of Volume 4 of "Modelling Radioactivity in the Environment:[2]"

> *Representative values for deposition velocity of 10^{-3} m s^{-1} for 1 μm particles, 10^{-2} m s^{-1} for elemental iodine and 10^{-5} m s^{-1} for organic iodine are suggested by [Simmonds.]*

Therefore, the NUREG/CR-3332 values are consistent with values that have been determined to be reasonable for long-term use for other applications.

In addition to modeling the suggested values of NUREG/CR-3332, the analysis considered meteorological conditions (specifically for wind direction, speed, and stability class) that result in maximizing the cumulative deposition of material on the operator ingress/egress path over the duration of the event. If this phenomenon did occur, while the deposition of material would be concentrated on the standard ingress/egress path (consistent with the analysis), the site locations not directly downwind would be at a lower concentration than that modeled within the analysis. In other words, while the analysis considers the impact of inhalation dose (operators not being able to avoid the plume as the wind is assumed to shift to the worst case direction) as well as short-term deposition (operators not being able to avoid material recently deposited on the ground), procedure controls are in place to identify and respond appropriately to high radiation areas that would result from consistent wind conditions that maximize deposition on the operator ingress/egress path. Specifically, from Step 6.3.21 of WCNOC Procedure AP 06-002, "Radiological Emergency Response Plan," Revision 19:

> WCGS maintains control over the Exclusion Area as necessary, restoring affected on-site areas to acceptable conditions for access.
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> 1. Reentry into affected areas is a controlled evolution. Surveys are performed, environmental samples are obtained and analyzed, and areas posted or decontaminated.

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[1] HPA-RPD-058, "The Methodology for Assessing the Radiological Consequences of Routine Releases of Radionuclides to the Environment Used in PC-CREAM 08," 2009.

[2] Reactivity in the Environment, Volume 4, Chapter 1, "Design and evaluation of environmental radioactivity models," 2003.

AP 06-002 is the procedure that governs the Radiological Emergency Response Plan (RERP). Additionally, Step 7.2.9 of WCNOC Procedure EPP 06-001, "Control Room Operations," Revision 29A documents the specific requirements of the control room staff:

> **IF** radiological conditions warrant, **THEN** direct the following onsite protective actions as necessary:
>
> - Authorize emergency exposures in accordance with EPP 06-013, EXPOSURE CONTROL AND PERSONNEL PROTECTION
> - Decontamination of on-site personnel in accordance with RPP 02-305, PERSONNEL SURVEYS/DECONTAMINATION
> - Issuance of KI in accordance with EPP 06-013, EXPOSURE CONTROL AND PERSONNEL PROTECTION
> - Notify HP of teams being dispatched to the field and their job duties to ensure proper radiological instructions are provided and personnel radiation exposure is tracked.

While personnel would not be able to respond immediately to abrupt wind direction changes that impact inhalation and short-term deposition, they would be able to respond to long-term meteorological conditions that result in localized areas with a high concentration of deposition. Therefore, modeling the short-term deposition values with accumulation bounds the actual plant response due to the fact that if an area was subjected to these conditions (consistent, sustained wind direction that maximized deposition on the standard ingress/egress path), ingress/egress paths would be rerouted in order to avoid localized high deposition areas. While winds could still shift during operator shift changes, the accumulation would be significantly less than what is modeled in the analysis.

In addition to the conservatism that exists due to accounting for accumulated deposition, it is noted that the NUREG/CR-3332 values correspond to vegetation data, primarily grass, as documented in Table 5.3, Table 5.4, and Table 5.5 of NUREG/CR-3332. As shown in Figure 5.4 of NUREG/CR-3332, the deposition velocity is highly dependent on the roughness height of the surface of interest. As the deposition velocities of NUREG/CR-3332 correspond to vegetation, the roughness height is considerably higher than that of the surfaces located at the Wolf Creek Generating Station (WCGS) site. Specifically, when traveling from the parking lot to the control room an operator will walk over paved surfaces and smooth concrete. As such, the lower roughness height of the operator pathway will result in less limiting deposition velocities than those provided in NUREG/CR-3332.

While a formal position by the NRC associated with this topic (deposition velocity of concrete/paved areas relative to grass/vegetation) could not be located, the following information supports the conservatism of paved surfaces relative to grass/vegetation:

> Table III of IAEA-TECDOC-760[3] documents that leafy vegetation deposition velocities are 10 times higher for particulates, greater than 5 times for elemental iodine, and 1.25 times higher for organic iodine as compared to smooth surfaces including pavement.
>
> Table 2 of "Measurement in a wind tunnel of dry deposition velocities of submicron aerosol with associated turbulence onto rough and smooth urban

[3] IAEA-TECDOC-760, "Modelling the deposition of airborne radionuclides into the urban environment, First report of the VAMP Urban Working Group," August 1994.

surfaces,[4]" documents that synthetic grass yields deposition velocities that were greater than 10 times higher than that of horizontal cement facings.

Table 1 of Chapter 6 of Volume 15 of "Reactivity in the Environment,[5]" documents that the deposition velocities for grass are 5 times greater for elemental iodine and greater than 3 times larger for particles less than 2 μm relative to paved areas.

Consistent with Figure 5.4 of NUREG/CR-3332 and reinforced with the provided references, the deposition velocities modeled within the analysis bound the surface conditions present at the WCGS site for elemental iodine, organic iodine, and particulate deposition.

In regards to rain moisture, it will have different impacts on each of the various deposition velocities. First for organic iodine, the washout factor (amount of iodine removed due to rain) is 2-3 orders of magnitude less than that of elemental iodine and particulates (Table 5.7 of NUREG/CR-3332). This is analogous to the containment spray removal coefficients; i.e., since the removal rate of organic iodine via spray is low, no removal due to containment spray is credited. Similarly, the effect of rain moisture will have minimal impact to the contribution of organic iodine on the overall deposition dose.

For elemental iodine, rain will result in a larger portion of the elemental iodine being removed from the air (relative to dry deposition). However, rain will also result in removal of both the elemental iodine added to the ground during the rain event as well as the elemental iodine deposited on the ground prior to the rain. Specifically, the following references provide additional information in regards to the percentage of elemental iodine removed following a rain event:

Table IV of IAEA-TECDOC-760 documents that rainfall will remove more iodine than it deposits for cement tile surfaces due to runoff.

Table VI of IAEA-TECDOC-760 documents that 70 to 100% of the elemental iodine is removed from a paved area following a 4-10 mm rain.

Table 2 of Chapter 6 of Volume 15 of "Reactivity in the Environment" documents that 97.5% of elemental iodine will be removed from paved areas following a rain.

While a rain storm will result in a larger amount of elemental iodine being removed from the air (relative to dry deposition), runoff will also remove the majority of the elemental iodine that had accumulated on the ground prior to the rain event, in addition to the elemental iodine deposited during the rain.

For particulate deposition, as documented within Table 5.7 of NUREG/CR-3332, the washout factor is less than that of elemental iodine and as a result, fewer particles will be removed from the atmosphere during rain. However, the fraction of particulate deposition removed from runoff will be less than that of elemental iodine. Specifically, the following removal percentages were located for particulates:

Table VI of IAEA-TECDOC-760 documents that 20 to 60% of cesium is removed from a paved area following a 4-10 mm rain.

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[4] Pierre Roupsard, Muriel Amielh, Didier Maro, Alexis Coppalle, Hubert Branger, et al. Measurement in a wind tunnel of dry deposition velocities of submicron aerosol with associated turbulence onto rough and smooth urban surfaces. Journal of Aerosol Science, Elsevier, 2013, 55, pp.12-24.

[5] Reactivity in the Environment, Volume 15, Chapter 6, "Estimation of Doses in Inhabited Areas," 2009.

Table 2 of Chapter 6 of "Airborne Radioactive Contamination in Inhabited Areas" documents that 55% of particulates will be removed from paved areas following a rain.

Thus, while not as large a percentage of particulates will be removed from the atmosphere and deposited during a rain event relative to elemental iodine; fewer deposited particles will be removed from the location due to runoff when compared to elemental iodine. Depending on the rainfall rate (large enough to maximize the amount of particulate pulled out of the atmosphere while also minimizing the amount of material removed due to runoff), it is possible that the deposition of particulates could increase relative to the dry deposition value. However, the contribution of particulate deposition is currently a small contributor to the overall dose (<0.05 rem). Conditions that maximize the particulate deposition dose would reduce the control room dose from activity that enters the control room (currently approximately 2.8 rem). Specifically, the operators are assumed to enter from east of the power plant (including the auxiliary building). In order to maximize the deposition dose, the wind would need to blow primarily from the west. However, as the control room intake is located on the west side of the auxiliary building, the wind would be blowing most of the radionuclides away from the intake of the control room. Additionally, in order to maximize the dose due to particulates, rainfall would need to be present. While precipitation would serve to remove more nuclides (except for organic iodine) from the released plume and potentially increase the deposition of particulates, activity removed from the air would not be available for the control room occupancy dose (currently approximately 2.8 rem) or the operator ingress/egress airborne dose (0.5 rem). Furthermore, the runoff due to precipitation would aid in removing deposited elemental iodine from ingress/egress surfaces and reduce the resulting dose (currently approximately 0.2 rem). In total, out of the current operator dose value of 3.7 rem, the contribution of sources that make up at least 3.5 rem (2.8 rem + 0.5 rem + 0.2 rem) would decrease as the meteorological conditions would be less limiting for them versus when the meteorological conditions are limiting for particulate deposition (<0.05 rem).

Finally, as previously stated, if a rain event resulted in a high concentration of deposited particles, procedure controls exist within the RERP to identify the area and simply reroute if needed.

In summary, the deposition velocities within the analysis support an overall conservative methodology, in the absence of any other NRC approved methodology, relative to the WCGS site. The justification for the proposed change (addition) to the licensing basis analysis to include the deposition factors from NUREG/CR-3332 is summarized as follows:

1. The analysis models accumulation of deposited material over the duration of the event with no credit for removal other than decay.

2. The NUREG/CR-3332 values used in the analysis correspond to vegetation, which are more limiting than the surface conditions at the WCGS site (e.g., pavement and concrete).

3. The conditions required to maximize the particulate deposition dose (currently <0.05 rem) would also reduce the control room occupancy dose (currently approximately 2.8 rem), operator ingress/egress airborne dose (currently 0.5 rem), and elemental iodine deposition dose (currently approximately 0.2 rem).

4. The RERP has procedural controls in place to identify and avoid localized high concentrated areas of deposited activity (e.g., following a rain event or sustained constant wind direction).

RAI ARCB1-LOCA-3

In the supplemental response to RAI ARCB1-LOCA-3 by letter dated June 19, 2018, a new analysis (determining the offsite doses from a design basis LOCA and assuming that the EES is not credited) is discussed. Some of the details of the analysis described in the RAI AERB1-LOCA-3 response needs to be confirmed or provided in order to enable the NRC staff to make a current finding of compliance with 10 CFR 50.67 and 10 CFR 50.36. Accordingly, please confirm or provide the following information regarding the proposed new LOCA analysis:

1. *Please confirm that the new analysis assumes a ground level release from the auxiliary building, and provide the corresponding atmospheric dispersion factor(s) used.*

   The analysis assumes a ground level release from the auxiliary building.

   The Exclusion Area Boundary (EAB) χ/Q value is equal to 1.40E-4 sec/m^3 for all time intervals in order to determine the limiting 2-hour period.

   The Low Population Zone (LPZ) χ/Q values for each time period are subsequently provided:

Time Period	X/Q (sec/m^3)
0 to 2 hours	4.50E-05
2 to 8 hours	2.39E-05
8 to 24 hours	1.29E-05
1 to 4 days	5.49E-06
4 to 30 days	1.61E-06

2. *Please confirm that the release from the auxiliary building assumes no holdup or mixing of the radioactivity released into the auxiliary building (consistent with WCGS UFSAR Section 15.6.5.4.1.2).*

   No reductions due to dilution or holdup were assumed.

3. *Please confirm that the assumed releases into the auxiliary building and atmospheric dispersion factors bound any release from the auxiliary building without the EES credited.*

   The assumed dispersion factors modeled bound any release from the auxiliary building.

   In regards to the offsite releases, for sources located close to the containment structure (such as the unit vent stack, equipment hatch, MSSVs/ARVs vent, or TDAFW exhaust vent), the cross-sectional area of the containment building is used for calculating the building wake term. A release from the auxiliary building (which is directly connected to the containment structure) will be consistent with these release locations.

   In addition to the sources located close to the containment structure, the RWST location, which is not classified as close to the containment structure, was also considered. The cross-sectional area of the RWST was used for the building wake term when calculating offsite dispersion factors for the RWST source.

The most limiting dispersion factor (corresponding to that of the RWST location) was conservatively applied to all release locations analyzed for the event where EES is not credited. Therefore, the assumed dispersion factors modeled bound any release from the auxiliary building.

4. *Please provide the revised LOCA offsite dose results with the EES not credited.*

The following LOCA offsite dose results were obtained for the case where EES is not credited:

	EAB Dose (rem TEDE)	**LPZ Dose (rem TEDE)**
Containment Leakage	4.00	1.82
ECCS Leakage	4.90	11.5
RWST Back-leakage	0.00149	0.34
Mini-Purge Releases	0.0	0.000749
Total dose =	9.0	14.0

<u>RAI ARCB1-FHA-5 and ARCB1-FHA-6</u>

In the letter dated June 19, 2018, in response to RAI ARCB1-FHA-5 and ARCB1-FHA-6, a revised analysis modeling the control room dose from a fuel handling accident in containment with an open personnel airlock is discussed. Additional information relating to the assumptions and inputs of this analysis is needed to enable the NRC staff to make a finding of compliance with 10 CFR 50.67 and 10 CFR 50.36. Please provide the following information regarding the new analysis:

1. *AEC Research and Development Report NAA-SR-10100, "Conventional Buildings for Reactor Containment," developed by Atomics International, is used to calculate the unfiltered inleakage through the various penetrations prior to the control room ventilation isolation signal. The document and equation used from this document may be a proposed change to your licensing basis. Please provide a technical justification for the use of this methodology for this intended application and why it is valid (i.e., an analysis showing how sensitive the control room dose is to varying amounts of unfiltered inleakage to show how important using this proposed methodology is, or justify why using NAA-SR-10100 for determining the assumed unfiltered inleakage for control room habitability has been accepted by the NRC for your facility and is in your licensing basis), or use clearly conservative or bounding and justified values of unfiltered inleakage to calculate a conservative postulated dose.*

   Sensitivity analyses were performed to demonstrate the insensitivity of the overall dose results to the amount of unfiltered inleakage. Specifically, if the unfiltered inleakage from the auxiliary building to the equipment room increases by 10% (110 cfm), the resulting dose increases by 0.8%. Likewise, if the unfiltered inleakage from the equipment room to the control room increases by 10% (110 cfm), the resulting dose increases by less than 0.1%. Thus, the overall dose results are relatively insensitive to the modeled inleakage.

   Regarding the use of NAA-SR-10100, this methodology was utilized in the original licensing basis (NUREG-0881). Specifically, from Section 9.2.1.3 (consistent with Revision 0 of the FSAR):

   > If the control room were isolated but unpressurized, the amount of inleakage resulting from a differential pressure of 1/4 inch w.g., caused by temperature, barometric, or wind variations, would be less than 80 cfm. Leakage rates are calculated in accordance with "Conventional Buildings for Reactor Containment," NAA-SR-[10100].

   NAA-SR-10100 was utilized to demonstrate that if outside air resulted in a pressure increase of ¼ inch w.g., the resulting inleakage would be less than 80 cfm for the entire unpressurized control room. This value is less limiting than the conservative value calculated and utilized (100 cfm) to address a fuel handling accident with an open personnel hatch.

2. *Therefore, additional justification for the assumption of terminating the inleakage after the control room ventilation isolation is needed or the assumption needs to be revised and justified to show that this input determines a conservative postulated dose.*

   In order to support a response to this request, the source of the 40 cfm unfiltered inleakage into the control room after the control room ventilation isolation was moved from the environment to the equipment room. Thus, the updated analysis conservatively bounds any inleakage into the HVAC ductwork from the equipment room. In addition to this change, credit for containment isolation at 2 hours was also removed, as discussed within the response to part 4 of this request. The resulting control room dose increased to 3.1 rem and is discussed in the supplemental response to ARCB1-GENERAL-3.

Also, please confirm the value of 300 cfm of filtered forced air flow from the equipment room to the control room during the emergency mode (or provide the value assumed) and justify the value assumed.

The control room HVAC system is designed to exhaust 350 cfm to the equipment room (after passing through the control room filtration fan). Additionally, 300 cfm of forced air flow is transferred from the equipment room to the control room. The 300 cfm is filtered prior to being discharged to the control room. This design aids in ensuring that the equipment room is maintained at a positive pressure.

If the analysis was modeled consistent with the design of the control room HVAC system, the result would be a net +50 cfm into the equipment room (+350 cfm/-300 cfm). In order to balance the flow rate, 50 cfm would be exhausted to the environment, which would aid in purging the radionuclides from the equipment room. However, the purging effect is conservatively neglected in the analysis. Rather than credit the positive air flow into the equipment room, the flow rate from the equipment room to the control room is set equal to the supply flow rate to the equipment room (i.e., both are set to 350 cfm). As a higher filtered flow rate results in a lower dose due to increased filtration, an uncertainty of 10% is applied in the negative direction to obtain a flow rate of 315 cfm both to and from the equipment room. This conservatively accounts for the design flow rates into and out of the equipment room as it does not credit the +50 cfm design flow rate into the equipment room that would aid in purging the activity.

3. *Therefore, please provide a revised value for the unfiltered inflow due to ingress and egress prior to the control room ventilation isolation signal, and justify the value used.*

In regards to ingress/egress, the doors of interest (between the auxiliary building and equipment room and between the equipment room and control room) are not the primary control room entrance locations. On the contrary, during the licensing basis accident scenario, there is no reason to utilize the doors to pass from the auxiliary building, through the equipment room, and into the control room. Rather, personnel exiting containment and/or supporting event mitigation would utilize the Radiological Controlled Area exit located within the basement of the auxiliary building. Specifically, the applicable off-normal procedure, OFN KE-018, "Fuel Handling Accident" was reviewed to verify that no actions require the use of both of the doors. Thus, the doors of interest are expected to not be opened immediately following a Fuel Handling Accident. However, in order to avoid imposing procedural and administrative requirements to prevent the use of the doors during fuel movement, the analysis conservatively assumes that the doors are utilized consistent with the control room main access door and thus the standard 10 cfm was allocated for ingress and egress through the doors.

That being stated, the analysis assumes that at the start of the event that the pressure on the outside of the equipment room will be higher than the inside pressure of the equipment room and the control room (assuming wind pressurization spreads to the equipment room without credit for any pressure reduction within containment or auxiliary building). However, due to the low pressure difference and the conservatively high inleakage assumed, the rooms will quickly equalize in pressure. Specifically, per the RAI response dated June 19, 2018 (ADAMS Accession No. ML18177A198), the pressurization due to wind will be bounded by 0.004 psi, which is less than a 0.03% pressure increase when compared to atmosphere. The ideal gas law can be utilized to calculate the mass required to increase the pressure of the equipment room and control room by 0.004 psi. Specifically, pressure is directly proportional to the increase in air mass. Thus, in order to obtain a 0.03% increase in pressure, the equipment room and control room air mass would need to increase by the same amount. As the equipment room volume is modeled at 30,000 ft^3, it would equalize in pressure at an increase of less than 1 lbm of air (assuming a maximum density of 0.09 lbm/ft^3). Likewise, as the control room volume is modeled at 100,000 ft^3, it would equalize in pressure at an increase of less than 3 lbm of air (assuming a maximum density of 0.09 lbm/ft^3). As the analysis assumes 100 cfm (9 lbm/min at a density of 0.09 lbm/ft^3) inleakage from the auxiliary building to the equipment room and from the equipment room to the control room, the rooms will rapidly equalize in pressure (less than 30 seconds).

Based upon the limited use of the doors, and considering the minimal mass increase needed to equalize in pressure, the 10 cfm utilized in the analysis is considered to be conservative. Nevertheless, in order to add additional conservatism to the value, out of the 28 cfm margin contained within the 100 cfm total inleakage, an additional 8 cfm will be allocated to ensure that the ingress/egress value is bounding (total of 18 cfm). As the CRVIS is actuated at 30 minutes, the volume corresponding to the additional 8 cfm would account for an air volume of 240 ft^3 (greater than 15 lbm), which is considerably larger than that required to pressurize either the equipment room or the control room.

In summary, the overall leakage value of 100 cfm for unfiltered inleakage for both the auxiliary building to the equipment room and the equipment room to the control room includes an allowance of 18 cfm for ingress/egress prior to a CRVIS. Additionally, out of the overall 100 cfm value, 20 cfm is conservatively retained as margin.

4. *Please confirm that the fuel handling accident analysis conforms to Regulatory Position 5.1.3 and Appendix B to Regulatory Position 5.3, and that all the radioactive material in containment is released to the environment or auxiliary building over a 2-hour time period with the objective of calculating a conservative dose (such an analysis would consider the release through the pathway that maximizes the control room operator dose).*

The analysis has been revised to conservatively remove credit for closure of the containment penetrations at 2 hours and thus now accounts for containment being open for the duration of the event. The control room dose increased to 3.1 rem and is discussed in the supplemental response to ARCB1-GENERAL-3.

In regards to the 2-hour release period, the accident considers two release pathways. First, the pathway that is the primary contributor to the overall dose is via the open personnel hatch. As documented within the RAI response dated January 15, 2018 (ADAMS Accession No. ML18024A477), the flow rate into the auxiliary building is limited by the mechanical capability of the auxiliary building HVAC equipment. The second path considered is out the equipment hatch to the outside air. The second release pathway is not limited by mechanical equipment and thus could result in a 2-hour release (a 2-hour release through the equipment hatch is explicitly considered as one of the cases analyzed for the fuel handling accident).

As the 2-hour closure of the containment personnel hatch is no longer being credited, the flowrate through the personnel hatch is more limiting than the flowrate through the equipment hatch. Thus, any release through the equipment hatch will result in a less limiting event. Therefore, rather than modeling a 2-hour release (maximum flow rate of the HVAC equipment through the personnel hatch combined with the remainder of the activity exiting the equipment hatch), the analysis models a more limiting release where the personnel hatch is assumed to be open for the duration of the event and all activity passes through it at a flow rate limited by the mechanical capability of the auxiliary building HVAC equipment.

Please justify how the proposed changes to the TS LCO 3.9.4 align with the proposed safety analysis (which assumes that the penetrations and personnel air lock are closed at 2 hours) or modify the TS LCO and the proposed safety analysis so that they are consistent.

As previously discussed, the analysis has been revised to remove credit for closure of the containment penetrations at 2 hours and thus now accounts for containment being open for the duration of the event. As such the safety analysis is consistent with the proposed changes to TS LCO 3.9.4.

Please state how the words "Penetration flow path(s) providing direct access from the containment to the outside atmosphere" are defined for TS 3.9.4.

As discussed during the March 19-20, 2018 audit, the definition of the term "outside atmosphere" had previously been debated generically between the industry and the NRC, but that the issue of if this was meant only to refer to the outside environment was not a concern for WCNOC (academic discussion not related to any NRC technical concern), at that time. Since that time, it is our understanding that the issue has subsequently been raised again during the recent TSTF meetings and that there was agreement reached between the TSTF and the NRC that outside atmosphere refers to outside environment ("blue sky").

Based on the above, WCNOC will defer to the Senior Reactor Operator on duty to use their judgement on the application of the term "outside environment" should an applicable condition arise.

RAI ARCB1-WT-5

According to the supplemental response to RAI ARCB1-WT-5 by letter dated June 19, 2018, the partition factor of 100 is removed from the calculations, and all iodine activity in the volume control tank is conservatively modeled to become airborne and is available for transfer to the waste gas decay tank. However, the values provided in Table 4.3-2a in Enclosure of the LAR to the letter dated January 17, 2017, does not appear to have been updated after the stated change in the assumed partition factor. Please provide the updates to Table 4.3-2a.

The following tables are presented as replacements to Tables 4.2-4 and 4.3-2a to Enclosure IV of the LAR to the letter dated January 17, 2017. The tables have been updated to reflect removal of the partition factor such that all iodine activity in the volume control tank is available for transfer to the waste gas decay tank.

Table 4.2-4 Waste Gas Decay Tank Activity	
Waste Gas Decay Tank Inventory	
Nuclide	**Activity [Ci]**
Kr-83m	1.92E+01
Kr-85	5.52E+03
Kr-85m	1.49E+02
Kr-87	3.00E+01
Kr-88	1.79E+02
Kr-89	1.18E-01
Xe-131m	1.07E+03
Xe-133	8.12E+04
Xe-133m	1.27E+03
Xe-135	1.02E+03
Xe-135m	5.97E+01
Xe-137	3.30E-01
Xe-138	4.06E+00
I-131	3.99E+00
I-132	2.30E+00
I-133	4.28E+00
I-134	4.96E-01
I-135	1.94E+00

Table 4.3-2a Tank Activities – AST			
Isotope	**Waste Gas Decay Tank (Ci)**	**Recycle Holdup Tank (Ci)**	**Hypothetical Tank to Maximize Iodine (Ci)**
Kr-85m	1.49E+02	4.00E+00	0.0
Kr-85	5.52E+03	1.69E+03	0.0
Kr-87	3.00E+01	7.34E-01	0.0
Kr-88	1.79E+02	4.49E+00	0.0
Xe-131m	1.07E+03	3.67E+02	0.0
Xe-133m	1.27E+03	1.44E+02	0.0
Xe-133	8.12E+04	1.79E+04	0.0
Xe-135m	5.97E+01	1.09E-01	0.0
Xe-135	1.02E+03	3.64E+01	0.0
Xe-138	4.06E+00	8.74E-02	0.0
I-130	0.0	6.36E-03	2.75E-03
I-131	3.99E+00	5.83E+00	2.75E+01
I-132	2.30E+00	8.52E-02	7.10E-03
I-133	4.28E+00	1.15E+00	8.07E-01
I-134	4.96E-01	7.04E-03	2.26E-04
I-135	1.94E+00	2.07E-01	4.88E-02

RAI ARCB1-SGTR-1
Supplemental Response

As a result of the audit conducted on March 19 and 20, 2018 at the Westinghouse Rockville, MD office (ADAMS Accession No. ML18107A756) and subsequent October 2018 clarification calls, the NRC requested the following clarification to the previous response: The revised SGTR dose analysis presented in the additional supplemental response to ARCB1-SGTR-2 is affected by the post-audit supplemental responses to RAIs ARCB1-SGTR-2, ARCB1-GENERAL-2, and ARCB1-GENERAL-3. The SGTR dose analysis modeled the effects of a loss of offsite power at the start of the event. Releases from the steam generators to the atmosphere begin at the start of the event. Iodine and alkali metals in the flashed portion of the break flow are assumed to be released directly to the environment with no mitigation, dilution, or credit for scrubbing. Iodine and alkali metals in the unflashed portion of the break flow are assumed to mix with the secondary coolant, where they are subject to release via steaming. A partition factor of 100 is applied to the iodines for these steaming releases. The moisture carryover of 0.25% is applied to the alkali metals for these steaming releases. The results are summarized in the response to ARCB1-GENERAL-3.

RAI ARCB1-CONTROL ROOM-1
Supplemental Response

As a result of the audit conducted on March 19 and 20, 2018 at the Westinghouse Rockville, MD office (ADAMS Accession No. ML18107A756) and subsequent October 2018 clarification calls, the NRC requested the following clarification to the previous response: The LOCA dose analysis is affected by the post-audit supplemental responses to RAIs ARCB1-LOCA-1, ARCB1-CONTROL ROOM-3, ARCB1-GENERAL-2, ARCB1-SGTR-6, and ARCB1-GENERAL-3. The control building shine dose was affected by these updates to the LOCA dose analysis, and thus the response to ARCB1-CONTROL ROOM-1 must be updated.

The post-LOCA 30-day integrated dose to the control room operators from activity dispersed within the control building was calculated to be approximately 26.2 mrem (maximum). The 26.2 mrem contribution from activity in the control building is approximately 0.7% of the overall dose of 3.7 rem reported for LOCA. Thus, it was concluded that the activity remaining in the control building is not a significant dose contributor.

For events other than LOCA, the activity accumulated the control building would be bounded by that of the LOCA. Thus, the contribution to the LOCA of 26.2 mrem would be bounding for the events other than LOCA. This is within the rounding applied to events other than LOCA. Thus, the contribution to control room doses for events other than LOCA was considered and judged to be within the rounding applied, and therefore, not calculated.

RAI ARCB1-GENERAL-3
Additional Supplemental Response

Following the audit conducted on March 19 and 20, 2018 at the Westinghouse Rockville, MD office (ADAMS Accession No. ML18107A756), the dose analyses were updated to address several RAIs:

ARCB1-LOAC-1 and ARCB1-LOAC-2: A pre-accident iodine spike was added to the dose analysis. Additionally, doses for only the limiting 2-hour intervals are reported for the EAB.

ARCB1-LLBA-2: A pre-accident iodine spike was added to the dose analysis. Note that control room isolation (i.e., the initiation of emergency mode HVAC flows and filtration) was credited following a high radiation signal.

ARCB1-LLBA-4: The flowrate assumed for the broken letdown line is increased from 222 gpm to 444 gpm to conservatively account for reverse break flow.

ARCB1-LOCA-1: Credit for sedimentation is removed. Note that the spray duration was increased from 5 hours to 9.5 hours (consistent with the CLB) to offset the impact on the doses.

ARCB1-FHA-2: The overall pool decontamination factor for iodine was decreased from 200 to 170.

ARCB1-FHA-5 and ARCB1-FHA-6: The equipment room and associated HVAC flows were added to the model.

ARCB1-SGTR-2: The SGTR doses were reanalyzed to reflect a loss of offsite power at the start of the event. Note that control room isolation was credited at 60 seconds.

ARCB1-SGTR-6: The effects of the communication corridor HVAC intake on the unfiltered inleakage were added to the dose analyses.

ARCB1-WT-5: The iodine partition factor used in the calculation of the waste gas decay tank iodine inventory is removed.

ARCB1-CONTROL ROOM-3: The breathing rate applied to the transit doses is doubled to 7E-04 m^3/sec.

ARCB1-GENERAL-2: Normal mode control building and control room HVAC flows were conservatively increased by 10%. This applies to all dose analyses.

In addition, the increase (typically 10%) applied to the final calculated doses was removed.

The dose analyses were updated to reflect the responses to the above RAIs. It is noted that the analyses updates made prior to the audit (e.g. letdown line break airborne fraction [ARCB1-LLBA-1], main steamline break control room isolation timing [ARCB1-MSLB-2], and reduced LOCA RWST back-leakage rate [ARCB1-CONTROL ROOM-4]) have been retained. Additionally, the discussion on control room modeling that was previously part of the supplemental response to ARCB1-SGTR-2 was updated to reflect the above changes and included below. The final calculated doses are presented at the end of this supplemental response in Tables 5 and 6.

Control Room Isolation

The control room isolation is modeled in the dose analyses in two parts: actuation of the emergency mode filtration (in both the control building and the control room) and closure of the normal HVAC intake damper. The actuation of the emergency mode filtration occurs following receipt of an isolation signal (e.g. high radiation, safety injection or manual action). In the analyses, emergency mode filtration is actuated after a delay of at least 60 seconds to account for instrumentation delays and damper movement following an automatic isolation signal.

Closure of the normal HVAC intake damper occurs on a safety injection signal. It would also occur on manual action but this is not credited in the analyses. The total unfiltered inleakage modeled during emergency mode is 50 cfm. Prior to the closure of the normal HVAC intake damper, the 50 cfm unfiltered inleakage is associated with the normal HVAC intake X/Q. After closure of the normal HVAC intake damper, the unfiltered inleakage is apportioned between the emergency mode HVAC intake (40 cfm) and the communications corridor intake (10 cfm associated with ingress/egress). The X/Qs associated with the communications corridor that are modeled in the analyses are presented in Table 2. See also the supplemental response to ARCB1-SGTR-6.

Table 2: Communication Corridor Atmospheric Dispersion Factors X/Q (sec/m^3)*			
Time Period	**Unit Vent Exhaust**	**MSSVs**	**RWST**
0 to 2 hours	1.32E-03	5.10E-03	7.90E-04
2 to 8 hours	1.02E-03	3.77E-03	6.75E-04
8 to 24 hours	4.08E-04	1.43E-03	2.59E-04
1 to 4 days	2.99E-04	1.00E-03	2.20E-04
4 to 30 days	2.37E-04	7.34E-04	1.67E-04

*The Unit Vent Exhaust X/Qs are used for the LOCA and Rod Ejection Containment Leakage releases, LOCA Containment Purge, LOCA ECCS leakage to the auxiliary building releases, and MSLB faulted SG releases. The MSSV X/Qs are used for the MSLB intact SG releases and the SGTR ruptured and intact SG releases. The RWST X/Qs are used for the LOCA RWST back-leakage release. The other analyses do not credit closure of the normal HVAC intake damper.

In the analyses, a failure of one of the filtration fans is assumed at the start of emergency mode resulting in a larger unfiltered inflow to the control room (since only half of the makeup flow to the control room passes through a filter). After a defined time of 90 minutes from the start of the event, operator action isolates the failed train and terminates the unfiltered inflow to the control room, and consequently lowers the filtered inflow to the control building.

A summary of control room modeling assumptions for all events is provided below:

Table 3: Control Room Modeling Assumptions				
Event/Scenario	**High Radiation Signal, Time from event initiation**	**SI Signal Generation, Time from event initiation**	**Emergency Mode Actuation Credited**	**Normal HVAC Intake Damper Closure**
Main Steamline Break, both iodine spikes	N/A	Immediate	120 seconds*	120 seconds*
Loss of AC Power, both iodine spikes	N/A	N/A	N/A	N/A
Locked Rotor	Immediate	N/A	120 seconds	N/A
Control Rod Ejection – Containment Leakage	N/A	<150 seconds	210 seconds	210 seconds
Control Rod Ejection – Primary to Secondary Leakage	Immediate	N/A	120 seconds	N/A
Letdown Line Break , both iodine spikes	Immediate	N/A	120 seconds**	N/A
SGTR, both iodine spikes	Immediate	325 seconds	60 seconds	600 seconds
LOCA	N/A	Immediate	120 seconds	120 seconds
Tank Ruptures	N/A	N/A	N/A	N/A
Fuel Handling Accident	Immediate	N/A	120 seconds	N/A
Fuel Handling Accident – Auxiliary Building Releases	N/A	N/A	30 minutes (operator action)***	N/A

*See response to ARCB1-MSLB-2

**See supplemental response to ARCB1-LLBA-2

***See response to ARCB1-FHA-5

The HVAC flows are illustrated in Figure 1 with flowrates described in Table 4:

Figure 1: Control Room and Control Building Ventilation Flows

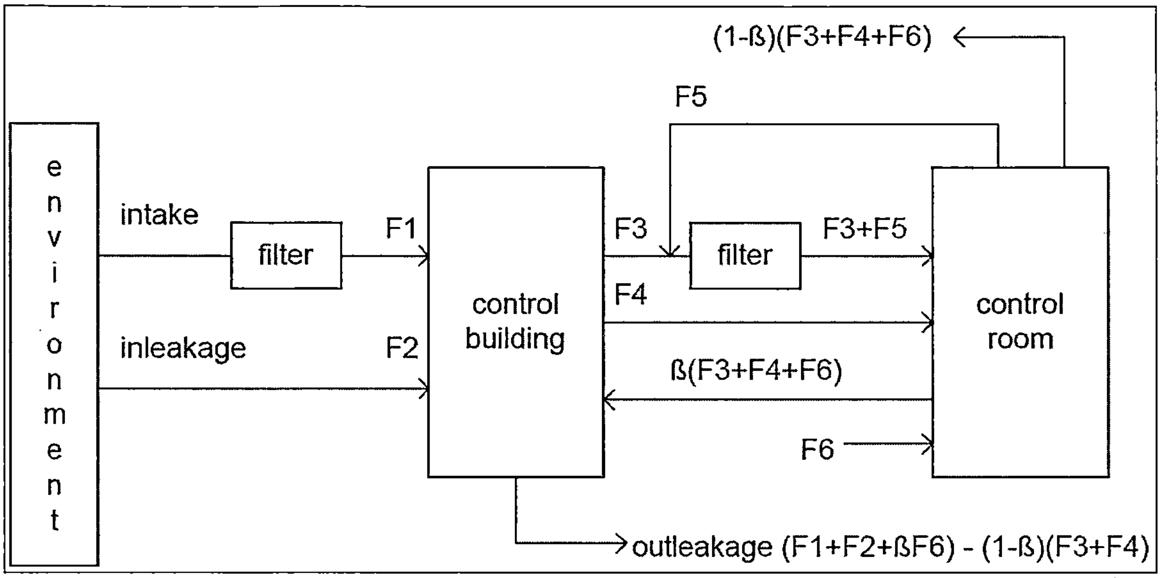

Table 4: Control Room and Control Building Ventilation Flows			
Flow Path	**Normal Mode Flow (cfm)**	**Emergency Mode Flow Prior to Operator Action (cfm)**	**Emergency Mode Flow After Operator Action (cfm)**
F1	0	1350	675
F2	14360*	400	400
F3	0	550	550
F4	0	550	0
F5	0	1250	1250
F6	2195**	50***	50***
β	0	0	0

*13050 cfm *1.1 = 14355 cfm, rounded to 14360 cfm.

** 1950 cfm makeup * 1.1+ 50 cfm inleakage = 2145 cfm + 50 cfm = 2195 cfm.

*** After Normal HVAC intake closure: 10 cfm via communications corridor associated with ingress/egress plus 40 cfm via Emergency HVAC intake. For the FHA auxiliary building release case, the 50 cfm comes from the Equipment Room; see the response to ARCB1-FHA-5.

Revised Doses

The dose analyses were revised in response to the RAIs described above. The revised doses are tabulated below. These doses do not contain the adder (typically 10%) that was described in the previous response to ARCB1-GENERAL-3. Instead, the calculated total doses are rounded up to 2 significant figures. Table 5 contains the updated doses for events other than LOCA, and Table 6 contains the LOCA doses.

Table 5: Updated Non-LOCA Doses (rem TEDE)				
Event/Location	**EAB***	**LPZ**	**CR**	**TSC**
MSLB – AI Spike	0.58	0.54	4.8	0.44
MSLB – Pre-Accident Spike	0.20	0.12	4.5	0.28
LOAC – AI Spike	0.0013	0.0047	2.5	0.0034
LOAC – Pre-Accident Spike	0.0018	0.0015	0.86	0.0021
Locked Rotor	0.38	0.32	3.5	0.16
CREA – Containment Leakage	1.1	1.9	2.6	2.0
CREA – Secondary Releases	0.38	0.32	3.5	0.16
LLB – AI Spike	0.35	0.12	0.37	0.43
LLB – Pre-Accident Spike	0.57	0.19	1.5	0.78
SGTR – AI Spike	0.80	0.26	1.1	1.5
SGTR – Pre-Accident Spike	0.99	0.32	4.2	2.2
LOCA	See Table 6			
Waste Gas Decay Tank Rupture	0.090	0.029	0.057	0.0076
Recycle Holdup Tank Rupture	0.025	0.0080	0.053	0.0058
Hypothetical Liquid Waste Tank Rupture	0.045	0.015	0.23	0.024
FHA	1.2	0.39	1.1	1.1
FHA – Auxiliary Building Releases	N/A	N/A	*3.1*	N/A

*The pre-accident spike scenarios added to the LOAC and LLB dose analyses have limiting 2-hour intervals for the EAB of 10 to 12 hours and 0 to 2 hours, respectively. The limiting 2-hour interval for the LOAC accident-initiated iodine spike is 10 to 12 hours. The limiting 2-hour intervals for the EAB dose for the other analyses are unchanged from those previously reported.

Table 6: Updated LOCA Doses (rem TEDE)				
Event/Location	**EAB**	**LPZ**	**CR**	**TSC**
Containment Leakage	4.36E+00	1.82E+00	1.09E+00	2.89E+00
ECCS Leakage	4.21E-01	1.15E+00	1.00E+00	5.60E-01
RWST Back-leakage	1.08E-03	3.40E-01	6.13E-01	1.46E-01
Containment Purge	0.0	7.50E-04	6.78E-02	3.57E-03
Transit*	N/A	N/A	8.0E-01	N/A
External Sources	N/A	N/A	1.26E-01	6.32E-01
Total	**4.8**	**3.4**	**3.7**	**4.3**

*The transit doses are discussed in the response to ARCB1-CONTROL ROOM-3.