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

Zion Nuclear Power Station, Units 1 and 2
Facility Operating License Nos. DPR-39 and DPR-48
NRC Docket Nos. 50-295 and 50-304

Subject: License Termination Plan Request for Additional Information

References:

1) Gerard van Noordennen, Zion*Solutions*, Letter to U.S. Nuclear Regulatory Commission, "License Amendment Request for the License Termination Plan", dated December 19, 2014
2) Gerard van Noordennen, Zion*Solutions*, Letter to U.S. Nuclear Regulatory Commission, "License Termination Plan Update of the Site-Specific Decommissioning Costs", dated February 26, 2015
3) John B. Hickman, U.S. Nuclear Regulatory Commission, Letter to John Sauger, Zion*Solutions,* "Request for Additional Information Related to the License Termination Plan for Zion Nuclear Power Station, Units 1 and 2," dated December 10, 2015
4) Gerard van Noordennen, Zion*Solutions*, Letter to U.S. Nuclear Regulatory Commission, "License Termination Plan Request for Additional Information", dated March 8, 2016
5) John B. Hickman, U.S. Nuclear Regulatory Commission, Letter to John Sauger, Zion*Solutions,* "Request for Additional Information Related to the License Termination Plan for Zion Nuclear Power Station, Units 1 and 2," dated May 31, 2016

The Zion Station License Termination Plan (LTP) was submitted to the U.S. Nuclear Regulatory Commission (NRC) for review on December 19, 2014 as documented in Reference 1. Following initial NRC review, a Request for Additional Information (RAI), as documented in Reference 3, was received on December 10, 2015. A response to that request was submitted on March 8, 2016 as documented in Reference 4. This letter provides responses to additional information requested as documented in Reference 5.

Responses to the issues identified in the Reference 5 are provided in Enclosure 1. Supporting references are provided in Enclosure 2. Enclosure 3 contains a preflight report for Enclosures 1 and 2.

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There are no regulatory commitments made in this submittal. If you should have any questions regarding this submittal, please contact Robert Yetter at (224) 789-4250.

Respectfully,

Gerard van Noordennen

Gerard van Noordennen
Vice President Regulatory Affairs

Enclosures:

Enclosure 1: RAI Responses

Enclosure 2: Reference Documentation containing:

- TSD 14-009 Revision 2, BNL – Evaluation of Max Radionuclide Groundwater Concentrations for Basement Fill Model
- TSD 14-010 Revision 2, RESRAD Dose Modeling for Basement Fill Model, Soil DCGL and Calculation of Basement Fill Model Dose Factors
- TSD 14-015 Revision 2, Buried Pipe Dose Modeling & DCGLs
- TSD 14-017 Revision 0, Milian, L., T. Sullivan (2014). Sorption (Kd) measurements on Cinder Block and Grout in Support of Dose Assessments for Zion Nuclear Station Decommissioning, Brookhaven National Laboratory Report to ZionSolutions, April 2014
- TSD 14-019 Revision 1, Radionulides of Concern for Soil and Basement Fill Model Source Terms
- TSD 14-020 Revision 0, Yim, S.P, T.M. Sullivan, and L. Milian, Sorption (Kd) measurements in Support of Dose Assessments for Zion Nuclear Station Decommissioning, Brookhaven National Laboratory Report to ZionSolutions, December 12, 2012
- TSD 14-021 Revision1, BFM Drilling Spoils and Alternate Exposure Scenarios
- TSD 14-031 Revision 1, BNL – Basement Fill Model Evaluation of Maximum Radionuclide Concentrations for Initial Suite of Radionuclides
- ZS-LT-300-001-002, Revision 2, Survey Unit Classification
- ZS-LT-400-001-002, Revision 0, Contamination Verification Surveys

Enclosure 3: Preflight Report for Enclosure 2 to this submittal

cc: John Hickman, U.S. NRC Senior Project Manager (2 copies of the enclosures)
Regional Administrator, U.S. NRC, Region III (1 copy of the enclosures)
Service List (Cover letter only, no enclosures)

Zion Nuclear Power Station, Unit 1 and 2 License Transfer Service List

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Enclosure 1

RAI Responses

PAB Zion RAIs

1. NRC Comment: General Comment - Revisions to the LTP

Discussion: Some of the RAI responses have caused revisions to the LTP. The revisions to the LTP are contained as italicized text in the RAI response in some cases, but in other cases, the RAI response states that a section will be changed to be consistent with another section. It would be helpful to the staff to have a version showing track changes once all the revisions are complete.

For example, pg. 29 of 156 of the RAI response states, "Sections 6.8.2 and 6.12.1 restate the DCGL investigation levels, but use a value of 10% of the DCGL. This is not correct and will be revised to a SOF of 0.5 consistent with section 5.1."

Resolution:

a. Please provide a track change version of the LTP with proposed changes once it is revised.

Zion Station Restoration Project (ZSRP) Response (PAB 1a) – Once all RAI comments have been resolved, ZSRP will submit to NRC a revised LTP with all revisions identified by change bars.

2. NRC Comment: PAB Chapter 3, RAI 5 - More information is needed regarding the backfilling of the basements.

Discussion: Prior to reuse in basements, concrete will be surveyed according to limits in NRC IE Circular No. 81-07, and soil will be surveyed on a graded approach to ensure levels are at or below background. It appears that no additional survey will be conducted after the backfill is placed in the basements.

For land survey units, it appears that reuse soil will be surveyed on a graded approach comparable to the FSS prior to placement and according to the FSS after placement. However, it is unclear if concrete material will be allowed to be reused as backfill in the Land Survey Units and what types of surveys the material will be subject to for this use.

See Table below on the NRC staff's understanding of the surveys intended for different types of backfill which is reused in either Land Survey Units or Basements to ensure the NRC staff's understanding is correct.

Table 1 Surveys for Reuse Concrete or Soil to be placed in a Land Survey Unit or Backfilled Basement

	Concrete debris from demolition of buildings above 588 ft elevation	Reuse Soil from other parts of the site	Clean soil from offsite sources
Land Survey Unit	Prior to demolition, concrete will be surveyed to meet the limits in IE Circular No. 81-07. After concrete material is placed in a land void, no additional survey of this material will be conducted.	Soils above background but below some other release criteria (e.g., DCGLs?) may be used to backfill excavation voids outside of basement footprints. *Please be more specific on what release criteria will be applied.* (CH 3 RAI 5). Prior to reuse, soils will be scanned. Scanning requirements and soil sample frequency shall also be determined in accordance with the classification of the area where the soil had originated. (CH 3 RAI 5) "After soil is placed in the void, reuse soil shall be subject to FSS as an open land survey unit commensurate with the classification of the area in which it resides." (CH 5 RAI 1)	Soil is from Zion Municipal Landfill, is virgin and undisturbed and was sampled for radiological and non-radiological constituents prior to it being deemed acceptable for use as clean backfill material. After placement soil shall be subject to FSS as an open land survey unit commensurate with the classification of the area in which it resides. (CH 5 RAI 1)
Backfilled Basement	*Prior* to demolition survey to meet the limits in IE Circular No. 81-07. After backfill concrete is placed, no additional survey will be conducted. (CH 3 RAI 5)	Only reuse soils free of detectable plant-derived radionuclides (at background levels). Prior to reuse surveys will be conducted "comparable to rigor of FSS", and will "satisfy the criteria of unconditional release." (CH 3 RAI 5). *Please be more specific on what criteria will be applied for determining that soils are indistinguishable from background and how unconditional release criteria will be utilized.* After backfill reuse soil is placed in basements, no additional survey of soils will be conducted.	Soil from Zion Municipal Landfill which is virgin and undisturbed and was sampled for radiological and non-radiological constituents prior to it being deemed acceptable for use as clean backfill material. After backfill is placed in basements, no additional survey of the soil will be conducted.

Resolution:

a. The licensee should evaluate whether or not the NRC's understanding is in agreement with the licensee's anticipated actions with respect to surveys of backfill material.

ZSRP Response (PAB 2a) – In response to this RAI, ZSRP provides responses/clarifications to each of the sections from Table 1.

Concrete debris from demolition of buildings above 588 foot elevation

- Land Survey Units – Concrete debris from the demolition of buildings will not be used to backfill excavations made in soil or land voids.
- Backfilled Basements – Prior to demolition, the standing concrete surface (designated by process knowledge and previous characterization results as a suitable candidate for potential use as clean fill) will be surveyed for unconditional release in accordance with Zion*Solutions* procedure ZS-LT-400-001-001, "Unconditional Release of Materials, Equipment and Secondary Structures." In accordance with procedure ZS-LT-400-001-001, the criterion for unconditional release is "indistinguishable from background." Once the concrete has been determined to be suitable for unconditional release (indistinguishable from background), the structure will be demolished, all metal removed and the concrete crushed to pieces that are 10 inches in diameter or less. The material will then be stockpiled and controlled as "non-radioactive clean fill" (per LTP Chapter 5, section 5.6.3) until such time that it is placed in the basement void.

  If the unconditional release surveys positively detect plant-derived radionuclides, then the concrete will not be used as clean fill. In this case, it will be segregated, packaged and disposed of as low level radioactive waste.

  Unconditionally released concrete debris will only be used as fill in building basement voids and only to a maximum depth of 3 feet below ground surface. The top 3 feet of fill material will be clean soil. Once the basement void has been filled to grade, a FSS survey will be performed on the land survey unit in which the basement is located per LTP Chapter 5, section 5.6.4, including the area of the backfilled basement void.

Reuse soil from other parts of the site

- Land Survey Units – Soils excavated and removed from an impacted open land survey unit (e.g. to remove or expose a pipe, or to install or remove utilities, etc…) will not be used as backfill for excavation voids. All soil excavated from impacted open land survey units will be segregated, packaged and disposed of as low level radioactive waste. Soils excavated from impacted land survey units may be used to backfill excavation voids outside of the building basement footprints. Stockpiled excavated impacted soils used in this manner will be surveyed (scanning and soil sample frequency) in accordance with the classification of the area where the soil had originated. Controls will be instituted to prevent mixing of soils from more restrictive survey area classifications (e.g., Class 2 material could be used in either Class 1 or 2 areas and Class 1 material could only be used in Class 1 areas).

Once the excavation void has been filled to grade, a FSS survey will be performed on the land survey unit in which the excavation was located per LTP Chapter 5, section 5.6.4, including the area of the backfilled excavation void.

- Backfilled Basements – ZSRP will not use soils excavated from impacted land areas to backfill the building basement voids. ZSRP has committed to only use soils imported from the Zion Municipal Landfill. This soil is virgin and undisturbed and was sampled for radiological and non-radiological constituents prior to it being deemed acceptable for use as clean backfill material. If alternate sources of clean soil are identified, ZSRP will perform additional sampling for radiological and non-radiological constituents. Once the basement void has been filled to grade, a FSS survey will be performed on the land survey unit in which the basement is located per LTP Chapter 5, section 5.6.4, including the area of the backfilled basement void.

Clean soil from offsite sources

- Land Survey Units – Soil for use as backfill will be imported from the Zion Municipal Landfill. This soil is virgin and undisturbed and was sampled for radiological and non-radiological constituents prior to it being deemed acceptable for use as clean backfill material. This soil may be used as backfill anywhere on site in any land excavation void. If alternate sources of clean soil are identified, ZSRP will perform additional sampling for radiological and non-radiological constituents.

  Once the excavation void has been filled to grade, a FSS survey will be performed on the land survey unit in which the void is located per LTP Chapter 5, section 5.6.4, including the area of the backfilled excavation.

- Backfilled Basements – Soil for use as backfill will be imported from the Zion Municipal Landfill. This soil is virgin and undisturbed and was sampled for radiological and non-radiological constituents prior to it being deemed acceptable for use as clean backfill material. If alternate sources of clean soil are identified, ZSRP will perform additional sampling for radiological and non-radiological constituents. This soil may be used anywhere on site in any building basement void.

  Once the building basement has been filled to grade, a FSS survey will be performed on the land survey unit in which the basement is located per LTP Chapter 5, section 5.6.4, including the area of the backfilled void.

3. **NRC Comment**: PAB Chapter 3, RAI 6 and Chapter 6, RAI 18 - More information is needed on the filling of abandoned piping with grout or fill.

Discussion: With regard to buried piping the response states, "ZSRP intends to grout or fill all remaining buried pipe that is greater than four feet in diameter and at least three feet below ground with the exception of any system pipe that is to remain in service." TSD 14-015, Attachment 1 lists the inventory of buried pipes, but only 4 items on the list have a diameter greater than 4 ft (48 inches). Attachment 1 does indicate the elevation, so it is reasonable to assume that anything below 585 ft (3 ft below the 585 ft) would be grouted if it is greater than 4 ft, but this is not entirely clear. If that is the case, it seems like only 8 items from Attachment 1 match the criteria for grouting (i.e., ice melting pipes to Forebay).

In the response to Chapter 6, RAI 18, a number of tables were provided describing the penetrations between basements. These tables list an end state of "leave open" for many of the penetrations. This appears to be inconsistent with the statement in Chapter 3, RAI 6 that the openings of embedded pipe systems will be plugged.

Resolution:

a. Please clarify, of all the buried pipes listed in TSD 14-015 Attachment 1, which pipes will be grouted. Also, please clarify if any of the pipes in Attachment 1 will be treated as embedded pipes or penetrations which will undergo an STS as opposed to being compared to the Buried Piping DCGLs.

ZSRP Response (PAB 3a) - Four pipes listed in Attachment 1 of TSD 14-015 have been earmarked for grouting. These are the U1 Ice Melting Line to Forebay (144" and 96" sections) and U2 Ice Melting Line to Forebay (144" and 96" sections). These lines have already undergone a FSS to a buried pipe DCGL and have been subsequently grouted. All other pipes listed in Attachment 1 will undergo a FSS but are not earmarked for grouting. None of the pipes listed in Attachment 1 will be treated as an embedded pipe or a penetration.

b. Clarify whether the openings to penetrations or embedded pipe will be plugged.

ZSRP Response (PAB 3b) - All embedded piping will be plugged. The piping will be removed from all penetrations, leaving just a sleeve. It is ZSRP's intention to leave all penetrations "open" however, to support decommissioning, penetrations below the 580' elevation will be plugged to prevent in-leakage from an adjacent building where backfill has been completed. As an example, after the Turbine Building STS has been completed and backfill operations have commenced, the Turbine Building basement will be backfilled up to the 588' elevation and will eventually become saturated with water. If the penetrations connecting the Turbine Building with the Auxiliary Building (along the "G" wall) are not plugged, then this water could flow into the Auxiliary Building and hinder ongoing decommissioning. As a remedy, it is ZSRP's intention to plug all penetrations and then, just prior to completing backfill, perforate the walls as necessary between the lowest floor elevation up to the 580' elevation to allow for the equilibrium described in the hydrological reports (TSD 14-032 and TSD 14-006 which have been provided to NRC).

4. **NRC Comment**: Chapter 6, RAI 7 - Additional information is needed to evaluate the Radionuclides of Concern (ROC).

Discussion: Note 1 of Table 6-3 in the LTP states that H-3, Eu-152 and Eu-154 are activation products and are, therefore, applicable to the containment building only. The LTP, Section 6.5.2.2 states that the SFP/Transfer Canal and Circulating Water Discharge Tunnel are assumed to have the same radionuclide mixture as the Auxiliary Building for planning purposes, but that the radionuclide mixture could be somewhat different due to the source of the contamination and that these areas will require further characterization. It is unclear if tritium (H-3), Eu-152, or Eu-154 will be treated as significant ROCs in the SFP/Transfer Canal or Circulating Water Discharge Tunnel.

Resolution:

a. Clarify the status of H-3, Eu-152, and Eu-154 in the SFP/Transfer Canal and the Circulating Water Discharge Tunnel as ROCs.

ZSRP Response (PAB 4a) – ZSRP commits in LTP Chapter 2, sections 2.3.3.3 and 2.5 to perform additional characterization of the underlying concrete pad and remaining pool walls of the SFP/Transfer Canal once the liner is removed and the underlying concrete is exposed. LTP Chapter 5, section 5.1 also states that the characterization will include the acquisition of concrete core samples and that those core samples will be analyzed for the presence of HTD radionuclides. ZSRP commits to the analysis of the initial suite of radionuclides as was performed for previous concrete core characterization samples which includes H-3, Eu-152, and Eu-154.

Note that Np-237 will be removed from the initial suite list and not included in any future analyses. Np-237 was not positively identified in any characterization sample and was not positively identified in any of the 19 representative Part 61 samples reviewed in Zion*Solutions* TSD 11-001, "Potential Radionuclides of Concern during the Decommissioning of the Zion Station." Np-237 was originally included in the initial suite because it was listed in one Table (Table 4.4) in NUREG/CR-4289 "Residual Radionuclide Concentration Within and Around Commercial Nuclear Power Plants; Origin, Distribution, Inventory, and Decommissioning Assessment." However, the Np-237 relative concentration in NUREG/CR-4289, Table 4.4 is orders of magnitude below the 0.01% threshold applied in TSD 11-001 to exclude radionuclides from the initial suite and therefore should not have been included in the initial suite. Note that excluding Np-237 from the initial suite applies only to future HTD analyses. The hypothetical dose contribution to the insignificant contributor dose will be retained.

The characterization results for the SFP/Transfer Canal will be used to identify and calculate the dose from insignificant contributor radionuclides, including MDC values for non-detected radionuclides. If the insignificant contributor dose from the characterization results is less than the insignificant contributor dose assigned to the SFP/Transfer Canal for planning purposes, then the current adjustment to the BFM Dose Factors to account for insignificant contributor dose will be retained. If the insignificant contributor dose from the SFP/Transfer Canal characterization is greater than the insignificant contributor dose assigned to the SFP/Transfer Canal for planning purposes, then the Basement Dose Factors for the SFP/Transfer Canal will be re-adjusted to account for the increased dose. It is possible, but not likely, that the data could indicate different

ROC for the SFP/Transfer Canal. If so, a specific ROC list for SFP/Transfer Canal will be applied. The characterization data will also be reviewed to determine if the ratios of Sr-90/Cs-137 and Ni-63/Co-60 are significantly different from the ratios currently assigned which are based on the Auxiliary Building mixture. If so, the ratios from the characterization data will be applied to the FRS surrogate calculations for the SFP/Transfer Canal.

During site characterization, the Circulating Water Discharge Tunnels were open to Lake Michigan and flooded. However, process knowledge and the results of environmental monitoring of radiological conditions at effluent outfalls in the past indicate that residual radioactivity in the Circulating Water Discharge Tunnels is likely a minute fraction of the allowable inventory. Based upon the contamination potential, the HSA initially classified the interior of the tunnels as Class 3.

In January of 2016, the tunnels were isolated from the lake, dewatered and STS was performed in the accessible portions. Both Unit 1 and Unit 2 Circulating Water Discharge Tunnel were designated as STS unit #B3-09200B-S. The STS unit consisted of both Discharge Tunnels from the 12 foot diameter Condenser water box discharge pipes down into the tunnels to the isolation point at the valve house. The portion of the tunnel from the stop valve to the site boundary will remain flooded as isolation from the lake is not feasible. Access to the tunnels was through openings at the Valve House. The lower portions of the tunnels were deemed not accessible due to safety concerns. Also, after dewatering, approximately 6 to 12 inches of sludge remained on the bottom of the tunnels.

A total of 14 static measurements were taken at random selected locations on the combined internal surface area of both tunnels using a suspended ISOCS. The field-of-view for each shot was approximately 28 m^2, resulting in a total areal coverage of approximately 396 m^2 or 8%. In addition, 3 samples of composited sediment and sludge were acquired from each tunnel. The maximum measurement observed by the ISOCS resulted in a sum-of-fraction of 0.04. The mean inventory fraction for the STS unit was 0.01 resulting in a total mean dose of 0.13 mrem/yr. The 6 sediment samples were analyzed by the on-site gamma spectroscopy system. Cs-137 was positively detected ranging in concentration from 2.75E-02 pCi/g to 9.03E-02 pCi/g. Co-60 was positively detected ranging in concentration from 3.38E-02 pCi/g to 1.66E-01 pCi/g.

ZSRP will analyze selected sediment samples taken from the Circulating Water Discharge Tunnels for the initial suite radionuclides (with the exception of Np-237 as discussed above). As with the characterization of the SFP/Transfer Canal, ZSRP commits to calculate the insignificant contributor dose. If the insignificant contributor dose from the sample(s) is less than the insignificant contributor dose assigned to the Circulating Water Discharge Tunnels for planning purposes (see LTP Chapter 6, Section 6.6.8), then the current adjustment to the BFM Dose Factors to account for insignificant contributor dose will be retained. If the insignificant contributor dose from the Circulating Water Discharge Tunnels characterization is greater than the insignificant contributor dose assigned to the Circulating Water Discharge Tunnels for planning purposes, then the Dose Factors for the Circulating Water Discharge Tunnels will be re-adjusted to account for the increased dose. It is possible, but not likely, that the data could indicate different ROC for the Circulating Water Discharge Tunnels. If so, a specific ROC list for the Circulating Water Discharge Tunnels will be applied. The characterization data will also be reviewed to determine if the ratios of Sr-90/Cs-137 and Ni-63/Co-60 are significantly different from the ratios currently assigned that are based on the Auxiliary Building radionuclide mixture. If so, the ratios from the characterization data will be applied to the FRS surrogate calculations for the Circulating Water Discharge Tunnels.

5. **NRC Comment**: Chapter 6, RAI 8 and RAI 13 - Dose contribution from insignificant ROCs and subsequent adjustments to the basement dose factors and soil DCGLs.

Discussion: NUREG 1757, Vol 2, Rev 1, Appendix O.2 states, "radionuclides which are undetected may be considered insignificant, as long as the MDCs are sufficient to conclude that the dose contribution is less than 10% of the dose criterion (i.e., with the assumption that radionuclides which are undetected are present at the MDCs)."

For soil, the only detected radionuclides were Cs-137 and Co-60. Therefore, the licensee relies on the Auxiliary Building core samples (5 floor cores and 1 wall core analyzed for HTDs) for all basements besides containment. Using the data from the Auxiliary Building cores, the licensee attributes 0.171% of the dose to the insignificant radionuclides for soil and 1.207% for all basements except containment. Based on the results from containment characterization (21 cores analyzed for HTDs), the licensee attributes 0.514% to insignificant radionuclides for containment basements. Given that these are small percentages (relative to that allowed of 10%), there is a risk that continued characterization could reveal a different radionuclide mixture that would require a change to the adjusted soil DCGLs or the adjusted Basement Dose Factors. A change in the adjusted DCGLs or Basement Dose Factors during FSS or STS activities would impose extra burden since the DCGLs and/or Basement Dose Factors would need to be approved.

Section 6.5.2.2 of the LTP states that, "Access to the Circulating Water Discharge Tunnel was not possible and therefore characterization data is unavailable. The discharge tunnel will be used as the approved liquid effluent release pathway throughout decommissioning. As additional radioactive material from different sources (i.e. processed SFP water) is introduced, this could potentially result in a mixture that is different from the Auxiliary Building concrete mixture. The mixture in the SFP/Transfer Canals could also be somewhat different than the Auxiliary Building due to the source of potential contamination, i.e., fuel pool water leaking into the concrete under the liner." This seems to contradict the statement in the response stating, "..., there is no credible mechanism for increasing the relative concentrations of insignificant radionuclides during decommissioning."

The licensee is attempting to show that the dose contributions of the insignificant radionuclides and pathways will be approximately 1% or less of the dose criteria post remediation. It may be less burdensome on the licensee to show that the insignificant radionuclides and pathways contribute less than 10% of the limit than it is to show that the insignificant radionuclides and pathways contribute much less than 1%, for example. Thus, it may be preferable to round the dose contributions of the insignificant radionuclides and pathways higher, and thereby provide greater safety margin in meeting the dose criteria.

Resolution:

a. The NRC is concerned that, given the limited characterization, it is possible that the licensee has not attributed enough margin to the estimated dose contribution to the insignificant radionuclides. This increases the risk of having to recalculate the adjusted DCGLs and Basement Dose Factors. This risk can be lessened by attributing a larger percentage (up to 10%) of the dose criterion (0.025mSv/yr or 2.5 mrem/yr) to the insignificant radionuclides prior to adjusting the soil DCGLs and or basement dose factors. This would lessen the risk of having to recalculate the adjusted DCGLs and Basement Dose Factors if the radionuclide mixture is different from that of the building cores analyzed for HTDs.

b. The licensee will still need to perform some level of verification that the assumed ratios are valid to ensure that the insignificant radionuclides are not exceeding 10% of the dose. However, by attributing a greater percentage of the dose to insignificant radionuclides upfront, the licensee has less risk of needing to revise DCGLs and Basement Dose Factors.

ZSRP Response (PAB 5a and 5b) – NRC requested that the dose attributed to the HTD radionuclides that were removed from further detailed evaluation be rounded higher to provide "greater safety margin." The calculation of the insignificant contributor dose for basements, soil and buried pipe was based on a reasonable estimate of radionuclide mixture based on high activity cores. The calculation already incorporates conservatism in that even with the application of high activity cores, the majority of the insignificant contributor dose was calculated using MDC values, which overestimated their dose contribution. However, ZSRP will add additional safety margin that provides an upper bound on the potential insignificant contributor dose.

For the basements, a margin of 100% (factor of two) will be added to the insignificant contributor dose percentage for the basements. The revised insignificant fractions, after applying the multiplier factor of two, are 2.640% and 1.028% for Auxiliary Building Basement and Containment, respectively. For soil, the insignificant contributor dose fraction was increased from the value of 0.171% calculated using a reasonable radionuclide mixture to 10% to allow a simplified assessment of potential future soil characterization that may include HTD analyses. Assigning a 10% value is highly conservative and represents a factor of 58 increase over the more reasonable and technically justified value of 0.171% calculated using the Auxiliary Building radionuclide mixture. The large increase is not driven by technical analysis but is proposed only because the concentrations of residual radioactivity in soil are expected to be far below the DCGLs and, the 10% adjustment to lower the DCGLs will have minor, if any, impact. The insignificant contributor dose fractions listed above will be applied in the calculation of BFM Dose Factors, Soils DCGLs and Buried Pipe DCGLs in TSD 14-010 Revision 2 and TSD 14-015 Revision 2 (attached for NRC review).

The calculation of insignificant contributor dose using the radionuclide mixture is provided in TSD 14-019, Revision 1, which is attached for NRC review. Note that the calculation of the BFM Auxiliary Building basement insignificant dose percentage in TSD 14-019 Revision 1 was revised slightly by performing the percent dose calculation using mixture data decayed to the July 1, 2018 scheduled license termination date.

The NRC comment also states "the licensee will still need to perform some level of verification that the assumed ratios are valid to ensure that the insignificant radionuclides are not exceeding 10% of the dose. However, by attributing a greater percentage of the dose to insignificant radionuclides upfront, the licensee has less risk of needing to revise DCGLs and Basement Dose Factors." As described in the ZSRP response to HP Chapter 5, RAI 3, ZSRP does not believe that additional verification of the insignificant contributor dose fraction is justified during FRS. Note that the purpose of the additional characterization of the Circulating Water Discharge Canal and the Spent Fuel Pool/Transfer Canal is to validate that the insignificant contributor dose assigned for planning purposes, which is based on the Auxiliary Building basement cores, is conservative for these areas. If the assigned insignificant dose fraction is not conservative, then a separate insignificant dose fraction will be applied to the given area. See RAI PAB Chapter 6, RAI 9 for a discussion of the additional characterization to be performed and how the characterization results will be evaluated for insignificant contributor dose contribution.

Finally, ZSRP would like to provide a clarification to an NRC statement/question in the discussion section. The comment refers to Section 6.5.2.2 of the LTP which states "Access to the Circulating Water Discharge Tunnel was not possible and therefore characterization data is unavailable. The discharge tunnel will be used as the approved liquid effluent release pathway throughout decommissioning. As additional radioactive material from different sources (i.e. processed SFP water) is introduced, this could potentially result in a mixture that is different from the Auxiliary Building concrete mixture. The mixture in the SFP/Transfer Canals could also be somewhat different than the Auxiliary Building due to the source of potential contamination, i.e., fuel pool water leaking into the concrete under the liner." The NRC discussion then states that this seems to contradict the statement in the original RAI response stating, "…, there is no credible mechanism for increasing the relative concentrations of insignificant radionuclides during decommissioning."

The original ZSRP response to PAB Chapter 6 RAI 8 referenced was "Regarding the second part of the RAI, there is no credible mechanism for increasing the relative concentrations of insignificant radionuclides during decommissioning. The remediation would either isolate or remove the contaminated material which has been evaluated in the insignificant radionuclide calculation or result in inadvertent mixing with adjacent clean material. Neither of these processes would concentrate one radionuclide preferentially versus another." A key component of the original ZSRP response was that it referred to decommissioning activities in areas that have already been evaluated for insignificant radionuclides. Section 6.5.2.2 specifically states that the Circulating Water Discharge Tunnel or SFP/Transfer Canal require additional characterization to evaluate the insignificant dose contribution. Therefore, Section 6.5.2.2 does not contradict the ZSRP statement in the original response.

6. **NRC Comment**: Chapter 6, RAI 9 - Process for revising the assumed mixture of radionuclides.

Discussion: The response states that "During continuing characterization, if a sample gamma spectroscopy result exceeds a Sum-of-Fraction (SOF) of 0.5, then the sample will be analyzed for HTD radionuclides. The dose impact of any positively identified HTD radionuclide in a sample with a SOF greater than 0.5 will be evaluated. The dose evaluation will include a review of the radionuclide mixtures and insignificant contributor results provided in the LTP to determine if any adjustments are justified. This review will be conducted during continuing characterization and will be resolved and finalized before FRS begins. No additional HTD analysis will be conducted during FRS."

The proposed approach only commits to measuring for HTDs in locations where gamma emitting radionuclides are present in high quantities. However, a consistent ratio of gamma emitting radionuclides to the insignificant radionuclides has not been established. TSD 14-013 evaluating the ratios for the Auxiliary Building states that, "as seen in Table 14, the range of key radionuclide ratios varied by several orders of magnitude across the 542' elevation cores." TSD 13-006 evaluating the containment ratios states, "as seen in Table 20 and Table 21 the range of key radionuclide ratios varied by several orders of magnitude across the Unit 1 and 2 568 foot elevation cores." Therefore, the licensee should also commit to measuring in locations that take into account process knowledge and radionuclide transport properties.

The licensee states in the RAI response that the concrete underlying the SFP/Transfer Canal will be characterized for HTDs - "characterization will include the acquisition of concrete core samples and that those core samples will be analyzed for the presence of HTD radionuclides." This implies that the Basement Dose Factors for the SFP/Transfer Canal (Table 6-18 in LTP) will be revised to account for a different percent contribution from insignificant radionuclides since they are currently based on the Auxiliary Building mixtures. However, the RAI response is silent with respect to the further characterization of HTDs in the Circulating Water Discharge Tunnels.

Furthermore, it is unclear how the 0.5 of the SOF will be calculated given that the STS approach uses a total inventory instead of a concentration. The calculation of 0.5 of the SOF is especially unclear in STSs that contain more than one survey unit. For example, would the trigger be 0.5 of a fraction of the BIL, or the total BIL?

Resolution:

a. The licensee should commit to an appropriate number of measurements during decommissioning to validate insignificant radionuclide ratios and the assumed dose contribution by insignificant ROCs. The locations for such measurements should not be limited to only those with high gamma results, but should incorporate all available information such as process knowledge and radionuclide transport properties.

ZSRP Response (PAB 6a) – While there is variability in radionuclide ratios, the only ratios applied during FRS are Sr-90/Cs-137 and Ni-63/Co-60 (and H-3/Cs-137 for containment) which are used in the surrogate calculations. As discussed in the ZSRP response to RAI HP Chapter 5, RAI 3, the potential dose contribution from Sr-90, Ni-63 and H-3 is trivial at a combined 0.27 mrem/yr based on Auxiliary Building characterization results from areas with the highest activity. The dose from Sr-90, Ni-63 and H-3, and all other initial suite HTD radionuclides (with the exception of Np-237 as discussed in ZSRP response to PAB Chapter 6 RAI 7), will be calculated for the SFP/Transfer Canal and Circulating Water Discharge Tunnel based on the results of additional HTD characterization but is expected to be in the same range and likely lower. The potential dose impact of variable ratios in the surrogate calculations used for FRS data assessment for basements is essentially bounded by the 0.27 mrem/yr dose because the levels of residual radioactivity remaining during FRS will be lower than those found during characterization.

In response to PAB Chapter 6 RAI 8 and RAI 13, ZSRP committed to adding an additional safety margin to the assigned insignificant dose fractions. The added dose margin for the Auxiliary Building is greater than 0.27 mrem/yr and therefore, any potential underestimate of dose in the surrogate calculation due to ratio variability is accounted for in the insignificant dose fraction.

The data from high activity cores that was used to calculate the radionuclide mixture for the Auxiliary Building is the most representative and accurate data available. As stated in LTP Chapter 6 section 6.5.2.2, "*The use of cores with higher concentrations was required to ensure that the percentage assigned to HTD radionuclides were not overly influenced by the MDC values which was the only concentration data available for the majority of the HTD radionuclides in the initial suite*." The cores with the highest activity, as indicated by onsite gamma spectroscopy, were sent to an offsite laboratory for analysis of the HTD radionuclides in the initial suite.

The use of higher activity cores is necessary to derive a realistic ratio of the gamma emitters to HTD radionuclides. A total of 39 concrete core samples were collected from the Containment basements, 20 from Unit 1 Containment and 19 from Unit 2 Containment. Of the 39 concrete core samples taken, 17 contained gamma concentrations that were considered sufficient to produce reasonably realistic mixture fractions for HTD radionuclides. The top ½-inch puck from each of these 17 cores was sent to Eberline Laboratory for gamma spectroscopy and HTD analyses. For the Auxiliary Building basement, a total of 20 concrete core samples were collected. Of the 20 concrete core samples taken, 6 contained gamma concentrations considered sufficient to produce reasonably realistic mixture fractions. The top ½-inch puck from each of these 6 cores was also sent to Eberline Laboratory for gamma spectroscopy and HTD analyses. The results of these analyses are presented in LTP Chapter 2, Tables 2-19 and 2-20 for the Containment Buildings and Table 2-23 for the Auxiliary Building basement.

The most accurate radionuclide mixture fractions are calculated when the HTD radionuclides are positively detected. If the HTD radionuclides are not positively detected, then the mixture percentages assigned to the HTD radionuclides are based on the MDC values. Use of the MDC value is conservative. However, the accuracy of the mixture fractions assigned to HTD radionuclides using MDC values will decrease as the sample activity, predominately Cs-137, decreases.

Using low activity cores to determine the mixture is technically incorrect in that the mixture percentage assigned to HTD radionuclides will artificially increase as an inverse function of Cs-137 activity. There is no credible mechanism that would cause the HTD mixture percentage to increase with decreasing Cs-137 activity.

ZSRP has already committed to acquire additional concrete core samples from the underlying concrete of the SFP/Transfer Canal below the 588 foot elevation when exposed. All of the contaminated concrete in the Containment basements will be removed during decommissioning, reducing residual radioactivity to very low levels. The source term in the Turbine Building was demonstrated to be very low and a minute fraction of the Turbine Basement Inventory Limit (BIL). Consequently, the only major end-state structure of significance is the Auxiliary Building basement (and potentially the SFP/Transfer Canal which will undergo additional characterization).

As stated above, the current population of 20 concrete core samples was collected from the locations with the highest observed results from surface scanning the floor and lower walls of the Auxiliary Building basement. If ZSRP were to acquire additional concrete cores samples from the Auxiliary Building 542 foot elevation, assuming that the current core samples are bounding based on the scans, the gamma radionuclide concentrations in the new samples would be less than the samples already acquired. It is also likely that if these samples were analyzed for HTD radionuclides, the analytical results would be less than MDC or, if positively detected, within the range already derived by the results presented in LTP Chapter 2, Table 2-23. Increasing the population of concrete core samples would likely reduce accuracy by artificially increasing the HTD mixture fractions.

It can also be assumed that remediation in the Auxiliary Building to meet the open air demolition criteria will reduce the concentration of Cs-137. There is no credible mechanism that would increase the concentration of Cs-137 during remediation. Collecting additional concrete core samples after remediation to "validate insignificant radionuclide ratios" would again, only artificially increase the HTD mixture fraction.

It should also be noted that the characterization of soil at Zion did not produce any samples with sufficient gamma activity to derive meaningful ratios to HTD radionuclides. During characterization, 888 surface soil samples and 871 subsurface soil samples were taken in impacted soils. In Class 1 areas, the locations selected for sampling were biased to the highest probability for radioactive contamination based on surface scan results, process knowledge, visual indications (discoloration, indentations, evidence of system leakage, etc.), and the findings in te HSA. Of those samples, the maximum Cs-137 concentration that was observed was 3.4 pCi/g. The 10 samples with the highest Cs-137 concentrations, nine surface soil and one subsurface soil, were sent for HTD analysis. The results are presented in LTP Chapter 2,

Table 2-34. No HTD radionuclides were positively identified in any of the 10 samples. Because accurate mixture fractions could not be calculated from the soil data, the Auxiliary Basement mixture data was applied to soil.

In conclusion, ZSRP contends that the process used to determine the radionuclide mixture in the Auxiliary Building and calculate the dose contribution from HTD radionuclides is technically correct, defensible and reasonably accurate. As stated above, the only use of the radionuclide mixture at FRS is in the surrogate calculation, which has a very low potential dose impact and is accounted for in the conservative values assigned to the insignificant dose percentages for basements and soil. The Auxiliary Building cores provide the best data set available, now or in the future, to calculate a realistic radionuclide mixture.

The insignificant contributor dose percentage assigned to the Auxiliary Building basement was also assigned to all other basements other than Containment. While this approach is reasonable and defensible, a margin has been added to the assigned insignificant contributor dose percentage (see RAI PAB Chapter 6, RAI 8 and RAI 13) to account for uncertainty.

Regarding the potential benefit of performing additional HTD analyses, MARSSIM section 4.3.2 states, "If consistent radionuclide ratios cannot be determined during the Historical Site Assessment (HSA) based on existing information, MARSSIM recommends that one of the objectives of scoping or characterization be a determination of the ratios rather than attempting to determine ratios based on the final status survey. If the ratios are determined using final status survey data, MARSSIM recommends that at least 10% of the measurements (both direct measurements and samples) include analyses for all radionuclides of concern." The MARSSIM recommendation regarding 10% HTD analysis during final status survey is not applicable to Zion because characterization data was used to determine the ratios. Consequently, no attempt will be made to determine ratios based on FRS data. MARSSIM section 4.3.2 also states, "MARSSIM recommends that when the ratio is established prior to remediation, additional post-remediation samples should be collected to ensure that the data used to establish the ratio are still appropriate and representative of the existing site condition." This statement pertains to the use of surrogates. The Auxiliary Building mixture is the most accurate and representative radionuclide mixture available and it is unlikely that future HTD analysis will not improve accuracy (and may in fact reduce accuracy). Therefore, the Auxiliary Building mixture will be applied in the FRS surrogate calculation for Basements other than Containment and possibly the SFP/Transfer Canal and Circulating Water Discharge Tunnel depending on results of additional characterization. The Auxiliary Building mixture will also be applied to soil and buried pipe surrogate calculations. No additional HTD analysis during FRS is proposed or justified.

b. Clarify whether the Basement Dose Factors for the SFP/Transfer Canal and the Circulating Water Discharge Tunnels will be revised after the planned characterization to account for the potential different radionuclide mixture than that of the Auxiliary Building.

ZSRP Response (PAB 6b) – ZSRP commits in LTP Chapter 2, sections 2.3.3.3 and 2.5 to perform additional characterization of the underlying concrete pad and remaining pool walls of the SFP/Transfer Canal once the liner is removed and the underlying concrete is exposed. LTP Chapter 5, section 5.1 also states that the characterization will include the acquisition of concrete core samples and that those core samples will be analyzed for the presence of HTD radionuclides. ZSRP commits to the analysis of the initial suite of radionuclides as was performed for previous concrete core characterization samples (with the exception of Np-237 as discussed in the ZSRP response to PAB Chapter 6 RAI 7).

The characterization results for the SFP/Transfer Canal will be used to calculate the dose from insignificant contributor radionuclides, including MDC values for non-detected radionuclides. If the insignificant contributor dose from the characterization results is less than the insignificant contributor dose assigned to the SFP/Transfer Canal for planning purposes (see LTP Chapter 6, Section 6.6.8), then the current adjustment to the BFM Dose Factors to account for insignificant contributor dose will be retained. If the insignificant contributor dose from the SFP/Transfer Canal characterization is greater than the insignificant contributor dose assigned to the SFP/Transfer Canal for planning purposes, then the Basement Dose Factors for the SFP/Transfer Canal will be re-adjusted to account for the increased dose. It is possible, but not likely, that the data could indicate different ROC for the SFP/Transfer Canal. If so, a specific ROC list for SFP/Transfer Canal will be applied. The characterization data will also be reviewed to determine if the ratios of Sr-90/Cs-137 and Ni-63/Co-60 are significantly different from the ratios currently assigned which are based on the Auxiliary Building mixture. If so, the ratios from the characterization data will be applied to the FRS surrogate calculations for the SFP/Transfer Canal.

During site characterization, the Circulating Water Discharge Tunnels were open to Lake Michigan and flooded. However, process knowledge and the results of environmental monitoring of radiological conditions at effluent outfalls in the past, indicate that the inventory of residual radioactivity in the Circulating Water Discharge Tunnels is a minute fraction of the allowable inventory. Based upon the contamination potential, the HSA initially classified the interior of the tunnels as Class 3.

In January of 2016, the tunnels were isolated from the lake, dewatered and STS was performed in the accessible portions. Both Unit 1 and Unit 2 Circulating Water Discharge Tunnel were designated as STS unit #B3-09200B-S. The STS unit consisted of both Discharge Tunnels from the 12 foot diameter Condenser water box discharge pipes down into the tunnels to the isolation point at the valve house. The portion of the tunnel from the stop valve to the site boundary will remain flooded as isolation from the lake is not feasible. Access to the tunnels was through openings at the Valve House. The lower portions of the tunnels were deemed not accessible due to safety concerns. Also, after dewatering, approximately 6 to 12 inches of sludge remained on the bottom of the tunnels.

A total of 14 static measurements were taken at random selected locations on the combined internal surface area of both tunnels using a suspended ISOCS. The field-of-view for each shot was approximately 28 m^2, resulting in a total areal coverage of approximately 396 m^2 or 8%. In addition, 3 samples of composited sediment and sludge were acquired from each tunnel. The maximum measurement observed by the ISOCS resulted in a sum-of-fraction of 0.04. The mean inventory fraction for the STS unit was 0.01 resulting in a total mean dose of 0.13 mrem/yr. The 6 sediment samples were analyzed by the on-site gamma spectroscopy system. Cs-137 was positively detected ranging in concentration from 2.8E-02 pCi/g to 9.0E-02 pCi/g. Co-60 was positively detected ranging in concentration from 3.4E-02 pCi/g to 1.7E-01 pCi/g.
ZSRP will analyze selected sediment samples taken from the Circulating Water Discharge Tunnels for the initial suite radionuclides (with the exception of Np-237 as discussed in ZSRP response to PAB Chapter 6 RAI 7). As with the characterization of the SFP/Transfer Canal, ZSRP commits to calculate the insignificant contributor dose. If the insignificant contributor dose from the sample(s) is less than the insignificant contributor dose assigned to the Circulating Water Discharge Tunnel for planning purposes (see LTP Chapter 6, Section 6.6.8), then the current adjustment to the Basement Dose Factors to account for insignificant contributor dose will be retained. If the insignificant contributor dose from the Circulating Water Discharge Tunnels samples is greater than the insignificant contributor dose assigned for planning purposes, then the Basement Dose Factors for the Circulating Water Discharge Tunnels will be re-adjusted to account for the increased dose. It is possible, but not likely, that the data could indicate different ROC for the Circulating Water Discharge Tunnels. If so, a specific ROC list for Circulating Water Discharge Tunnels will be applied. The characterization data will also be reviewed to determine if the ratios of Sr-90/Cs-137 and Ni-63/Co-60 are significantly different from the ratios currently assigned that are based on the Auxiliary Building radionuclide mixture. If so, the ratios from the characterization data will be applied to the FRS surrogate calculations for the Circulating Water Discharge Tunnels.

c. Clarify how 0.5 of the SOF will be determined in STS areas, especially those with multiple survey units.

ZSRP Response (PAB 6c) – The original response to PAB Chapter 6 RAI 9 states, "If a sample and/or measurement is taken on any other end-state structure or embedded pipe system to support decommissioning activities, i.e., Radiological Assessments (RA) or Remedial Action Support Surveys (RASS), and the result indicates a SOF in excess of 0.5 based on gamma spectroscopy results, then a sample will be collected at the location of the highest accessible individual measurement and analyzed for HTD radionuclides. If any continuing characterization surveys taken in soil or buried pipe indicate the presence of gamma-emitting radionuclides at concentrations in excess of a SOF of 0.5, then the samples will be analyzed for the presence of HTD radionuclides."

This 0.5 SOF requirement only applies to surveys taken prior to performing FRS (continuing characterization, RASS, RA, turnover, etc.). It does not apply to FRS measurements. Note that sufficient characterization has been performed on the Auxiliary Building 542 foot elevation floor and individual measurements with SOF greater than 0.5 are expected. Consequently, the commitment to analyze for HTDs at 0.5 SOF does not apply to the Auxiliary Building 542 foot floor. In addition, it does not apply to the continuing characterization of the concrete under the steel liner in the SFP/Transfer Canal, the Auxiliary Building 542 foot elevation floor drains or the Circulating Water Discharge Tunnels (which is addressed in the response to PAB 6b). Samples have already been collected from the interior of the Auxiliary Building 542 foot floor drains and these samples have been sent for HTD analysis. In addition to the SFP/Transfer Canal, Auxiliary Building 542 foot elevation floor drains, and the Circulating Water Discharge Tunnels, there are three additional distinct areas at Zion where additional characterization will occur. These areas are:

- The subsurface soils in the "keyways" between the Containment Buildings and the Turbine Building after subsurface utilities have been removed and the exposure of subsurface structures in this area create access.
- The soils under the basement concrete of the Containment Buildings, the Auxiliary Building and the SFP/Transfer Canal after commodity removal and building demolition have progressed to a point where access can be achieved. This soil will be characterized by soil borings at select locations along the foundation walls that are the nearest to the under-basement soil. If plant-derived activity is not positively detected (above background for Cs-137) in the cores located adjacent to the foundation, then no additional samples will be collected and the soil under the foundations will be assumed to not contain residual radioactivity. This approach is justified based on the characterization data which demonstrates that there is a very low expectation that significant subsurface contamination exists. If positive plant-derived activity is identified in the borehole samples then additional investigation will be performed considering the concentrations and locations of the activity detected.
- When the interior surfaces become accessible, several potentially contaminated embedded pipe systems that will be abandoned in place, specifically the Core Spray penetrations between the Containment basements and the Auxiliary Building basement.

Of all these areas, based on process knowledge, the HSA, characterization in adjacent soils and the monitoring of groundwater wells, the only survey where 50% of a limit is expected to be encountered is the interior of a pipe system, specifically Class 1 embedded pipe. ZSRP does not anticipate encountering any other areas or matrices during the decommissioning of Zion where a measurement will exceed 0.5 SOF (except as noted above).

Based on the results of the analysis, ZSRP commits to calculate the insignificant contributor dose. If the insignificant contributor dose is less than the insignificant contributor dose assigned to the given area for planning purposes (see LTP Chapter 6, Section 6.6.8), then the current adjustment to the Basement Dose Factors or soil DCGLs to account for insignificant contributor dose will be retained. If the insignificant contributor dose from the given area is greater than the insignificant contributor dose assigned for planning purposes, then the Basement Dose Factors or soil DCGLs for the given area will be re-adjusted to account for the increased dose. It is possible, but not likely, that the data could indicate different ROC for the given area. If so, a specific ROC list will be applied to the area. The characterization data will also be reviewed to determine if the ratios of Sr-90/Cs-137 and Ni-63/Co-60 are significantly different from the ratios currently assigned that are based on the Auxiliary Building radionuclide mixture. If so, the ratios from the characterization data will be applied to the FRS surrogate calculations for the given area.

7. NRC Comment: Chapter 6, RAI 10 - Additional information is necessary to evaluate the site-specific Kd parameters applied in the RESRAD and DUST-MS models.

Discussion: The LTP assumes a value of 2.3 cm^3/g for the Kd in the models to calculate soil DCGLs. This corresponds to the site-specific value for native sand. The site specific values for other soil types were 5.7 cm^3/g and 3.4 cm^3/g. The literature values for Sr-90 Kd are about an order of magnitude greater (see Table 3 of TSD-14-004). The 75th percentile of the Kd for Sr-90 is 131 cm^3/g. For radionuclides with site-specific data, the media with the lowest measured Kd was selected to provide a lower bound.

NUREG 1757, Vol. 2, Rev. 1, Appendix I (page I-72) states that, "the licensee is encouraged to use sensitivity analyses to identify the importance of the Kd parameter on the resulting dose either (1) to demonstrate that a specific value used in the analysis is conservative or (2) to identify whether site-specific data should be obtained (if the licensee feels Kd is overly conservative)."

The text of the LTP describes the selection process for the Kd values as being conservative. However, low Kd values generally maximize the release and transport of radionuclides through groundwater, while high Kd values generally maximize the concentration of the radionuclides in soil that is irrigated with contaminated groundwater, which in turn maximizes the concentration in plants and ingestion doses. It seems that the choice of the lower Kd was intended to be conservative (as opposed to the licensee feeling the literature Kd was overly conservative). However, it is unclear if choosing a site-specific Kd for Sr-90 is conservative in calculating the soil DCGLs. The primary pathway for dose in the surface and subsurface soil scenarios for Sr-90 is the plant pathway (water independent), as opposed to the drinking water pathway which peaks later in time.

Resolution:

a. Provide justification that the Kd value for Sr-90 selected is appropriate for use in the calculation of the soil DCGLs if not otherwise provided in the requested reference.

ZSRP Response (PAB 7a) – Zion recognized early in the decommissioning planning process that Kd would be a sensitive parameter in both the soil and basement dose modeling scenarios. Given this *apriori* knowledge that the Kd was a sensitive and important parameter, resources were allocated to determine site-specific Kds by laboratory analysis. The driver for determining site-specific Kds was not necessarily a concern that literature values and/or parameter distributions were overly conservative but, as stated in NUREG 1757, Vol 2, Rev 1, Appendix A, to "perform a site-specific Kd determination, so that the dose assessment reflects true site conditions."

Four soil types were sampled from the Zion site and analyzed by Brookhaven National Laboratory for Kd; Disturbed Sand, Native Sand, Silt/Clay, and Clay. The site surface and subsurface soil is contained in the Upper Sand Unit and is a mix of Disturbed Sand and Native Sand. The majority of the site surface soil is Disturbed Sand. The Silt/Clay and Clay were sampled from depths of 24'-28' below ground surface (bgs) and 31'-36' bgs, respectively. These samples were collected to understand the characteristics of the Upper Silt/Clay Unit which underlies the Upper Sand Unit. The Upper Silt/Clay unit is an aquitard that inhibits groundwater flow between the Upper and Lower Sand Unit aquifers. The Zion dose model conservatively assumes that all wells are screened in the Upper Sand Unit as opposed to the Lower Sand Unit which is isolated from the Zion site source term by the clay aquitard.

The site soil type (down at least several feet) is predominantly Disturbed Sand as a result of excavation and backfill during plant construction. However, some areas could consist of Native Sand. Therefore, both sand types are considered applicable to the surface (0.15 m depth) and subsurface (1 m depth) soil categories.

The site-specific Kds for Native Sand and Disturbed Sand are listed in Zion*Solutions* TSD 14-004 "Brookhaven National Laboratory (BNL) Report: Recommended Values for the Distribution Coefficient (Kd) to be used in Dose Assessments for Decommissioning the Zion Nuclear Station" October 2014 and are shown in Column 2 of Tables 1 and 2.

The assessment of Kd impact on the dose calculations included a probabilistic uncertainty analysis for surface and subsurface soil with the Kds being the only parameters considered probabilistically. This maximizes the effect of Kd on the dose results and the potential for a Kd being identified as sensitive (as defined in section 3.1 of TSD 14-010 a sensitive parameter is one with an absolute value of PRCC greater than 0.25). The Kd parameter distributions were entered in RESRAD as uniform distributions with minimum and maximum values defined by the Native and Disturbed sand site-specific Kds. The uncertainty analysis did not identify any of the Kd parameters as being sensitive. The RESRAD Uncertainty Report file names are listed below. The full reports are provided in the enclosed CD.

- Zion Surface Soil Kd Sensitivity RESRAD Uncertainty Report.pdf
- Zion Subsurface Soil Kd Sensitivity RESRAD Uncertainty Report.pdf

As an additional level of review, a deterministic sensitivity analysis was performed that included RESRAD analyses of surface soil and subsurface soil using the maximum site-specific sand Kd. The resulting DCGLs were compared to the DCGLs calculated using the minimum site-specific sand Kd. The file names of the two RESRAD Summary Reports that used the maximum Kds are listed below. The full reports are provided in the enclosed CD.

- Zion Surface Soil Kd Sensitivity RESRAD Summary Report.pdf
- Zion Subsurface Soil Kd Sensitivity RESRAD Summary Report.pdf

The results are summarized in TSD 14-010 Revision 2 Tables 19-21 which are reproduced below. The deterministic approach is very conservative in that it includes each radionuclide independently and ignores the actual dose consequences of a given radionuclide in the context of the radionuclide mixture. As seen on Table 21, when Sr-90 is considered independently the maximum Kd resulted in a DCGL that was 6% lower. Ni-63 is lower by a very small fraction. The gamma emitters, which represent the vast majority of dose from soil were not affected by the Kd change.

Although the Sr-90 DCGL was lower by 6% with the maximum Kd, when the radionuclide mixture percentage of Sr-90 is considered, the dose consequences are orders of magnitude lower than 6%. Notwithstanding the trivial potential of increased dose consequence, the maximum Kds will be used for both Sr-90 and Ni-63 in the final Surface and Subsurface DCGL modeling as opposed to the minimum Kds originally used.

TSD 14-010 Revision 2 Table 19 – Surface and Subsurface Soil DCGL with Minimum Site-Specific Sand Kds

Radionuclide	Kd	Subsurface Soil DCGL	Subsurface Soil DCGL
	(cm^3/g)	(pCi/g)	(pCi/g)
Co-60	1161	4.734	3.825
Cs-134	615	7.524	4.930
Cs-137	615	15.76	8.606
Ni-63	62	3995	848.6
Sr-90	2.3	14.36	1.860

TSD 14-010 Revision 2 Table 20 – Surface and Subsurface Soil DCGL with Maximum Site-Specific Sand Kds

Radionuclide	Kd	Subsurface Soil DCGL	Subsurface Soil DCGL
	(cm^3/g)	(pCi/g)	(pCi/g)
Co-60	1161	4.734	3.825
Cs-134	635	7.523	4.930
Cs-137	635	15.76	8.606
Ni-63	331	3969	847.8
Sr-90	3.4	13.43	1.840

TSD 14-010 Revision 2 Table 21 – Ratio of Maximum Kd DCGL/Minimum Kd DCGL for Surface and Subsurface Soil

Radionuclide	Surface Soil Ratio	Subsurface Soil Ratio
Co-60	1.00	1.00
Cs-134	1.00	1.00
Cs-137	1.00	1.00
Ni-63	0.99	1.00
Sr-90	0.94	0.99

b. Provide the following references:

Yim, S.P, T.M. Sullivan, and L. Milian, Sorption (Kd) measurements in Support of Dose Assessments for Zion Nuclear Station Decommissioning, Brookhaven National Laboratory Report to Zion*Solutions*, December 12, 2012.

Milian, L., T. Sullivan (2014). Sorption (Kd) measurements on Cinder Block and Grout in Support of Dose Assessments for Zion Nuclear Station Decommissioning, Brookhaven National

ZSRP Response (PAB 7b) – The two documents below were requested by NRC and are attached.

- Yim, S.P, T.M. Sullivan, and L. Milian, Sorption (Kd) measurements in Support of Dose Assessments for Zion Nuclear Station Decommissioning, Brookhaven National Laboratory Report to Zion*Solutions*, December 12, 2012 (TSD 14-020).
- Milian, L., T. Sullivan (2014). Sorption (Kd) measurements on Cinder Block and Grout in Support of Dose Assessments for Zion Nuclear Station Decommissioning, Brookhaven National Laboratory Report to Zion*Solutions*, April 2014 (TSD 14-017).

8. NRC Comment: Chapter 6, RAI 11 - Soil Area Factors (AF)

Discussion: The LTP lists Area Factors in Table 5-7 and 5-8 as well as in Tables 6-28 and 6-29. Tables 6-28 and 6-29 list AFs for sizes 1, 3, 10, 30, and 100 m2 while Tables 5-7 and 5-8 list AFs for those sizes as well as additional sizes.

The AFs in Table 5-7 do not match those in Table 6-28 for Sr-90 for the same size. For example, the surface soil AF for Sr-90 for 1 m2 is listed as 957 in Table 5-7 but is listed as 890 in Table 6-28. The LTP does not explain why the Sr-90 the AFs in these two sets of tables are different.

The NRC staff acknowledges the licensee's use of the alternative "base case" value in the denominator of the AF calculation due to changing the contamination fraction parameters for meat, milk and plants to -1. However, this change does not seem to be related to the different Sr-90 values in Table 5-7 and 6-28.

The response states that the Table in 5-7 is based on RESRAD Summary reports in TSD-14-0011 provided in Enclosure 2. However, staff was unable to reproduce the Table 5-7 values using these reports. For example, the Sr-90 DCGL for 1 m2 is 1.915E+04, while the DCGL for the base case is 2.15E+01. The ratio of these two number gives an AF of 890, which is the value in Table 6-28. The Sr-90 AF for 1 m2 in Table 5-7 is 957.

Resolution:

a. Explain the discrepancy between Tables 5-7 and Tables 6-28 for Sr-90.

ZSRP Response (PAB 8a) – Soil Area Factors (AF) are calculated in Zion*Solutions* TSD 14-011, Revision 0 which has been provided to NRC in a previous submittal. The AFs from TS 14-011 Revision 0 for areas 1, 3, 10, 30, and 100 m^2 areas, for Surface and Subsurface soil, were copied to LTP Tables 6-28 and 6-29. The AFs in TSD 14-011 Revision 0 match the AFs in LTP Tables 6-28 and 6-29.

The full AF tables from TSD 14-011, including all areas evaluated, were copied to LTP Tables 5-7 and 5-8 for surface and subsurface soil, respectively. However, the AFs in LTP Tables 5-7 and 5-8 were extracted from a final draft of TSD 14-011 as opposed to Revision 0 which was slightly revised. Tables 5-7 and 5-8 will be corrected to match those listed in TSD 14-011 Revision 0 and LTP Tables 6-28 and 6-29.

9. NRC Comment: Chapter 6, RAI 12 - Additional information is necessary to evaluate the Buried Pipe DCGLs.

Discussion: TSD 14-0015, Rev 1, Attachment 1 provides an inventory of Buried Piping. Attachment 1 of Rev. 1 does not match Attachment 1 of Rev. 0 for this TSD, nor does either table match Table 2-27 in the LTP.

TSD 14-0015, Rev 1 states that the Excavation, Unsaturated Zone *In-situ*, and Saturated Zone *In-situ* scenarios were modeled with the same parameters as those assumed in the Surface DCGL model with the exception of the few noted (e.g., CZ Area, CZ thickness, etc.). However, it appears that certain parameters (e.g., depth of mixing soil, Kds for Unsaturated Zone in the Excavation scenario) were different from those assumed in the Surface Soil DCGL calculations. The licensee should explain the reasons for using different parameter values.

Also, given that the *In-situ* conceptual models are somewhat different than the Surface DCGL model, the sensitive parameters and correlations may not be the same as for the Surface DCGL model. In general, the sensitivity of the parameters for the Buried Pipe conceptual models should be reviewed to ensure that the appropriate values are used for the sensitive parameters.

The assumption regarding CZ thickness needs additional explanation. The contaminated zone thickness is assumed to be 0.15 m in all three scenarios (Excavation, UZ *In-situ*, and SZ *In-situ*). The conceptual models do not seem to address the possibility that roots could encounter a contaminated zone that is more than 0.15 meters thick. Given that the overall volume of piping in Attachment 1 is greater than the overall volume in the buried pipe models (2153 m^2 x 0.15 m), and that many of the pipes are greater than 0.15 m in diameter, the sensitivity of the CZ thickness on the results should be explored.

Also, TSD 14-0015, Rev 1 presents $DCGL_{EMC}$ values for the buried piping which are calculated using the prior conceptual model in Rev 0 of the TSD. In Chapter 6 RAI 12, the NRC staff described why it is unclear if this prior conceptual model applies to piping, and that the staff does not believe the particular application of Surface Area Factors to be appropriate. The RAI response does not state anything with regard to $DCGL_{EMC}$ values for buried piping, nor does it justify the prior conceptual model.

Resolution:

a. Explain the discrepancies between TSD 14-0015, Rev 1, Attachment 1, TSD 14-0015, Rev 0, and LTP Table 2-27.

ZSRP Response (PAB 9a) – The list of buried pipe to remain has been periodically reviewed by ZSRP as the project proceeds. The final buried pipe inventory is provided in TSD 14-015, Revision 2, Attachment 1 (which is enclosed for NRC review). Note that a discrepancy was found in the version of Attachment 1 provided in TSD 14-015 Revision 1. The ice-melting pipes were inadvertently listed in two categories; Crib House and Forebay. The duplicate listings in the Forebay category were deleted. In response to an NRC question, a few adjustments to the buried pipe list in TSD 14-015 Revision 0 were also made during the process of completing TSD 14-015, Revision 1. As with all other required changes to the LTP as a result of the RAI process, LTP Table 2-27 will be revised in the next LTP submission to correspond to TSD 14-015 Revision 2, Attachment 1.

b. Explain the reasons for using different parameter values from those assumed in the Surface DCGL calculation that may not be conservative for the calculation of the Buried Piping DCGLs.

ZSRP Response (PAB 9b) – The 0.23 m soil mixing zone parameter is the value assigned to the Subsurface Soil dose assessment and was inadvertently used for the Buried Pipe DCGL analyses. Regarding the Kd values for the unsaturated zone in the BP Excavation scenario, they were reset to the default values after transitioning from a BP Insitu Saturated RESRAD analysis to a BP Excavation RESRAD analysis and were not subsequently revised. Note that neither of these parameters were shown to be sensitive in the uncertainty analysis performed for the buried pipe scenarios (see ZSRP response to PAB Chapter 6 12c). The revised Buried Pipe DCGLs calculated in TSD 14-015 Revision 2 include a mixing depth of 0.15 m and unsaturated zone Kds that are consistent with the Surface Soil RESRAD parameters.

c. Consider that the sensitivity analysis conducted for the Surface DCGL model may not result in the same sensitive parameters or relationships as the conceptual model for buried piping. Verify that appropriate values are chosen for sensitive parameters.

ZSRP Response (PAB 9c) – In response to this comment, a full uncertainty analysis was conducted for the three Buried Pipe scenarios (Excavation, Insitu Unsaturated, Insitu Saturated). The process used and the resulting RESRAD Uncertainty Reports are provided in TSD 14-015, Revision 2 which is attached for NRC review. The summary table of the uncertainty results from TSD 14-015 Revision 2 is reproduced below.

The only parameters that required change as a result of the uncertainty analysis were the Saturated Zone Hydraulic Gradient for the Insitu Saturated scenario and the Depth of Roots for the Insitu Unsaturated scenario. All of the remaining parameters identified as sensitive in Table 2 were already identified as sensitive, with the same correlation, in the soil DCGL sensitivity analyses. The corresponding parameters, either 25th or 75th percentile, were included in the surface soil DCGL deterministic parameter sets used for the Buried Pipe RESRAD runs.

TSD 14-015 Revision 2, Table 2 - Sensitive Parameters for the Three Buried Pipe Scenarios

Parameter Name	BP Excavation		BP Insitu Unsaturated		BP Insitu Saturated	
	Percentile	Parameter	Percentile	Parameter	Percentile	Parameter
Plant Transfer Factor for Sr-90	75th	0.59	75th	0.59	NS	
Plant Transfer Factor for Cs-137	75th	0.078	NS[1]		NS	
External Gamma Shielding Factor	75th	0.4	NS		NS	
Depth of Roots	25th	1.22	75th	1.15[5]	NS	
Saturated Zone Hydraulic Gradient	NS		NS		25th	0.0022[2]
Weathering Removal Constant of all Vegetables	NS		NS		25th	21.50
Well Pump Intake Depth	NS		NS		25th	3.3[3]
Kd of Sr-90 in Contaminated Zone	NS[6]		NS		25th	2.3[4]

Note 1: NS = Not Sensitive

Note 2: Saturated Zone Hydraulic Gradient was slightly negatively correlated. The 25th percentile value of the NUREG-6697 recommended distribution is 0.00185. However, the lowest site-specific value is 0.0022 as reported in "Zion*Solutions* TSD 14-006 "Conestoga Rovers & Associates (CRA) Report, Evaluation of Hydrological Parameters in Support of Zion Restoration Project" October 2014" which was used as opposed to the generic 25th percentile value.

Note 3: The 25th percentile value of the NUREG-6697 recommended distribution is11.02 m. However, the selected well depth parameter for soil (and applied to Buried Pipe) is the average depth of the Upper Sand Unit which is 3.3 m. Because 3.3 m is site-specific as well as being less than the NUREG-6697 25th percentile 3.3 m was used.

Note 4: the minimum site-specific soil Kd of 2.3 was used.

Note 5: The dose from root depth in the Insitu Unsaturated scenario is a step function with zero plant dose up to a 1 m depth, maximum dose at 1.15 m depth and decreasing dose with depth > 1.15 m. Therefore, a 1.15 m root depth was used to maximize dose.

Note 6: Maximum site-specific Sr-90 Kd of 3.4 cm^3/g was shown to result in slightly increased dose for surface soil in TSD 14-010 therefore 3.4 cm^3/g was used.

d. Provide additional justification for the assumed CZ thickness of 0.15 m for the buried pipe models.

ZSRP Response (PAB 9d) – A sensitivity analysis of the CZ thickness was performed as described in TSD 14-015 Revision 2, which is reproduced below.

The sensitivity of the assumed source term thickness required a separate analysis. The buried pipe scenarios assume that residual radioactivity is released from the pipes into adjacent soil. The thickness of soil into which the released activity was assumed to mix was 0.15 m, which is considered the minimum reasonable mixing depth, particularly for the excavation scenario. As the "Thickness of Contaminated Zone" parameter is increased, assuming a unit concentration for all radionuclides, the dose increases. However, for the buried pipe scenario, as the contaminated zone thickness increases the source term concentration decreases as an inverse linear function of the mixing depth. To determine the dose impact of the conflicting effects of increasing the Thickness of Contaminated Zone, a separate sensitivity analysis was performed that accounts for both effects using source term thicknesses of 0.15 m and 1.0 m.

Tables 1-3 below provide the results of the sensitivity analysis. Note that for all scenarios and for all radionuclides except Sr-90, increasing the Thickness of Contaminated Zone either has no effect on dose (indicated by a value of 1 in the column labeled "DSR Ratio*Source Term Decrease" in Tables 1-3) or causes the dose to decrease (indicated by a fractional value in the column labeled "DSR Ratio*Source Term Decrease" in Tables 1-3). The one exception, i.e., Sr-90, showed an 8% increase in dose at a 1 m source term depth for the Insitu Saturated scenario and a 13% increase at 1 m depth for the Excavation Scenario.

For the Insitu Saturated Scenario, increasing the source term thickness had no effect on dose for any radionuclides other than Sr-90. Note that the actual dose impact from the slightly increased Sr-90 dose for a 1 m thick source, as opposed to 0.15 m, is much lower than the values calculated individually for Sr-90 when the mixture percentages are considered. As shown in LTP Chapter 5, Table 5-2, the mixture fraction for Cs-137 is 75.32% while the mixture fraction for Sr-90 is 0.05%. Therefore, the actual potential dose consequences of the 8% and 13% increases can be approximated as the ratio of Sr-90/Cs-137 mixture percentages multiplied by the percentage increase and 25 mrem/yr, i.e., 0.08*0.05/75.32*25 and 0.13 *0.05/75.32*25, or 1.33E-03 mrem/yr and 2.16E-03 mrem/yr, respectively.

For the excavation scenario, there are conflicting results for Sr-90 and the gamma emitters. While the Sr-90 dose shows an increase of 13% for the 1 m depth, the Cs-137 dose decreases by 79%. When the mixture fractions are considered, it is clear that the impact of the decrease in Cs-137 dose at 1 m source term depth would be orders of magnitude greater than the slight Sr-90 increase which would result in a non-conservative dose calculation.

For the Insitu Unsaturated scenario the dose decreased for all radionuclides with increasing mixing depth as shown by fractional values in the "DSR Ratio*Source Term Decrease" columns in Table 3.

In conclusion, the Thickness of Contaminated Zone parameter will be maintained at 0.15 for all scenarios. However, to account for the slight dose increase for Sr-90 at 1m depth, the DSRs for Sr-90 will be increased by factors of 1.08 and 1.13 for the Insitu Saturated and Excavation scenarios, respectively.

Table 1 Buried Pipe Insitu Saturated Scenario Thickness of Contaminated Zone

Radionuclide	DSR (mrem/yr per pCi/g)		DSR Ratio	DSR Ratio * Source Term Decrease
Contaminated Zone Thickness (m)	0.15	1	1/.15	.15/1
Co-60	5.7100E-04	3.807E-03	6.667E+00	1.00
Cs-134	2.8810E-03	1.922E-02	6.671E+00	1.00
Cs-137	2.2870E-03	1.525E-02	6.668E+00	1.00
Ni-63	2.7450E-04	1.837E-03	6.692E+00	1.00
Sr-90	1.3700E+00	9.908E+00	7.232E+00	1.08

Table 2 Buried Pipe Excavation Scenario Thickness of Contaminated Zone

Radionuclide	DSR (mrem/yr per pCi/g)		DSR Ratio	DSR Ratio * Source Term Decrease
Contaminated Zone Thickness (m)	0.15	1.00	1/.15	.15/1
Co-60	4.975E+00	5.753E+00	1.16E+00	1.73E-01
Cs-134	2.836E+00	3.476E+00	1.23E+00	1.84E-01
Cs-137	1.238E+00	1.717E+00	1.39E+00	2.08E-01
Ni-63	1.445E-03	8.338E-03	5.77E+00	8.66E-01
Sr-90	1.318E+00	9.950E+00	7.55E+00	1.13E+00

Table 3 Buried Pipe Insitu Unsaturated Scenario Thickness of Contaminated Zone Sensitivity

Radionuclide	DSR (mrem/yr per pCi/g)			DSR Ratio		DSR Ratio * Source Term Decrease	
Contaminated Zone Thickness (m)	0.15	1	1	1/0.15	1/.15	.15/1	.15/1
Co-60	7.298E-02	1.012E-01	2.798E-01	1.39E+00	3.83E+00	2.08E-01	5.75E-01
Cs-134	1.070E-01	1.484E-01	4.103E-01	1.39E+00	3.83E+00	2.08E-01	5.75E-01
Cs-137	8.491E-02	1.178E-01	3.257E-01	1.39E+00	3.84E+00	2.08E-01	5.75E-01
Ni-63	1.285E-03	1.784E-03	4.932E-03	1.39E+00	3.84E+00	2.08E-01	5.76E-01
Sr-90	1.384E+00	2.190E+00	6.053E+00	1.58E+00	4.37E+00	2.37E-01	6.56E-01
AA1:H31		1.22 m root	2 m root	1.22 m root	2 m root	1.22 m root	2 m root

e. The conceptual model for the Piping $DCGL_{EMC}$ proposed in TSD 14-0015 may not be not appropriate for the reasons stated in the RAI. Clarify if the licensee intends to use these $DCGL_{EMC}$ values. If so, justify their use.

ZSRP Response (PAB 9e) – The contamination levels in buried pipe are expected to be very low and it is highly unlikely that the Buried Pipe DCGLs will be exceeded. The potential for needing to apply a Buried Pipe $DCGL_{EMC}$ value is therefore also very low. Therefore, the Buried Piping $DCGL_{EMC}$ values proposed in TSD 14-015 Revision 1, and all supporting text, is deleted in TSD 14-015 Revision 2 (which is enclosed for NRC review).

10. NRC Comment: Chapter 6, RAI 15 - Additional information is needed on the process of determining the total basement inventory from STS data.

Discussion: The RAI response provided useful examples of how STS data will be analyzed to generate the total dose for each basement from hypothetical data for the Turbine and Auxiliary Buildings. However, the RAI response did not include sufficient information on a few portions of this calculation.

It is not clear how the water pathway dose will be calculated for the inventory in the SFP from the STS data. In Section 6.5.4 of the LTP, it is stated that the potential contribution of the SFP inventory to a well water pathway will be considered by adding the SFP inventory to the containment basement. The potential dose from the spoils for the SFP were analyzed separately. In the sample calculations of the mean dose for a STS unit in the RAI responses, the mean activity is multiplied by the basement dose factors from Table 6-18 in the LTP. It is not clear to the NRC staff which basement dose factors would be used for STS units in the SFP and whether the inventory would be included in both the SFP and containment totals. The basement dose factors in Table 6-18 for containment include contributions from both the water and the spoils, while the basement dose factors for the fuel only include the spoils.

Additionally, because the BIL values in Table 5-9 of the LTP for the fuel building were developed only on the dose from the spoils and the groundwater dose from the SFP is included in containment, it is not clear how the BIL values are going to be used to limit the final inventory in the fuel building to ensure that the groundwater pathway dose is acceptable. The BIL values for fuel for H-3, Sr-90, and Ni-63 are orders of magnitude higher than the BIL values for these radionuclides for containment. If the final inventories of these radionuclides are as high as their BILs in the fuel building, then the calculated groundwater dose from the containment basement will be driven by the SFP inventory that is added to the containment basement and the resulting groundwater dose could be much higher than 25 mrem/yr.

On p.42 of the RAI response, it was stated that "the data will be summarized, including any judgmental samples or investigation measurements." It is not clear from this whether all data would be used in the development of the mean inventory or whether the data from biased samples would simply be summarized. Additionally, on p. 42 of the RAI response, it was stated that "the Sign Test will be used to evaluate the remaining residual radioactivity in each survey unit against the dose criterion. The SOF for each measurement will be used as the weighted sum for the Sign Test." It is not clear if "each measurement" refers to all measurements, including the judgmental or investigation samples. MARSSIM would typically use only the unbiased samples to define the survey unit average.

With respect to elevated areas, the RAI responses also stated that the activity in elevated areas contained in an ISOCS field of view will be accounted for and that no additional consideration of elevated areas is necessary because total activity is the only data required to determine dose in the BFM. In areas where there is less than 100% ISOCS coverage (e.g., Class 2 or 3 units), the total inventory may be underestimated if an elevated area is outside the field of view of the ISOCS. This concern is discussed in more detail in the NRC's comments on the HP RAIs (Chapter 5, RAI 7 and Chapter 6 RAI 15).

Resolution:

a. Provide a description or example calculation showing how the dose will be assessed for inventory in the SFP, including the water pathway dose.

b. Describe how the BIL values in Table 5-9 of the LTP will be implemented to ensure that the groundwater pathway dose from inventory that is in the SFP is consistent with the license termination criteria in 10 CFR 20.1402.

ZSRP Response (PAB 10a and 10b) – As stated in LTP Chapter 6, section 6.5.4, the potential contribution of the residual radioactivity inventory in the SFP/Transfer Canal to the well water pathway will be accounted for by adding the measured STS inventory attributed to the SFP/Transfer Canal to the measured STS inventory attributed to the most limiting Containment basement. STS will be performed separately for Containment and the SFP/Transfer Canal. As shown in the example calculation provided in ZSRP responses to the original RAI 15, after a sufficient number of STS measurements are collected, a sum of fractions (SOF) calculation will be performed for each measurement by dividing the reported concentration by the applicable BIL/area value for each ROC. The individual ROC fractions will then be summed to provide a total SOF value for each measurement. The Sign Test will then be used to evaluate the measured residual radioactivity in Containment and the SFP/Transfer Canal separately against the dose criterion. If the Sign Test demonstrates that the mean activity of the STS unit is less than the BIL at a 5% Type 1 error rate, then the STS will pass. If the Sign Test fails, or if the Mean Inventory Fraction exceeds one, then the survey unit will fail STS.

As an additional measure specific to the SFP/Transfer Canal STS unit, after the Sign Test is passed for Containment and SFP/Transfer Canal separately, a fraction of the Containment BILs is allocated to each basement such that the sum of the allocated fractions equals one. The Sign test will be re-run using the allocated BIL fractions as the limit for each basement. If both basements pass the Sign Test at a 5% Type I error rate with the allocated fractions of Containment BILs as the limits, then the sum of the mean ROC inventories from each Basement will result in a SOF that is less than the Containment BILs. This will ensure that the groundwater pathway dose from the combined Containment and SFP/Transfer Canal inventories is below the Dose Criterion.

If a combination of allocated Containment BIL fractions cannot be selected such that both the Containment and SFP/Transfer Canal pass the Sign Test, or if the SOF of the combined mean inventory exceeds one, then the SFP/Transfer Canal STS unit will fail STS. If the SFP/Transfer Canal STS unit fails STS, then additional remediation will be performed and the STS performed again. Note that theoretically, the Containment could also be evaluated for additional remediation, but the residual radioactivity projected to remain at the time of STS is expected to be a trivial fraction of the Containment BILs. Additional remediation considerations, if required, would very likely be focused on the SFP/Transfer Canal.

The allowable levels of inventory in the SFP/Transfer Canal are in practice limited to the Containment BILs as discussed above. However, to reduce the potential for confusion, the SFP/Transfer Canal Basement Dose Factors listed in TSD 14-010, Revision 2, Table 8 were adjusted to equal the higher of either the Containment or SFP/Transfer Canal values. This results in the SFP/Transfer Canal BILs listed in Chapter 5, Table 5-9 being reduced to be equal to or lower than the Containment BILs.

ZSRP will ensure the performance of these steps as described above by adding a "NOTE" to Zion*Solutions* procedure ZS-LT-300-001-004, "FRS Data Assessment."

c. Clarify if the sample results from all samples, including any judgmental or biased samples, will be included in the sign tests and in the calculation of the mean inventory.

ZSRP Response (PAB 10c) – ZSRP intends to include only systematic samples taken for STS for the population used to perform the Sign Test. Judgmental sample results will be included in the calculation of the Mean Inventory Fraction.

11. **NRC Comment**: Chapter 6 RAI 16 - Additional justification is needed to demonstrate that the BFM adequately assesses the potential dose from inventory in the basements.

Discussion: As noted in the NRC's RAI, the basement fill model contains several assumptions which are conservative and are not realistic (e.g., water from the basement is used to support a farm). However, it is not clear whether other assumptions are optimistic, so the conservatism of the overall model is not clear. For example, although the inventory is modeled as being instantly released in many of the basements, the radionuclides are also modeled as instantly sorbing back onto the backfill material. For example, Table 10 in TSD 14-009 shows a peak radioactivity in solution that corresponds to less than a few percent of the inventory for all radionuclides except H-3. The RAI response provides some justification for this modeling result.

While the BFM does not include any flow, it is likely that there would be flow in reality. As noted in the RAI response, the assumption of no flow is typically conservative. However, in the case where channeling flow could occur through an area that has a higher inventory and does not have sufficient fill to sorb onto, the assumption of no flow would be non-conservative and the resulting groundwater concentration could be higher than was calculated in the BFM. Such a scenario could occur if flow were to occur through an embedded pipe that had significant inventory that had hydraulic connectivity to the subsurface.

Resolution:

a. Provide justification that the basement fill model adequately accounts for the dose from embedded piping and any other inventory that could be released to the subsurface at higher concentrations than predicted in the BFM. Alternatively, provide an assessment of the potential dose from this inventory

ZSRP Response (PAB 11a) - There are no pathways where radioactivity could be released from embedded pipe to the subsurface at higher concentrations than predicted by the Basement Fill Model (BFM). All embedded pipe to remain in the Auxiliary Building basement (and the Turbine Building basement) originates as floor drains or equipment drains in the basement floors. The piping runs through the concrete floor and terminates in various sumps in the floors (which have no outlets) such as Equipment and Floor Drain Sumps. Any radioactivity released from the pipe openings will immediately contact the fill material on floors and in the sumps in the same manner as radioactivity leaching from concrete. To provide an additional barrier to the release of residual radioactivity from the embedded pipe in the Auxiliary Building basement, all pipe openings will be grouted.

There are no pathways to the subsurface from embedded pipe as discussed above. In addition, there are no other pathways where radioactivity could be released to the subsurface at higher concentrations than predicted by the BFM. All penetrations between basements and between the basements and surrounding ground were evaluated in detail in Zion*Solutions* TSD 14-032, "Conestoga Rovers & Associates Report, Simulation of the Post-Demolition Saturation of Foundation Fill Using a Foundation Water Flow Model" (previously provided to NRC). The conclusion of TSD 14-032 was that there are no water pathways from the basements to surrounding ground below the 579' average groundwater level and in fact, additional perforations would be required to ensure that the water elevation within the basements is maintained at essentially the same elevation as surrounding groundwater.

12. NRC Comment: Chapter 6 RAI 19 - Additional information is needed on the drilling spoils, construction, excavation, and "worst case" scenarios analyzed in TSD 14-021.

Discussion: Table 5 contains a value of 0 for the drill spoils dose factors for tritium for all basements except the SFP. It is not clear why the value would be non-zero for the SFP given that the sorption coefficient was assumed to be 0 for tritium.

The dose calculated for the large scale construction scenario in TSD 14-021 is 187 mrem/yr for the spent fuel pool. Additionally, in the large scale construction scenario, it was assumed that large scale construction would not take place for 50 years post closure because of the storage of spent fuel on the site. However, it is possible that the spent fuel could be moved off site to an interim storage facility or repository prior to 50 years and that construction could occur on the site prior to this time. If so, the projected dose would be even higher. The Table 15 Source Terms do not match the BILs in Table 5-9 of the LTP. Furthermore, there is uncertainty surrounding the radionuclide activity ratios applied in Table 16, it does not appear that these ratios are presented accurately (they are not a normalized fraction that should add to 1), and they do not account for decay. It would be simpler and more transparent to eliminate the step of multiplying by an assumed activity fraction and instead show that the dose from each individual radionuclide would be less than 25 mrem/yr. Also, by using the soil DCGLs in calculating the dose, the pathways may not be realistic for the construction scenario. An analysis demonstrating that the radiological dose will be consistent with the license termination criteria in 10 CFR 20.1402 if construction occurs on the site following license termination is needed.

The NRC staff notes that there are several conservative assumptions in the construction analysis in TSD 14-021 (e.g., volume of material excavated, use of DCGLs based on the resident farmer) while simultaneously there are assumptions that have uncertainty or may be non-conservative (e.g., assumed radionuclide fractions). A more transparent, and more realistic assessment may result in a projected dose that is clearly less than 25 mrem/yr.

Resolution:

a. Clarify the reason for a non-zero drill spoils dose factor for tritium for the SFP.

ZSRP Response (PAB 12a) – The sorption coefficient (Kd) is zero for H-3, however the release of H-3 from concrete is dependent on the diffusion coefficient, which is 5.0E-07 cm^2/s. Although the diffusion coefficient is a relatively high value compared to the other ROCs, and leaches relatively quickly, it does not instantly release. For the Auxiliary Basement and SFP/Transfer Canal, DUST calculates the maximum fill and water concentrations for each ROC as a function of diffusion coefficient, Kd, and half-life. Therefore, there are theoretically trace concentrations of H-3 remaining in the concrete at the time of maximum concentrations. But these trace concentrations are very near zero and are calculated as positive or negative depending on the rounding in the calculations. For the SFP/Transfer Canal, the remaining H-3 concentration in concrete at the time of maximum water concentration was very slightly above zero. The calculation of activity remaining in concrete takes the difference between the decayed source term and the source term in water at the time of maximum water concentration. Converting this value to a BFM Drilling Spoils Dose Factor resulted in a negligible value of 1.45E-09 mrem/yr per mCi for H-3. For the Auxiliary Building Basement, the H-3 activity difference between the decayed source term and the source term in water at the time of maximum water concentration (i.e., the activity remaining in concrete) was slightly negative, which is simply a result of rounding error in the negligible activities involved in the calculation. Therefore, the BFM Drilling Spoils Dose Factor for the Auxiliary Building Basement was reported as zero in TSD 14-021, Table 5. The rounding differences correspond to negligible dose consequences.

b. Provide an analysis that demonstrates that the dose will be consistent with the license termination criteria in 10 CFR 20.1402 in the event of a large scale excavation/construction scenario.

ZSRP Response (PAB 12b) – The scenario to be used for compliance with 10 CFR 20.1402 is the Resident Farmer Scenario, which is a conservative "bounding" scenario for the Zion site. As stated in LTP Chapter 6, Section 6.7, the large scale excavation scenario is considered a "less likely but plausible" scenario as defined in NUREG-1757, Table 5.1 which also states that a less likely but plausible scenario is *"not analyzed for compliance, but is used to risk-inform the decision."*

Future large scale industrial development of the site is unlikely given the current land use of the surrounding areas including proximity to Illinois Beach State Park and the sites lake front location. The reasonably foreseeable scenarios for the site are residential, recreational use or possibly smaller scale commercial operations. It is clear that all three of these scenarios would have lower dose consequences than the bounding Resident Farmer scenario selected for compliance demonstration. But the most compelling reason for concluding that future large scale excavation of the basements is a less likely but plausible (if not "implausible" as defined in NUREG 1757 Table 5.1) is the fact that the major basements are below the water table with floor elevations at depths of 23', 31' and 49' below ground surface (bgs) for the Turbine, Containment, and Auxiliary Building, respectively. These depths are even greater when the thickness of the concrete floors and foundations are considered. The depths of the other basement floors range from 15' (SFP/Transfer Canal) to 39' bgs and are also below the water table. The logistics and cost of a very deep excavation, below the water table, for a future industrial use would be prohibitive and not commercially viable. Excavation is particularly unjustified given that there is a significant area of land available on the site that could be used without requiring the excavation of basement concrete. Not only would the cost of such an excavation be prohibitive but a viable industrial use at the Zion site that would require such an immense excavation is difficult to envision and is clearly "less likely." A secondary, though still significant hurdle to large scale excavation is the environmental sensitivity of such a project given the sites proximity to Lake Michigan and the Illinois Beach State Park.

The future large scale excavation of the Zion site basements cannot be considered a reasonably foreseeable scenario and in fact could readily be justified as implausible. Note that designating the large scale excavation as implausible would be consistent with NRC approved LTPs for other decommissioned reactors where no evaluation of the basement excavation scenario was required. The ZSRP designation of large scale industrial excavation as "less likely but plausible" exceeds the level of consideration required by NRC in approved LTPs for other decommissioned reactor sites.

As stated above, a less likely but plausible scenario is *"not analyzed for compliance, but is used to risk-inform the decision."* NUREG 1757, Volume 2, Revision 1 Section 5 (p5.5) states that *"the evaluation of less likely but plausible scenarios ensures that, if land uses other than the reasonably foreseeable land use were to occur in the future, significant exposures would not result."* NUREG-1757 further states that *"results of these analyses will be used by the staff to evaluate the degree of sensitivity of dose to overall scenario assumptions (and the associated parameter assumptions). The reviewer will consider both the magnitude and time of the peak dose from these scenarios. If peak doses from the less likely but plausible land use scenarios are significant, the licensee would need to provide greater assurance that the scenario is less likely to occur, especially during the period of peak dose."* The guidance does not recommend that the dose value be compared to the compliance dose of 25 mrem/yr, and in fact specifically states that it is not, but that the NRC staff evaluates whether the dose is "significant."

NRC had four comments/questions related to the dose assessment for the large scale industrial excavation scenario which are addressed in this response;

- provide further explanation of the dose calculation in TSD 14-021,
- perform the dose assessment using more realistic assumptions applicable to an industrial use scenario (as opposed to the bounding approach used which compared results to the Resident Farmer soil DCGLs),
- re-evaluate the proposed 50-year decay period before excavation, and
- consider simplifying the calculation

1. <u>Provide further explanation of the dose calculation in TSD 14-021</u>

NUREG-1757 states that *"the compliance scenario should result in the greatest exposure to the average member of the critical group for all scenarios <u>given the mixture of radionuclides</u>."* The mixture is required for dose assessment. Consistent with this recommendation, the dose assessment from the large scale excavation scenario calculated in TSD 14-021 also considers the mixture of radionuclides.

NRC had two questions related to the method for calculating the Large Scale Industrial Excavation dose. The questions specifically related to TSD 14-021, Table 16 as listed below:

1. there is uncertainty surrounding the radionuclide activity ratios applied in Table 16, it does not appear that these ratios are presented accurately (they are not a normalized fraction that should add to 1), and
2. they do not account for decay.

The answer to the second question is that the activity values provided in Table 16 are decay corrected to July 1, 2018 (from TSD 14-019, Table 19).

The answer to the first question is that yes, the inventories in Table 16 are presented accurately. To explain why this is the case, Tables 15-18 from TSD 14-021 require consideration since they are all part of the calculation. As recognized by NRC in the comment, the inventory values in Table 16 are not the full input required. In the end, the "normalized" relative mixture fractions are required to determine the Maximum Allowable Inventory at License Termination" in Table 18. But the "normalization" can occur in different steps in the calculation. The process used in the TSD 14-021 calculation is described below.

The inventory values in Table 16 are the decay corrected inventories for each radionuclide from TSD 14-019, Table 19 and do not add to 1. The inventories represent the relative fractions between the radionuclides for the purpose of this calculation. Normalization occurs in two subsequent steps as shown in Tables 17 and 18. Table 17 provides the results of dividing the Table 16 values by the BIL and sums the results. For example, for the Auxiliary Building, the summation is 0.9 (labeled as "Total" in Table 17). The "normalization" then occurs in Table 18 which provides the results of dividing the Table 16 values by the "Total."

The Table 18 values represent the maximum inventory for each radionuclide that could be present at license termination based on the BFM. Another way of explaining this is that the maximum inventories in Table 18 are the values that would result in a sum of fractions of one given the BILs in Table 15. The Table 18 values are then the assumed inventories in the Large Scale Industrial Excavation dose assessment.

Note that in the "Discussion" section of this RAI, NRC commented that the Table 15 BIL values do not match LTP Chapter 5 Table 5-9 BILs. The BILs do not match because the Table 5-9 values for the SFP/Transfer Canal include a factor 7.5 adjustment lower to address the large scale excavation dose as calculated in TSD 14-021 Revision 0. The 7.5 adjustment factor was reduced to 2.11 based on the revised calculations in TSD 14-021 Revision 1 performed in response to this RAI. A corresponding increase in the SFP/Transfer Canal BILs will be included in the revised Table 5-9. In addition, the BILs listed in Table 15 for all basements are not adjusted for the dose from insignificant contributors which maximizes the BILs and corresponding excavation dose.

TSD 14-021, Revision 1, Table 3 – ROC Maximum Allowable License Termination Source Term (BIL)

Nuclide	Aux mCi	Containment mCi	Spent Fuel mCi	Turbine mCi	Crib House mCi	WWTF mCi
H-3	4.03E+03	9.20E+02	9.20E+02	3.68E+03	4.31E+03	2.02E+01
Co-60	2.31E+03	6.08E+02	1.58E+02	2.01E+03	1.23E+03	3.34E+01
Ni-63	8.75E+04	1.56E+04	1.56E+04	6.23E+04	7.27E+04	3.42E+02
Sr-90	7.59E+01	5.54E+00	5.54E+00	2.21E+01	2.59E+01	1.21E-01
Cs-134	1.61E+03	1.16E+02	1.16E+02	4.55E+02	4.76E+02	2.73E+00
Cs-137	8.45E+02	1.52E+02	1.52E+02	6.01E+02	6.60E+02	3.46E+00
Eu-152	4.92E+03	1.42E+03	3.35E+02	4.62E+03	2.76E+03	8.88E+01
Eu-154	4.44E+03	1.23E+03	3.03E+02	4.08E+03	2.51E+03	6.80E+01

= Activated Concrete ROC

= Basement Fill and Soil ROC

Note: Spent Fuel BILS set to lower of either Containment or Spent Fuel values

The normalized composite inventory values for the Containments and Auxiliary Building from TSD 14-019, Table 19, are used to represent the relative mixture fractions of the ROC as listed in Table 16. The relative fractions are normalized to one in Table 18.

TSD 14-021, Revision 1, Table 4 - ROC Inventories Using Aux Building and CTMT Normalized Composite Source Terms

3.

Nuclide	Aux mCi	Containment mCi	Spent Fuel mCi	Turbine mCi	Crib House mCi	WWTF mCi
H-3		7.40E-01				
Co-60	9.08E+00	4.68E+01	9.08E+00	9.08E+00	9.08E+00	9.08E+00
Ni-63	2.35E+02	2.63E+02	2.35E+02	2.35E+02	2.35E+02	2.35E+02
Sr-90	5.10E-01	2.73E-01	5.10E-01	5.10E-01	5.10E-01	5.10E-01
Cs-134	1.03E-01	8.15E-02	1.03E-01	1.03E-01	1.03E-01	1.03E-01
Cs-137	7.46E+02	6.76E+02	7.46E+02	7.46E+02	7.46E+02	7.46E+02
Eu-152		4.36E+00				
Eu-154		5.79E-01				

= Activated Concrete ROC

= Basement Fill and Soil ROC

The fraction of the TSD 14-021, **Revision 1, Table 3** limit (BIL) for each source term is shown in TSD 14-021, **Revision 1, Table 5**.

TSD 14-021, Revision 1, Table 5 - ROC Max Inventory Fractions for Auxiliary Building and Containment Source Terms

Nuclide	Aux	Containment	Spent Fuel	Turbine	Crib House	WWTF
H-3		8.04E-04				
Co-60	3.93E-03	7.69E-02	5.75E-02	4.52E-03	7.35E-03	2.71E-01
Ni-63	2.68E-03	1.69E-02	1.51E-02	3.77E-03	3.23E-03	6.87E-01
Sr-90	6.71E-03	4.94E-02	9.20E-02	2.31E-02	1.97E-02	4.20E+00
Cs-134	6.42E-05	7.00E-04	8.86E-04	2.27E-04	2.16E-04	3.78E-02
Cs-137	8.83E-01	4.44E+00	4.90E+00	1.24E+00	1.13E+00	2.15E+02
Eu-152		3.08E-03				
Eu-154		4.69E-04				
Total	0.90	4.58	5.06	1.27	1.16	220.69

= Activated Concrete ROC

= Basement Fill and Soil ROC

The TSD 14-021, **Revision 1, Table 4** inventories divided by the Total value in TSD 14-021, **Revision 1, Table 5** normalizes the inventory fractions. The results of the calculation are provided in Table 18. The Table 18 inventories are the maximum values, in mCi, that can remain in the basements at license termination. They represent the inventory that would result in a sum of fraction (SOF) value of one using the BFM limits (BIL).

TSD 14-021, Revision 1, Table 6 - Maximum Allowable Inventory at License Termination

Nuclide	Aux mCi	Containment mCi	Spent Fuel mCi	Turbine mCi	Crib House mCi	WWTF mCi
H-3		1.62E-01				
Co-60	1.01E+01	1.02E+01	1.79E+00	7.14E+00	7.82E+00	4.11E-02
Ni-63	2.62E+02	5.73E+01	4.64E+01	1.85E+02	2.02E+02	1.06E+00
Sr-90	5.68E-01	5.97E-02	1.01E-01	4.01E-01	4.39E-01	2.31E-03
Cs-134	1.15E-01	1.78E-02	2.04E-02	8.11E-02	8.89E-02	4.67E-04
Cs-137	8.32E+02	1.47E+02	1.47E+02	5.87E+02	6.43E+02	3.38E+00
Eu-152		9.51E-01				
Eu-154		1.26E-01				

2. Perform the dose assessment using more realistic assumptions applicable to an industrial use scenario

Any project that included large scale excavation of the deep basements below the water table would be for industrial use of the site. Therefore, an industrial use scenario soil dose assessment was added to TSD 14-010 Revision 2 (attached for NRC review). The resulting DCGLs were used in the revised large scale excavation dose assessment in TSD 14-021 Revision 1. The details of the calculation and supporting RESRAD Summary Reports are provided in Section 6 of TSD 14-010 Revision 2. Excerpts from Section 6 are reproduced below.
The large scale excavation scenario in TSD 14-021 assumes that the excavated material is spread on the surface over a 1 m depth. Therefore, the RESRAD parameters for the industrial use soil assessment were set to the same values used for the subsurface soil dose assessment with the following changes:

- Inhalation Rate: 1917 m^3/yr

  NUREG/CR-5512, Vol. 3 Table 5.1.1 mean value is 8400/y which equates to 23 m3/d. Industrial Scenario m3/yr =23 m3/d ÷ 24h/d * 2000 h/y.

- Fraction of time spent indoors: 0.1875

  NUREG-6697 Att. C, Table 7.6-1 recommends a median indoor work day as 8.76 hours/day. Assuming 5 days a week and 50 weeks per years this equates to 2190 hours per year. Majority of industrial work is expected to be indoors. Consistent with Table 2-3 of the "User's Manual for RESRAD Version 6," 75% of work time is indoors and 25% outdoors. The corresponding RESRAD indoor Fraction parameter = (2190*0.75)/(24*365) = 0.1875

- Fraction of time spent outdoors: 0.0625

  As explained in the basis for the Indoor Fraction parameter, the indoor time fraction was set at 75% and outdoor time fraction at 25%. The corresponding RESRAD outdoor time fraction is (2190*.25)/(24*365) = 0.0625.

- Drinking water intake: 327 L/y

  NUREG/CR-5512, Vol. 3 Table 6.87. Industrial Scenario water supply assumed to be from an onsite well. 478 L/y from NUREG/CR-5512 corresponds to 1.31 L/d which is considered a conservative value for 8 hour work day. 1.31 L/d * 250 work days = 327 L/y

- Plant/Meat/Milk Pathways:

  All food ingestion pathways inactive in industrial scenario.

- Kds for Sr-90 and Ni-63:

  Kds for Sr-90 and Ni-63 set to the minimum site-specific values to maximize dose through groundwater pathway which is predominant pathway with plant/meat/milk inactive.

- Kds for remaining radionuclides are set to minimum values in the subsurface soil parameter set used therefore no adjustment required.

The resulting Industrial Use DCGLs are listed in Table 18, column 2, of TSD 14-010, Revision 2 which is reproduced below. The RESRAD report file name is "*Zion Industrial Use Soil RESRAD Summary Report 5_27*.pdf " which is enclosed for NRC review.

Note that H-3, Eu-152, and Eu-154 were added to the list of radionuclides evaluated because the industrial use scenario DCGLs were used in TSD 14-021 to evaluate the excavation of backfilled concrete, which includes H-3, Eu-152 and Eu-154 as ROCs for the Containment Basement. TSD 14-010, Revision 2 Table 18, column 3 provides the DCGLs after adjustment to account for the dose fraction attributable for the removed insignificant contributors. The calculated insignificant dose fraction assigned to surface soil, i.e., 0.171% (see TSD 14-019, Revision 1, Table 24), was used to adjust the industrial use DCGLs. This is conservative because the plant pathways are not applicable to industrial use which reduces the relative dose fraction from non-gamma emitting radionuclides (i.e., HTD radionuclides) that comprise the majority of radionuclides removed as insignificant dose contributors.

TSD 14-010, Revision 2, Table 18 – Industrial Use Soil "DCGLs" and Adjusted "DCGLs" for use in the Large Scale Industrial Excavation Dose Assessment

Radionuclide	Industrial Use DCGL (pCi/g)	Adjusted Industrial Use DCGL (pCi/g)
Co-60	12.36	12.34
Cs-134	23.37	23.33
Cs-137	55.86	55.76
Eu-152	27.48	27.43
Eu-154	25.47	25.43
H-3	1819	1815.89
Ni-63	9.50E+06	9.48E+06
Sr-90	14.09	14.07

3. <u>Re-evaluate the proposed 50-year decay period before excavation</u>

As stated in LTP Chapter 6 Section 6.7, a nominal 50-year decay period was assumed before the basements were excavated citing the presence of the ISFSI as being a negative influence on potential future industrial development. NRC commented that *"it is possible that the spent fuel could be moved off site to an interim storage facility or repository prior to 50 years and that construction could occur on the site prior to this time."* ZSRP reviewed the potential time delay between license termination and implementation of a large scale excavation of the site for industrial use. A qualitative evaluation of the minimum time after license termination when a large scale industrial enterprise at the site could possibly be conceived, financed, designed, and approved concluded that a minimum of 10 years would be required. In addition, it is likely that the ISFSI will remain at the site for a 10-year period. Therefore, the decay period used in the excavation dose assessment was reduced from 50 years to 10 years.

4. <u>Consider simplifying the calculation</u>

The calculation of the large scale excavation dose in TSD 14-021 Revision 2 was simplified by making two separate dose assessments. The first takes the maximum allowable inventories (i.e., BILs) and assumes inadvertent mixing with basement concrete as it is excavated. The second calculation uses the maximum calculated fill concentrations to determine the maximum excavated fill concentrations after inadvertent mixing. Both calculations assume 10 years of decay. This process is conceptually simple in that the source term can only reside in one of two solid matrices, either concrete or fill, depending on the extent of release from concrete. However, these are mutually exclusive since the source term cannot be in both concrete and fill at the same time.

The radionuclide inventories from TSD 14-021, Revision 1, Table 18 were divided by the concrete mass and fill mass to determine the excavated concrete and fill concentrations, respectively. The resulting concentrations are divided by the adjusted industrial use DCGLs listed in TSD 14-010, Revision 2, Table 17 after adjusting for the area factors applicable to the surface area of the excavated material. The resulting dose fractions for all ROC were summed to determine the total dose from the large scale excavation scenario assuming maximum residual radioactivity at the time of license termination. The revised dose assessment results are provided in TSD 14-021, Revision 1, Tables 22 and Table 26 which are reproduced below. The assessment applies area factors that are based on the Resident Farmer scenario and are approximations for the area factors that would be applicable to the Industrial Scenario. Therefore, Tables 22 and 26 also contains the dose with no area factor correction which provides the maximum dose.

As expected, the large scale industrial excavation scenario doses all decreased when a less conservative scenario was applied. The previous calculation applied a bounding approach using Resident Farmer DCGLs. The doses for concrete and fill are below 25 mrem/yr for all Basements except the SFP/Transfer Canal, with maximum doses of 20.02 mrem/yr and 31.40 mrem/yr, for concrete and fill, respectively. The maximum revised SFP/Transfer Canal dose was slightly above the 25 mrem/yr limit and is not significant given that large scale industrial excavation is a "less likely but plausible" scenario which is not a compliance scenario. In addition, the 31.40 mrem/yr dose for the SFP/Transfer Canal is very likely conservative. First, the dose values in Tables 22 and 26 assume excavation of each basement separately. It is unlikely that any future excavation would involve the SFP/Transfer Canal only. The addition of excavated fill from adjacent basements and/or adjacent clean soil would reduce the dose. Second, it is likely that the levels of residual radioactivity in the SFP/Transfer Canal will be well below the BIL resulting in a dose below 25 mrem/yr.

TSD 14-021, Revision 1, Table 7 - Concrete Fractions of Soil DCGLs and Bounding Large Excavation Doses at t=10 years

Nuclide	Soil DCGL pCi/g	Aux DCGL Fraction	Containment DCGL Fraction	Spent Fuel DCGL Fraction	Turbine DCGL Fraction	Crib House DCGL Fraction	WWTF DCGL Fraction
H-3	1815.89		3.37E-06				
Co-60	12.34	5.86E-03	1.34E-02	1.26E-02	1.97E-03	6.76E-03	8.30E-04
Ni-63	9480000	4.22E-07	1.24E-07	2.67E-07	1.62E-07	4.53E-07	5.95E-09
Sr-90	14.07	7.06E-04	1.49E-04	1.18E-03	2.51E-04	7.97E-04	2.69E-05
Cs-134	23.33	4.05E-06	1.31E-06	7.31E-06	1.42E-06	4.60E-06	4.62E-07
Cs-137	55.76	2.60E-01	9.11E-02	4.15E-01	9.28E-02	2.93E-01	2.48E-02
Eu-152	27.43		1.38E-03				
Eu-154	25.43		1.50E-04				
Total		**2.66E-01**	**1.06E-01**	**4.29E-01**	**9.50E-02**	**3.00E-01**	**2.56E-02**
Dose mrem/yr		6.66	2.65	10.72	2.37	7.51	0.64
Dose mrem/yr No AF		8.57	3.90	20.02	2.83	9.96	1.43

= Activated Concrete ROC

= Basement Fill and Soil ROC

TSD 14-021, Revision 1, Table 8 - Fill Fractions of Soil DCGLs and Bounding Large Excavation Doses

Nuclide	Soil DCGL pCi/g	Aux DCGL Fraction	Containment DCGL Fraction	Spent Fuel DCGL Fraction	Turbine DCGL Fraction	Crib House DCGL Fraction	WWTF DCGL Fraction
H-3	1815.89		2.78E-06				
Co-60	12.34	3.77E-03	1.16E-02	2.16E-02	2.36E-03	2.80E-03	5.10E-04
Ni-63	9480000	2.71E-07	2.35E-07	3.75E-07	1.78E-07	2.05E-07	8.82E-09
Sr-90	14.07	3.76E-04	1.18E-04	1.56E-03	2.40E-04	2.81E-04	3.68E-05
Cs-134	23.33	2.74E-06	1.27E-06	1.25E-05	1.74E-06	2.05E-06	2.96E-07
Cs-137	55.76	1.65E-01	8.79E-02	6.48E-01	1.06E-01	1.24E-01	1.53E-02
Eu-152	27.43		1.14E-03				
Eu-154	25.43		1.24E-04				
Total		**1.70E-01**	1.01E-01	**6.71E-01**	**1.08E-01**	**1.27E-01**	**1.58E-02**
Dose mrem/yr		4.24	2.52	16.77	2.71	3.17	0.40
Dose mrem/yr No AF		4.89	2.97	31.40	3.05	3.63	0.74

= Activated Concrete ROC

= Basement Fill and Soil ROC

13. NRC Comment: Chapter 6 RAI 20 - Additional details on the derivation of the maximum concentration for the "worst case" drilling spoils scenario is needed.

Discussion: The basis for the activity assumed in the determination of the maximum concentration is not clear. Table 33 of TSD 14-021 lists the activities measured in the highest core sample. The text below Table 33 states that the activity of a 1 ft diameter source is calculated by multiplying the concentration in pCi/g by a 2224 g mass and dividing by 1e12 pCi/Ci. However, using this method to convert the concentrations in Table 33 to a total activity does not result in the values listed in Table 34.

The analysis of the maximum concentration also does not appear to consider potential elevated areas in pipes. If the pipes are not subject to the open air demolition survey and the requirement that the dose rate is less than 2 mR/hr, then the maximum elevated concentration in the pipes could be larger than was assumed in the "worst case" scenario.

Also, the NRC staff noted that the doses reported for the "worst case" drilling spoils scenario are inconsistent (p. 6-37 of the LTP and Table 36 of TSD-14-021 lists a value of 4.2 mrem/yr for the Auxiliary Building, while the text on p34 of TSD 14-021 lists a value of 5.68 mrem/yr for the Auxiliary Building. Additionally, the "worst case" dose from the SFB calculated in TSD 14-021 was higher than that for the Auxiliary Building, so it is not clear why the auxiliary building was considered to be the worst case.

Note that the maximum concentration derived could affect the evaluation of potential size of hot spots with regard to survey design (see NRC comments on Chapter 5, RAI 7 and Chapter 6, RAI 15).

Additionally, note that a key assumption in the determination of the "worst case" concentration is that the open air demolition survey has adequate coverage to ensure that all areas are less than 2 mR/hr (See NRC comments on Chapter 5, RAI 8).

Resolution:

a. Provide additional details on the calculation of the "worst case" maximum concentration, including the derivation of the total activity values in Table 34 of TSD 14-021.

ZSRP Response (PAB 13a) – The activity calculations in Table 34 (designated as Table 29 in TSD 14-021 Revision 1 - which is enclosed for NRC review) are based on an 8 inch diameter elevated area which is consistent with the assumed diameter of the drill and the Microshield evaluations in Attachment B to TSD 14-021. The calculations in Tables 29, 30 and 31 (previously Tables 34, 35, and 36 in TSD 14-021, Revision 0) are correct. However, the text incorrectly states that a 1 foot diameter elevated area was assumed in the calculation. The text has been revised in TSD 14-021, Revision 1 to state that an 8 inch diameter area was assumed with a concrete density of 2.35 g/cm3 which corresponds to a mass of 968 g, as opposed to the 2224 g mass stated in TSD 14-021 Revision 0.

b. Provide an assessment of the potential dose from an elevated area in a pipe or provide justification that the "worst case" scenario analyzed in TSD 14-021 bounds this dose.

ZSRP Response (PAB 13b) – The drilling spoils scenario assumes that drilling stops after meeting refusal by contact with the concrete floor. It is not considered "plausible" as defined in NUREG-1757, Table 5.1, that a driller expecting to encounter sand and clay would proceed with drilling after encountering concrete. After the first 0.5 inch of concrete, the drill would need to traverse 8 inches of the lightly reinforced (rebar) concrete finish floor and then through four feet of the heavily reinforced (1.38 inch diameter rebar) concrete foundation slab to encounter the embedded drain pipes in the Auxiliary Basement floor.

There are a few equipment drains embedded in the Auxiliary Basement floor concrete that have been determined to be at a depth of 2 inches from the floor surface. The drains have diameters of 2 inches and 6 inches. These pipes were added to the worst-case drilling spoils scenario because it is considered "less likely but plausible" (as defined in NUREG-1757, Table 5.1) that a driller could continue beyond the assumed 0.5 inch of concrete to a depth of 2 inches and then through the equipment drains before stopping. Per NUREG-1757, Table 5.1, a "less likely but plausible" scenario is not analyzed for compliance but used to risk-inform the decision. The activity in the 8 inch length of pipe assumed to be encountered by the 8 inch diameter borehole is brought to the surface with the drilling spoils. The resulting dose from the activity in the 2 inch and 6 inch equipment drains, after 2-year decay to the projected July 2018 license termination date, is 23 mrem/yr and 2 mrem/yr, respectively. These dose levels are considered insignificant, particularly when the probability of the hypothetical borehole encountering the drain is considered. The effective surface areas of the drains when projected to the floor surface, are 0.9% and 1.4% of the Auxiliary floor surface area for the 2 inch and 6 inch drains, respectively. When the surface area of all basements is considered, the projected surface areas are 0.2% and 0.3% for the 2 inch and 6 inch drains, respectively. The dose calculation is provided in TSD 14-021, Revision 1.

c. Clarify what the calculated dose is for the "worst case" drilling spoils scenario.

ZSRP Response (PAB 13c) – The 4.2 mrem/yr values reported in LTP Chapter 6 and Table 36 of TSD 14-021 Revision 0 (Table 31 in TSD 14-021 Revision 1), which reports the calculation results, are correct. The value of 5.68 mrem/yr provided in the text of TSD 14-021 Revision 1 was corrected to match the calculation result reported in Table 36 of TSD 14-021 Revision 0 (designated as Table 31 in TSD 14-021 Revision 1).

The worst case drilling spoils dose was assumed to occur in the Auxiliary Basement because it is expected to contain the highest levels of residual radioactivity. In addition, the characterization data used for the assessment was collected from the Auxiliary basement. However, regardless of which worst case drilling spoils dose is considered, 4.2 mrem/yr or 5.7 mrem/yr, for the Auxiliary Building and SFP/Transfer Canal, respectively, the dose is insignificant.

14. NRC Comment: Chapter 6 RAI 21 - The calculated groundwater pathway dose did not appear to include the SFP inventory.

Discussion: In Section 6.5.4 of the LTP, it is stated that the potential contribution of the SFP inventory to a well water pathway will be considered by adding the SFP inventory to the containment basement. The BIL values for the fuel building in Table 5-9 of the LTP are much larger than the BIL values for the other basements. However, an inventory contribution from the SFP does not appear to have been included in the outside well receptor analysis despite the fuel inventory being a significant fraction of the total inventory represented by the BILs. Although the volume of water in the fuel basement may not be large enough to support a resident farmer, it is plausible that the inventory would move into other basements and/or the subsurface and that this inventory could then cause a dose to a well receptor.

Resolution:

a. Provide an assessment of the outside well receptor scenario that includes the contribution from inventory associated with the SFP.

ZSRP Response (PAB 14a) – The commitment in Section 6.5.4 to add the SFP inventory to the containment inventory to assess the potential contribution of SFP inventory to the groundwater pathway effectively limits the SFP BILs to values no greater than the Containment BILs. This commitment will be implemented by adding the SFP inventory (determined by STS) to inventory in Containment (determined by STS). The Containment with the highest inventory will be used for the summation. See ZSRP response to PAB Chapter 6, RAI 15. The summation of the SFP/Transfer Canal and Containment inventories will therefore be limited to the values of the Containment BILs.

Because the SFP/Transfer Canal and Containment inventories will be added and cannot in total exceed the Containment BILs, the inventories that will remain in each basement will be, by definition, less than their respective BILs. Notwithstanding the fact that the calculated values could not be reached during implementation of the STS, the calculated values were retained in the reported BFM Dose Factor Tables in Chapter 6 and the BIL Tables in Chapter 5. In order to improve clarity as to the actual maximum activity that could remain, the SFP/Transfer Canal BILs for H-3, Ni-63 and Sr-90 provided in Chapter 5 will be reduced to equal the Containment values with additional text added to describe the basis for the values. In addition, a footnote and/or additional text will be added to LTP Chapter 6 Section 6.5.4 to clarify the process of summing the SFP/Transfer Canal and Containment for demonstrating compliance with the 25 mrem/yr dose criterion.

The "Resolution" section of the comment requests an assessment of the outside well receptor scenario that includes the inventory from the SFP. As described above, the inventory in the Containment and SFP combined will be limited to the Containment BIL. The outside well scenario was performed assuming that the activity in the Containment was equal to the Containment BIL. Therefore, the SFP inventory was fully accounted for in the outside well receptor scenario previously provided.

HP Zion RAIs

1. **NRC Comment**: Chapter 3, RAI 5 and Chapter 5, RAIs 1 & 12 - Per the License Termination Rule (LTR), dose contributions from all radiologically impacted materials left on-site must be considered. There are questions about how this is accomplished when off-site release criteria are used instead of DCGLs.

Discussion: As noted in multiple RAI responses, the licensee intends to backfill areas on-site with concrete and soils deemed to be free of radiological contamination (per detection/release criteria in NRC IE Circular 81-07 and the licensee's ODCM Chapter 12). Free standing structures are also intended to be released using NRC IE Circular 81-07. NRC staff notes that these release criteria are intended for materials which are to be removed from the site and do not directly correlate to the dose-based license termination rule (LTR).

The current proposal does not clearly specify how any dose contribution from re-used soil/concrete will be considered. It also remains unclear how results for free standing structures would be factored into a dose assessment to meet the LTR. Clarification is needed on the dose assessment associated with both cases.

NRC staff notes that assuming zero dose contribution for materials surveyed per the criteria in NRC IE Circular 81-07 or the licensee's ODCM Chapter 12 may not be accurate or consistent with the LTR.

Current guidance in NUREG-1757, Vol. 2, Rev. 1, acknowledges some confusion may occur between off-site release criteria and the LTR criteria. Appendix G of that volume discusses "Special Characterization and Survey Issues", and specifically discusses the dose-based criteria of the LTR, and how it may relate to other release criteria. Section G.1.1 concludes that "for all approaches, the residual radioactivity in building structures, systems and components, and all other media at the site (e.g., soils or ground water) must be in compliance with the applicable criteria of the LTR (e.g., for unrestricted use, doses must not exceed 0.25 mSv/y (25 mrem/y) and must be ALARA)."

Resolution:

a. The licensee should justify the usage of IE Circular 81-07 and the ODCM criteria to meet the LTR. In doing so, the licensee must also account for potential doses from all impacted materials remaining onsite (including applicable hard-to-detect or insignificant radionuclides).

ZSRP Response (HP 1a) – Unconditional release criteria specified in Zion*Solutions* procedures require that no detectable plant-derived radioactive material be released from the site. MARSAME guidance is used in establishing survey intensities, and NRC has reviewed and audited the ZSRP unconditional release programs and found them to be acceptable. Materials unconditionally released from Zion, regardless of their point of origin on the site, have been verified to contain no detectable plant-derived radioactivity and are free to be used and relocated anywhere without tracking, controls, or dose considerations. All concrete to be used as clean fill at Zion will be surveyed to the non-detectable criterion and considered clean material.

ZSRP will ensure and demonstrate that all concrete designated as backfill material is clean by using the Unconditional Release Survey (URS) program at Zion presented in Zion*Solutions* procedure ZS-LT-400-001-001, "Unconditional Release of Materials, Equipment and Secondary Structures." In accordance with procedure ZS-LT-400-001-001, ambient background is determined for the area of the survey and a "critical level" based on the ambient background is derived for the instrument used. If a measurement result is greater than the critical level established for the instrument in the area specific to the material being surveyed, then an investigation is performed, typically using a portable gamma spectroscopy instrument (Inspector), but in some cases a volumetric sample is taken. If the investigation positively identifies plant-derived radioactivity, then the material may not be "unconditionally released." In the case of concrete surveyed as candidate material for use as clean fill, the material would be disqualified for use as fill, segregated and disposed of as low level radioactive waste.

Although the concrete to be used as fill is clean and can be viewed as having a zero dose impact, a dose value will be assigned for the purpose of demonstrating compliance with 10 CFR 20.1402 in the same manner as other materials to remain at license termination that are surveyed and found to not contain detectable activity. The "detection limit" used for the dose calculation is conservatively assumed to be the 5,000 dpm/100 cm^2 value in I&E Circular 81-07. Actual detection limits in the unconditional release program are lower than this value. Note that if the use of the 5,000 dpm/100 cm^2 maximum non-detect limit is deemed to be too conservative, this dose calculation will be revised based on actual survey detection limits as opposed to the conservative 5,000 dpm/100 cm^2 upper value.

The details of the clean concrete dose assessment are provided in TSD 14-010, Revision 2 (enclosed for NRC review) and summarized below.

The vast majority of clean concrete fill to be used will come from two buildings; Containment and Turbine. The source term for the dose assessment is calculated by determining the total surface area of the concrete to be used as backfill, assuming uniform surface contamination at 5,000 dpm/100 cm^2 gamma, and dividing the resulting total activity by the volume of concrete fill. The source term is then produced with units of mCi/m^3 for both Containment and Turbine. The resulting source terms were 8.57E-04 mCi/m^3 and 4.29E-04 mCi/m^3 for the Turbine Building and Containment, respectively. Consistent with the bounding and conservative approach used for this dose assessment, the maximum source term of 8.57E-04 mCi/m^3 was applied to all concrete fill.

Because the source term was from both Containment and Turbine, the dose calculation was performed for both the Containment and Auxiliary ROC mixtures. The dose was essentially the same for both mixtures, but the dose with the Containment mixture was slightly higher (with trivial exception of WWTF). Consistent with the bounding approach used for the clean concrete dose assessment, the Containment mixture was applied to all concrete. In addition, when applying the ROC mixture, the 5,000 dpm/100 cm^2 maximum detection limit was assumed to be 100% Cs-137. The remaining radionuclide concentrations were added to the assumed Cs-137 concentration at their respective ratios to Cs-137.

The dose values are calculated separately for each basement assuming that the entire basement void is filled with concrete only. This conservatively includes the top three feet of fill which will be soil for all basements. The dose results for each basement are provided in TSD 14-010, Revision 2 Table 22. The dose values in Table 22 will be added to the dose determined by STS for applicable basements during the STS data assessment process. The full dose in Table 22 will be added to any basement where concrete fill is used regardless of the concrete fill volume. This is a conservative and bounding approach. As stated above, if deemed necessary by ZSRP, the dose values in Table 22 may be adjusted based on actual survey detection limits as opposed to the conservative 5,000 dpm/100 cm2 upper value.

TSD 14-010, Revision 2, Table 22 Clean Concrete Fill Hypothetical Dose using Containment ROC Mixture

Radionuclide	Auxiliary	Containment	Spent Fuel Pool/ Transfer Canals	Turbine	Crib House/ Forebay	WWTF
	mrem/yr	mrem/yr	mrem/yr	mrem/yr	mrem/yr	mrem/yr
Co-60	2.48E-02	2.98E-02	1.00E-02	3.23E-02	5.63E-02	4.60E-02
Cs-134	6.21E-05	2.71E-04	2.33E-05	2.49E-04	2.54E-04	9.83E-04
Cs-137	9.80E-01	1.72E+00	1.48E-01	1.56E+00	1.52E+00	6.42E+00
Eu-152	1.09E-03	1.19E-03	4.41E-04	1.31E-03	2.35E-03	1.61E-03
Eu-154	1.60E-04	1.82E-04	6.47E-05	1.97E-04	3.43E-04	2.81E-04
H-3	2.25E-04	3.12E-04	2.68E-05	2.79E-04	2.55E-04	1.20E-03
Ni-63	3.68E-03	6.55E-03	5.63E-04	5.85E-03	5.37E-03	2.53E-02
Sr-90	4.41E-03	1.91E-02	1.65E-03	1.72E-02	1.57E-02	7.42E-02
Total	**1.01E+00**	**1.78E+00**	**1.61E-01**	**1.62E+00**	**1.60E+00**	**6.57E+00**

ZSRP also proposes to apply the URS process to the "minor structures" that will remain at license termination. As stated in the response to the previous RAI, the minor structures are identified as the Sewage Lift Station, the active switchyard, the North Guard House, the Com Ed Microwave Tower and minor valve and conduit boxes. The North Guard House is a portable, temporary structure with no poured foundation that can be readily relocated to onsite or offsite locations and is therefore included in the minor structure category.

The minor structures are located in non-radiologically controlled areas and the potential for residual contamination on the surfaces of these structures are minimal. Miscellaneous items such as power poles, culverts, and duct banks, which also have a very low potential for containing residual radioactivity, will also be surveyed by the URS process. ZSRP proposes to demonstrate that the minor structures and miscellaneous items are acceptable for unconditional release by using the graded survey approach described in procedure ZS-LT-400-001-001 with no additional assessments. The scan surveys meet or exceed the rigor of scan surveys in a Class 3 MARRSIM survey unit. As stated in the response to the initial RAIs, ZSRP contends that there is precedence for the use of this approach, citing the release for unrestricted use of the Emergency Operations Facility at the Haddam Neck decommissioning in 2007 as an end-state structure using URS to demonstrate compliance.

2. **NRC Comment**: Chapter 5, RAI 2 - The response to RAI 2 of Chapter 5 does not fully address updates to the FSS design as a result of additional characterization. NRC staff notes that areas affected by ongoing decommissioning operations may require a different survey design based on future contamination potential. There are also challenges associated with sub-slab soils that may need to be considered. Two examples are discussed here, sub-slab soils and the Circulating Water Discharge Tunnels. Additionally, Section 5.5.1.8 of the LTP does not exist, though it is referred to in the RAI response and in Chapter 2 of the LTP.

Discussion: A portion of the original RAI discussed the necessity to evaluate the radiological conditions of sub-slab soils beneath several areas (as noted in Section 5.7.1.5.3 of the LTP), and requested that the licensee indicate how newly acquired characterization results will be used in the FSS design. It does not appear that the RAI response provided on subsurface soils addresses the challenges associated with characterization and remedial action support surveys of sub-slab soils, and the potential implications for FSS design revisions.

Section 5.3.4.3 of the LTP notes that "the soil (i.e., open land) survey units and survey unit classifications that will be used for the FSS of open land at ZNPS are presented in LTP Chapter 2, section 2.1.6 and Table 2-4." Table 2-4 of the LTP lists areas where soils underneath buildings are considered impacted. Some of these survey units also co-exist with building floors that will remain per the decommissioning end state (as shown in Figure 2-7). Based on the current presentation of these survey units, the NRC staff assumes that core borings through the concrete will be used to sample portions of soil survey units that are underneath a building, as it is noted in Section 5.7.1.5.3 of the LTP that "samples of building basement sub-slab soils will be obtained by coring through concrete slabs and foundations to facilitate the collection of soil samples." Due to the sub-slab nature of these soils, the remedial action support survey and remediation strategies discussed in the response to RAI 2 of Chapter 5 may be difficult or impossible to apply. Since it appears that additional characterization is required for sub-slab soils, as noted in the original RAI and in Section 5.7.1.5.3 of the LTP, the licensee should consider updates to the survey design that might result. As scanning surveys are not applicable to subsurface soils, additional considerations for grid spacing may be required to address elevated areas of contamination. Appendix G.2.1 of NUREG-1757, Vol. 2, Rev. 1 provides some guidance on this topic, and notes the following:

"When the appropriate DCGLs and mixing volumes based on an acceptable site-specific dose assessment are established, the FSS is performed by taking core samples to the measured depth of the residual radioactivity. The number of cores to be taken is initially the number (N) required for the WRS or Sign test, as appropriate. The adjustment to the grid spacing for an elevated measurement comparison (EMC) is more complicated than for surface soils, because scanning is not applicable. The core samples should be homogenized over a soil thickness that is consistent with assumptions made in the dose assessment, typically not exceeding 1 meter in depth. It is not acceptable to average radionuclide concentrations over an arbitrary soil thickness. The appropriate test (WRS or Sign) then is applied to the sample results. Triangular grids are recommended, because they are slightly more effective in locating areas of elevated concentrations. Site-specific EMCs may also need to be developed to demonstrate regulatory compliance. Generic guidance has not yet been developed for performing an EMC for subsurface samples; therefore, licensees should discuss this matter with NRC staff on a case-by-case basis."

The RAI response also indicates that, per Section 5.7.1.5 of the LTP, "during decommissioning of Zion, any subsurface soil contamination that is identified by continuing characterization or operational radiological surveys that is in excess of the site specific ($DCGL_w$) for each of the potential ROC as presented in Table 5-2 will be remediated." This would indicate that contaminated sub-slab soils will be remediated. In that case, the survey challenges above still remain for remedial action support surveys, which (also per Section 5.7.1.5 of the LTP) will be performed "in a manner that is intended to meet the rigors of FSS." However, if the licensee were to find contaminated sub-slab soil during additional characterization or FSS and wish to leave it in place, the residual radioactivity must be considered in correlation with the basement fill model.

Additional areas that may require a revision to the survey design are the Circulating Water Discharge Tunnels. Section 6.5.1.5 of the LTP indicates that "the Circulating Water Discharge Tunnels are still being used as an effluent pathway during decommissioning which may result in additional contamination, and that "the extent of this contamination will be determined at the appropriate time during decommissioning as a part of continuing characterization or during Remedial Action Support Surveys (RASS)." As such, the mixture of ROCs in these tunnels may change as a result of ongoing operations. The response to RAI 2 of Chapter 5 only indicates that additional assessments of the mixture will occur if a gamma measurement to support decommissioning activities, Radiological Assessments (RA) or Remedial Action Support Surveys (RASS) indicates a SOF in excess of 0.5. NRC staff also notes that the discharge tunnels are currently considered Class 3, but the classification and survey design may need to be re-considered in light of additional characterization.

Resolution:

a. The licensee should consider the potential need for updates to the FSS design for survey units where additional characterization is required.

b. Areas including sub-slab soils, in particular, may require additional considerations. Decisions on FSS design and grid spacing in those areas should consider characterization results and the size of potential areas of elevated contamination as discussed in NUREG-1757, Vol. 2, Rev. 1, Appendix G.2.1. Indications of soil contamination in these areas may also necessitate the consideration of additional radionuclides associated with structures (e.g., Eu-152, Eu-154, H-3). If contaminated sub-slab soils were to be left in place, the licensee must also consider the dose contribution from those soils in conjunction with the basement fill model.

c. The licensee should also consider areas where additional contamination may occur as a result of decommissioning operations. The Circulating Water Discharge Tunnels are one example.

ZSRP Response (HP 2a, 2b and 2c) – There are four distinct areas at Zion where additional characterization will occur. These areas are:

- The underlying concrete of the SFP/Transfer Canal below the 588 foot elevation after the steel liner has been removed.
- The subsurface soils in the "keyways" between the Containment Buildings and the Turbine Building once subsurface utilities have been removed and the exposure of subsurface structures in this area create access.
- The soils under the basement concrete of the Containment Buildings, the Auxiliary Building and the SFP/Transfer Canal once commodity removal and building demolition have progressed to a point where access can be achieved. This soil will be characterized by soil borings at the nearest locations along the foundation walls that can be feasibly accessed. If plant-derived activity is not positively detected (above background for Cs-137) in the cores located adjacent to the foundation, then no additional samples will be collected and the soil under the foundations will be assumed to not contain residual radioactivity. This approach is justified based on the characterization data which demonstrates that there is a very low expectation that significant subsurface contamination exists. If positive plant-derived activity is identified in the borehole samples, then additional investigation will be performed considering the concentrations and locations of the activity detected.
- When the interior surfaces become accessible, several potentially contaminated embedded pipe systems will be abandoned in place, specifically the floor drains in the 542 foot elevation basement floor of the Auxiliary Building and the Core Spray penetrations between the Containment basements and the Auxiliary Building basement.

Based on process knowledge, the HSA, characterization in adjacent soils and the monitoring of groundwater wells, the only one of the four areas specified above where any significant concentration of radioactivity is expected is the interior of the pipe.

ZSRP understands and acknowledges the challenges and process for determining compliance for residual contamination in subsurface soils. However, based on process knowledge, the HSA, characterization in adjacent soils and the monitoring of groundwater wells, the potential for subsurface soil contamination at Zion is very low. This includes the soils under the basement floor slabs of the remaining end-state structures.

The titles in Table 2-4 of Chapter 2 are meant to be descriptive of the locations of open land surface soil survey units. These descriptions are not intended to convey the belief that there is any subsurface soil contamination in any of these survey units. For example, the description of open land survey unit #12104, which is described as "Area Under the North Half of Unit 2 Containment" is meant to convey that the majority of the surface soil surface in this survey unit is obstructed by the footprint of the north half of the Unit 2 Containment Building. It is not implying that the subsurface soils in this survey unit are contaminated. ZSRP will revise the text in these descriptions to "around" or "adjacent to" as clarification.

As it is ZSRPs contention that the potential for subsurface soil contamination is very low and in accordance with the guidance of NUREG-1757, Appendix G, section G.2.1, subsurface soil surveys during FSS is not necessary. However, ZSRP is committing to perform minimal subsurface sampling during FSS as specified in LTP Chapter 5, section 5.7.1.5.2. This commitment is not in response to any historical finding or characterization result but rather, as a conservative measure to provide additional assurance that no residual radioactivity resides in subsurface soils.

During site characterization, a total of 871 composited subsurface soil samples were collected in impacted open land survey units to depths of approximately 3 meters below grade and analyzed for potential ROC. Subsurface soil samples were taken adjacent and around building structures, down-gradient from potential radioactivity sources and in one case, through the floor of the Turbine Building into the sub-slab soils. Of the 871 subsurface soil samples taken, only Cs-137 and Co-60 have been identified at concentrations greater than the analytic MDC of the instrument used and no residual radioactivity was identified at concentrations greater than the generic screening values from NUREG-1757, Appendix I. Most of the positive results were from surface and subsurface soil samples taken from Class 1 open land survey units. For surface soils, the average Co-60 concentration observed was 0.13 pCi/g with a maximum observed concentration of 1.04 pCi/g. Of the 111 surface soil samples taken in Class 1 open land survey units during characterization, only 14 samples indicated Co-60 concentrations greater than MDC. The average Cs-137 concentration observed in surface soil samples was 0.12 pCi/g with a maximum observed concentration of 3.39 pCi/g. In subsurface soil samples taken in Class 1 open land survey units, the average Cs-137 concentration observed was 0.18 pCi/g with a maximum observed concentration of 0.70 pCi/g. The Cs-137 concentrations in both surface and subsurface samples are predominantly within the range of natural background. The one subsurface soil sample where Co-60 was positively identified had a Co-60 concentration of 0.10 pCi/g.

For continuing characterization, ZSRP intends to take soil borings along the foundation walls to access the soils that bound the basement foundation subslab soils for the Containment Buildings and Auxiliary Buildings. Demolition of the Fuel Handling Building will expose the soils surrounding the SFP/Transfer Canal. These samples would have been taken during initial site characterization, but safety concerns for the presence of live underground utilities prevented their acquisition.

In January of 2016, the Circulating Water Discharge tunnels were isolated from Lake Michigan, dewatered and STS was performed in the accessible portions. Both Unit 1 and Unit 2 Circulating Water Discharge Tunnel were designated as STS unit #B3-09200B-S. The STS unit consisted of both Discharge Tunnels from the 12 foot diameter Condenser water box discharge pipes down into the tunnels to the isolation point at the valve house. The portion of the tunnel from the stop valve to the site boundary will remain flooded as isolation from the lake is not feasible. Access to the tunnels was through openings at the Valve House. The lower portions of the tunnels were deemed not accessible due to safety concerns. Also, after dewatering, approximately 6 to 12 inches of sludge remained on the bottom of the tunnels.

A total of 14 static measurements were taken at random selected locations on the combined internal surface area of both tunnels using a suspended ISOCS. The field-of-view for each shot was approximately 28 m^2, resulting in a total areal coverage of approximately 396 m^2 or 8%. In addition, 3 samples of composited sediment and sludge were acquired from each tunnel. The maximum measurement observed by the ISOCS resulted in a sum-of-fraction of 0.04. The mean inventory fraction for the STS unit was 0.01 resulting in a total mean dose of 0.13 mrem/yr. The 6 sediment samples were analyzed by the on-site gamma spectroscopy system. Cs-137 was positively detected ranging in concentration from 2.75E-02 pCi/g to 9.03E-02 pCi/g. Co-60 was positively detected ranging in concentration from 3.38E-02 pCi/g to 1.66E-01 pCi/g.
ZSRP will analyze selected sediment samples taken from the Circulating Water Discharge Tunnels for the initial suite radionuclides (with the exception of Np-237 as discussed in ZSRP response to PAB Chapter 6 RAI 7). As with the characterization of the SFP/Transfer Canal, ZSRP commits to calculate the insignificant contributor dose. If the insignificant contributor dose from the sample(s) is less than the insignificant contributor dose assigned to the Circulating Water Discharge Tunnel for planning purposes (see LTP Chapter 6, Section 6.6.8), then the current adjustment to the Basement Dose Factors to account for insignificant contributor dose will be retained. If the insignificant contributor dose from the Circulating Water Discharge Tunnels samples is greater than the insignificant contributor dose assigned for planning purposes, then the Basement Dose Factors for the Circulating Water Discharge Tunnels will be re-adjusted to account for the increased dose. It is possible, but not likely, that the data could indicate different ROC for the Circulating Water Discharge Tunnels. If so, a specific ROC list for Circulating Water Discharge Tunnels will be applied. The characterization data will also be reviewed to determine if the ratios of Sr-90/Cs-137 and Ni-63/Co-60 are significantly different from the ratios currently assigned that are based on the Auxiliary Building radionuclide mixture. If so, the ratios from the characterization data will be applied to the FRS surrogate calculations for the Circulating Water Discharge Tunnels.

Based on STS survey results, the inventory in the Circulating Water Discharge Tunnel is a minute fraction of the allowable inventory for the Turbine Building. The Circulating Water Discharge tunnels have since been isolated to prevent the introduction of any additional residual radioactivity into these tunnels during the remainder of the decommissioning.

d. The licensee should clarify the appropriate reference for FSS surveys of pipes, as Section 5.5.1.8 of the LTP does not exist in the current version.

ZSRP Response (HP 2d) – The reference to section 5.5.1.8 is a typo, the correct reference is section 5.7.1.8.

3. **NRC Comment**: Chapter 5, RAI 3 - The licensee proposes that no measurements for hard-to-detect (HTD) radionuclides will take place during the final radiation surveys (FRS). However, MARSSIM recommends taking some HTD measurements during the FRS to validate surrogate ratios.

Discussion: The licensee indicates in the RAI response that "for FSS and STS, ZSRP does not propose to analyze for HTD radionuclides." Per MARSSIM guidance, the licensee should perform HTD measurements during the final radiation surveys to validate the ratios developed during site characterization. Applicable guidance in MARSSIM Section 4.3.2 indicates that "...when the ratio is established prior to remediation, additional post-remediation samples should be collected to ensure that the data used to establish the ratio are still appropriate and representative of the existing site condition," and "if these additional post-remediation samples are not consistent with the pre-remediation data, surrogate ratios should be re-established." MARSSIM Section 4.3.2 also notes that "if the ratios are determined using final status survey data, MARSSIM recommends that at least 10% of the measurements (both direct measurements and samples) include analyses for all radionuclides of concern."

While the licensee has developed some surrogate ratios using current characterization data, there may be areas that require the development of new ratios using additional characterization or FSS results. For example, there are questions raised about whether or not H-3, Eu-152, and Eu-154 should be included as ROCs for the SFP/Transfer Canal or Circulating Water Discharge Tunnel (see the response to Chapter 6, RAI 7). The currently established ratios are based on data from the Auxiliary Building floor that do not include these ROCs. The licensee acknowledges in the response to RAI 3 of Chapter 5 that new mixtures may need to be evaluated - MARSSIM guidance should be utilized for that purpose.

The licensee has indicated in Section 6.5.2.3 of the LTP that the dose contribution of some HTD radionuclides may be minimal, but they remain as radionuclides of concern as their potential to be present is recognized. NRC staff notes that, in lieu of a surrogate approach for certain HTDs, the licensee may be able to perform additional characterization to justify consideration of those HTDs as insignificant.

NRC staff also notes that there is no basis for the statement in the response to RAI 3 of Chapter 5 that "ZSRP contends that there is no reasonable or plausible scenario at Zion where a HTD ROC would be present in any dose significant concentration without the presence of a plant-derived gamma emitting ROC." This contention is fundamentally flawed because soil sorption parameters vary among the ROCs. This variation leads to differences in the movement of radionuclides through the environment. As such, differences in soil sorption distribution coefficients would point to a reasonable and plausible scenario in which HTD and gamma emitting ROCs would not be co-located in soils.

Resolution:

a. As discussed in MARSSIM Section 4.3.2, the licensee should perform an appropriate number of HTD measurements during the final radiation surveys to validate surrogate ratios established from characterization results. Additionally, the licensee should evaluate the need to establish additional ratios for areas that may include ROCs not previously considered (e.g., the SFP/Transfer Canal, Circulating Water Discharge Tunnel). Selection of 10% of the final radiation survey measurements for analysis of all applicable HTDs may be appropriate in both cases, similar to the discussion in MARSSIM Section 4.3.2 on ratios established during FSS.

b. NRC staff notes that this comment applies only to HTDs which remain as ROCs during the FRS (i.e., they have not been de-listed as "insignificant"). Alternatively, the licensee could perform additional characterization to support the consideration of these HTDs as "insignificant" per the guidance in NUREG-1757, Vol. 2, Rev. 1, Section 3.3. NRC Staff notes that these characterization results, and the associated assessment, should be provided for NRC review and approval.

ZSRP Response (HP 3a and 3b) – Comment HP Chapter 5, RAI 3 refers to HTD radionuclides in the context of the level of effort during FRS that may be reasonable to confirm the surrogate ratios for HTD radionuclides that were not removed as insignificant dose contributors and therefore remain as ROCs in LTP Chapter 5 Revision 0. The NRC comment quoted Section 6.5.2.3 of the Zion LTP, Revision 0 which states "Sr-90 and Ni-63 are HTD radionuclides that are low dose contributors but do have some, albeit low, potential for actually being present at levels above the MDC at the time of license termination and are therefore also retained as ROC." It would have been entirely acceptable, and consistent with the process for determining the insignificant dose contributors, to remove Sr-90, Ni-63 and H-3 from the ROC list and add the dose contribution from these radionuclides to the insignificant contributor dose percentage.

NRC comment HP Chapter 5, RAI 3 states that any HTD radionuclide that is included in the ROC list, and will therefore be evaluated by surrogate relationship during FRS, should be specifically analyzed for, to some extent, during FRS. The NRC further notes "that this comment applies only to HTDs which remain as ROCs during the FRS (i.e., they have not been de-listed as "insignificant")." Zion contends that, consistent with a risk-informed approach, the low potential dose from the three HTD radionuclides included as ROCs (Sr-90, Ni-63, and H-3 with a combined dose of 0.27 mrem/yr for Auxiliary basement and 0.05 mrem/yr for soil (see TSD 14-019 Revision 1 Tables 19 and 25) does not warrant additional evaluation during FRS and in fact, these three radionuclides clearly meet the definition of "insignificant" regardless of their being included in the list of radionuclides (i.e., ROC) that were subjected to more detailed evaluation. The Zion decision to include these radionuclides as ROC was discretionary and intended to enhance clarity by listing radionuclides that are either known to be present in the mixture (i.e., Ni-63) or were commonly included for detailed evaluation based on past experience (i.e., Sr-90 and H-3 for activated concrete). Given the fact that Sr-90, Ni-63, and H-3 are in fact "insignificant" dose contributors as defined by NUREG-1757, no additional evaluation of these radionuclides are considered necessary during FRS.

4. **NRC Comment**: Chapter 5, RAI 6 - There appear to be differences between commitments for additional concrete core sampling in the LTP and RAI responses compared to recommendations in TSD 14-022.

Discussion: The response to RAI 6 of Chapter 5 indicates that "with the exception of the characterization of the SFP/Transfer Canal end-state concrete, the decision to obtain any additional concrete core samples from other end-state concrete structures would be made only if a condition were encountered during development of the STS survey design where the condition of the concrete surfaces following any remediation or demolition activity appeared to be significantly inconsistent with the depth profile and geometries assumed in TSD 14-022." TSD 14-022 was reviewed, and it was indicated in the conclusions to TSD 14-022 that:

"Additional concrete core samples should be collected from the following areas to either validate the limited core data currently available or to provide new data in areas that are considered to have unique operational history or contamination profile relative to other building areas. The ISOCS Geometry Template to apply in these areas will be developed using the methods described in this TSD based on a combination of existing and new core data. The areas are listed below:

- HUT walls and floor. If there is evidence of elevated readings on walls outside the HUT cubicles, additional core samples should be considered in the elevated areas.
- Auxiliary Building Pipe Tunnels
- Fuel Pool and Fuel Transfer Tunnel after Fuel Pool liner removed
- North Unit 2 Discharge Tunnel"

Clarification is needed on why there is an apparent discrepancy between the RAI response and TSD 14-022 with regard to additional core sampling.

Resolution:

c. The licensee should clarify the discrepancy between statements in the RAI response and recommendations in TSD 14-022 with regard to additional concrete core sampling.

ZSRP Response (HP 4a) – The examples specified in TSD 14-022 pertain to areas in various STS survey units where additional concrete cores may be necessary to verify the geometry assumed for ISOCS efficiency calibration. These concrete cores, if taken, will not be used to determine the nature and extent of contamination in the structural surfaces. Rather than characterization, ZSRP considers these samples, if taken, as integral to survey design for STS.

The necessity to validate geometry for ISOCS efficiency calibration will be addressed in the survey package for each STS survey unit. Step 4.2.7 of Zion*Solutions* procedure ZS-LT-300-001-001, "FRS Package Development" states;

"The Canberra *In-Situ* Object Counting System (ISOCS) has been selected as the primary instrument that will be used to perform STS. Zion*Solutions* Technical Support Document (TSD) 14-022, "*Use of In-Situ Gamma Spectroscopy for Source Term Survey of End State Structures*" (Reference 6.5) provides the initial justification for selecting a reasonably conservative geometry for efficiency calibrations for the ISOCS based on the physical conditions of the remediated surface and the depth and distribution of activity in the concrete surface. Review post remediation conditions and surveys to determine if the geometry of remaining residual radioactivity has significantly changed from that assumed in TSD 14-022. If the geometry appears to be significantly different from that which was assumed in TSD 14-022, then inform the C/LT Manager."

The three areas in addition to the SFP/Transfer Canal (where additional concrete core samples will be collected after the liner is removed) are areas where the geometry may require validation during survey design. As an alternative to taking additional samples if the geometry is in question, a more conservative bounding geometry may be used for the efficiency calibration. The application of a more conservative, bounding geometry for the efficiency factor will be considered during FRS package development based on conditions encountered when access is made available.

Of the three remaining areas listed in TSD 14-022, the Circulating Water Discharge Tunnels can be eliminated as a potential area for the acquisition of a concrete core sample. STS has already been performed in the tunnels using the ISOCS (see the ZSRP response to HP Chapter 5 RAI 2) and the minimal levels of activity detected support the use of the generic geometry of 0.5 inch contamination depth for the efficiency calibration

5. **NRC Comment**: Chapter 5, RAI 7 and Chapter 6, RAI 15 - The licensee states in the LTP that the concept of a graded survey approach based upon the contamination potential, as well as the conceptual processes for survey design and data assessment from MARSSIM have been retained. However, there are questions regarding deviations from MARSSIM survey design, particularly in Class 2 units.

Discussion: It is noted that STS survey strategies are not directly analogous to typical MARSSIM strategies. However, the NRC staff has concerns that the treatment of Class 2 survey units is substantially different than MARSSIM and that sufficient justification for the deviation has not been provided in the RAI responses. In particular, it appears that Class 2 surveys will be completely random rather than random-start systematic, and the increased survey unit sizes do not appear to consider the increased area between measurements.

The response to RAI 15 of Chapter 6 provided an example calculation for the Auxiliary Building walls, which is defined as a Class 2 area. It was noted that 14 random STS measurements were used in the example. It is not clear why random measurements would be taken in a Class 2 area as opposed to random-start systematic measurements. Per MARSSIM Section 2.5.5, "systematic grids are used for "Class 2 survey units because there is an increased probability of small areas of elevated activity," and "the use of a systematic grid allows the decision maker to draw conclusions about the size of any potential areas of elevated activity based on the area between measurement locations, while the random starting point of the grid provides an unbiased method for determining measurement locations for the statistical tests."

The response to RAI 7 of Chapter 5 discusses the rationale for designing survey units that are larger than those recommended in MARSSIM. The rationale for Class 2 units described the fact that the actual coverage area per measurement is increased, even in the proposed larger sized units (i.e., by comparing the ISOCS FOV to a typical survey probe FOV). However, NRC staff opinion is that a more important consideration is the area that receives no quantitative measurement, or in other words, the area remaining between samples. This unmeasured area is larger in the proposed Class 2 surveys than would be for the recommended survey unit size for structures (1000 m^2). NRC staff recognizes that the basement fill model is unique and not analogous to a building occupancy model. However, justification for the increased survey unit sizes should account for the unmeasured space and the potential for elevated areas that could remain undetected.

In the interest of addressing the space between measurements, NRC staff considered the analysis provided in Section 5.5.2.1 of the LTP, which notes that after remediation to the 2 mR/hr open air demolition criteria, an area of the 542 foot elevation of the Auxiliary Building could hypothetically have an average Cs-137 concentration of 4,255 pCi/g over a three inch depth of concrete. It was indicated that the contaminated area would need to be approximately 350 m^2 in size before it would exceed the BIL for Cs-137. The underlying details and assumptions of this calculation are not provided, and it also does not consider ROCs other than Cs-137. Therefore, NRC staff cannot rely on it for the sake of the current question. A similar calculation could be provided (while also considering all ROCs) for NRC staff review.

Resolution:

a. Systematic samples are appropriate in Class 2 survey units to clearly define the coverage and spacing between samples. Otherwise, this strategy is effectively the same as a typical MARSSIM Class 3 survey.

ZSRP Response (HP 5a) – ZSRP intends to use the systematic random start approach for determining STS measurement locations in a Class 2 STS unit in the same manner as MARSSIM. As an illustration, step 5.4.8 (5) C of Zion*Solutions* procedure ZS-LT-300-001-001, "FRS Package Development" states "If the survey unit is STS and classified as Class 2 or, if the survey unit is FSS and classified as Class 1 or Class 2, then calculate the Grid Spacing (L) as follows;

$$L = \sqrt{\frac{\text{Area}}{.866\left(N\,or\,N/2\right)}} \text{ for a triangular grid, or } L = \sqrt{\frac{\text{Area}}{\left(N\,or\,N/2\right)}} \text{ for a square grid}$$

The example provided in the previous response to RAI 15 of Chapter 6 was meant to illustrate how the inventory of two STS units that reside in a single STS basement were added to demonstrate compliance. The use of the term "random" to describe the example sample population for the Class 2 STS unit was incomplete. It was not meant to imply that the STS measurement locations in a Class 2 STS unit at Zion will be determined at random but that a systematic random start approach will be used.

b. The licensee should evaluate survey unit sizes by considering the area between measurement locations and the size of any potential areas of elevated activity that might go unmeasured. The details and underlying assumptions of such an analysis should be provided, and the analysis should consider all applicable ROCs.

ZSRP Response (HP 5b) – During the characterization of the Auxiliary Building basement, extensive scan surveys were performed on the walls of the 542 foot elevation in an effort to determine the locations representing the worst case radiological condition for concrete in each survey unit. These scans were performed of accessible walls surfaces to the extent practicable while standing on the 542 foot elevation, to a nominal elevation of approximately six feet up the wall from the floor. The scan surveys indicated that, for a majority of the lower wall surfaces on the Auxiliary Building 542 foot elevation, the residual radioactivity on the wall was indistinguishable from ambient background. This was particularly true for all the outer wall surfaces in the east portion of the Auxiliary Building 542 foot elevation, including the Waste Gas Decay Tank area, the Lake Discharge Tank area, the Blowdown Monitor Tank area and the areas adjacent to the Cavity Fill Pump cubicles. Residual contamination at concentrations greater than the ambient background was only detected on the outer walls of the Unit 1 and Unit 2 Pipe Chases, the Unit 1 and Unit 2 ABEDCT cubicles and the outer walls of the HUT cubicles. However, with the exception of the HUT cubicles, the contamination identified on the walls in the Pipe Chases and ABEDCT cubicles was not uniform. The contamination on the walls in these cubicles was primarily from valve leakage and gland seal spray from primary system pumps.

The highest observed scan locations on the walls of the Auxiliary Building basement are represented by two concrete core samples. The highest observed scan measurement was located in the Unit 1 ABEDCT room (B105113-CJWCCV-003 with a Co-60 surface concentration of 6.71E+02 pCi/g and a Cs-137 surface concentration of 1.66E+04 pCi/g). This activity was identified in an isolated location; the next highest location on the walls identified by scan was 10,000 times lower. This location was from the East Common Area Wall (B101111-CJWCCV-002 with a Co-60 surface concentration of 1.94E-01 pCi/g and a Cs-137 surface concentration of 9.52E-01 pCi/g). The sample from the Unit 1 ABEDCT room wall represents the worst case bounding activity for the lower walls of the Auxiliary Building basement based on the scans.

Scans were also performed on the lower outer walls of the HUT cubicles, however no concrete core locations were chosen on the walls as the floor concrete exhibited significantly more inventory. With the exception of the HUT cubicles, scans performed on upper wall surfaces (i.e. between 3 and 6 feet above the floor) also showed also activity indistinguishable from ambient background. At the time characterization was performed, it was determined that scanning the walls higher than the lower six feet of wall on the 542 foot elevation was not necessary based on the scan results and process knowledge. It was determined that the radiological conditions for the lower walls was bounding.

Using the two bounding core samples from the Auxiliary Building lower walls and the floor core sample from the HUT floor, a conservative bounding estimate of 150 mCi of Cs-137 was derived for the walls of the Auxiliary Building basement, which is less than 18% of the total allowable Cs-137 inventory for the Auxiliary Building. This bounding estimate assumed that the lower three feet surface of the Auxiliary Building basement walls was homogeneously contaminated to a depth of ½ inch at the contamination levels represented by the worst case core sample taken from the wall (B105113-CJWCCV-003). For the area of the HUT walls, the bounding estimate assumed that the entire wall surface of the HUT from the 542 foot elevation to the 588 foot elevation was homogeneously contaminated to a depth of ½ inch at the contamination levels represented by the floor core taken in the HUT (B105107-CJFCCV-001). The bounding source term estimate calculated for the walls, including the walls of the HUT cubicles, is very conservative as scans showed that the actual inventory in the walls is significantly less. For almost all of the Auxiliary Building basement wall surface, scans show that the activity on the wall is indistinguishable from background. Only a very small percentage of the Auxiliary Building basement wall surface was shown to be actually contaminated. This bounding calculation is represented by Table 18 of TSD 14-013, "Zion Auxiliary Building End State Estimated Concrete Volumes, Surface Areas, and Source Terms."

For the Containment Building basements, no scans were performed of the basement walls. The basement walls of the Containment basements were not considered as viable locations for the acquisition of concrete core samples during characterization due to the fact that in both Containment basements, all concrete will be removed to expose the steel liner. As a consequence, the entire source term associated with the interior Containment concrete will be removed as well.

Based on the decommissioning approach for the Containments and the characterization scans/concrete core samples taken from the Auxiliary Building basement walls, the STS survey units for the walls of the Auxiliary Building and the two Containment basements are classified analogous to Class 2 as defined in MARSSIM, section 2.2. Consistent with the Class 2 definition in MARSSIM, a Class 2 STS unit is an area that has a potential for radioactive contamination, but the total inventory in the STS unit is not expected to exceed the BIL and, that there is a high degree of confidence that no individual measurement will exceed the BIL.

To date, no measurement has been taken on any exposed surface classified as STS Class 2 which would prompt a reclassification to STS Class 1. As with FSS, the relevance of a Class 2 classification is assessed from initial classification through compliance demonstration. In accordance with the "Remediation, Reclassification and Resurvey Actions" specified in the Attachment 9 table of Zion*Solutions* procedure ZS-LT-300-001-004, "FRS Data Assessment," if one or several survey measurements in a Class 2 STS unit exceed 50% of the dose criterion, the STS unit or a portion of the STS unit will be investigated, reclassified as STS Class 1 and resurveyed in accordance with the new classification. This is analogous to the same reclassification process recommended in MARSSIM. As with the FSS of a Class 2 survey unit as described in MARSSIM, there is no expectation that residual radioactivity exists in a Class 2 survey unit which would exceed the BIL (or result in a measurement with a SOF equal to or greater than one).

The RAI states that "...the area between measurement locations and the size of any potential areas of elevated activity that might go unmeasured" be considered. However, an evaluation of potential elevated area size is not recommended in MARSSIM as a part of survey design in a Class 2 area, regardless of the survey unit size. MARSSIM defines Class 2 as areas that "have, or had prior to remediation, a potential for radioactive contamination or known contamination, but are not expected to exceed the "Limit" (BIL). The existing data (from the HSA, scoping surveys, or characterization surveys) should provide a high degree of confidence that no individual measurement would exceed the "Limit" (BIL)." Based upon the radiological surveys performed to date and the expected decommissioning process for the Class 2 STS units (e.g. the removal of interior Containment concrete to expose the steel liner), ZSRP believes that there is high confidence that no individual STS measurement will exceed the BIL in a Class 2 area. However, if RASS, turnover surveys or any operational survey present any radiological data that would question the basis for the classification, ZSRP commits to the same reclassification process that would be applicable to a Class 2 FSS survey unit.

6. **NRC Comment**: Chapter 5, RAI 10 and Chapter 6, RAI 15 - There are discrepancies in the Type I error listed in the LTP and the RAI responses.

Discussion: Updated text for Section 5.5.4 of the LTP was provided in RAI responses for both Chapters 5 and 6. However, the Type I error differs between the two responses (i.e., 5% vs. 95%). Additionally, a Type I error of 0.5 is specified in the "Attachment 14" worksheet provided in the Chapter 6 RAI 15 example. Based on language elsewhere in the LTP, NRC staff assumes that the licensee intends to use a Type I error of 0.05 (or 5%), but this point should be clarified for the sake of text that will be updated in the LTP.

Resolution:

a. The licensee should clarify the Type I value to be used in updated text to Section 5.5.4 of the LTP and ensure a consistent value is used throughout.

ZSRP Response (HP 6a) – The Type I error listed in the example Sign Test in the response to Chapter 6 RAI 15 is a typo. ZSRP commits to using 0.05 or 5% Type I error for FRS survey design. It should be noted that the Sign Test used in the example for the response to Chapter 6 RAI 15 used correct Type I error value.

As clarification, the revised text for the proposed revision will be changed as follows:
"If the Sign Test demonstrates that the mean activity of the survey unit is less than the BIL at a Type 1 error of 0.05 (or 5%), then the mean of all the total SOFs for each measurement in a given survey unit (or Mean Inventory Fraction) is calculated.

7. **NRC Comment**: Chapter 5, RAI 11 - The RAI response describes piping survey considerations, but NRC staff notes that there does not appear to be a current classification system for piping. There is an indication that a new TSD and methodology may be developed. A commitment for NRC review of that document is not provided. The RAI response addresses piping surveys via conventional detectors (e.g., CsI or NaI), but does not describe the basis for ISOCS surveys of pipes.

Discussion: The response to RAI 11 of Chapter 5 acknowledges that piping will be considered per the contamination potential, but it is not clear that the survey classification of piping has been established. A listing of piping/conduit was provided in Table 2-27 of the LTP, but it does not classify the contamination potential. NRC staff notes that the entries in Table 2-27 are associated with land survey units, and there appear to be instances where potentially contaminated piping traverses survey units of differing classification. As such, the licensee should classify piping based on contamination potential, and should additionally consider the effect that contaminated piping may have on the associated survey unit.

The NRC staff notes that Section 5.5.5 of the LTP indicates that "the ISOCS may also be used to assess hard-to-access embedded pipe and sleeves." The technical basis for using ISOCS was not provided in response to this RAI, and does not appear to have been provided elsewhere. As such, the licensee should provide the basis for NRC review/approval in the event that an ISOCS strategy is utilized.

The response to RAI 11 of Chapter 5 discusses emergent concerns with surveys/remediation of embedded piping and notes that "ZSRP is in the process of assessing a practicable method for determining the total activity inventory that is defensible and bounding," and that "if the approach proposed for demonstrating compliance in this system is different from the more traditional approach previously described, then ZSRP will document the process that will be used in a TSD." There is no discussion regarding NRC review/approval of this document.

Resolution:

a. The licensee should specify the classification of piping based upon the contamination potential of the contents. The licensee should consider the effect that contaminated piping may have on the associated survey unit.

ZSRP Response (HP 7a) – Based on operational and process knowledge, all the buried pipe listed in LTP Chapter 2, Table 2-27 is classified as Class 3 with the exception of the 4 pipes designated as "Fuel Pool Drains" to Unit 1 and Unit 2, which are classified as "Class 1." These 4 pipes range from 2 inch diameter to 4 inch diameter and are all 4 feet in length. It should also be noted that soil classification for the adjacent soils for the Class 1 pipes are also "Class 1."

For buried pipe sections less than 20 feet in length, classification of the pipe is not relevant as this pipe will be surveyed at the same measurement frequency regardless of classification. A static measurement will be acquired for every foot of pipe that is accessible. Accessibility is defined as the ability to transport a detector through a pipe using a fiber rod (as a means of movement) from the opening on either end of a length of pipe without having to create new access points. Assuming an "area of detection" for the NaI detector of one foot, this will conservatively provide 100% areal coverall of the pipe interior surfaces. Of the 101 sections of pipe listed in Table 2-27, 66 pipes will be completely surveyed in this manner, including the "Fuel Pool Drains" to Unit 1 and Unit 2.

Based on the process knowledge, it is expected that the concentrations of residual radioactivity in the 35 Class 3 pipe sections listed on Table 2-27 with lengths greater than 20 feet will be insignificant. A frequency greater than "one measurement for every foot of pipe" may be used as long as the number of measurements is sufficient to pass the Sign Test. This will demonstrated in the survey design for the pipe.

Pertaining to the concern raised in the comment that there will be instances where potentially contaminated piping traverses open land survey units of differing classification, this concern is alleviated by compliance dose calculation presented in LTP Chapter 5, section 5.2.7. As illustrated by Equation 5-3, the end state compliance dose for the site is the summation of the maximum mean dose from residual radioactivity in soil, existing groundwater (if present), buried pipes and basements (including embedded piping and penetrations), regardless of survey unit location. The compliance dose summation must be less than 25 mrem/yr.

b. In the event that the survey approach changes for certain areas of piping and a new TSD is issued, that TSD and approach should be provided for NRC review and approval. Additionally, as no basis for the usage of ISOCS for pipes has been provided, the licensee should provide a technical basis document for review and approval if ISOCS will be used.

ZSRP Response (HP 7b) – The previous response to RAI 11 of Chapter 5 states that ZSRP is currently evaluating the accessibility of the embedded floor drain systems specifically in the concrete floor of the Auxiliary Building 542 foot elevation. The response also states that "ZSRP is in the process of assessing a practicable method for determining the total activity inventory that is defensible and bounding. If the approach proposed for demonstrating compliance in this system is different from the more traditional approach previously described, then ZSRP will document the process in a TSD." If a TSD is developed that will propose a unique approach for the survey of the Auxiliary Building drains (different than the process already described in the LTP), then ZSRP will submit the TSD to NRC for review and approval.

The ISOCS has already been used to perform STS surveys in large bore pipe (Circulating Water Inlet Pipe, Circulating Water De-Icing Pipe and Circulating Water Discharge Tunnels). For smaller bore pipe, the inclusion of the ISOCS as a potential instrument for the STS of embedded pipe is specific only to the opening of a shallow penetration on a STS unit wall surface. The ZSRP position was that this is a simple geometry for the ISOCS which can be derived in the geometry composer program for the instrument and that a specific TSD was not necessary for this use. It was intended that the change of geometry would be addressed in the survey design and documented in the survey package for the STS unit in which the penetration resides. ZSRP does not intend to use the ISOCS in the same manner as described for performing a pipe survey of small bore (defined as a pipe less than 12 inches in diameter) buried or embedded pipe using a NaI or CsI detector (i.e. advancing the detector using a fiber-rod for movement and acquiring measurements).

8. NRC Comment: Chapter 5, RAI 22 - It does not appear that Section 5.10.2.1 of the LTP was updated to clarify differences between scanning and static measurement MDCs.

Discussion: The RAI response notes that "Section 5.10.2.1 pertains to the *a priori* scan MDC requirement for detection at the investigation level commensurate with the classification of the area surveyed in accordance with MARSSIM section 5.5.2.6 and, to ensure during data assessment that the scan MDC was sufficient for the applicable investigation level." However, the correlation to scan MDC remains unclear because Section 5.10.2.1 refers to the "instrumentation MDC for fixed or volumetric measurements." Fixed or volumetric measurements would not be the same as scanning. While it appears the licensee understands the expectations for scanning instruments vs. static measurement instruments, the text regarding "fixed or volumetric measurements" has not been updated. The licensee updated text in Section 5.8.1 of the LTP, but Section 5.10.2.1 should be updated per the above discussion.

Resolution:

a. The licensee updated text in Section 5.8.1 of the LTP. However, text in Section 5.10.2.1 still requires updating. The licensee should update text in Section 5.10.2.1 to clarify scan MDC instrumentation (if that was the original intent) or update the MDC requirement if the intent is to describe fixed or volumetric measurements.

ZSRP Response (HP 8a) – The following statement will be added to LTP Chapter 5, section 5.8.1:

"The target MDC for field instruments is the maximum acceptable value. The actual MDCs expected to be used during FSS will be much lower."

ZSRP will add the same sentence to the end of the first bullet of section 5.10.2.1.

9. **NRC Comment**: TSD 14-022-1 and Chapter 5, RAI 8 - NRC staff believes the integration of preliminary scans, judgmental sampling, and investigation levels needs to be better defined for the STS. Staff is also of the opinion that the potential for elevated areas needs to be more fully considered for STS surveys as elevated areas could affect the total inventory. Additionally, it appears that some commitments on STS investigation levels have not been incorporated into the LTP.

Discussion: The RAI response to TSD 14-022-1 acknowledges the proposed coverage for Class 1 areas is actually less than 100% because of no overlap in the FOV for each measurement. NRC staff notes that if this survey were intended to replicate scanning to find elevated areas, as is the case for a typical MARSSIM Class 1 survey, the proposed coverage would be inconsistent with MARSSIM. The licensee has indicated that the applicable basement fill model is a total activity mixing model that is not as influenced by hot spots. However, elevated areas could affect the total inventory, which is compared to the BIL. As such, a more clear integration of all survey methods (e.g., open air demolition scans, judgmental measurements, and investigations) is needed to evaluate the adequacy of the licensee's approach.

There are several survey steps which the NRC staff views as necessary and complimentary to the STS program. For example, the LTP indicates that "extensive surface scan surveys, in some cases 100% of the surface area, will be performed to identify areas exceeding the open air demolition criteria prior to remediation," and that "the scanning performed during the RASS or radiological survey during remediation is integral to the STS survey planning process and will provide a high degree of confidence that areas with contamination exceeding the open air demolition criteria will be identified and remediated." Staff recognizes that these scans will help delineate some areas of elevated contamination, but the scans are not otherwise tied to investigation levels or judgmental sampling for the final radiation surveys.

Judgmental surveys should also be integrated into the overall survey approach, as discussed in RAI 8 for Chapter 5. The response to that RAI indicates that new text in the LTP will state that "in addition to the prescribed areal coverage, additional judgmental measurements may be collected at locations with higher potential for containing elevated concentrations of residual radioactivity based on professional judgment." The NRC staff notes that in addition to sampling based on professional judgment, preliminary open air demolition scans may be useful in determining areas for judgmental measurements.

NRC staff also notes that neither the statement regarding scan coverage for open air demolition surveys nor the description of judgmental scans provides definitive details on when or to what extent these events will occur.

In addition to the preliminary scans and judgmental surveys, NRC staff views investigations of potentially elevated areas as a necessary step in the overall survey strategy. As a response to the TSD 14-022-1 RAI, the licensee indicates that an investigation level has been developed for STS surveys in Class 1 areas in order to ensure the gaps between each FOV are addressed. NRC staff notes that this investigation level and additional STS investigation levels presented in ZS-LT-300-001-004 (as provided with the RAI responses) do not appear to be integrated into the LTP.

Resolution:

a. The licensee should provide details on how all applicable survey methods will be integrated into the STS strategy. This should include preliminary scans (e.g. RASS, open air demolition), judgmental measurements, and investigation measurements.

b. The licensee appears to rely on the open air demolition surveys throughout the LTP to address potential areas of elevated contamination. As such, the anticipated frequency and coverage of these surveys should be defined. With regard to judgmental surveys, the licensee should describe the conditions that would lead to such measurements. As noted in the discussion, the open air demolition surveys may be useful in determining areas for judgmental measurements. It is not sufficient to simply say these surveys "may" occur as this provides no commitment on the part of the licensee.

ZSRP Response (HP 9a and 9b) – Contamination Verification Surveys (CVS) are performed at Zion on structures prior to undergoing building demolition to ensure that airborne radioactivity levels remain within regulatory limits and off-site dose consequences remain ALARA. CVS is performed in accordance with Zion*Solutions* procedure ZS-LT-400-001-002, "Contamination Verification Surveys prior to Demolition," which is attached for NRC review. If measurements taken during the performance of these surveys, as well as any RASS, turnover surveys or any operational survey present any radiological data that would question the basis for the current classification of the survey unit, ZSRP commits to the same reclassification process that would be applicable to a Class 2 or Class 3 FSS (MARSSIM) survey unit.

The survey unit classification process is performed in accordance with Zion*Solutions* procedure ZS-LT-300-001-002, "Survey Unit Classification," which is attached for NRC review. The results of CVS, RASS, turnover surveys and applicable operational surveys are integrated into the survey design process in accordance with Zion*Solutions* procedure ZS-LT-300-001-001, "Final Radiation Survey Package Development," which is attached for NRC review. Step 5.4.8, (8) of this procedure states that biased samples will be taken at the discretion of the survey designer and that the basis for taking biased samples will be documented in the survey package. There is no regulatory requirement or guidance that would require a licensee to commit to a frequency for when and where to acquire judgmental measurements during FRS. Per the procedure, the determination for selecting when and where to acquire biased or "judgmental" samples is integrated into the survey design process and at the discretion of the survey design engineer, which is consistent with MARSSIM. However, ZSRP will commit to take judgmental samples on the lower walls of the Auxiliary Building basement during STS at the locations previously identified by the characterization (Unit 1 and Unit 2 Pipe Chases, the Unit 1 and Unit 2 ABEDCT cubicles and the outer walls of the HUT cubicles) to ensure that the residual radioactivity at these locations are accounted for in the calculation of the Mean Inventory Fraction.

c. Alternatively, the licensee may commit to using typical MARSSIM FSS protocols which includes direct measurements and scanning commensurate with the survey unit classification.

ZSRP Response (HP 9c) – The process described in LTP Chapter 5, section 5.5 for performing STS incorporates all of the "typical MARSSIM FSS protocols" commensurate with the survey unit classification. The recommended areal scan coverage is provided by the FOV of the ISOCS measurement verses scanning a percentage of the surface area with a hand-held detector. As an illustration, the Auxiliary Building walls have been designated as a Class 2 structural survey unit. The area of the wall survey unit is 3,912 m^2. The basis for the Class 2 designation was derived from process knowledge, knowledge of historical incidents, surface scanning of the lower 6 feet of the walls during characterization and the acquisition of two concrete core samples of the walls at the locations of the highest observed scan readings. Per section 2.2 of MARSSIM, the definition of a Class 2 area is "Areas that have, or had prior to remediation, a potential for radioactive contamination or known contamination, but are not expected to exceed the $DCGL_W$. To justify changing the classification from Class 1 to Class 2, there should be measurement data that provides a high degree of confidence that no individual measurement would exceed the $DCGL_W$." Using this process, ZSRP has determined that the Auxiliary Building walls is an area that has known contamination, but is not expected to exceed the inventory limit per area (i.e. the inventory limit divided by the surface area of the STS unit in units of pCi/m^2). Based on the scans and the analyses of the concrete core samples taken from the walls at bounding locations during characterization, there is high degree of confidence that no individual measurement would exceed the inventory limit (pCi/m^2).

MARSSIM recommends a scan coverage of 10% to 100% for a Class 2 structural survey unit with a caveat for 10% to 50% for upper walls and ceilings. ZSRP has determined that 14 ISOCS measurements will be taken of the Auxiliary Building walls. The ISOCS measurement will have a FOV of approximately 28 m^2, which will result in an areal coverage of 392 m^2, equating to a scan coverage of 10%, which is within the MARSSIM guidance. ZSRP has already committed to take judgmental samples on the lower walls of the Auxiliary Building basement during STS at the locations previously identified by the characterization (Unit 1 and Unit 2 Pipe Chases, the Unit 1 and Unit 2 ABEDCT cubicles and the outer walls of the HUT cubicles) to ensure that the residual radioactivity at these locations are accounted for in the calculation of the Mean Inventory Fraction. Acquisition of these samples will provide additional areal scan coverage above the 10% coverage from the systematic measurements. In addition, if during survey design (in accordance with procedure ZS-LT-300-001-001, "Final Radiation Survey Package Development"), the survey designer is prompted by the results of previous surveys taken on the Auxiliary Building wall surfaces (CVS, RASS, turnover or operational, which are documented in the survey package) to take additional judgmental ISOCS measurements at biased locations, the areal scan coverage of the Auxiliary Building walls will be increased further. This process is consistent with MARSSIM.

d. With regard to the STS investigation levels noted in the response to RAI TSD 14-022-1 and within Attachment 7 of ZS-LT-300-001-004, the licensee should incorporate these levels into the LTP. Additionally, as the STS measurements represent an average over the instrument FOV, NRC staff notes that it may be useful to consider the inclusion of additional scans to supplement the STS when there is an indication of elevated contamination. Traditional scanning methods would allow for better definition of elevated areas prior to quantitative measurements being taken.

ZSRP Response (HP 9d) – The STS investigation level noted in the response to RAI TSD 14-022-1 pertains specifically and only to Class 1 STS survey units (which require 100% areal coverage). This commitment to use triangular grid spacing, to establish an investigation level of 0.75 SOF for individual measurements in Class 1 STS units and, to take additional measurements in the five gap areas surrounding the measurement FOV that exceeds 0.75 SOF will be added to LTP Chapter 5, section 5.5.3.

As described in TSD-022, activity in elevated areas is fully and conservatively accounted for using STS ISOCS measurements. Additional scans surveys are therefore not considered necessary.

10. NRC Comment: Multiple RAIs referencing TSD 14-013 - NRC staff reviewed TSD 14-013 (provided in response to PAB Chapter 6, RAI 8 and RAI 17) which discusses concrete characterization in the Auxiliary Building. Based on the descriptions of wall characterization it is not clear that the proposed classification of wall survey units (i.e., Class 2 instead of Class 1) is appropriate.

Discussion: The licensee states in Section 3.2 of TSD 14-013 that:

"As noted in Section 3.2, all of the HUT walls were assumed to be contaminated at the same levels as the HUT floor cores, but only the bottom 3 feet of the remaining walls was assumed to be contaminated to the levels indicated by the one wall core from the Unit 1 AEDCT Room B105113-CJWCCV-003. There is a potential for the walls above 3 feet to be contaminated in spots where there were localized leaks and by surface contamination. The potential contribution of localized leaks will be limited by the 2 mrem/hr contact dose rate cut-off for open air demolition."

Section 4.4 of MARSSIM discusses the classification of areas by contamination potential and provides one example of Class 1 areas as "locations where leaks or spills are known to have occurred." The MARSSIM discussion on Class 2 survey units further notes that "to justify changing an area's classification from Class 1 to Class 2, the existing data (from the HSA, scoping surveys, or characterization surveys) should provide a high degree of confidence that no individual measurement would exceed the $DCGL_{w}$," and that "other justifications for this change in an area's classification may be appropriate based on the outcome of the DQO process." TSD 14-013 indicates that samples from only the lower 3 feet of the Auxiliary Building walls were taken, and one sample was used for the balance of the wall area. There is otherwise no discussion on characterization data for the upper portions of the walls, though the licensee acknowledges a history of leaks and surface contamination. As such, the classification of these areas as Class 2 is not well defined.

Resolution:

a. The licensee should provide additional characterization data to justify that the contamination potential of upper walls (in particular, where leaks and surface contamination have occurred) is consistent with a Class 2 designation. Alternatively, the licensee could re-classify these areas to Class 1.

ZSRP Response (HP 10a) – As per the Class 2 definition in MARSSIM, a Class 2 STS unit is an area that has a potential for radioactive contamination, but the total inventory in the STS unit is not expected to exceed the BIL and, that there is a high degree of confidence that no individual measurement will exceed the BIL.

The section of TSD 14-013 in which the reviewer is referring states the following;

"Three cores from Auxiliary Building walls were also obtained. The results are included in the Attachment 2 summaries. As noted above in **Error! Reference source not found.**, the source term was assumed to be limited to within three feet of the floor for all the walls except those in the HUT cubicles walls which were assumed to be contaminated at the same concentration as the floor core B105107-CJFCCV-001. As seen in **Error! Reference source not found.** the total contaminated wall surface area is 8.43E+06 cm^2. At depths of ½ inch this is 1.07E+07 cc and at a density of 2.40 g/cc this is 2.57E+07 grams. This mass multiplied by the average picocuries per gram (pCi/g) at each depth is used to estimate the source term in the walls. Since this includes the HUT floor sample which goes to 14 inches deep, the source term in the walls is a very conservative estimate that is probably greater than the actual activity embedded in the walls."

This paragraph is pertaining to the assumptions used to derive the bounding estimate for the assumed inventory in the Auxiliary Building walls. In addition, the last sentence of the paragraph clearly states that "the source term in the walls is a very conservative estimate that is probably greater than the actual activity embedded in the walls."

It should be noted that section 3.2 of TSD 14-013 also states the following;

"As noted above, the core locations are biased to those with the greatest potential for high concentrations based upon their physical location (e.g., locations with visual evidence of past leaks) and exhibiting high contact dose rates. This biases the overall concentrations high and provides a bounding source term that over estimates the overall concentrations. To add another layer of conservatism, reported minimum detectable activities (MDAs) for Co-60, Cs-137 and Cs-134 were included in the results when the nuclide was not positively identified."

During the characterization of the Auxiliary Building basement, extensive scan surveys were performed on the walls of the 542 foot elevation in an effort to determine the locations representing the worst case radiological condition for concrete in each survey unit. These scans were performed of accessible walls surfaces to the extent practicable while standing on the 542 foot elevation, to a nominal elevation of approximately six feet up the wall from the floor. The scan surveys indicated that, for a majority of the lower wall surfaces on the Auxiliary Building 542 foot elevation, the residual radioactivity on the wall was indistinguishable from ambient background. This was particularly true for all the outer wall surfaces in the east portion of the Auxiliary Building 542 foot elevation, including the Waste Gas Decay Tank area, the Lake Discharge Tank area, the Blowdown Monitor Tank area and the areas adjacent to the Cavity Fill Pump cubicles. Residual contamination at concentrations greater than the ambient background was only detected on the outer walls of the Unit 1 and Unit 2 Pipe Chases, the Unit 1 and Unit 2 ABEDCT cubicles and the outer walls of the HUT cubicles. However, with the exception of the HUT cubicles, the contamination identified on the walls in the Pipe Chases and ABEDCT cubicles was not uniform. The contamination on the walls in these cubicles was primarily from valve leakage and gland seal spray from primary system pumps.

The highest observed scan locations on the walls of the Auxiliary Building basement are represented by two concrete core samples. The highest observed scan measurement was located in the Unit 1 ABEDCT room (B105113-CJWCCV-003 with a Co-60 surface concentration of 6.71E+02 pCi/g and a Cs-137 surface concentration of 1.66E+04 pCi/g). This activity was identified in an isolated location; the next highest location on the walls identified by scan was 10,000 times lower. This location was from the East Common Area Wall (B101111-CJWCCV-002 with a Co-60 surface concentration of 1.94E-01 pCi/g and a Cs-137 surface concentration of

9.52E-01 pCi/g). The sample from the Unit 1 ABEDCT room wall represents the worst case bounding activity for the lower walls of the Auxiliary Building basement based on the scans. Scans were also performed on the lower outer walls of the HUT cubicles, however no concrete core locations were chosen on the walls as the floor concrete exhibited significantly more inventory. With the exception of the HUT cubicles, scans performed on upper wall surfaces (i.e. between 3 and 6 feet above the floor) also showed no activity indistinguishable from ambient background. At the time characterization was performed, it was determined that scanning the walls higher than the lower six feet of wall on the 542 foot elevation was not necessary based on the scan results and process knowledge. It was determined that the radiological conditions for the lower walls was bounding.

Scans were also performed on the lower outer walls of the HUT cubicles, however concrete core locations were not chosen on the walls as the floor concrete exhibited significantly more inventory. As illustrated in the first paragraph quoted from TSD 14-013 above, the floor inventory was used to estimate the source term inventory for the entire area of the HUT walls, which is extremely conservative and definitely bounding.

Using the two bounding core samples from the Auxiliary Building lower walls and the floor core sample from the HUT floor, a conservative bounding estimate of 150 mCi of Cs-137 was derived for the walls of the Auxiliary Building basement, which is less than 18% of the total allowable inventory for Cs-137. This bounding estimate assumed that the lower three feet of the Auxiliary Building basement walls was homogeneously contaminated to a depth of ½ inch at the contamination levels represented by the worst case core sample taken from the wall (B105113-CJWCCV-003). For the area of the HUT walls, the bounding estimate assumed that the entire wall surface of the HUT from the 542 foot elevation to the 588 foot elevation was homogeneously contaminated to a depth of ½ inch at the contamination levels represented by the floor core taken in the HUT (B105107-CJFCCV-001). The bounding source term estimate calculated for the walls, including the walls of the HUT cubicles, is very conservative as scans showed that the actual inventory embedded in the walls is significantly less. For almost all of the Auxiliary Building basement wall surface, scans show that the activity on the wall is indistinguishable from background. Only a very small percentage of the Auxiliary Building basement wall surface was shown to be actually contaminated. This bounding calculation is represented by Table 18 of TSD 14-013, "Zion Auxiliary Building End State Estimated Concrete Volumes, Surface Areas, and Source Terms."

For the Containment Building basements, no scans were performed of the basement walls. The basement walls of the Containment basements were not considered as viable locations for the acquisition of concrete core samples during characterization due to the fact that in both Containment basements, all concrete will be removed to expose the steel liner. As a consequence, the entire source term associated with the interior Containment concrete will be removed as well.

Based on the decommissioning approach for the Containments and the characterization scans/concrete core samples taken from the Auxiliary Building basement walls, the STS survey units for the walls of the Auxiliary Building and the two Containment basements are classified analogous to Class 2 as defined in MARSSIM, section 2.2. As per the Class 2 definition in MARSSIM, a Class 2 STS unit is an area that has a potential for radioactive contamination, but the total inventory in the STS unit is not expected to exceed the BIL and, that there is a high degree of confidence that no individual measurement will exceed the BIL.

To date, no measurement has been taken on any exposed surface classified as STS Class 2 which would prompt a reclassification to STS Class 1. As with FSS, the relevance of a Class 2 classification is assessed from initial classification through compliance demonstration. In accordance with the "Remediation, Reclassification and Resurvey Actions" specified in the Attachment 9 table of Zion*Solutions* procedure ZS-LT-300-001-004, "FRS Data Assessment," if one or several survey measurements in a Class 2 STS unit exceed 50% of the dose criterion, the STS unit or a portion of the STS unit will be investigated, reclassified as STS Class 1 and resurveyed in accordance with the new classification. This is analogous to the same reclassification process recommended in MARSSIM. As with the FSS of a Class 2 survey unit as described in MARSSIM, there is no expectation that residual radioactivity exists in a Class 2 survey unit which would exceed the BIL (or result in a measurement with a SOF equal to or greater than one). In addition, for a Class 2 STS unit, such as the Auxiliary Building walls, that resides in a STS basement with multiple STS units, compliance with the Sign Test is based upon SOF for each measurement derived from the expected fraction of the total inventory in the Class 2 STS unit and not the full inventory.

Based upon the radiological surveys performed to date and the expected decommissioning process for the Class 2 STS units (e.g. the removal of interior Containment concrete to expose the steel liner), ZSRP believes that there is an adequate basis for the Class 2 classification. However, if RASS, turnover surveys or any operational survey present any radiological data that would question the basis for the classification, ZSRP commits to the same reclassification process that would be applicable to a Class 2 FSS survey unit. In addition, ZSRP has already committed to take judgmental samples on the lower walls of the Auxiliary Building basement during STS at the locations previously identified by the characterization (Unit 1 and Unit 2 Pipe Chases, the Unit 1 and Unit 2 ABEDCT cubicles and the outer walls of the HUT cubicles) to ensure that the residual radioactivity at these locations are accounted for in the calculation of the Mean Inventory Fraction.

Enclosure 3

Preflight Report for Enclosure 2

This document serves as preflight report for Enclosure 2 to the letter ZS-2016-0084. The following files do not pass pre-flight criteria or do not meet NRC criteria, but text is word searchable with clarity/legibility of high quality.

Reference Document Name	File Name	Preflight Status	Reason
TSD 14-009, Brookhaven National Laboratory: Evaluation of Maximum Radionuclide Groundwater Concentrations for Basement Fill Model, Revision 2	TSD-14-009 Rev 2	Failed	Scanned document (unembedded fonts), logos, backgrounds, maps, and signatures < 300 ppi, clear and legible
TSD 14-100, RESRAD Dose Modeling for Basement Fill Model, Soil DCGL and Calculation of Basement Fill Model Dose Factors, Revision 2	TSD-14-010 Rev 2	Failed	Scanned document (unembedded fonts), logos, backgrounds, maps, and signatures < 300 ppi, clear and legible
TSD 14-010 Rev.2 Attachments 2			
	Co-60 BFM Sensitivity Analysis Report	Passed	
	Co-60 BFM Sensitivity Summary Report	Passed	
	Cs-134 BFM Sensitivity Analysis Report	Passed	
	Cs-134 BFM Sensitivity Summary Report	Passed	
	Cs-137 BFM Sensitivity Analysis Report	Passed	
	Cs-137 BFM Sensitivity Summary Report	Passed	
	Eu-152 BFM Sensitivity Analysis Report	Passed	
	Eu-152 BFM Sensitivity Summary Report	Passed	
	Eu-154 BFM Sensitivity Analysis Report	Passed	
	Eu-154 BFM Sensitivity Summary Report	Passed	
	H-3 BFM Sensitivity Analysis Report	Passed	
	H-3 BFM Sensitivity Summary Report	Passed	
	Ni-63 BFM Sensitivity Analysis Report	Passed	
	Ni-63 BFM Sensitivity Summary Report	Passed	
	Sr-90 BFM Sensitivity Analysis Report	Passed	

Reference Document Name	File Name	Preflight Status	Reason
	Sr-90 BFM Sensitivity Summary Report	Passed	
TSD 14-010 Rev.2 Attachments 4			
	BFM Dose Factor Concentration Report 9_8	Passed	
	BFM Dose Factor Summary Report 9_8	Passed	
TSD 14-010 Rev.2 Attachments 8			
	Co-60 Sensitivity Analysis Report 9_9_14	Passed	
	Co-60 Subsurface Soil Sensitivity Analysis Report 9_9_14	Passed	
	Cs-134 Sensitivity Analysis Report 9_9_14	Passed	
	Cs-134 Subsurface Soil Sensitivity Analysis Report 9_9_14	Passed	
	Cs-137 Sensitivity Analysis Report 9_9_14	Passed	
	Cs-137 Subsurface Soil Sensitivity Analysis Report 9_9_14	Passed	
	Ni-63 Sensitivity Analysis Report 9_9_14	Passed	
	Ni-63 Subsurface Soil Sensitivity Analysis Report 9_9_14	Passed	
	Sr-90 Sensitivity Analysis Report 9_9_14	Passed	
	Sr-90 Subsurface Soil Sensitivity Analysis Report 9_9_14	Passed	
TSD 14-010 Rev.2 Attachments 10			
	ZION Subsurface Soil DCGL RESRAD Summary Report 5_26_16	Passed	

Reference Document Name	File Name	Preflight Status	Reason
	ZION Surface Soil DCGL RESRAD Summary Report 5_26_16	Passed	
TSD 14-010 Rev.2 Attachments 12			
	Concentration Report BFM ROC Screening 12_10_14	Passed	
	Summary Report BFM ROC Screening 12_10_14	Passed	
TSD 14-010 Rev.2 Attachments 13			
	Surface Soil AF Initital Suite 0.3m	Passed	
	Surface Soil AF Initital Suite 1.0m	Passed	
	Surface Soil AF Initital Suite 3.0m	Passed	
	Surface Soil AF Initital Suite 10m	Passed	
	Surface Soil AF Initital Suite 64500m	Passed	
TSD 14-010 Rev.2 Attachments 13			
	Summary Report Soil ROC Screening	Passed	
TSD 14-010 Rev.2 Section 7 – Industrial Use			
	Zion Industrial Use Soil RESRAD Summary Report 5_27	Passed	
TSD 14-010 Rev.2 Section 8 - Kd Uncertainty			
	ZION Subsurface Soil Kd Sensitivity RESRAD Summary Report	Passed	
	ZION Subsurface Soil Kd Sensitivity RESRAD Uncertainty Report	Passed	

Reference Document Name	File Name	Preflight Status	Reason
	ZION Surface Soil Kd Sensitivity RESRAD Summary Report	Passed	
	Zion Surface Soil Kd Sensitivity RESRAD Uncertainty Report	Passed	
TSD 14-015, Buried Pipe Dose Modeling & DCGLs, Revision 2	TSD-14-015 Rev 2	Failed	Document contains logos and signatures < 300 ppi, clear and legible
TSD 14-015 Rev.2 Attachments			
	Zion Buried Pipe Excavation 1 m source RESRAD Summary Report 5_23_16	Passed	
	Zion Buried Pipe Insitu Sat 1 m source RESRAD Summary Report 5_23_16	Passed	
	Zion Buried Pipe Insitu Unsat 1 m source 1.22 m root RESRAD SR 5_23_16	Passed	
	Zion Buried Pipe Insitu Unsat 1 m source 2 m root RESRAD SR 5_23_16	Passed	
	Zion Buried Pipe Excavation Area Check RESRAD Summary Report	Passed	
	Zion Buried Pipe Insitu Sat Area Check RESRAD Summary Report	Passed	
	Zion Buried Pipe Insitu Unsat Area Check RESRAD Summary Report	Passed	
	Buried Pipe Excavation RESRAD Uncertainty Report 5_22_16	Passed	

Reference Document Name	File Name	Preflight Status	Reason
	Buried Pipe Insitu Sat RESRAD Uncertainty Report 5_22_16	Passed	
	Buried Pipe Insitu Unsat RESRAD Uncertainty Report 5_22_16	Passed	
	Zion Buried Pipe Excavation RESRAD Summary Report 5_23_16	Passed	
	Zion Buried Pipe Insitu Sat RESRAD Summary Report 5_23_16	Passed	
	Zion Buried Pipe Insitu Unsat RESRAD Summary Report 5_23_16	Passed	
TSD 14-017, BNL Report – Sorption (KD) Measurements on Cinder Block and Grout in Support of Dose Assessments for Zion Nuclear Station Decommissioning, Revision 0	TSD-14-017 Rev 0	Failed	Document contains unembedded fonts, logos, digital photos, graphics, and signatures < 300 ppi, clear and legible
TSD 14-019, Radionuclides of Concern for Soil and Basement Fill Model Source Terms, Revision 1	TSD-14-019 Rev 1	Failed	Scanned document (unembedded fonts), logos, and signatures < 300 ppi, clear and legible
TSD 14-120, Sorption (K_d) Measurements in Support of Dose Assessments for Zion Nuclear Station Decommissioning, Revision 0	TSD-14-020 Rev 0	Failed	Scanned document (unembedded fonts), logos, and signatures < 300 ppi, clear and legible
TSD 14-021, BFM Drilling Spoils and Alternate Exposure Scenarios, Revision 1	TSD-14-021 Rev 1	Failed	Scanned document (unembedded fonts), logos, graphics and signatures < 300 ppi, clear and legible
TSD 14-009, Brookhaven National Laboratory: Evaluation of Maximum Radionuclide Groundwater Concentrations for Basement Fill Model, Revision 2	TSD-14-031 Rev 1	Failed	Scanned document (unembedded fonts), logos, map and signatures < 300 ppi, clear and legible
ZS-LT-300-001-001, Survey Unit Classification, Revision 2	ZS-LT-300-001-002 Rev 2	Failed	Scanned document (unembedded fonts), and signatures < 300 ppi, clear and legible

Reference Document Name	File Name	Preflight Status	Reason
ZS-LT-400-001-002, Contamination Verification Surveys Prior to Demolition, Revision 0	ZS-LT-400-001-002 Rev 0	Failed	Scanned document (unembedded fonts), and signatures < 300 ppi, clear and legible