1. NRC Comment (PAB 1): Additional information is needed on continuing characterization.

Basis: Per 10 CFR 50.82, the license termination plan must include a site characterization. NUREG-1700, Rev. 1 (Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans) states that NRC staff should review the licensee's site characterization plans and site records (required under 10 CFR 50.75(g)).

In the response to RAI PAB 4 (as received in July 2016), the licensee commits to performing continuing characterization of areas that have/had not been characterized. The response describes the continuing characterization of the Circulating Discharge Tunnel which has occurred since the submittal of the LTP. The response to HP RAI 2 (as received in July 2016) acknowledges four additional distinct areas at Zion where characterization will occur. As characterization results for these five areas (i.e., the circulating discharge tunnel and the four area noted in the response to HP RAI 2 in July 2016) were not provided in the LTP, plans to accomplish additional characterization should be provided for NRC evaluation. In particular, characterization plans should describe the manner in which the licensee will take (or has taken) additional characterization surveys, how the number and location of samples will be (or has been) determined, how hard-to-detect/insignificant radionuclides will be (or have been) considered (see NRC PAB RAI 2 in this document), and how additional characterization results will be utilized to inform final radiation survey designs. For any locations already characterized, the plans and results should be provided for NRC evaluation.

Path Forward:

a. Provide plans for additional characterization to the NRC for evaluation. As discussed in the comment above, characterization plans should describe the manner in which the licensee will take (or has taken) additional characterization surveys, how the number and location of samples will be (or has been) determined, how hard-to-detect/insignificant radionuclides will be (or have been) considered, and how additional characterization results will be utilized to inform final radiation survey designs.

b. Commit to providing additional characterization results to the NRC for evaluation.

ZSRP Response (PAB 1a) – Continuing characterization sample plans will be provided to NRC for information and results provided to NRC for evaluation for the following areas. Survey design and DQOs for continuing characterization surveys will be developed and implemented in accordance with Zion*Solutions* procedure ZS-RP-107-001-001, Characterization Survey Package Development. LTP Chapter Rev 1 Chapter 2, section 2.5 and Chapter 5, section 5.3.4.4 have been revised accordingly.

- The underlying concrete of the SFP/Transfer Canal below the 588 foot elevation after the steel liner has been removed. Continuing characterization will consist of scanning of the exposed concrete surfaces and the acquisition of concrete core sample(s) at the location of highest activity. The number and location of the additional concrete core sample(s) will be determined by DQO during survey design.

- The concrete walls and floor of the Under-Vessel areas in Unit 1 and Unit 2 Containments. Continuing characterization will consist of the acquisition of additional concrete core sample(s). The number and location of the additional concrete core samples will be determined by DQO during survey design.
- The floors and walls of the Hold-Up Tank (HUT) cubicle as recommended by Zion*Solutions* TSD 14-022. Continuing characterization will consist of the acquisition of additional concrete core sample(s). The number and location of the additional concrete core samples will be determined by DQO during survey design.
- The floor of the Auxiliary Building 542 foot elevation Pipe Tunnel floors as recommended by Zion*Solutions* TSD 14-022. Continuing characterization will consist of the acquisition of additional concrete core sample(s). The number and location of the additional concrete core samples will be determined by DQO during survey design.
- The floor and lower walls of the 542 foot elevation of the Auxiliary Building to augment the existing characterization data. The number and location of the additional concrete core samples will be determined by DQO during survey design.
- The subsurface soils in the "keyways" between the Containment Buildings and the Turbine Building once subsurface utilities have been removed and the removal of subsurface structures in this area create access (e.g., Waste Annex Building). Continuing characterization will consist of the scanning of soils exposed by the demolition and building removal, the acquisition of soil sample(s) of the exposed soil and the acquisition of additional subsurface soil samples using test pits or soil borings. The number and location of the additional subsurface soil samples will be determined by DQO during survey design.
- 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. Continuing characterization will consist of soil borings at the nearest locations along the foundation walls that can be feasibly accessed, angled soil bores to access the soils under the concrete, and the acquisition of concrete core bores deep into the building floors (but not entirely through the foundation due to risk of groundwater intrusion) at bias locations to assess migration potential from building interiors to soils under basement concrete. The number and location of the additional subsurface soil samples will be determined by DQO during survey design. The sample plan will define additional investigations and sampling to be performed if activity is positively identified in the deepest core slice. See response to RAI HP 4.
- When the interior surfaces become accessible, several potentially contaminated embedded and buried pipe systems that will be abandoned in place. The list of piping is provided in in

Zion*Solutions* TSD 14-016, "Description of Embedded Piping, Penetrations and Buried Piping to Remain in Zion End State". Continuing characterization will consist of direct measurements on pipe openings and the acquisition of sediment and/or debris samples (if available) for analysis.

- The exposed steel liner in the Containment basements after concrete removal. Continuing characterization of the steel liner will consist of scans and swipe samples.

All surface soil at ZNPS has been adequately characterized and additional characterization of surface soil is not anticipated during continuing characterization. Radiological Assessment (RA) surveys will be performed in currently inaccessible soil areas that are exposed after removal of asphalt or concrete roadways and parking lots, rail lines, or building foundation pads (slab on grade).

Additional areas previously cited for continuing characterization are the Circulating Water Discharge Tunnels. In January of 2016, the planned continuing characterization of the Circulating Water Discharge Tunnels was combined with Final Status Survey (FSS). The tunnels were isolated from the lake, dewatered and a FSS was performed in the accessible portions. As previously stated in the response to RAI PAB 4a (as received in July 2016), a total of 14 static measurements were taken at randomly selected locations on the combined internal surface area of both tunnels using a suspended ISOCS. In addition, 3 samples of composited sediment and sludge were acquired from the bottom of each tunnel.

ZSRP Response (PAB 1b) – Continuing characterization sample plans will be provided to the NRC for information and results will be provided to NRC for evaluation for the areas listed in response to PAB 1a above. The FSS Release Record for the Circulating Water Discharge Tunnels will be provided to the NRC for evaluation in place of a continuing characterization sample plan or report due to the fact that in this case, continuing characterization was combined with FSS.

2. **NRC Comment (PAB 2)**: Additional information is needed on the methodology for deciding where to sample and analyze for the full initial suite of radionuclides during continuing characterization.

Basis: NUREG 1757, Vol. 2, Appendix O, Question 2, states that "It is incumbent on the licensee to have adequate characterization data to support and document the determination that some radionuclides may be deselected from further detailed consideration in planning the Final Status Survey (FSS). Per 10 CFR 50.82, the license termination plan must include a site characterization. NUREG-1700, Rev. 1 (Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans) states that NRC staff should review the licensee's site characterization plans and site records (required under 10 CFR 50.75(g)).

In the LTP and in response to RAI PAB 3a (as received in March 2016), the licensee committed to analyze for HTDs during continuing characterization (or RASS) if SOF > 0.5.

"If a sample and/or measurement is taken on any other end-state structure or embedded pipe system to support decommissioning activities, 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."

However, in response to RAI PAB 6c (as received in July 2016), the licensee seems to retract this commitment by stating the following:

"…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 continuing characterization to the concrete under the steel liner in the SFP/Transfer Canal the Aux Building 542 ft elevation floor drains or the Circulating Water Discharge Tunnels. 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."

The response to RAI PAB 6c (as received in July 2016) states that the rule (to measure for HTDs where SOF > 0.5) will only apply to the following areas:

- Soils in keyways between Containment and Turbine Buildings
- Soil along foundation walls
- Specific embedded pipe systems (e.g., Core Spray Penetration between Containment and Auxiliary Basement)

Furthermore, the RAI PAB 6c requested that the licensee "Clarify how 0.5 of the SOF will be determined in STS areas, especially those with multiple survey units." The response states that the only area where a measurement is expected to be greater than 50% of the limit is a Class 1 embedded pipe system, but the response did not clarify how 0.5 of the SOF would be determined in STS areas during continuing characterization.

Path Forward:

a. Describe why the SOF > 0.5 rule does not apply to the continuing characterization of the Auxiliary Building 542 foot elevation floor, especially given that measurements with SOF greater than 0.5 are expected. Describe if the samples sent for HTD analysis from the Auxiliary Building 542 foot elevation were decided following this rule, or some other criteria. Describe why the SOF > 0.5 rule does not apply to the continuing characterization of the SFP/Transfer Canal, and Circulating Discharge Tunnel. Describe if this rule, or some other criteria, was followed for deciding where to sample for the full initial suite of radionuclides. If the rule was not applied, describe if a greater or fewer number of samples would have been analyzed for the initial suite in these areas if the SOF > 0.5 rule had been followed.

b. Provide a numerical example of how 0.5 of the SOF is determined during continued characterization of STS areas, especially those with multiple survey units. For example, how was 0.5 of the SOF determined for measurements in the Auxiliary Building characterization? Include details regarding the assumed fraction of the BIL for each survey unit as well as any assumptions about the area of the survey unit. How will 0.5 of the SOF be calculated for the continuing characterization of the Class 1 embedded pipe system between Containment and Auxiliary Basements? Will it be based on a fraction of the Containment BIL or a fraction of the Auxiliary BIL? How will the fraction be determined? How will the area of the pipe be calculated?

c. Clarify whether there are other Class 1 embedded pipe systems that have not yet been characterized other than the Core Spray Penetration between Containment and Auxiliary Basement. If so, clarify whether the SOF > 0.5 rule will apply to those pipes or some other method for determining when to analyze for the full initial suite of radionuclides.

ZSRP Response (PAB 2a) –The purpose of the SOF > 0.5 criteria was to provide a risk-informed basis for justifying the expenditure of resources for analyzing continuing characterization samples for HTD in the three specific areas listed, plus buried pipe, where samples were expected to contain trivial or no activity. However, as a conservative measure, and to address NRC questions/concerns regarding the SOF > 0.5 rule, ZSRP is proposing to discard the SOF > 0.5 rule and replace with the following in LTP Rev 1, Chapter 5, section 5.1,

"For continuing characterization, 10% of all media samples collected in a survey unit, with a minimum of one sample, will be analyzed for the full initial suite of radionuclides. The samples selected will be biased to those areas exhibiting the highest gamma activity. The IC dose will be calculated for each individual sample result. If the IC dose calculated from the sample result is greater than the IC dose assigned for DCGL adjustment (see LTP Rev 1 Chapter 6, Section

6.5.2.3), then an investigation will be performed to determine if the DCGL requires readjustment." The selection of samples to be analyzed for HTD will be determined by DQO during survey design. In the response to RAI PAB 1a, all areas where continuing characterization will occur are specifically defined and a commitment is made to provide NRC continuing characterization sample plans for information and results for evaluation.

To address the specific concerns in the basis, the following clarification is provided. As quoted, ZSRP did commit in response to RAI PAB 3a (as received in March 2016) to analyze for HTDs during continuing characterization (or RA/RASS) if SOF > 0.5. However, the commitment was made as pertaining to any future continuing characterization (or RA/RASS). It was never intended to be retroactively applied to characterization surveys already performed and documented in LTP Chapter 2. ZSRP attempted to communicate this intent in the paragraph from the response to RAI PAB 3a (as received in March 2016) which stated "*Sufficient characterization samples have been taken from the Containment structures, Auxiliary Building, Turbine Building and Crib House/Forebay concrete*" and the words "*any other end-state structure or embedded pipe system*" with the word "other" intending to pertain to any other structures than those quoted (e.g. Containment, Auxiliary Building, Crib House/Forebay, etc…).

In response to RAI PAB 6c (as received in July 2016), it was not ZSRP's intent to retract this commitment. The response reiterated that the criteria for SOF > 0.5 commitment was intended for continuing characterization, and RA/RASS of specific areas and was not intended to be retroactively applied to characterization surveys that had already been performed. ZSRP now believes that the criteria for applying the SOF > 0.5 criteria no longer applies given the commitment in RAI PAB 1a to provide HTD analysis in all areas that undergo continuing characterization, regardless of the gamma activity in the samples. As stated in the response to RAI PAB 1a, the proposal to limit HTD analysis in certain specific areas (i.e., those expected to contain trivial or no activity) to samples that contain gamma activity with SOF > 0.5 is retracted. However, for soil only, if levels of residual radioactivity in an individual soil sample exceed the Sum-of-Fractions (SOF) of 0.1 then the sample(s) will be analyzed for HTD radionuclides.

Notwithstanding the commitment to retract the SOF > 0.5 proposal, responses to the specific questions in PAB 2a related to the SOF > 0.5 rule are provided below. The question was considered in two parts.

RAI PAB 2a Part 1: *Describe why the SOF > 0.5 rule does not apply to the continuing characterization of the Auxiliary Building 542 foot elevation floor, especially given that measurements with SOF greater than 0.5 are expected. Describe if the samples sent for HTD analysis from the Auxiliary Building 542 foot elevation were decided following this rule, or some other criteria.*

The characterization survey of the Auxiliary Building 542 foot elevation and Auxiliary Building exterior walls was performed in May and June of 2012. The determination of the number of samples and sample location(s) were determined by DQO, which are documented in the characterization survey package(s). The characterization survey consisted of surface scans and the acquisition of 20 concrete core samples taken at locations identified by the surface scan as the highest activity. All 20 cores were analyzed for gamma emitting radionuclides by the on-site gamma spectroscopy system. DQOs also determined which samples were analyzed for HTD radionuclides; only the higher activity concrete cores from each area were to be used. Six samples were sent from the Auxiliary Building.

It should also be noted that ZSRP has committed to take additional concrete core samples as part of continuing characterization (see response to RAI PAB 1a) of the Auxiliary Building 542 foot elevation floor for the purpose of augmenting the initial suite HTD data reported in LTP Chapter 2 for assessment of insignificant contributor dose. However, there is no activity limitation (such as the SOF > 0.5 rule) as to when a sample would be analyzed for HTD. The number and locations of HTD analysis will be determined by the DQO process.

RAI PAB 2a Part 2: *Describe why the SOF > 0.5 rule does not apply to the continuing characterization of the SFP/Transfer Canal, and Circulating Discharge Tunnel. Describe if this rule, or some other criteria, was followed for deciding where to sample for the full initial suite of radionuclides. If the rule was not applied, describe if a greater or fewer number of samples would have been analyzed for the initial suite in these areas if the SOF > 0.5 rule had been followed.*

The continuing characterization of the SFP/Transfer Canal is currently ongoing with additional samples planned after demolition is completed and the surface is accessible. Core sample locations and the selection of samples for HTD analysis are based on the sample plan developed using the DQO process. As stated in the response to RAI PAB 1a, ZSRP commits to provide the SFP/Transfer Canal continuing characterization sample plans to NRC for information and the results for evaluation. The samples from the SFP/Transfer Canal analyzed to date for HTD are less than the 0.5 SOF based on the DCGLs calculated in LTP Revision 1 section 6.6.8. The location and number of additional samples to be collected and analyzed for HTD will be determined by the DQO process. It is not known at this time whether activity will be present at SOF > 0.5. However, samples will be collected from the locations with the highest gamma activity as identified by scan survey even in the event that that the SOF is < 0.5.

As stated in the response to RAI PAB 1a, due to the apparent low source term and limited accessibility, continuing characterization was combined with the FSS in the Circulating Water Discharge Tunnels. Fourteen static ISOCS measurements were taken. No concrete core samples were taken due to safety concerns. The maximum measurement observed by the ISOCS resulted in a sum-of-fraction less than 0.5 Even though the 0.5 SOF rule was not exceeded, a composite of 3 sediment/sludge samples were acquired from each tunnel and analyzed for the full initial suite of radionuclides. Results for the Unit 2 Discharge Tunnel have been reported. Positively detected radionuclides included H-3 (7.44E+01 pCi/g), Co-60 (1.34E+00 pCi/g), Cs-137 (1.61E-01 pCi/g) and Am-241 (1.62E-01 pCi/g). All other initial suite radionuclides were reported as non-detect. The initial suite radionuclides from the continuing characterization of the Discharge Tunnel will be evaluated as described in LTP Rev 1, Chapter 5, section 5.1.

ZSRP Response (PAB 2b) – ZSRP believes that this RAI no longer applies as ZSRP is proposing to replace the SOF > 0.5 rule with the following, "For continuing characterization, 10% of all media samples taken in a survey unit, or a minimum one sample, will be analyzed for the full initial suite of radionuclides. The samples selected will be biased to those areas exhibiting the highest gamma activity." ZSRP also commits to provided continuing characterization sample plans and results to NRC for evaluation for all areas cited.

ZSRP Response (PAB 2c) – There are few Class 1 pipes that will remain other than the Core Spray Penetration between Containment and Auxiliary Basement. As stated in response to HP 8a, the classification of all embedded pipe, penetrations, and buried pipe are listed in Zion*Solutions* TSD 14-016 "Description of Embedded Piping, Penetrations and Buried Pipe to Remain in Zion End State". As stated in response to PAB 2a, the SOF > 0.5 rule will not apply to pipes. For continuing characterization, 10% of all media samples collected in a survey unit, with a minimum of one sample, will be analyzed for the full initial suite of radionuclides.

3. **NRC Comment (PAB 3)**: Additional characterization data or technical justification is needed to inform the potential dose contribution of Np-237.

Basis: NUREG 1757, Vol. 2, Appendix O, Question 2, states that "It is incumbent on the licensee to have adequate characterization data to support and document the determination that some radionuclides may be deselected from further detailed consideration in planning the Final Status Survey (FSS)." The licensee included in the response to RAI PAB 4 (as received in July 2016) that Np-237 will be excluded from any further analysis (including during the continuing characterization of places that have not yet been characterized). The licensee's basis is that Np-237 has not been found in any samples taken during characterization. The NRC staff note that some of the areas have yet to be characterized (e.g., Spent Fuel Pool, soil in "keyways" between Containment and the Turbine Building, embedded piping, etc.). Given that these areas (which likely have different relative mixtures of radionuclides compared to areas which have been characterized), have not yet been characterized, the licensee has not demonstrated that Np-237 is either not present or present in quantities that result in insignificant doses. Np-237 can be formed over the long term in spent fuel through decay of Am-241 (432.2 yr half-life), and can also be formed in the short term through successive neutron capture. Am-241 was detected above MDC in several of the concrete cores taken from Containment and in one of the cores taken from the Auxiliary Building.

NUREG 1757, Vol. 2, Appendix O also indicates that "Radionuclides that are undetected may also 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 the radionuclides are present at the MDC concentrations)." In response to PAB 5, the licensee has increased the assumed insignificant fraction for soil to 10% from 0.171%. The NRC staff note that the sum of potential doses from the radionuclides labeled as insignificant reported by the licensee in response to RAI PAB 8 (as provided in March 2016, see pg. 20-21 of ZS-2016-0022: Enclosure 1, ML16081A010) utilizing the MDCs for non-detects in soil is 3.2 mrem, or 13% of 25 mrem, which is greater than the 10% the licensee is assuming for soil. Of the 3.2 mrem, Np-237 contributes approximately 1.18 mrem or 4.7% of 25 mrem at the average MDC for the soil samples (0.0379 pCi/g). Given that Np-237 has a higher relative dose factor in certain scenarios, there is potential for it to be a significant radionuclide should it be detected.

The response to RAI PAB 4 also stated that the "Np-237 relative concentration in NUREG/CR-4289, Table 4.4 is orders of magnitude below the 0.01% activity threshold applied in TSD 11-001 to exclude radionuclides from the initial suite and therefore should not have been included in the initial suite." NUREG/CR-4289 aggregates data from seven Nuclear Power Plants in U.S., and Np-237 was analyzed in samples from three plants (Indian Point (PWR), Turkey Point (PWR), and Dresden (BWR)). This data may not be representative of what is at the Zion site. The RAI response did not discuss how the concentrations in NUREG/CR-4289 directly relate to the residual radioactivity concentrations that are potential at the Zion site. Furthermore, the RAI response does not relate the Np-237 concentrations listed in NUREG/CR-4289 to a potential dose using the Zion site-specific dose factors.

Path Forward:

a. The licensee should analyze for Np-237 in the samples that are analyzed for the full initial suite of radionuclides during continuing characterization (as was committed to in the LTP) in order to verify that the dose contribution from Np-237 is insignificant in those areas.

b. Alternatively, the licensee should provide additional justification for why Np-237 should be considered insignificant across the site. The licensee should provide assurance that the potential dose for Np-237 will be accounted for within the assumed insignificant fractions of the compliance limit for soil and concrete. This additional justification should include technical details about the various ways in which Np-237 may be formed, as well as the relationship between Np-237 and other radionuclides which will be measured for during additional characterization. The licensee should commit to perform additional investigations, sampling and/or analysis in the case that presence of other radionuclides indicate the potential for Np-237 to be present. The analysis should clearly demonstrate that the potential dose contribution of Np-237 is insignificant under conservative assumptions.

ZSRP Response (PAB 3a and 3b) – ZSRP will analyze for Np-237 in the samples that are analyzed for the full initial suite during continuing characterization in order to verify that the dose contribution from Np-237 is not significant. Initial suite analysis will be performed in 10% of all media samples taken during continuing characterization in the areas specified in LTP Rev 1, Chapter 2 section 2.5 (also listed in ZSRP response to PAB 1a).

4. NRC Comment (PAB 4): Equation 6-5 used for Total Compliance Dose is not clear.

Basis: Equation 6-5 describes how the compliance dose will calculated from summing the various media source terms at the ZNPS.

(Equation 6-5)

Compliance Dose = Max BFM + Max Soil + Max Buried Pipe + Max Existing Groundwater

It is not clear how the dose from the Max BFM term will be calculated from the final site FSS data. In response to RAI PAB 14 (as provided in March 2016) on this topic, the licensee stated, "The dose from the maximum individual survey unit for each media will be used in the compliance calculation regardless of the physical location of the survey unit or time of maximum exposure." The response also states, "The dose attributable to the survey unit is calculated in accordance with Zion*Solutions* procedure ZS-LT-300-001-004." Because this procedure only provides a method for determining dose from *each individual* survey unit, it does not describe how the maximum dose from the basements (Max BFM) will be determined in basements with more than one survey unit (e.g., Auxiliary Basement). It is the NRC's position that the Max BFM term should represent the dose from the entire basement with the maximum dose. The inventory from all survey units within a basement, including embedded piping or penetrations, should be summed as opposed to only considering the maximum inventory from any one of the STS survey units. The STS units are fundamentally different from the soil or buried pipe because the inventory level in each basement is equivalent to 25 mrem/yr as opposed to a DCGL for soil or a DCGL for piping for the entire site being equivalent to 25 mrem/yr.

In addition to the issue regarding multiple survey units in a single basement, it is unclear how the Max BFM term considers the connection between the SFP/Transfer Canal and Containment basements. The LTP Section 6.5.4 states that "The SFP will be hydraulically connected to the Containment Basement through perforations cut between the SFP and the Transfer Canals for the purpose of equilibrating the SFP water levels with the other Basements." Given that the Containment and SFP are hydraulically connected, it is the NRC's position that the inventory of the SFP/Transfer Canal should be added to the inventory of Containment and multiplied by the larger of the Containment or SFP Dose Factors for each ROC to find the dose from the combined Containment and SFP/Transfer Canal. This combined inventory dose would be compared to the doses from other basements to find the Max BFM dose in Equation 6-5. As indicated in response to RAI PAB 10 (as received in July 2016) "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." This commitment will help to ensure that the inventory is accounted for when determining if the individual survey units pass, but the licensee has not clearly described how this commitment will impact the Max BFM term in Equation 6-5.

Furthermore, it is unclear whether other basements besides the Containment and SFP would be hydraulically connected via the existing penetrations or intentionally cut perforations. In response to RAI PAB 3b (as provided in July 2016), the licensee states that "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). In response to RAI PAB 11a (as provided in July 2016), the licensee states that there are no hydraulic connections to the outside soil, but also states that additional perforations are necessary. The response states, "The conclusion of TSD 14-032 was that there are no water pathways from the basements to surrounding ground below 579' average groundwater level and in fact, additional perforations would be required to ensure that the water elevation within the basements is maintained as essentially the same elevations as surrounding groundwater." Another analysis (TSD 14-009, Rev. 1) clearly indicates that penetrations will connect basements, "the Auxiliary Basement is adjacent to the Turbine Basement and there are penetrations that will remain in place and connect these basements. The Containment Basements are also connected to the Auxiliary Basement by penetrations." If basements are hydraulically connected to each other, the inventory in one basement could be transported to an adjacent basement and potentially increase the concentrations above what was assumed in the model. Also, if multiple basements are hydraulically connected to the outside soil, then the source term from those basements could potentially combine and contribute dose to a receptor. (See RAI PAB 7 in this document).

The licensee provided an analysis of a scenario of an outside well with potential to receive inventory from the Containment, Turbine and Auxiliary Buildings in TSD-14-009, Rev. 1 (see RAI PAB 21 of ZS-2016-0022: Enclosure 1 as provided in July 2016). The key findings of the study are quoted as follows:

- *For mobile nuclides (H-3 and Sr-90) it does not make much difference where the contamination is located as it will reach the receptor well. Adding the contribution from the Containment at the same level as in the Auxiliary Basement led only to a 20 – 33% increase in concentration at the well.*
- *For Ni-63 and Cs-137 due to their long half-lives and somewhat low distribution coefficients (62 for Ni-63 and 45 for Cs-137 in this simulation) contamination in the Containment Basement and Auxiliary Basement will reach the receptor well, but at peak concentrations less than 10% (Ni-63) and 1% (Cs-137) of their value in these basements.*
- *For less mobile nuclides with short half-life (Co-60, Cs-134, Eu-152 and Eu-154) very little contamination (<0.1%) in the Auxiliary Basement will reach the receptor well.*

This sensitivity analysis is somewhat limited in its usefulness in that it is unclear how the source terms relate to the end-state inventory that will be left on the site, and it does not consider fast pathways for elevated areas of contamination. Also, the analysis concluded that "for the mobile nuclides (H-3 and Sr-90) the peak well concentrations increase due to the contributions from the Containment Basement. The peak H-3 receptor well concentration increases 20% and the peak

Sr-90 concentration increases 30%." The conclusion from the report supports the NRC staff's concern that source terms from multiple basements, especially more mobile nuclides, could combine yielding a water concentration which is higher than the maximum concentration evaluated for any of the individual basements.

In addition, with regard to potential dose from backfill, the RAI response to HP 1 states that the "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." It is unclear how the dose from the fill is accounted for in Equation 6-5 because of the ambiguities aforementioned with the Max BFM term.

Path Forward:

a. Provide additional details on how the Max BFM term in Equation 6-5 will be determined from FSS data. Include the equations used for determining MAX BFM from FSS data considering that some basements have multiple survey units, and/or embedded piping/penetrations as well as the fact that the Containment and SFP/Transfer Canal are hydraulically connected.

b. Describe if any basements in addition to the Containment and SFP/Transfer Canal will be hydraulically connected in the end state.

c. Describe how the MAX BFM term adequately accounts for the potential for a receptor to receive dose from more than one basement.

d. Describe how the dose from the backfill material is accounted for in Equation 6-5. Consider creating an additional term in Equation 6-5 to account for the dose from backfill to avoid confusion.

e. Update the LTP to include details on the terms in Equation 6-5.

ZSRP Response (PAB 4a) – Zion*Solutions* TSD 17-004 "Operational Derived Concentration Guideline Levels for Final Status Surveys" was developed to provide detailed descriptions and equations for the calculation of the Max BFM term including basements with multiple survey units. Note that the term "Max BFM" was revised to "Max SOF_B" in TSD 17-004 as well as in Equation 6-5 (which is Equation 6-11 in Revision 1 of LTP Chapter 6). TSD 17-004 also provides Operational DCGLs that limit the percentage of the 25 mrem/yr dose criterion allocated to the Max SOF_B term to ensure that the dose criterion will be met after FSS is completed for all four source terms in LTP Rev 1 Equation 6-11. The details regarding implementation of the Operational DCGLs during FSS are provided in LTP Chapter 5 Rev 1 and TSD 17-004.

Zion*Solutions* procedure ZS-LT-300-001-004 will be revised to include the methods for calculating the final compliance dose in accordance with Equation 6-11 as described in TSD 17-

004. A brief summary description of the Equation 6-11 terms and calculations have also been incorporated into LTP Rev 1, Chapter 6, section 6.17.1.

ZSRP Response (PAB 4b)

Penetrations are present that provide hydraulic connections between the Containment, Auxiliary, Turbine and SFP/Transfer Canal basements. These penetrations were incorporated into the assessments provided in CRA report "Simulation of Post-Demolition Saturation of Foundation Fill Using a Foundation Water Flow Model" (CRA Report) (previously provided to NRC). Figure 10 of the CRA Report shows the general clusters of the penetration locations. The spreadsheet supporting Figure 10 of the CRA report that specifically lists the penetrations was also previously provided to NRC. A definitive description of the penetrations, as well as embedded pipe and buried pipe, is provided in ZionSolutions TSD 14-016 "Description of Embedded Piping, Penetrations and Buried Pipe to Remain in Zion End State" (submitted with these RAI responses).

ZSRP Response (PAB 4c) –PAB 4c is considered to pertain to the following statements from the Basis "If basements are hydraulically connected to each other, the inventory in one basement could be transported to an adjacent basement and potentially increase the concentrations above what was assumed in the model. Also, if multiple basements are hydraulically connected to the outside soil, then the source term from those basements could potentially combine and contribute dose to a receptor." The basis also states that the flow assessment provided in the PAB 21 (July 2016) does not consider fast pathways for elevated areas of contamination. Therefore, the potential for fast pathways for elevated areas are also addressed in this response.

Two conservative and bounding flow models are run in TSD 14-009, Revision 3. The first model addresses flow between all basements by assessing the maximum concentrations that would occur in each "downstream" basement assuming that the structures provide no resistance to groundwater flow. Using the assumption of no resistance to flow provides the maximum flow rate through basements. The model can also be interpreted as conservatively representing a source term in outside soil if released through a hydraulic connection to a basement because the assumed flow rate and direction are the same as outside groundwater and the basements. If activity were to be release to soil from multiple buildings the flow and peak concentrations "downstream" would be bounded by the flow model results in part because the soil Kds are generally lower than assumed in the BFM.

Note that ZSRP has categorized and listed all basement penetrations, including those that could potentially provide hydraulic connection between a basement and outside soil, in TSD 14-016. Although not required by the results of the flow models, all penetrations between a basement and the outside soil ground that are below the 580 foot elevation will be grouted to refusal in order to provide greater certainty in the flow pathways between basements and outside soil that will exist after license termination. As seen in TSD 14-016, with the exception of the 48 inch diameter service water pipe for which grouting or sealing to prevent water ingress has always been planned, the total area of the penetrations with potential hydraulic connection to soil is small.

The second flow model assessed in TSD 14-009 calculates the maximum concentration in outside soil adjacent to the engineered opening to be made in the Steam Tunnel wall. This Engineered opening will ensure that the water elevation inside the basements is maintained at approximately the same elevation as surrounding groundwater. The water flow in the second model is based on the rainwater infiltration rate to the basements, which is a more realistic flow assumption for the basements because in fact the structures will significantly impeded outside groundwater from entering.

The first flow model is discussed in this RAI response. The second flow model is discussed in response to PAB 7b.

During the development of the flow models, the potential effect of fast pathways from elevated areas is addressed by considering the potential for elevated areas to be present. Both of the flow models in TSD 14-009 calculate water concentrations as a function of time within each basement using the BFM mixing assumption in the same manner as was used to calculate the BFM Dose Factors and corresponding DCGLs (see LTP Rev 1 Chapter 6, section 6.6.8 for DCGL calculations). The potential effect of fast pathways for elevated areas on the mixing assumption is addressed by ensuring that no elevated areas are present in the basements. As described in the response to RAI PAB 7a, the methods for calculating the basement surface DCGLs ensure that the source term is uniformly distributed over all walls and floors. No ISOCS FSS measurement is allowed to exceed the Base Case DCGL. For embedded pipe and penetrations, remediation and grouting action levels have been established (see LTP Rev 1 Chapter 5 section 5.5.5). These action levels ensure that the residual radioactivity in the embedded pipe and penetrations will either not exceed the wall/floor surface Operational DCGL or that the pipe will be grouted to ensure that the activity released from the embedded pipe or penetration to the floor/wall surface will be a very small fraction of that which could be released from a wall/floor surface at the Operational DCGL concentration. See RAI PAB 7a for a discussion of the effect of grouting on release of activity from pipes. The wall/floor surface, embedded pipe, and penetration source terms will therefore not include any elevated areas that could result in water concentrations higher than predicted by the BFM as a result of a fast pathway.

<u>Assessment of Flow through all Basements (First Model)</u>

The assessment of flow through all basements is provided in TSD 14-009, Revision 3, Attachments D (and Attachment I). Water is assumed to move through all basements, at the rate and direction of surrounding groundwater, with no flow restrictions presented by the basement structures. Flow direction is west to east starting at Containment and then through the Auxiliary Basement, Turbine Basement and Crib House/Forebay.

The model was run with two source terms; the Groundwater DCGL only and the Basement DCGL($DCGL_B$) . The ($DCGL_B$) includes the dose from the drilling spoils scenario as well as the groundwater scenario (see LTP Rev 1, Chapter 6, section 6.6.8). Attachments D and I provide the model results for the Groundwater DCGL and $DCGL_B$ source terms, respectively.

The source terms for the Containment and Auxiliary basements were set at the DCGL concentrations (normalized) in both Attachment D and I. The source terms for the Turbine Basement and Crib House/Forebay were normalized to actual FSS to provide a more realistic assessment. The SFP/Transfer Canal was included with Containment through the DCGL concentrations and is accounted for by the use of Containment DCGLs in the flow models..

The BFM will, by definition, result in equal peak water concentrations in each basement when the Groundwater Scenario DCGLs are applied. This limiting condition is demonstrated in TSD 14-009, Revision 3, Attachment C. The activity in all downstream basements will therefore be less than the peak concentration calculated using the BFM. The results of the flow simulation through all buildings are provided in Table D-5 of TSD 14-009, Revision 3, which is reproduced below. As seen in Table D-5, the peak concentrations (and corresponding dose) with flow, in all basements are equal to or less than the peak concentrations calculated using the BFM mixing model. As expected when using the Groundwater DCGL, the peak concentrations in the Containment and Auxiliary Basements are equal (with rounding error). The other basements are lower because the source term (based on FSS results) was lower.

TSD 14-009, Rev 3 Table D-5 Peak Concentration for each ROC in each Building

	Peak Concentration (pCi/L)						
	Containment	Auxiliary	Aux /CMNT Ratio	Turbine	Turbine /CMNT Ratio	Crib House	Crib House /CMNT Ratio
H-3	1.01E-03	1.01E-03	1	8.52E-04	0.84	6.35E-04	0.63
Co-60	2.90E-08	2.88E-08	0.99	2.88E-09	0.1	1.96E-09	0.07
Ni-63	2.12E-06	2.11E-06	1	7.21E-07	0.34	1.88E-08	0.01
Sr-90	2.19E-05	2.19E-05	1	1.92E-05	0.88	1.26E-05	0.58
Cs-134	7.67E-07	7.64E-07	1	1.42E-08	0.02	9.68E-09	0.01
Cs-137	2.76E-06	2.76E-06	1	3.08E-07	0.11	9.71E-09	0
Eu-152	1.20E-07	1.19E-07	0.99	6.75E-09	0.06	4.61E-09	0.04
Eu-154	9.37E-08	9.30E-08	0.99	6.75E-09	0.07	4.61E-09	0.05

TSD 14-009, Revision 3, Attachment I, provides a second flow simulation using the same methods described in Attachment D but replacing the Groundwater DCGL with the Basement DCGL ($DCGL_B$). The drilling spoils dose will vary as a function of basement geometry assuming equal concentrations in each basement. Therefore, when the $DCGL_B$ is used as the source term, the relative maximum groundwater concentrations will vary between basements as opposed to being equal for all basements when activity is present at the Groundwater DCGLs.

The flow simulation results using the $DCGL_B$ are summarized in TSD 14-009, Revision 3, Table I-6 which is reproduced below. The results are summarized by calculating the ratio of the peak concentrations in the flow model to the peak concentration using the BFM. As seen in Table I-6, the ratios are always equal to or less than one which demonstrates that the BFM provides an upper bound on peak concentrations.

TSD 14-009, Rev 3, Table I-6 Ratio of peak centerline concentration in the transport case for all buildings as compared to the mixing bath model for each building.

Nuclide	Containment	Aux	Turbine	Crib House
H-3	1.0	0.97	0.90	0.67
Co-60	1.0	1.00	0.04	0.06
Ni-63	1.0	1.00	0.37	0.010
Sr-90	1.0	0.99	0.94	0.62
Cs-134	1.0	1.00	0.013	0.010
Cs-137	1.0	1.00	0.11	0.004
Eu-152	1.0	1.00	0.004	0.005
Eu-154	1.0	1.00	0.004	0.005

ZSRP Response (PAB 4d) – The method for including the dose from concrete fill is discussed in response to PAB 4(a). The dose is included with the other dose components for a basement (wall/floor surfaces, penetration and embedded pipe). The dose from concrete is assigned by calculating a SOF corresponding to the fixed dose value. As an example, the SOF for the concrete fill dose assigned to the Auxiliary Building (1.01 mrem/yr from Draft LTP Revision 1, section 6.16) the SOF is calculated as 1.01/25 = 0.04. The concrete fill SOF is then added to the SOF values for surfaces, penetrations, and embedded pipe to calculate the total basement dose.

The dose attributed to basement fill is a Basement-specific value that is only applied if concrete debris is used as fill in a given basement. As described in TSD 17-004, because the concrete fill dose is basement-specific, the concrete fill dose is accounted for as one of the dose components in each basement during the calculation of the total dose for each Basement. Note that the calculation of the dose from clean concrete fill assumes that the entire basement is filled with concrete. As a conservative measure, 100% of the entire concrete fill dose is assigned regardless of the percentage of concrete fill used.

ZSRP Response (PAB 4e) – Detailed descriptions, definitions of terms, and methods for calculating the compliance dose in accordance with Equation 6-5 (Equation 6-11 in LTP Chapter 6 Rev 1) are provided in TSD 17-004. Zion*Solutions* procedure ZS-LT-300-001-004 will be revised to include the methods for calculating the final compliance dose in accordance with Equation 6-11 as described in TSD 17-004 as well as the requirement to include the documentation of the compliance calculation in the final FSS Report for the site. A brief summary description of the terms in Equation 6-11 has also been added to LTP Chapter 6, Rev 1, section 6.17.1.

5. **NRC Comment (PAB 5)**: Additional information is needed on the process for determining the total basement inventory from STS data in basements with multiple survey units, as well as the Containment and Fuel Basements.

Basis: RAI PAB 10 (as received in July 2016) points to a procedure (ZS-LT-300-001-004, Rev 2), but Rev 2 of this procedure does not reflect the current status of the RAI response. While ZS-LT-300-001-004, Rev 2, discusses that the total mean dose inventory in each basement, considering all STS units contained within the basement, must be below 25 mrem/yr, the text does not mention allocating a fraction of the BIL to the survey units in such cases (see RAI PAB 15 of ZS-2016-0022: Enclosure 1), and the tables in the Attachments do not seem to accommodate this scenario. ZS-LT-300-001-004, Rev 2, Attachment 12, STS Preliminary Survey Data Summary shows a column with BIL in units of (pCi/m2) and the footnote states the column is taken from Attachment 5 which is the BIL divided by the Area of the basement. The Attachments and footnotes in the procedure do not seem to account for the scenario where there are multiple survey units in one basement. In that scenario the BIL would be a fraction of the BIL, and the Area would be the surface area of the survey unit as opposed to the basement. The procedure also does not list the basis for the Areas used in BIL/Area or how the Area of the embedded pipes is determined. These details should be enumerated either in the LTP revision or the procedure. It would be preferable for the RAI response to enumerate the revisions to the LTP as opposed to pointing to a procedure, which may be subsequently revised.

Furthermore, the response to RAI PAB 10 (as received in July 2016) discusses an additional check for the SFP inventory to ensure compliance. "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 response states that SFP/Transfer Canal dose factors and BILs will be adjusted to be higher of either Containment or SFP/Transfer Canal values to reduce potential for confusion. The response also states that a NOTE will be added to the procedure ZS-LT-300-001-004 in "FRS Data Assessment" 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. However, it is unclear what the text of the NOTE will be and whether it will appropriately reflect the RAI response. For example, simply adjusting the SFP BILs to be the higher value of either Containment or SFP BIL alone will not ensure compliance since the additional test of comparing the summed inventory to the Containment BILs is also required.

Path Forward:

a. Provide the revisions to the LTP (or an updated revision of ZS-LT-300-001-004) which clearly describes how the compliance is shown from FRS data for basements with multiple survey units as well as the Containment and SFP basements.

ZSRP Response (PAB 5a) – The STS approach using inventory has been converted to a traditional MARSSIM FSS approach using DCGLs. DCGLs were derived from the Basement

Dose Factors provided in LTP Revision 0. The calculation of DCGLs for basement survey units is provided in Zion*Solutions* TSD 14-010, Revision 4, "RESRAD Dose Assessment for Basement Fill Model" which is provided with these RAI responses. A FSS will be conducted independently in each basement survey unit to demonstrate that the concentrations of residual radioactivity are equal to or below the Operational DCGLs.

In Basement Structures, there may be more than one dose component (e.g. concrete or metal surfaces, penetrations, embedded pipe, concrete fill). See TSD 17-004 for a detailed description of the process for summing the dose from multiple surface survey units, as well as the dose from penetration survey units, embedded pipe survey units and concrete fill in a given basement.

ZSRP LTP Chapter 5 Rev 1 contains the methods described in TSD 17-004 for demonstrating compliance for basements with multiple survey surface survey units as well as penetration and embedded pipe survey units. Procedure ZS-LT-300-001-004 will also be revised to clearly describe the compliance dose calculations as described in TSD 17-004.

6. **NRC Comment (PAB 6)**: It is not clear how the judgmental samples are being incorporated in the calculation of the mean inventory fraction in the basements.

Basis: In the response to RAI PAB 10c (as provided in July 2016), it was stated that "Judgmental sample results will be included in the calculation of the Mean Inventory Fraction". However, the manner in which these samples will be included in the calculation of the Mean Inventory Fraction was not provided. It is not clear if the judgmental samples will be simply arithmetically averaged with the systematic samples, if a weighted average will be used to account for the relative area represented by the different samples, or if some other method will be used.

Additionally, as is discussed in more detail in this document in RAI HP 13, the process for replacing sample data after remediation/resurvey is not clear. If an area is remediated and resurveyed, it is not clear what population of data will be used in determining the Mean Inventory Fraction.

Path Forward:

a. Provide a description of how the judgmental samples will be used in the calculation of the Mean Inventory Fraction. Include a sample calculation and a description of how the relative area represented by a sample will be determined. Provide justification that the method used to determine the Mean Inventory Fraction will appropriately calculate the inventory in the basements, including inventory from elevated areas of activity.

b. Provide a description of the process for determining the population of data that will be used in calculating the Mean Inventory Fraction in survey units in which remediation/resurvey occurs.

c. If a method other than the Mean Inventory Fraction will be used to demonstrate compliance with the criteria for unrestricted use in 10 CFR 20.1402 in the basements, provide a justification that the method adequately considers the potential dose from elevated areas.

ZSRP Response (PAB 6a) – Section 5.4.5 of LTP Rev 1, Chapter 5 has been revised to state, "Any areas identified that have the potential to exceed the Operational $DCGL_B$ by ISOCS measurement during the performance of CVS in these areas will be remediated. Any areas of elevated activity that could potentially approach the Operational $DCGL_B$ will be identified as a location for a judgmental ISOCS measurement during FSS". Section 5.5.2.1.1 of LTP Rev 1, Chapter 5 will be deleted in its entirety.

The definition of a judgmental measurement in MARSSIM states that a judgmental measurement and/or sample will not be included in the statistical evaluation of the survey unit data. However, ZSRP will incorporate the dose from "elevated areas" into the calculation of the mean SOF using Equation 5-5. Areas of elevated activity will be defined as any area identified and/or bounded by measurements/samples (systematic or judgmental) that exceeds the Operational DCGL but is less than the Base Case DCGL. Once the survey data set passes the Sign Test (using the Operational DCGL), the mean radionuclide activity for each ROC from systematic measurements along with any identified elevated areas (identified and/or bounded by systematic and/or judgmental measurements/samples) will be used with the Base Case DCGLs to derive a SOF for the survey unit. The dose from residual radioactivity assigned to the FSS unit is the SOF multiplied by 25 mrem/yr.

The following equation reproduces Equation 5-5 from LTP Chapter 5 and is applicable to basement surfaces.

$$SOF_B = \sum_{i=1}^{n} \frac{Mean\ Conc_{B_{ROC_i}}}{Base\ Case\ DCGL_{B_{ROC_i}}} + \frac{\left(Elev\ Conc_{B_{ROC_i}} - Mean\ Conc_{B_{ROC_i}}\right)}{\left[Base\ Case\ DCGL_{B_{ROC_i}} \times \left(\frac{SA_{SU}}{SA_{Elev}}\right)\right]}$$

where:

SOF_B	=	SOF for structural surface survey unit within a Basement using Base Case DCGLs
$Mean\ Conc_{B\ ROCi}$	=	Mean concentration for the systematic measurements taken during the FSS of structural surface in survey unit for each ROC_i
$Base\ Case\ DCGL_{B\ ROCi}$	=	Base Case DCGL for structural surfaces ($DCGL_B$) for each ROC_i
$Elev\ Conc_{B\ ROCi}$	=	Concentration for ROC_i in any identified elevated area (systematic or judgmental)
SA_{Elev}	=	surface area of the elevated area
SA_{SU}	=	adjusted surface area of FSS unit for DCGL calculation

As a hypothetical example, assume FSS was performed on the structural survey unit for the WWTF, a Class 1 structure with a surface area of 1,124 m^2. For the sake of simplicity, it is assumed that there is only one ROC, in this case, Cs-137, which has a Base Case DCGL of 2.93E+06 pCi/m^2. In accordance with LTP Chapter 5, Table 5-19, 71 systematic measurements are required for the FSS of the WWTF however, for this example, 14 systematic measurements are assumed. Using the Operational DCGL for Cs-137 (5.63E+05 pCi/m^2), 13 of the 14 measurements had a SOF of less than one, with the 14^{th} measurement exhibiting a Cs-137 concentration of 6.19 E+05 pCi/m^2 and a SOF of 1.1. The average Cs-137 concentration for the other 13 samples was 2.34 E+05 pCi/m^2. The survey unit passes the Sign Test and the mean SOF using the Operational DCGL is 0.465. Two (2) additional judgmental measurements were taken to bound the elevated area identified by the 14^{th} measurement. Cs-137 concentration in the two judgmental samples were measured at 5.71 E+05 pCi/m^2 and 7.25 E+05 pCi/m^2. The bounded area of the elevated area was estimated at 84 m^2. The calculation for the SOF_B for the survey unit then becomes;

$$SOF_B = \left(\frac{2.34E^{+05}}{2.96E^{+06}}\right) + \left(\frac{[7.25E^{+05} - 2.34E^{+05}]}{2.96E^{+06} \times [^{1124}/_{84}]}\right) = 0.0915$$

The dose from residual radioactivity assigned to the FSS unit is the SOF of 0.0915 multiplied by 25 mrem/yr or 2.288 mrem/yr.

If the result of a judgmental FSS measurement(s) and/or sample(s) in a Class 1 or Class 2 survey unit exceeds the Operational DCGL, or 50% of the Operational DCGL in a Class 3 survey unit, then the investigation process as specified in LTP Chapter 5, section 5.6.4.6 will be implemented. As discussed in the response to PAB 7, and described in LTP Revision 1, Chapter 6, section 6.6.9, for all media except soils, if the SOF for a sample/measurement(s) exceeds one when using Base Case DCGLs, then remediation will be required.

ZSRP Response (PAB 6b) – Remediation, reclassification and resurvey as part of the FSS investigation process is presented in LTP Rev 1, Chapter 5, sections 5.6.4.6.1 and 5.6.4.6.2. In revision 1 of the LTP, the FSS investigation process presented in these sections is now applicable to both open land and basement structure survey units. In addition, these sections have been revised to be consistent with MARSSIM sections 5.5.2.6 and 8.5.3. In accordance with MARSSIM section 5.6.4.6.1, the DQO process will be used as appropriate to evaluate the reclassification/resurvey action if an investigation level is exceeded. In Class 1 open land survey units, any areas of elevated residual radioactivity above the $DCGL_{EMC}$ will be remediated to reduce the residual radioactivity to acceptable levels. As stated in Zion Response to PAB 6a, any ISOCS result that exceeds the Base Case DCGL will be remediated. If an area is remediated, then measurements will be taken to ensure that the remediation was sufficient (Remedial Action Support Survey). If the remediated area is small, then additional FSS may not be needed to demonstrate compliance with the release criterion. The original FSS and the results of the post-remediation surveys may be sufficient. If the extent of the elevated area relative to the total area of the survey unit is significant, then the entire survey unit may require a new FSS using a new survey design. If a survey unit is re-classified (in whole or in part), or if remediation is performed within a survey unit, then the affected areas are subject to re-survey. Any re-surveys will be designed and performed as specified in this plan based on the appropriate classification of the survey unit. That is, if a survey unit is re-classified or a new survey unit is created, the survey design will be based on the new classification. In all cases, the mean SOF for the survey unit will be determined based on the systematic population for the statistical survey design (including the results of any elevated judgmental samples using an area-weighted average and, for soil only, the results of the EMC test if performed). This is presented in LTP Rev 1, Chapter 5, sections 5.5.4 and 5.10.

ZSRP Response (PAB 6c) –Compliance with the dose criterion from 10 CFR 20.1402 will be demonstrated by the mean SOF for the survey units including "elevated" (as defined in ZSRP response to PAB 6a) judgmental sample results using an area-weighted average and, for soil only, the results of the EMC test if applicable.

7. **NRC Comment (PAB 7)**: Additional justification is needed to demonstrate that the BFM adequately assesses the potential dose from inventory in the basements.

Basis: RAI PAB 11 (as requested in May 2016) requested justification that the basement fill model (BFM) adequately accounts for the dose from embedded piping and any other inventory that could be released to the subsurface at higher concentrations than predicted by the BFM. Although the BFM model does not contain any flow, there could be movement of water between the basements and from the basements to the subsurface in reality. As was noted in the RAI, movement of water through pipes that have a hydraulic connectivity to the subsurface could lead to a higher groundwater concentration than was predicted by the BFM. Additionally, inventory in or near a penetration or perforation between basements could move into the adjacent basement due to movement of water between the basements, resulting in an increased concentration in the adjacent basement and a lower concentration in the basement in which the inventory originated.

The RAI response discusses the potential dose from embedded piping to remain in the Auxiliary Building and Turbine Building, stating that embedded piping in these buildings terminates in sumps with no outlet, and that the Auxiliary Building embedded piping openings will be grouted. This response does not fully address the question for the reasons noted below.

The grouting of the pipe openings will provide some protection against water entering the pipes in the near term. However, the NRC staff does not find that this will be completely effective at preventing water from flowing into or through the pipes in the long term. Absent the entire length of the piping being grouted, the grout at the opening could fail and water could enter the pipes. If the pipes all terminate in sumps with no outlet, then the inventory within them may be less likely to release outside the basement before contacting the basement fill, but these sumps or termination points should be evaluated as part of (or bounded by) the worst-case drilling scenario (see RAI PAB 9 in this document).

The RAI response also did not provide sufficient justification that there are no other mechanisms for inventory to be released to the subsurface at higher concentrations than predicted by the BFM. For example, it is not clear if there are fast pathways to the subsurface through perforations, which may also allow mixing or combining of inventories between basements. Several scenarios for potential perforations in the basements were provided in TSD 14-032. It is not clear which of these scenarios ZSRP intends to use during decommissioning.

Also, as noted in RAI HP 8 in this document, there are several inconsistencies in information ZSRP has provided on the embedded piping and penetrations. It is not clear if all piping will be removed from penetrations, or if remaining piping will be fully grouted. If not, then the inventory in the piping could be released to the subsurface without contacting the basement fill, which would result in concentrations in the groundwater that are higher than predicted by the BFM.

Additionally, the potential dose from embedded piping and any other inventory that could be released to the subsurface at higher concentrations than predicted by the BFM was not addressed in the RAI response for basements other than the Auxiliary Building and Turbine Building.

Path Forward:

a. Provide a justification that the dose modeling adequately accounts for the dose from the embedded piping and penetrations, floor drains, sumps and any other inventory that could result in water concentrations higher than predicted by the BFM for all basements. The response should include the potential release for this type of inventory for the basements not addressed in the previous RAI response (i.e., basements other than the Auxiliary Building and Turbine Building basements).

b. Provide information on any perforations that will be placed in the basement walls between the walls and the subsurface, if applicable, and provide a justification that these perforations will not lead to a concentration of radionuclides in the water that is higher than predicted by the BFM.

ZSRP Response (PAB 7a) –

In response to General RAI 1, the inventory based approach for the assessment of the end-state source term in the BFM (i.e., the use of BIL) was converted to a DCGL approach. See TSD 14-010, Revision 4, sections 2.5, 9, and 10 and LTP Revision 1 section 6.6.8. DCGLs were calculated for basement surfaces (walls and floors), penetrations, and embedded pipe. However, all ISOCSs measurements must be less than the DCGL; area factors are not applicable to ISOCS FSS measurements. Any ISOCS FSS result that exceeds the Base Case DCGL will be remediated. In regards to embedded pipe and penetrations, remediation and grouting action levels have been established. The wall/floor surface DCGL calculation process and action levels for remediation and grouting of penetrations and embedded pipe will ensure that water concentrations will not be higher than predicted by the BFM. Details are provided below.

The following definitions are provided for clarity.

- An embedded pipe is defined as a pipe that runs vertically through a concrete wall or horizontally through a concrete floor and is contained within a given building. The Auxiliary Building and Turbine Building floor drains are examples of embedded pipe.
- A penetration is defined as a remaining system pipe (or the metal sleeve if the system pipe is removed, or concrete if the sleeve is removed or no sleeve was present) that runs through a concrete wall and/or floor, between two buildings, and is open at the wall or floor surface of each building. A penetration could also be a pipe that runs through a concrete wall and/or floor and opens to a building on one end and the outside ground on the other end. Note that all penetrations below 580 foot elevation that open to the ground will be grouted.

- Surface DCGLs apply to the wall and floor surfaces of the basements and includes concrete and the steel liner for Containment. In the context of the DCGL for concrete, that the term "surface" includes all activity at depth projected into the first 0.5inch layer of concrete. The steel liner will not have contamination at depth.
- Sump walls and floors are considered surfaces and therefore the surface DCGLs will be applied to sumps.

The approach to the DCGL calculation for the wall/floor surfaces is described here to provide context to the discussion of penetration and embedded pipe DCGLs and action levels for remediation and grouting. The calculations of the surface DCGLs assume uniform distribution of activity over all wall and floor surfaces. As described in Zion LTP Rev 1, section 6.6.9, there are no AFs applicable to ISOCS measurements during the FSS of basement surfaces which means that any ISOCS measurement exceeding the Base Case DCGL will be remediated.

Embedded Pipe

A separate DCGL was calculated for each embedded pipe survey unit (see LTP Rev1, section 6.13 for details of embedded pipe DCGL calculation). The total internal surface area of the embedded pipes in a given basement is less than the total wall/floor surface area of the basement containing them. This leads to the embedded pipe DCGL exceeding the wall/floor surface DCGL. The following remediation and grouting action levels will be applied to measurements in embedded pipe.. The action levels are reproduced from LTP Rev 1 Chapter 5 section 5.5.5which contains an explanation of the terms and the Tables referenced.

- *If maximum activity exceeds the Base Case $DCGL_{EP}$ from Table 5-11 (SOF >1), then remediation will be performed.*
- *If the maximum activity in an embedded pipe exceeds the surface Operational $DCGL_B$ from Table 5-4 (SOF>1) in the building that contains it, but is below the Base Case $DCGL_{EP}$ from Table 5-12, then the embedded pipe will be remediated or grouted.*
- *If an embedded pipe is remediated and the maximum activity continues to exceed the surface Operational $DCGL_B$ from Table 5-4 (SOF>1), but is less than the Operational $DCGL_{EP}$, then the embedded pipe will be grouted.*
- *If the maximum activity is below the surface Operational $DCGL_B$ from Table 5-4, then grouting of the pipe will not be required.*

The remediation and grouting action levels ensure that the residual radioactivity in the embedded pipe will either not exceed the wall/floor surface Operational DCGL or that the activity released from the embedded pipe to the floor surface, after grouting, will be well below that which could be released from a wall/floor surface at the Operational DCGL concentration (see discussion below regarding the effect of grouting on release of activity from pipes). The embedded pipe source term will therefore not result in water concentrations higher than predicted by the BFM.

Grouting reduces the potential release of activity by several orders of magnitude. Pipes will be fully grouted to refusal as opposed to only plugged near the pipe opening. As an example of the application of the remediation and grouting action levels, and the impact of grouting, consider the Auxiliary Basement Floor Drains. Although Operational DCGLs were not in place at the time the Auxiliary Basement Floor Drains were grouted, these drains did contain concentrations greater than the wall/floor surface Operational DCGLs but less than the Floor Drain Base Case DCGLs. The drains were remediated but after remediation the maximum activity still exceeded the wall/floor Operational DCGL. The drains were grouted to refusal. The release record for the Auxiliary Basement Floor Drains survey unit was previously provided to NRC (Zion Station Restoration Project Final Status Survey Release Record, Auxiliary Building 542 foot Embedded Floor Drain Survey Unit 05119A). The release of projected activity from the grouted floor drains was calculated in Attachment F of TSD 14-009, Revision 3, "Brookhaven National Laboratory: Evaluation of Maximum Radionuclide Groundwater Concentrations for Basement Fill Model". The calculation assumed a one foot length of grout in the pipe and that all the residual radioactivity in the pipe is located directly under the one foot grout layer. This is very conservative given that the length of the drain sections range from 18 to 188 feet and the entire drain system was grouted to refusal. The vast majority of the activity in the pipes would have a much longer length of grout to move through than 1 foot. The minimum depth to an identified obstruction in a grouted pipe to date (which may or may not cause refusal of grout flow) has been six feet.

Assuming that 100% of the total inventory in the Auxiliary Basement Floor Drains is contained in one drain and all of the inventory is located directly under a one foot thick layer of grout (from the floor surface), the fractional release is calculated in TSD 14-009, Revision 3, Attachment F. Using the TSD 14-009 fractional release values for each ROC, the total inventory released from the Auxiliary Floor Drains is calculated by multiplying the fractional release by the total inventory contained in the drains. The total inventory released from the pipe to floor surface was then compared to the wall/floor surface DCGL for each ROC, which is the total activity that can remain in 1 m^2 (pCi/m^2). The result was a maximum total inventory release of less than 0.05% of the wall/floor surface Base Case DCGL for Cs-137 (and lower for the other ROC). This very small percentage and will not lead to water concentrations higher than predicted by the BFM. Note that although the Fraction Release was slightly higher for Ni-63, the fraction of the Base Case DCGL was the greatest for Cs-137 due to much lower DCGLs. See table below.

Release Fraction Through 1 foot of Grout in Pipe[1]

	Floor Drain Total Inventory mCi	Fractional Release	Total Inventory Released to Floor Surface pCi	Auxiliary Basement Wall/Floor DCGL pCi/m^2	Auxiliary Floor Drains Total Inventory Release Fraction of DCGL
Co-60	96.4	<1E-30	9.64E-20	3.04E+08	3.17E-28
Ni-63	48.7	8.28E-07	4.03E+04	1.15E+10	3.51E-06
Sr-90	0.07	1.19E-16	8.33E-09	9.98E+06	8.35E-16
Cs-134	0.03	1.38E-25	4.14E-18	2.11E+08	1.96E-26
Cs-137	99.7	4.98E-07	4.97E+04	1.11E+08	4.47E-04

(1) From TSD 14-009, Revision 3

The Turbine Building floor drains have also undergone FSS and found to contain a maximum concentration well below the Turbine Basement wall/floor surface DCGLs (SOF <1) and were therefore not grouted.

As described in in TSD 14-016 “Description of Embedded Piping, Penetrations and Buried Pipe to Remain in Zion End State” (which was submitted to NRC with these RAI responses), additional embedded pipe will also remain in the Unit and Unit 2 Steam Tunnels (floor drains) and Containment (Tendon Tunnel Floor Drains (including Buttress Pits) and Unit 1 and Unit 2 IC Sump pipes in the Under Vessel areas).

<u>Penetrations</u>

There are penetrations between the basements which were incorporated into the assessments provided in CRA report “Simulation of Post-Demolition Saturation of Foundation Fill Using a Foundation Water Flow Model” (CRA Report) (previously provided to NRC). Figure 10 of the CRA report shows the general clusters of the penetration locations. The spreadsheet supporting Figure 10 of the CRA report was previously provided to NRC. A more detailed description an list of penetrations in both walls and floors between all basements is provided in TSD 14-016. The majority of penetrations in the End State are expected to be comprised of the sleeves in walls that remain after the system piping is removed and therefore, to contain low levels of residual radioactivity.

A separate DCGL was calculated for each group of penetrations that are open to a given basement. Each group is designated as a survey unit. Consistent with the definition of a survey unit, the penetration DCGLs represent the concentration that, if uniformly distributed throughout the interior surfaces of all penetrations in a survey unit, would result in 25 mrem/yr assuming zero activity in all other BFM sources (wall/floor surfaces, embedded pipe and clean fill). The DCGL assumes that the activity in the penetrations is released to the basement and mixed in the same manner as the activity released from walls and floors. See LTP Rev 1, section 6.14 for details of penetration survey units and DCGL calculation.

The dose from penetrations is added to both basements that the penetrations open to. By definition, a penetration traverses a wall or floor and is open to two basements. To ensure conservatism, 100% of the activity in penetrations is added to both basements simultaneously to address the fact that the activity could release to either basement. There are a number of penetrations that traverse a wall or floor and then into ground. These are designated in TSD 14-016 as "Building to Yard" penetrations. There are two types of Building to Yard penetrations;1) a penetration that traverses a wall and is cut on both the building side and the ground side of the wall, and 2) a penetration that traverses a wall and/or floor and is connected to a buried pipe that remains and opens to the ground at some point. All Building to Yard penetrations that connect to a buried pipe will be required to meet the buried pipe DCGL. All Building to Yard penetrations below 580 foot elevation, whether attached to a buried pipe or cut at the ground side of the wall, will be grouted.

The internal surface areas of the penetrations are smaller than the surface areas of the wall/floor surface survey units for the basements that the penetrations open to. This results in penetration DCGLs that are higher than the DCGL for the wall/floor surfaces adjacent to the penetration. If the penetration DCGLs were significantly higher than the wall DCGLs, one could envision the possibility of water concentrations exceeding the concentrations predicted by the BFM (perhaps in localized areas or through a "fast pathway"). To eliminate this potential, action levels are established for remediation and grouting.

Action levels for remediation and grouting of penetrations are the same as described above for embedded pipe with an adjustment to the lower action level to account for the fact that a penetration interfaces two basements. The action levels are reproduced from LTP Rev 1 Chapter 5 section 5.5.5 which contains an explanation of the terms and the tables referenced.

- *If maximum activity exceeds the Base Case $DCGL_{PN}$ from Table 5-13 (SOF >1), then remediation will be performed.*
- *If the maximum activity in a penetration exceeds the most limiting Operational $DCGL_B$ from Table 5-4 of the two basements where a penetrations interface (SOF>1), but is below the Base Case $DCGL_{PN}$ from Table 5-13, then the penetration will be remediated or grouted.*
- *If a penetration is remediated and the maximum activity continues to exceed the most limiting Operational $DCGL_B$ from Table 5-4 of the two basements where a penetrations interface (SOF>1), but is less than the Operational $DCGL_{PN}$, then the penetration will be grouted.*
- *If the maximum activity is below the surface Operational $DCGL_B$ from Table 5-4, then grouting of the penetration will not be required.*

As discussed above in the context of the Auxiliary Building floor drains, the fractional release through one foot of grout is 8.28E-07 for Ni-63 and less for the other ROC. Grouting a penetration will result in the same fractional release and ensures that activity released from a grouted penetration will be orders of magnitude below the activity released from adjacent walls assuming concentrations equal to the wall/floor surface DCGL.

In conclusion, the approach to calculating the wall/floor surface DCGLs and the requirement that no FSS individual ISOCS measurement can exceed the Base Case DCGL, with the mean limited to the Operational DCGL, ensures that elevated areas of residual radioactivity will not be present that could cause water concentrations to be higher than predicted by the BFM. In addition, because the DCGL calculation requires uniform distribution of activity over all wall/floor surfaces, if residual radioactivity is primarily located on the floors, as expected, dose cannot exceed 25 mrem/yr. For example, as discussed above, if activity were uniformly distributed over the Auxiliary Building floor at the DCGL concentration, the dose from the floor would be limited to 9 mrem/yr (36% of 25 mrem/yr) because the floor surface area is 36% of the total wall/floor surface area of the Auxiliary Building. The use of remediation and grouting action levels for penetrations and embedded pipe ensures that either the concentrations in the pipes will be less than the wall/floor surface Operational DCGL or the pipe will be grouted. This ensures that the release of residual radioactivity from penetrations and embedded pipe will be well below the release rate from the adjacent wall/floor surfaces that would occur if activity were present at a concentration equal to the wall/floor surface Operational DCGL.

The requirement for activity to be uniformly distributed over wall/floor surfaces, and to limit release from penetration and embedded pipe source terms to levels below the release which could occur from adjacent wall/floor surface, ensures that there is no condition that could result in water concentrations higher than predicted by the BFM.

ZSRP Response (PAB 7b) – A number of options are presented in 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) for perforating the basements to keep water levels at approximately 579 foot elevation. ZSRP has selected Scenario 3 from TSD 14-032, which entails breaching (perforating) the western most portion of the north foundation wall of the Unit 2 Steam Tunnel. A 15-feet wide section of the wall extending from the top of the wall after demolition (588' AMSL) to an elevation of 580 feet AMSL (i.e., one foot above the exterior water table) will be removed to create the "perforation".

The flow of activity from the basements through the perforation in the Steam Tunnel wall was evaluated in TSD 14-009, Revision 3, Attachment E. The DUST-MS model was used in the same manner as applied to calculate groundwater concentrations in the main body of the report. Water was assumed to flow from Containment through the Steam Tunnel to a well located two meters from the Steam Tunnel wall. The water exits the Steam Tunnel at the 580 foot elevation, which is the top of the water table, and immediately mixes with groundwater flow moving perpendicular to the Steam Tunnel wall. As a conservative assumption, no horizontal or vertical dispersion and mixing is assumed. Relative source terms were used based on Containment Groundwater DCGLs and known levels of residual radioactivity based on Turbine Basement FSS results (Steam Tunnels are part of the Turbine basement). The ratio of peak water concentration in Well located outside of the Steam Tunnel to the peak water concentration Containment was calculated. The results are reported in Table E-3 in TSD 14-009 which is reproduced below. The peak water concentrations in the well are always lower than the peak concentrations in Containment calculated using the BFM as seen in the last column of Table E-3.

TSD 14-009, Rev 3, Table E-3 Peak Concentration in each building and the Well located adjacent to the engineered opening in the Steam Tunnel with source term equal to the Groundwater DCGL

	Peak Concentration (pCi/L)			
	Containment	Steam Tunnel	Well	Ratio Well to Containment
H-3	1.00E-03	8.52E-04	7.63E-04	0.76
Co-60	2.87E-08	2.88E-09	7.29E-10	0.025
Ni-63	2.10E-06	1.82E-06	1.67E-06	0.80
Sr-90	2.17E-05	2.09E-05	2.01E-05	0.93
Cs-134	7.61E-07	6.63E-08	1.03E-08	0.014
Cs-137	2.73E-06	2.03E-06	1.70E-06	0.62
Eu-152	1.18E-07	4.26E-08	2.09E-08	0.18
Eu-154	9.27E-08	2.06E-08	6.97E-09	0.075

TSD 14-009, Revision 3, Attachment I, provides a second flow simulation using the same methods described in Attachment E but replacing the Groundwater DCGL with the total Basement DCGL ($DCGL_B$). The $DCGL_B$ includes both the groundwater and drilling spoils dose. See Zion LTP Rev 1, section 6.6.8 for discussion of the DCGL calculations. The groundwater concentrations are by definition equal for all basements when surface concentrations in each basement are equal to the groundwater DCGLs only. However, the drilling spoils dose will vary as a function of basement geometry assuming equal fill concentrations. Therefore, when the $DCGL_B$ is used as the source term, the relative maximum groundwater concentrations will vary between basements. The flow simulation results using the $DCGL_B$ are summarized in TSD 14-009, Revision 3, Table I-8 which is reproduced below. As seen in Table I-8, the peak Well concentrations are always lower than the peak Containment concentration calculated using the BFM.

TSD 14-009, Rev 3, Table I-8 Ratio of peak concentrations in Containment, Steam Tunnel and Well as compared to the mixing bath model for each building with source term at $DCGL_B$

Nuclide	Containment	Steam Tunnel	Well (1)
H-3	1.0	0.87	0.75
Co-60	1.0	0.27	0.001
Ni-63	1.0	0.88	0.79
Sr-90	1.0	0.99	0.93
Cs-134	1.0	0.09	0.01
Cs-137	1.0	0.76	0.62
Eu-152	1.0	0.44	0.17
Eu-154	1.0	0.26	0.07

(1) Ratio of Well to Containment Concentration

8. NRC Comment (PAB 8): The basis for the 2.11 factor for the SFP BIL was not clear.

Basis: In the response to RAI PAB 12 and in Rev 1 of TSD 14-021, ZSRP provided calculations of the fractions of the soil DCGLs represented by both the fill material in the basements and by the concrete. These fractions were used to calculate a potential dose from the excavation of the fill or concrete material. The RAI response states that based on these calculations an adjustment factor of 2.11 was applied to the BILs. However, the derivation of the factor of 2.11 from the potential doses was not provided.

Path Forward:

a. Provide a description of how the factor of 2.11 was generated.

ZSRP Response (PAB 8a): The statement regarding the factor of 2.11 for the SFP BIL in RAI PAB 12 was a typographical error in that it was inadvertently retained from a draft version of the RAI response. The 2.11 factor referred to a draft result for the calculation of the dose from excavation of SFP/Transfer Canal fill material in the Alternate Scenario of Large Scale Excavation in TSD 14-021, Revision 1 which provided a dose of 52.83 (2.11 times the 25 mrem/yr limit).

The text of the RAI PAB 12 response provides the correct dose results from the final version of TSD 14-021, Revision 1, (previously provided to NRC) "*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.*" Because the final dose from the Alternate Scenario was very near 25 mrem/yr and likely below when area factors are considered (see TSD 14-021, Table 26), no correction factor was applied to the SFP/Transfer Canal BFM Dose Factors (or corresponding DCGLs).

The SFP/Transfer Canal dose for the Alternate Scenario of Large Scale Excavation of fill material was also assessed at the Operational DCGL concentrations provide in TSD 17-004 (and listed in LTP Chapter5 Rev 1 Table 5-4) which are the actual maximum mean concentrations that will be allowed to remain at license termination. The resulting dose was reduced from 31.40 mrem/yr to 14.07 mrem/yr. See LTP Chapter 6, Rev 1, section 6.7 for additional discussion of this dose assessment and TSD 14-010, Revision 5 for calculation details.

9. **NRC Comment (PAB 9)**: Additional information is needed on the potential dose to a hypothetical individual who drills through radiologically contaminated embedded piping or penetrations, floor drains, sumps, and equipment associated with the pipes.

Basis: In RAI PAB 13 (as provided to the licensee in May 2016), the NRC staff requested information on the potential dose from an elevated area in a pipe. In the response, ZSRP stated that the calculated dose from the activity in 2 inch and 6 inch equipment drains was 23 mrem/yr and 2 mrem/yr respectively. However, the details of this calculation was not provided in either the RAI response or the associated Technical Support Document (TSD 14-021 Rev 1). In particular, it is not clear what activity was assumed for each of the pipes and how this activity compares to the maximum activity that is expected to remain in the pipes following decommissioning. Additionally, it is not clear what amount of piping material was assumed to be excavated and how much dilution with overburden materials was assumed. Without this information, it is not possible for the NRC staff to evaluate the appropriateness of the calculation and whether the calculated doses adequately evaluate or bound the potential dose.

Path Forward:

a. Provide details on the assumptions included in the calculation of dose based on drilling through equipment drains described in the response to RAI PAB 13. Include the inventory or concentration assumed in the pipes, the amount of piping assumed to be excavated, and the amount of dilution from mixing with overburden material that was assumed. Also, provide details on how the assumed inventory compares to maximum activity remaining in embedded piping or penetrations, floor drains, sumps, and equipment associated with the pipes following decommissioning. Provide a basis for how it is known that the assumed inventory bounds the potential dose from the drilling spoils scenario.

b. Alternatively, generate a criteria for the maximum concentration of radionuclides allowed to remain in elevated areas in embedded piping or penetrations, floor drains, sumps, and equipment associated with the pipes and provide an assessment of the dose associated with this activity. Provide a description of the survey methodology that will be used to ensure this criteria is met.

ZSRP Response (PAB 9a): There are two categories of pipe to remain in the basement structures; embedded pipe and penetrations (definitions provided in the response to RAI PAB 7)

The equipment drains discussed in RAI PAB 13 (May 2016) are two inches below the floor surface in the Auxiliary Building floor concrete and above the first layer of heavy steel reinforcement (1.38 inch diameter rebar at eight inches below the floor). Because the drains are shallow, the remediation plan has been changed to remove all of the equipment drains included in the drilling dose assessment described in RAI PAB 13 (May 2016). The source term will be removed along with the equipment drains and therefore, a description of the equipment drain source term is no longer considered germane. However, for information, the assumptions included in the calculation of dose based on drilling through equipment drains are discussed below.

The drilling spoils calculation for pipe used the same well-drilling parameters applied to the drilling spoils dose calculation for residual radioactivity in concrete (TSD 14-021, Revision 1, Table 2). As seen in Table 2, the mixing volume is the 8-inch diameter column of soil, directly above the pipe, from the basement floor to the ground surface. The concrete source term was replaced by the pipe source term. The drill bit is assumed to be 8 inches in diameter and it is assumed to penetrate and drill through the pipe. The pipe source term was conservatively determined by calculating the internal surface area of an 8-inch length of pipe. The total activity in the 8-inch length of pipe is assumed to mix with the column of soil brought up as the drilling spoils and be spread onto the ground surface.

An alternate drilling spoils scenario was evaluated in TSD 14-010, Revision 5 (which has been submitted to NRC) for all embedded pipe and penetrations, as well as basement surfaces for completeness, to remain after license termination. The pipes and penetrations are embedded in concrete floors and walls in various depths and geometries.

The alternate drilling spoils scenario assumes:

a) all residual radioactivity remains in the embedded pipe, penetrations and concrete after license termination,
b) worst-case radionuclide concentrations exist in these areas,
c) no release of the activity occurs to the fill water as is assumed in the BFM, and
d) the FSS of the Auxiliary Basement Floor Drains is complete.

Therefore, the drilling spoils dose from each individual FSS result from the Auxiliary Basement Floor Drains is evaluated up to and including the maximum dose from an individual FSS measurement. For other embedded pipe, penetrations and basement concrete, the ROC radionuclides are assumed to be present at the maximum concentrations (decay corrected) that could be hypothetically allowed to remain at license termination based on the DCGL values and the radionuclide mixtures listed in the TSD 14-019, Revision 1, Table 20 (previously submitted to NRC). The dose was calculated for the Resident Farmer and the worker (well driller).

Detailed discussion of the assumptions, inputs, equations and results for the alternate drilling spoils scenario dose assessment are provided in TSD 14-010 Revision 5. The results are provided in LTP Chapter 6 Rev 1 section 6.7. The maximum hypothetical dose for the Resident Farmer are provided in LTP Rev 1 Tables 6-28 to 6-30 which are reproduced below. The maximum hypothetical worker dose from all sources (penetrations, embedded pipe, basement surfaces) is 3.3 mrem/yr.

Reproduced from LTP Rev 1 Table 6-1 The maximum hypothetical resident farmer doses from penetrations for the Alternate Drilling Spoils Scenario (assuming well drilled 30 years after license termination)

Auxiliary (mrem/yr)	Containment (mrem/yr)	Fuel (mrem/yr)	Turbine (mrem/yr)	Crib House/ Forebay (1) (mrem/yr)	WWTF (1) (mrem/yr)
6.97	6.96	23.54	6.15	NA	NA

(1) No penetrations in Crib House/Forebay or WWTF

Reproduced from LTP Rev 1 Table 6-2 The maximum hypothetical resident farmer doses from embedded pipe for the Alternate Drilling Spoils Scenario (assuming well drilled 30 years after license termination)

Auxiliary Floor Drain (mrem/yr)	Containment IC Sump Drain (mrem/yr)	Steam Tunnel Floor Drain (mrem/yr)	Tendon Tunnel Floor Drain (mrem/yr)	Turbine Floor Drain (mrem/yr)
13.1	3.42	71.16	16.65	20.16

Reproduced from LTP Rev 1 Table 6-3 The maximum hypothetical resident farmer dose from basement surfaces for the Alternate Drilling Spoils Scenario (assuming well drilled 30 years after license termination)

Auxiliary (mrem/yr)	Containment (mrem/yr)	Fuel (mrem/yr)	Turbine (mrem/yr)	Crib House/ Forebay (mrem/yr)	WWTF (mrem/yr)
0.34	0.12	0.16	0.06	0.08	0.01

The alternate drilling spoils scenario dose for the Steam Tunnel Floor Drains is calculated to be 71.16 mrem/yr using the hypothetical maximum activity that could be allowed to remain. However, the actual levels of activity in these drains (and corresponding dose) is excepted to be orders of magnitude lower than the hypothetical maximum. The alternate drilling spoils scenario dose for all other embedded pipe, penetrations and basement surfaces are below 25 mrem/yr. Although the alternate scenario is not a compliance scenario, as a conservative measure the remediation levels for the Steam Tunnel Floor Drains will be reduced by a factor of 2.89 (71.16/25) which will reduce the maximum alternate scenario dose to 25 mrem/yr. The commitment to reduce the Steam Tunnel Floor Drain remediation level is provided in LTP Chapter 5 Rev 1 section 5.5.5.

As discussed in response to General RAI 1, DCGLs have been calculated for basement wall/floor surfaces (in this context, the term "surface" includes all activity at depth projected to the top 0.5-inch layer of concrete). The surface DCGLs include the dose from the drilling spoils scenario. The walls and floors of sumps are surfaces and the surface DCGLs will be applied, which accounts for the drilling spoils dose.

ZSRP Response (PAB 9b): The dose pathway for activity in penetrations are identical to the dose pathways applicable to activity in adjacent wall/floor surfaces. Consistent with the response to RAI PAB 7, the maximum activity allowed to remain in penetrations is linked to the DCGLs for the wall/floor surfaces to ensure that there are no elevated areas in penetrations that could result in water concentrations exceeding that predicted by the BFM.

For penetrations, if the maximum activity concentration exceeds the most limiting wall/floor surface Operational DCGL of the two basements where a penetration interfaces (SOF>1), but is below the penetration Base Case DCGL, the penetration will be grouted or remediated. If the maximum activity is below the wall/floor surface Operational DCGL after remediation, grouting is not necessary. As discussed in response to RAI PAB 7, the fractional release of activity through one foot of grout is 8.28E-07 for Ni-63 and less for the other ROC. Grouting a penetration ensures that activity released from a penetration will be orders of magnitude below the release which would occur from the surrounding walls at concentrations equal to the wall/floor surface Operational DCGL and that water concentrations will not exceed that predicted by the BFM.

If maximum activity concentration exceeds the penetration Base Case DCGL (SOF) remediation will be performed. If the maximum activity concentration exceeds the wall/floor surface Operational DCGL (SOF) after remediation, but is below the Base Case DCGL, the penetration will be grouted.

Although Operational DCGLs were not in place at the time the FSS was completed, the process described above for penetrations was in retrospect applied to embedded pipe in the Auxiliary Building and Turbine Building. The "Operational" and "Base Case" terminology is applied in this discussion for consistency with the process moving forward. The surface Operational DCGLs for the basement containing the drains were applied as opposed to the most limiting wall/floor surface Operational DCGL of the two basements where a penetration interfaces because the drains are contained in one basement. The maximum activity identified in the Turbine Building Floor Drains during FSS was less than the wall/floor Operational DCGL therefore the drains were not grouted. The Auxiliary Basement Floor Drains contained maximum activity less than the Floor Drain Base Case DCGL but greater than the Auxiliary wall/floor surface Operational DCGL. Therefore, the drains were grouted.

The potential dose from the maximum hypothetical activity that could remain in embedded pipe and penetrations was evaluated in the alternate drilling spoils scenario discussed in ZSRP response to PAB 9a.

The methods for surveying penetrations and embedded pipe are described in ZSRP responses to RAIs HP 8c and 8d.

PAB Clarifying Comment #1

Which column is Surface vs Subsurface in Table 19-20 on pg. 21 in response to PAB 7a (as received July 2016)?

ZSRP Response (Clarifying Comment PAB #1)

The third row of Table 19 and Table 20 are Surface.

PAB Clarifying Comment #2

The response to PAB 8a (as received July 2016) states, "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." Clarify whether the "final draft" of the TSD was a precursor to Revision 0 and if Revision 0 has the correct data.

ZSRP Response (Clarifying Comment PAB #2)

The 'final draft' was a precursor to TSD-011, Revision 0 which contains the correct data. Tables 5-7 and 5-8 have been corrected in Draft LTP Revision 1.

HP Zion RAIs Set 3

1. **NRC Comment (HP 1)**: HP RAI 1 and PAB 2 (as provided to the licensee in May 2016) inquired about the re-use of soils and concrete onsite and on the criteria against which these materials will be surveyed. It was noted in that RAI that "the current proposal does not clearly specify how any dose contribution from re-used soil/concrete will be considered." A licensee response was provided with regard to concrete reuse, but soil reuse has not been fully addressed.

Zion has previously indicated that Offsite Dose Calculation Manual (ODCM) criteria would be used for soil, and an evaluation of these criteria has not been provided as it relates to unrestricted use per the license termination rule (LTR) and 10 CFR 20.1402.

Additionally, the licensee's RAI response states that "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." With regard to this statement, it is worth noting that the stated definition of "residual radioactivity," as defined in 10 CFR 20.1003, indicates that a licensee is responsible for radioactivity (excluding background) from all licensed and unlicensed sources resulting from activities under the licensee's control. The entire definition is listed as follows:

"Residual radioactivity means radioactivity in structures, materials, soils, groundwater, and other media at a site resulting from activities under the licensee's control. This includes radioactivity from all licensed and unlicensed sources used by the licensee, but excludes background radiation. It also includes radioactive materials remaining at the site as a result of routine or accidental releases of radioactive material at the site and previous burials at the site, even if those burials were made in accordance with the provisions of 10 CFR part 20."

As such, an evaluation of this matter ultimately requires the licensee to definitively establish that soils dispositioned onsite are truly indistinguishable from background, or else a dose assessment based on survey results should be performed. To that end, the licensee has not established that ODCM criteria represent background for soils.

Additionally, specific details on how soils will be surveyed for reuse have not been provided to date. Previous RAI responses have only indicated that Section 5.7.1.6 of the LTP will be updated to state that "ZSRP will demonstrate that the soil is free of detectable plant-derived radioactivity through the use of a graded survey approach. Sufficient radiological surveys will be performed to demonstrate that the soils originating from impacted areas and intended for use as backfill meets the criteria for unconditional release off-site as clean material. The scope of the survey will be designed and documented using DQOs and will be comparable to the rigor of a Final Status Survey." Similar to the usage of IE Circular 81-07 criteria for concrete, the assessment of soils against "criteria for unconditional release off-site" may not be consistent with the dose based criteria of the LTR. Furthermore, the NRC will review these surveys to an FSS standard, so the design, record keeping, and reporting of results should be commensurate with an FSS.

In response to RAI PAB 2 the licensee states that "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." It is unclear whether surveys in accordance with MARSSIM will be conducted for the entire volume of reuse soil excavated and how the surveys will be conducted (e.g., will the licensee use sorters, use box counters, scan in lifts, etc.?). The response also states "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." This statement potentially implies that an FSS would only be conducted on the top layer of soil and not the entire volume of soil used to fill the void. The entire volume of reuse soil should be surveyed given that it is soil from an impacted area.

Basis:

10 CFR 20.1402 defines the dose basis for license termination

10 CFR 20.1003 defines residual radioactivity (see quoted text in comment).

Per 10 CFR 50.82, the license termination plan must include detailed plans for the final radiation survey.

Path Forward:

a. Justify the usage of ODCM criteria to meet the LTR, and in doing so, account for potential doses from reused soil remaining onsite (including applicable hard-to-detect or insignificant radionuclides).

b. Submit the survey plan for reuse soil from impacted areas as a part of the LTP, and commit to surveying the entire volume of soil appropriately. The licensee's response should demonstrate that surveys are in fact designed to the rigor of a Final Status Survey (FSS).

c. Provide details regarding when the surveys for reuse soil will be conducted (upon excavation before stockpiling, upon placement in void, etc.), as well as the instrumentation and methods used for surveying the reuse soil.

d. Commit to providing the results of soil reuse surveys in a Final Status Survey Report.

ZSRP Response (HP 1a, 1b, 1c and 1d) – ZSRP will commit to not stockpile excavated soil for re-use onsite as backfill for basement voids. However, there are excavations that have occurred and will occur in the future to remove piping or equipment, or in some cases to install piping or equipment. In these cases, after the activity is completed, the overburden soil is replaced into the hole that it was removed from. This overburden soil is not "stockpiled" for use as backfill at other site locations as the soil must return to the excavation from where it came from.

The methodology for the survey of overburden materials is described in section 5.7.1.7 of the LTP and in procedure ZS-LT-200-001-001, Radiological Assessment and Remedial Action Support Surveys. ZSRP will use the same instrumentation as specified in LTP Rev 1, Chapter 5 Table 5-26 and instrument quality as specified in the QAPP. Following is the approach ZSRP will use for the survey of overburden soils prior to re-introduction of the soil into the excavation from where it originated:

- Perform a pre-excavation gamma scan over excavation footprint and the proposed area where the excavated soil will be temporarily staged. The scan coverage will be in accordance with survey unit classification where excavation occurred. Appropriate scanning speed and scanning distance will be implemented to ensure that an MDC of 50% of the applicable soil Operational DCGL will be achieved.
- The ODCM survey criterion is no longer being utilized. Collection and analysis of soil sample(s) or portable multichannel analyzer measurement(s) will be obtained at any scan location that indicates activity in excess of 50% of the soil Operational DCGL If plant-derived residual radioactivity is positively identified in the soil in excess of 50% of the soil Operational DCGL, then the soil will not be returned to the excavation and will be dispositioned as radioactive waste.
- Intermittent gamma scans will be performed of the exposed subsurface soil in the excavation as the excavation progresses. Soils sample(s) or portable multichannel analyzer measurement(s) will be obtained at any area identified as elevated during scan of the exposed subsurface soils during excavation or the walls and floor of the excavation. If plant-derived residual radioactivity is positively identified in any excavated soil, or identified in the walls or floor of the excavation in excess of 50% of the soil Operational DCGL, then excavation will continue to remove the contaminated soil and the identified contaminated soil will be disposed of as radioactive waste.
- Section 5.1 of the LTP has been revised to state: *Radiological Assessment (RA) surveys will be performed in currently inaccessible soil areas that are exposed after removal of asphalt or concrete roadways and parking lots, rail lines, or building foundation pads (slab-on-grade). A limited number of soil samples are typically collected as a part of the RA. Ten percent (10%) of any soil samples collected during an RA in a survey area, with a minimum of one sample, will be analyzed for the full initial suite of radionuclides. Additionally, if levels of residual radioactivity in an individual soil sample exceed the Sum-of-Fractions (SOF) of 0.1 then the sample(s) will be analyzed for HTD radionuclides.*

2. **NRC Comment (HP 2)**: The response to HP RAI 1 (as received in July 2016) indicates that "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." It should be noted that the NRC considers these surveys as final radiation surveys for material left on site, as that is the disposition pathway proposed by the licensee. Additional information on the survey design is required to allow NRC staff to evaluate whether or not the licensee's unconditional release program is adequate in the context of a final radiation survey to comply with 10 CFR 20.1402 and 10 CFR 50.82.

As a response to HP RAI 1, the licensee points to ZS-LT-400-001-001 (Revision 3), "Unconditional Release of Materials, Equipment and Secondary Structures." Review of this document indicates that there is limited discussion on survey design. For example, the manner in which previous site survey/characterization data is utilized to determine the number of samples or coverage per survey is not provided the manner in which "action levels" and "discrimination limits" are used to establish the width of the gray region is not described, the determination of a relative shift is not described, the null hypotheses (and the usage of Scenario A vs. Scenario B) is not defined, and the usage of Type I and Type II decision errors is not described. Additionally, the usage of a "critical level" is mentioned in the RAI response, and ZS-LT-400-001-001 (Revision 3) indicates this level is "associated with the appropriate minimum detectable concentrations (MDCs), after correcting for applicable background interferences, as necessary." This definition does not match definitions of a critical level in MARSSIM. In particular, MARSSIM Section 6.7.1 indicates that the critical level is:

"The lower bound on the 95% detection interval defined for LD [detection limit] and is the level at which there is a 5% chance of calling a background value "greater than background." This value should be used when actually counting samples or making direct radiation measurements. Any response above this level should be considered as above background (i.e., a net positive result). This will ensure 95% detection capability for LD."

As such, the current information provided to date does not allow for an evaluation of whether or not the licensee is using a statistically based process that maintains the rigor of a final status survey.

Basis:

Per 10 CFR 50.82, the license termination plan must include detailed plans for the final radiation survey.

Path Forward:

a. Provide details on the survey design for the MARSAME surveys utilized in the licensee's unconditional release program. It should be clear that a statistically based approach is being used to determine survey coverage and numbers of discrete measurements. Per the discussion above:

- Provide details on the "critical level" discussed in ZS-LT-400-001-001 (Revision 3) and how it is used. Guidance in MARSSIM Section 6.7.1 should be utilized to define the critical level.
- Describe how null hypotheses are established and the overall survey approach (Scenario A vs. Scenario B) is established.
- Describe how characterization or previous site surveys are utilized to establish a standard deviation (σ).
- Describe how the lower bound of the gray region (LBGR) and the upper bound of the gray region (UBGR) are established, and how "action levels" and "discrimination limits" are utilized.
- Describe how a relative shift is determined and how it is utilized to determine survey coverage and discrete measurements.
- Describe how Type I and Type II decision errors are utilized in the survey design.

b. Surveys of impacted land areas and structures to remain on site are considered final radiation surveys - as such, the licensee should commit to providing results from "MARSAME" or "unconditional release" surveys performed in that context for NRC evaluation for license termination purposes.

ZSRP Response (HP 2a

<u>Response HP 2a, Bullet No. 1</u>

The term "critical level" was erroneously used in ZS-LT-400-001-001. The term "critical level" will be removed from section 4.2.2 of ZS-LT-400-001-001 and will be replaced with the more appropriate term "action level." Per Attachment 11 of ZS-LT-400-001-001, the action level is established during survey implementation. An instrument alarm set point is based on the detector background plus the MDCR and is determined in the same manner as other characterization surveys. Tables are provided in Attachment 11 for each type of detector and depict alarm set points (action levels) for a detectability value (*d'*) of 1.38 based on a 95% correct detection rate and a false positive rate of 60%. The action level will change in the field as background values change.

<u>Response to HP 2 a, Bullets 2-6</u>

The response to HP 2, Bullets 2-6 provided below uses the direct measurement results, including background, that were collected during the unconditional release survey (URS) process of selected above-grade buildings to be demolished. The unconditional release program is based on standard industry process for the unconditional release of material offsite which does not employ MARSSIM survey design process and parameters such as null hypothesis, UBGR and LBGR.

Prior to implementing a URS on a structure earmarked for demolition, the structure is divided into survey units. The scope of the URS for each structure is typically the floor, lower walls, upper walls, and ceiling in the interior and the lower walls, upper walls and roof in the exterior. Any systems, components, materials and equipment that reside in or traverse the survey unit are also subject to a URS. After reviewing the Historical Site Assessment and past radiological surveys, each survey unit is classified as Class 1, 2 or 3 based the potential for contamination to be present in excess of the release criteria (MDCR plus background). When it is determined that the survey unit is suitable for URS, and that the area will not be negatively impacted by nearby decommissioning activities, a formal turnover process is implemented and the survey unit is isolated and controlled via use of postings and other administrative controls. A walk down is performed to verify the area is suitable for URS and any hazards or support needs are identified.

A survey plan is written for each survey unit independently. The scan frequency, number of static measurements and the number of loose surface contamination measurements are prescribed using Attachment 6 from procedure ZS-LT-400-001-001 and are based on industry standard and similar surveys performed during previous decommissioning projects. For each survey unit, the structure surface was gridded to define the individual scan areas. During each survey, a static measurement was taken within each scan area at the location of highest activity identified during the scan. If no elevated areas were identified during the scan, then the location was selected based on surveyor's judgment. A loose surface contamination measurement was taken at each static measurement location. If an elevated area of activity was verified to be plant-related, then the area (material) was either segregated and removed as radioactive waste or the area was remediated and the survey unit (or portion of survey unit) was reclassified and resurveyed.

One primary difference between the survey design of the URS versus a MARSSIM-based FSS is the location of the static measurement represented the highest scan result location rather than a randomly selected location. However, there was no bias in the starting point for the grid system and the scan readings within the vast majority of the grids surveyed during URS were essentially uniform. The static measurements were therefore collected in a manner sufficiently similar to using random start grid intersection points that, for the purpose of the retrospective survey design and assessment of results using the Sign Test, no significant bias is considered to have been introduced. However, if there was a bias in the measurement set, it would represent an overestimate since locations for fixed-measurements were implicitly biased high.

The primary sources of clean concrete fill are the outer shell of the Containment Buildings, the concrete portions of the Turbine Building above the 588 foot elevation, the East and West Service Buildings above the 588 foot elevation, the Crib House and portions of the Forebay above the 588 foot elevation, and the Interim Radioactive Waste Storage Facility (IRSF) (which was never used to store radioactive waste). However, any concrete that is suitable for offsite release is a candidate for use as fill. Other structures that have or will undergo the URS process that could generate concrete for use as fill are the minor ancillary structures that will be completely demolished such as the, the Mechanical Maintenance Training Center (MMTC) and

Warehouse, the Fire Maze complex, the NGET building, the ENC building, the South Warehouse and the North Security Access Gatehouse.

The URS is complete for the larger structures. During the URS survey design of the U1 and U2 Containments, Turbine Building, East and West Service Buildings, Crib House/Forebay, and the IRSF, the interior and exterior of the structures were divided into 87 survey units total. All of the survey units had a sample size of static measurements between 14 and 157 with the exception of 3 survey units: the Turbine Building South Exterior (Class 3) had 10 measurements, the West Service Building Stairwell (Class 3) had 4 measurements and the West Service Building Roof (Class 3) had 5 measurements. However, these survey units were subdivided from a larger survey unit to better manage the URS and decommissioning activities. Had the survey units been joined with larger survey units the minimum statistically based value of 14 static measurements would have been attained. The table below provides a summary of the number of survey units, classifications, scan percentages and number of static measurements for the largest structures surveyed to date.

Summary of Survey Design from URS Packages Completed to Date

Individual Building Statistics											
	No. Survey Areas	No. Survey Units				Scan Percentage			No. of Statics	Mean No. of Statics per Area	Minimum No. of Statics in an Area
		Class 1	Class 2	Class 3	Total	Class 1	Class 2	Class 3			
Turbine Building	57	1	115	64	180	100	25	5	3172	56	10[1]
East & West Service Buildings	20	2	13	35	50	100	25	5-10	1047	52	4[2], 5[3]
IRSF	4	NA	5	4	9	NA	25	5	254	64	35
U1 and U2 Containment	2	NA	4	2	6	NA	25-100	5	65	33	30
Cribhouse	4	NA	4	6	10	NA	5-25	5-10	196	49	42

1: 06902C - Turbine Building South Exterior (873 m^2)
2: 07200C - West Service Building Stair S3 (53 m^2)
3: 07702 - West Service Building Roof (1,211 m2)

To evaluate whether the surveys performed on these selected building surfaces would have satisfied the MARSSIM required number of discrete measurements collected during the URS, a retrospective MARSSIM FSS design was performed using the direct measurement results that have been performed to date.

All of the direct measurements from unconditional release surveys conducted in the larger buildings were compiled for use in the retrospective MARSSIM survey design. The mean and standard deviation of the direct measurements (including background) from each URS package were calculated. The range of individual direct measurements from all survey packages was also determined. See the table below.

Summary of Direct Measurement Results from URS Packages completed to date

URS DIRECT MEASUREMENT SUMMARY DPM/100 cm^2			
Maximum	Minimum	Max. Mean	Largest σ
3339	219	2114	743

Based on the data above, a retrospective MARSSIM survey design was performed using the maximum mean and sigma from the table above:

- Null Hypothesis: Scenario A
- Maximum Standard Deviation: 743 dpm/100 cm^2
- UBGR: 5,000 dpm/100 cm^2 (bounding assumption in the dose assessment provided in response to RAI HP1 (July 20))
- LBGR: Maximum Mean Value: 2114 dpm/100 cm^2
- Δ/σ: (5000-2114)/743 = 3.9
- Type 1 and Type 2 error: 5%

From Table 5-5 of MARSSIM, the number of samples required for the Sign Test is 14. As stated in MARSSIM section 8.3, the null hypothesis is rejected if all discrete measurements are below the UBGR. The direct measurements in all URS surveys are below the UBGR and therefore all surveyed areas pass the retrospective survey design and Sign Test.

Additionally, TSD 17-007, *Evaluation of Static Measurements Performed for Unconditional Release Surveys of Building Materials Used for Backfill at the Zion Decommissioning Project*, has been developed and submitted to NRC for evaluation. This additional evaluation provides two determinations for the null hypothesis (Scenario A), a defined discrimination level and Type I and II decision errors as follows:

- Whether the static measurements collected for each survey unit would have passed the Sign Test described in MARSSIM and,
- Whether a sufficient number of static measurements would have been made if MARSSIM guidance had been used for survey design.

In order to perform this analysis, the ambient background data was used to determine a unique critical level (Lc) for each survey unit. This critical level was calculated for a type 1 error rate of 5%. In other words, this analysis uses the presumption that there is a 5% chance that an incorrect conclusion will result (i.e., that a survey unit would be released when it should have failed). As previously noted in RAI response HP 2a, Bullet No. 1, the use of a "critical level" was erroneously used in procedure and that in-fact, the critical level was not used as part of the unconditional release acceptance criteria. We also noted that our implementing procedures do not apply the critical level to our evaluations which remains to be the case. However, we have applied the critical level in this evaluation to conservatively demonstrate whether compliance with MARSSIM survey design would have been met.

The analysis shows that all 87 survey units pass the Sign Test when using the critical level (Lc) as a surrogate DCGL. In this analysis, two (2) of the survey units contained only one (1) ambient background measurement which prevents the calculation of a standard deviation for these units. Therefore, for these units, the average coefficient of variation for all 758 ambient background measurements was scaled against the measured ambient background value as an estimate of the standard deviation.

The design and implementation of the unconditional release surveys was similar to MARSSIM surveys regarding the use of data quality objectives and data quality assessment processes. Three principal differences between a MARSSIM survey design and our design for the unconditional release surveys were:

- Our survey design generally selected more fixed-measurement locations for each survey unit than what a MARSSIM design would dictate.
- The selection of the fixed-point measurement locations was biased to locations that may have contained licensed materials rather than using a random process whereas a MARSSIM design would be predicated on a random selection process (depending on classification).
- The acceptance criteria was based on the scan results rather than the fixed point measurement results using a discrete acceptance criteria of scan-MDCR plus the background count rate for each survey unit during scanning. In a MARSSIM-designed survey, the scan-MDCR is compared against the DCGLEMC which was not used for unconditional release surveys.

The data clearly shows that the scan measurement data and the static measurement data both meet the unconditional release acceptance criteria that was applied. In other words, all individual measurements (scan and static) were less than the scan-MDCR plus background and that all measurements were less than 5000 dpm/100cm^2. This analysis also shows that all static measurements for each survey unit separately would pass the Sign Test criteria when we conservatively use a DCGL that corresponds to the critical level for each survey unit. Furthermore, this analysis identifies six survey units where the number of static measurements was less than what would have been prescribed by MARSSIM while still passing the Sign Test criteria as described above. However, as previously noted, some of these units would have been combined with other larger adjacent units thereby eliminating this condition had the survey been designed and implemented as MARSSIM surveys.

Lastly, we will apply a very conservative dose for the materials used for backfill where we assume that all surfaces contain residual radioactivity at either 5000 dpm/100cm^2 or at the maximum observed value corresponding to the MDCR plus background count rate. The corresponding dose associated with 5000 dpm/100cm^2 is 0.7 mrem.

ZSRP Response (HP 2b) – ZSRP commits to submit a Final Report to NRC after all unconditional release surveys are completed, and prior to license termination, for structures that contained concrete that will remain onsite as clean fill. The Final Report will demonstrate that the direct measurements on concrete used as clean fill will pass the Sign Test, assuming an UBGR of 5,000 dpm/100 cm^2, and that the mean of all URS direct measurements is less than 5,000 dpm/100 cm^2.

3. **NRC Comment (HP 3)**: The response to HP RAI 1 (as received in July 2016) indicates that ZSRP proposes to release "minor structures" that will remain at license termination using the unconditional release survey (URS) process as discussed in ZS-LT-400-001-001 (Revision 3). As noted in the previous comment, there is limited discussion in ZS-LT-400-001-001 on the actual survey design, and the same comments apply here as well with regard to determination of the survey coverage and discrete sampling requirements. As noted in previous NRC RAIs, the usage of MARSAME for surveys of land areas and structures to remain on site is explicitly designated as outside the scope of MARSAME (per MARSAME Section 1.1). As such, it is incumbent on the licensee to adequately justify why these methods are appropriate as final radiation surveys.

Additionally, the licensee's response to HP RAI 1 indicates that no additional assessments will be performed for structures surveyed via URS. Regardless of the survey methodology chosen, the licensee still must demonstrate compliance with the dose based criteria for release per 10 CFR 20.1402 in order to leave impacted materials or structures on site.

Basis:

10 CFR 20.1402 defines the dose basis for license termination

Per 10 CFR 50.82, the license termination plan must include detailed plans for the final radiation survey.

Path Forward:

a. Justify why the proposed survey methods are acceptable as final radiation surveys to leave the designated "minor structures" on site. This justification should consider the need for a statistically based survey design as discussed in the previous RAI. Alternatively, the licensee may commit to using MARSSIM strategies and methods to release these structures.

b. Describe how dose will be considered to meet the release criteria from 10 CFR 20.1402.

c. Commit to providing results of these surveys for NRC evaluation as final radiation surveys.

ZSRP Response (HP 3a, 3b and 3c) – All above grade buildings will be removed in the end-state for ZSRP. The ISFSI Monitoring Building and the ISFSI Warehouse will remain, however they are not within the scope of FSS and will remain as part of the ISFSI license. The FSS of other minor solid items, such as but not limited to the switchyard structures, the microwave tower, telephone poles, fencing, culverts, duct banks and electrical conduit will be incorporated in the FSS design of the open land survey unit in which they reside as biased locations. The accessible areas of these items will be scanned in accordance with recommended survey coverage in LTP Rev 1 Chapter 5, Table 5-24. Any areas of elevated activity identified during the scan survey will be investigated. The investigation may include bounding the area of elevated activity and obtaining bulk material samples from the area as necessary and comparing the concentrations to the soil DCGL. An area-weighted average approach will be used (like any other biased or judgmental sample) to include the bulk sample result with the mean dose for the survey unit. The results of these surveys will be included in the survey unit release record and subsequent FSS Final Report which are submitted to the NRC for evaluation.

4. **NRC Comment (HP 4)**: The response to HP RAI 2 (as received in July 2016) discusses additional characterization of the soils under the basement concrete of the containment buildings, auxiliary building, and the SFP/Transfer Canal. There appear to be differing approaches for the characterization of these soils as listed in the LTP versus the response to HP RAI 2. For example, LTP Section 5.7.1.5.3 (Sampling of Subsurface Soils below Structure Basement Foundations) indicates that "locations selected for sampling will be biased to locations having a high potential for the accumulation and migration of radioactive contamination to sub-surface soil," and that "the biased locations for sub-slab soil and concrete assessment could include stress cracks, floor and wall interfaces, penetrations through walls and floors for piping, run-off from exterior walls, and leaks or spills in adjacent outside areas, etc." The licensee's response to HP RAI 2 indicates that "for continuing characterization, ZSRP intends to take soil borings along the foundation walls to access the soils that bound the basement foundation sub-slab soils for the Containment Buildings and Auxiliary Buildings." Clarification is needed on the licensee's intent to utilize biased core sampling to assess sub-slab soil and concrete, as described in LTP Section 5.7.1.5.3.

The response to HP RAI 2 (as received in July 2016) states "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." NUREG-1757, Appendix G, Section G.2.1 states that "if the HSA indicates that there is no likelihood of substantial subsurface residual radioactivity, subsurface surveys are not necessary." The response states "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." However, the HSA indicated that 64 documented spills have occurred. LTP, Section 2.1.4.1 states, "Of these [64 spills], 18 occurred either inside of Unit I or Unit 2 Containment, 21 occurred inside of the Auxiliary Building and two occurred inside of the Fuel Handling Building." As such, there is potential that these spills could have resulted in contamination below the foundation of these buildings. Section 2.1.4.1 further states, "Of the remaining 23 documented spill incidents, 14 occurred either inside the Rad Waste Annex trackways or just outside of the trackway doors in the open land areas between the Containment structures and the Turbine Building. The prevalence of these incidents causes concern for the potential contamination of ground coverings (concrete and asphalt) as well as surface and subsurface soils in these two areas and the foundations and below-grade exteriors of nearby buildings. The HSA specifically refers to these two areas as the "most extensively contaminated open land areas on the site." As such, it is incumbent on the licensee to justify the radiological status of subsurface soil and all below-grade structures - additional sampling to determine the extent of structure contamination should be performed in the event that soil contamination is found adjacent to below grade building foundations.

This RAI ultimately stems from the original HP RAI 2 (as provided to the licensee in December 2015). That RAI noted several examples of areas where surveys were described in the LTP as "deferred" as follows: soils under structures, soils under concrete or asphalt coverings, structural wall and floor surfaces in the basements of structures that will remain and be subjected to FRS, the remaining surfaces of the SFP and Transfer Canal after liner removal, the interiors of embedded and/or buried pipe that may remain and the interior and exterior of both Containment domes. Additional characterization of the interior and exterior of Containment appears to be unaddressed at this point, either in the LTP or in RAI responses to date. Characterization plans for Containment should be provided.

With regard to exterior characterization of the Containment Buildings, it is important to recognize that additional characterization of soils in the vicinity of Containment Buildings could necessitate further characterization of exterior concrete of the Containment Buildings and possibly other buildings as well. NRC staff notes that a question regarding exterior concrete was originally asked in HP RAI 2 related to Chapter 2 of the LTP (as provided to the licensee in December 2015). The licensee's response (as provided in March 2016) discussed subsurface sampling around Containment Buildings and noted that detectable plant-derived radioactivity was positively detected in these samples "at very low levels and not indicative of system leakage or a breach of containment." There was also an acknowledgement that additional characterization around the Containment Buildings will be required (particularly in areas between the Containment Buildings and the Turbine Building). Two of the original NRC requests from the December 2015 RAI were to provide future characterization plans and to "describe the steps that will be taken to investigate any elevated areas found during remediation." These aspects of the RAI were never fully addressed.

With regard to interior sampling of the Containment Buildings, the licensee's response to HP RAI 2 related to Chapter 2 of the LTP (as provided in March 2016) concluded that "the probability of contamination or activation of Containment Building concrete beneath the liner or exterior to the Containment is very low" based upon the aforementioned subsurface soil samples and studies to assess activation of Bio-Shield concrete. The licensee further indicated they "contend that the STS survey that will be performed on the interior surface of each Containment basement after the removal of the concrete floor above the liner will be sufficient to demonstrate compliance with the total inventory limit specified in the BFM." However, there is no discussion of additional characterization of these areas to assess post-remediation conditions or to investigate elevated areas during remediation.

Furthermore, Section 2.3.3.1 of the LTP indicates the following:

"During the time that initial characterization was performed, all radioactive systems and components were still located inside each Containment. Consequently, ambient radiation dose rates inside the Containments prohibited the direct assessment of concrete and steel structural surfaces below the 588 foot elevation by scanning or direct measurement. Once commodity removal is complete in both of these structures, additional characterization will be performed by scan and direct measurement to identify the lateral and vertical extent of surficial contamination and the extent of any remediation that will be necessary on the structural steel and concrete that will remain in the final configuration of the Containments."

As such, the licensee needs to provide plans for additional characterization of the interior of the Containment Buildings to assess post remediation conditions, and needs to address how elevated areas will be investigated.

Basis:

Per 10 CFR 50.82, the license termination plan must include a site characterization.

NUREG-1700, Rev. 1 (Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans) states that NRC staff should review the licensee's site characterization plans and site records (required under 10 CFR 50.75(g)).

Path Forward:

a. Clarify the intent to utilize biased core sampling to assess sub-slab soil and concrete, as described in LTP Section 5.7.1.5.3.

b. Provide additional justification for why the potential for subsurface soil contamination in the soils under the basement floor slabs at Zion is very low.

c. Describe how the exteriors of below-grade building foundations will be assessed for all basement structures.

d. Describe how additional sampling to determine the extent of structure contamination will be performed in the event that soil contamination is found outside of below grade building foundations.

e. As also discussed in PAB RAI 1, additional characterization plans should be provided to the NRC for evaluation. As such:

- Provide plans for additional characterization to assess sub-slab soils and concrete.
- Provide plans for additional characterization of both the exterior and interior of the Containment Buildings. Plans for exterior characterization should consider available and forthcoming subsurface soil characterization results. Plans for interior characterization should address the post remediation conditions of the Containment Buildings. In both cases, the licensee needs to describe the steps that will be taken to investigate any elevated areas found during remediation.

f. Commit to providing additional characterization results for NRC evaluation.

ZSRP Response (HP 4a) – The soil under the basement concrete of the Containment Buildings, the Auxiliary Building and the SFP/Transfer Canal have been included in the "continuing characterization" area list provided in response to PAB 1a. The area is also listed in LTP Revision 1 Chapter 2, section 2.5. The continuing characterization sample plans will be provided to NRC for information and results will be provided to NRC for evaluation.

There are two sources that could potentially contaminate sub-foundation soil. The first is migration from building interior through cracks, wall/floor interfaces, penetrations, etc. The second is migration from areas outside of the buildings where subsurface soil contamination is present, particularly if the contamination is found at a depth approaching the elevation of the foundation.

LTP Revision 0, section 5.7.1.5.3, statement regarding "stress cracks, floor and wall interfaces, penetrations through walls and floors for piping" refers to the potential source term that originates within a building. Core sampling through the entire foundation floor addresses the question as to whether contamination has migrated from the interior of a building and through the entire depth of the foundation as well as providing a sample of the sub-foundation soil. However, if a core collected from a location that is biased (based on interior conditions) shows that no contamination has migrated through the foundation to the sub-foundation soil, the soil sample in the sub-foundation soil at that location would not be needed to further corroborate this condition. In addition, we believe it is important to minimize unneeded breaches of the basement foundations for soil sampling purposes in order to limit groundwater intrusion

To minimize potential groundwater intrusion and still investigate the potential for migration of contamination from building interiors to the sub-foundation soils, additional characterization will include deep cores in the concrete foundations/floor but not fully through the foundation or steel liner. This investigation will be performed in the Auxiliary Building, SFP/Transfer Canal and Containment. The cores will be biased to areas with higher potential of providing a pathway for migration of contamination to sub-foundation soil including those listed in LTP Chapter 5, section 5.7.1.5.3, i.e. "stress cracks, floor and wall interfaces, and penetrations through walls and floors for piping". If the analysis of the deepest 0.5 inch "puck" from the core in the foundation does not contain detectable activity, then it will be assumed that the location was not a source of sub-foundation soil contamination. If activity is positively detected at the deepest point in the core, continuing the core to the soil under the foundation will be considered depending on the levels of activity identified and the potential for groundwater intrusion.

Characterization of sub-foundation soil will include angled soil borings from locations outside of a building to directly access the sub-slab soils. If a deep core indicates significant deep concrete contamination an investigation may be performed by targeting the angled soil boring to the location of interest, if access to the location is feasible, as opposed to breaching the foundation.

Each sample plan will use the DQO process to determine the sample type (deep core or angled drilling) location, and number, and provide investigation levels and follow-up actions based on the results of the sample analysis. LTP Revision 1, section 6.7.1.5.3 has been revised to reflect the above approach.

The contamination potential within the Turbine Basement and Crib House/Forebay is minimal and contamination potential of the sub-foundation soil from migration of contamination from a source inside these structures is very low. The minimal contamination levels in these structures was confirmed by characterization and FSS results. Note that one sub-slab soil sample was acquired in October of 2013 from the soil under the Turbine Building 560 foot basement floor. The basis for the selection of the location assumed groundwater flow from the west toward Lake Michigan and downstream from the Containment, SFP/Transfer Canal, and Auxiliary Building. A hole was drilled through the concrete floor slab, exposing the underlying soil. The soil consistency found was hard-packed clay. A single sample of the soil was acquired, representing a depth of approximately 38 feet below grade. The sample was analyzed on the on-site gamma spectroscopy system. No plant-derived radionuclides were detected.

ZSRP Response (HP 4b) – There are two sources that could potentially cause subsurface soil contamination in the soils under the basement floor slabs. The first is migration from building interior through cracks, wall/floor interfaces, penetrations, etc. The second is migration from areas outside of the buildings where subsurface soil contamination is present, particularly if the contamination is found at a depth approaching the elevation of the foundation.

The physical condition of the Auxiliary Building 542-foot elevation floor did not indicate a significant cracking or other signs of significant deterioration. The interiors of the Containment and SFP/Transfer Canal were steel lined. The physical condition and construction of these buildings lead to a general conclusion that the potential for significant migration through these structures to the sub-foundation soil was low. As described in ZSRP's response to 4a above, biased concrete cores will be taken to address potential migration from the building interior.

In regard to potential for subsurface soil contamination in the soils under the basement floor slabs as a result of migration of subsurface soil contamination, extensive soil characterization provided no indication of wide-spread subsurface contamination that could lead to sub-foundation contamination. In fact, the vast majority of the subsurface results were non-detect and the few positive subsurface samples were at very low concentrations and shallow depth. The potential for subsurface soil contamination in the "keyways" between the Containment Buildings and the Turbine Building is well known and identified as a location for continuing characterization in LTP Revision 0 (as well as on the list provided in response to PAB 1). Although there is a history of spills in this area, the resulting soil contamination is not expected to have migrated to the sub-foundation soil. This assumption will be evaluated during continuing characterization.

ZSRP Response HP 4c and 4d – The exterior of below grade walls and foundations of the Containments, Auxiliary Building and SFP/Transfer Canal will be evaluated by soil borings along the foundation walls down to a depth below the bottom of the foundation. The borings will be collected as near to the walls as feasible. These borings will be included in the sample plans discussed in response to HP 4a. The sample plan will use the DQO process to determine the location and number of soil borings adjacent to buildings and provide investigation levels and follow-up actions based on the results of the sample analysis. The plan will specifically include the additional investigation and sampling to be performed to determine the extent of structure contamination in the event that soil contamination is found in sub surface soil outside of below grade building walls or foundations. This may include actions such as a test pit to directly characterize the wall surface, if feasible depending on depth of soil contamination, or evaluation of maximum potential contamination levels of the outer wall surfaces and calculation of a bounding dose from the buried outer wall concrete source term.

ZSRP Response 4e and 4f - As discussed in response to PAB 1a, HP 4a, HP 4b, and HP 4c, a sample plan will be provided to NRC that contains the information requested and the continuing characterization results will be provided to NRC for evaluation. The plans for exterior characterization of Containment will consider currently available data and the results of subsurface soil samples collected during continuing characterization. The plans for interior characterization of Containment will be biased to stress cracks in the concrete, floor and wall interfaces, and the IC Sump in the Under-Vessel area. Surveys of post remediation conditions of the Containment Buildings will be performed including any breaches in the liner that are exposed after concrete removal, if any. The plan will describe the steps that will be taken to investigate elevated areas found during remediation.

5. **NRC Comment (HP 5)**: The response to HP RAI 3 (as received in July 2016) indicates that the hard-to-detect radionuclides of Sr-90, Ni-63, and H-3 will be considered insignificant, and further indicates that no additional evaluation of these radionuclides is considered necessary during FRS. HP RAI 3 (as provided to the licensee in May 2016) stated that "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," and that "these characterization results, and the associated assessment, should be provided for NRC review and approval." Although the licensee has committed to calculating the insignificant contributor dose during continuing characterization and comparing it to the assumptions made for planning purposes, there is no commitment by the licensee to provide additional characterization results to establish insignificant radionuclides for review and approval, and results received to date are not sufficient for the NRC to conclude Sr-90, Ni-63, and H-3 radionuclides are insignificant.

There are currently questions on the appropriateness of the licensee's proposed approach to assess the dose contribution due to H-3, Sr-90, and Ni-63. The doses presented in the response to HP RAI 3 (provided to the NRC in July 2016) are a combined dose for H-3, Sr-90, and Ni-63 of 0.27 mrem/yr for the Auxiliary Building Basement and 0.05 mrem/yr for soil per TSD 14-019 (Rev. 1) Tables 19 and 25. Tables 19 and 25 of TSD 14-019 (Rev. 1) provide normalized relative activity levels (based on scaling factors) and corresponding relative dose percentages, but these are not necessarily representative of actual post-remediation conditions and therefore do not necessarily bound the dose impact from these radionuclides.

With regard to the 0.27 mrem/yr estimated using the Auxiliary Building cores, the cores that were measured for HTDs do not show consistent ratios, so there is uncertainty in the scaling factors. TSD 14-013 (Rev. 0), Table 14, Summary of Key Radionuclide Ratios for 542' Floor and Wall, shows the variability present in the ratios. TSD 14-013 also states that "As seen in Table 14, the range of key radionuclide ratios varied by several orders of magnitude across the 542' elevation cores." The maximum or 95th percentile ratios were not applied as the scaling factors in calculating the dose of 0.27 mrem/yr. For example, TSD 14-013 (Rev. 0), Table 14 shows a maximum ratio of Ni-63 to Co-60 of 94.4, while the scaling factor in Table 17 is 14.5. The maximum ratio for H-3 to Cs-137 is 1.75E-2, and the scaling factor is 3.12E-3. The maximum ratio for Sr-90 to Cs-137 is 1.48E-3, and the scaling factor is 4.28E-4. Given the variability present in the ratios, and the fact that the scaling factors applied do not incorporate the variability in those ratios, the 0.27 mrem/yr is not viewed as bounding.

With regard to the estimated contribution of 0.05 mrem/yr of H-3, Ni-63, and Sr-90 for soil, this estimate is also based on normalized relative activity levels, and utilizes the mixture percentages from the Auxiliary Building. The NRC staff note that the sum of potential doses from H-3, Ni-63, and Sr-90 reported by the licensee in response to RAI PAB 8 (as provided in March 2016, see pg. 20-21 of ZS-2016-0022: Enclosure 1, ML16081A010) utilizing the MDCs for non-detects in soil is 0.5 mrem/yr. The dose of 0.5 mrem/yr probably also does not bound the contribution of these radionuclides for soil, given that soil which is likely contaminated (e.g., soil in the "keyways" between Containment and Turbine Buildings) has yet to be characterized. The NRC staff make this comparison here to demonstrate the magnitude of order difference in the two estimates which both use the characterization data which was submitted with the LTP.

Additionally, the licensee's proposal to consider H-3 as an insignificant radionuclide in certain areas of the site is not fully supported. The LTP, Table 6-3 list notes that H-3 is an activation product and therefore only applicable to the Containment Buildings. However, H-3 (tritium) is formed not only from activation of concrete (Li-6) but more commonly from neutron capture by boron (B-10) in PWRs (boric acid added to PWR reactor coolant system). Tritium can potentially build up in the SFP due to mixing with reactor coolant. Fuel cladding defects could also allow tritium transfer from fuel.

H-3 was detected in a groundwater monitoring well at the site in 2006. Although it has not been detected in any groundwater monitoring well above the MDC since 2006, its presence in 2006 shows potential for remaining H-3 contamination. The licensee stated that the well in which H-3 was detected is located up-gradient from the groundwater flow direction and should not be impacted by the decommissioning activities, but the fact that the well is up-gradient does not explain how H-3 transported to that location. H-3 was also positively detected above MDC in the Auxiliary basement cores, in addition to the Containment cores. The licensee has committed to analyze for the initial suite of radionuclides (including H-3) during continuing characterization of these locations, however this data has not yet been submitted to the NRC. Since characterization of these areas has not been submitted to the NRC, the licensee has not yet demonstrated, through adequate characterization data, that H-3 can be treated as an insignificant radionuclide in these areas.

The intent of the original HP RAI 3 (as provided to the licensee in December 2015) and the follow up HP RAI 3 (as provided to the licensee in May 2016) was to ascertain how the licensee intends to address HTD radionuclides during decommissioning and to ensure that adequate sampling is performed to justify conclusions on the quantity of HTD radionuclides remaining onsite. The licensee's characterization results (as provided in Chapter 2 of the LTP) indicate that only 9 surface soil samples, 1 subsurface soil sample, 6 core samples from the Auxiliary Building, and 21 core samples from the Containment Buildings have been analyzed for HTDs. Additional sampling of HTDs is warranted, regardless of whether the licensee chooses to utilize a surrogate approach during FRS or an insignificant approach prior to FRS. As such, the licensee should provide details on how adequate assessment of HTDs will occur for the chosen approach. If the licensee desires to categorize H-3, Ni-63, and Sr-90 as insignificant radionuclides, the licensee should provide additional supporting characterization results and the associated data assessment for NRC review and approval, as requested in the May 2016 RAI. This pertains to those areas that have yet to be characterized as well as for the Auxiliary Building and Containment Basements. If the licensee intends to utilize a surrogate approach during decommissioning, as discussed in both the December 2015 RAI and the May 2016 RAI, then the licensee should establish sampling protocols consistent with MARSSIM to validate surrogate ratios during FRS.

The licensee's method for potentially revising the ratios of Sr-90/Cs-137 and Ni-63/Co-60 as a result of ongoing characterization is also unclear. The responses to PAB RAI 6 and HP RAI 2 (as provided to the NRC in July 2016) state that "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." However, the licensee does not provide details on how "significantly different" is defined. Additionally, it is not clear that the licensee will also review the ratio for H-3 during ongoing characterization.

Basis:

Per 10 CFR 50.82, the license termination plan must include a site characterization.

NUREG-1757, Vol. 2, Rev. 1, Section 4.2 (Scoping and Characterization Surveys), provides objectives of characterization surveys, which include:

- Determining the nature and extent of residual radioactivity
- Developing input to the FSS design.

NUREG-1757, Vol. 2, Rev. 1 (Consolidated Decommissioning Guidance Characterization, Survey, and Determination of Radiological Criteria) states in Appendix O that "it is incumbent on the licensee to have adequate characterization data to support and document the determination that some radionuclides may be deselected from further detailed consideration in planning the FSS."

Per the acceptance criteria/information to be submitted, as described in NUREG-1700, Rev. 1, Section 5 (Final Status Survey Plan), licensees should provide methods used for addressing hard-to-detect radionuclides.

NUREG-1575, Rev. 1 (MARSSIM) indicates in Section 4.3.2, that the licensee should perform an appropriate number of HTD measurements during final radiation surveys to validate surrogate ratios established from characterization results. MARSSIM also indicates that 10% of the final radiation survey measurements should be analyzed for all radionuclides of concern if a surrogate ratio is established using FSS data.

Path Forward:

a. If the licensee intends to address H-3, Sr-90, and Ni-63 as insignificant, then the insignificant contribution assumptions will need to be reevaluated and a justification should be provided in the LTP for why the assumed insignificant contribution appropriately bounds the dose from H-3, Ni-63, and Sr-90 as well as other insignificant radionuclides. This approach may necessitate changes to the adjusted DCGLs as well.

b. Additional characterization plans should be provided for NRC evaluation as part of the revised LTP, which includes a description of how H-3, Ni-63, and Sr-90 will be addressed. Additionally, a commitment to providing characterization results for NRC review and approval should be made. This pertains to those areas that have yet to be characterized as well as for the Auxiliary Building and Containment Basements.

c. If the licensee intends to address HTDs during FRS, then guidance from MARSSIM 4.3.2 should be utilized to develop a sampling program to validate surrogate ratios during FRS.

d. Describe how "significantly different" will be determined in deciding whether the ratios used to assess HTDs are significantly different from the current ratios assigned. For example, will a statistical test be applied, and if so, which test?

e. Provide details on how H-3 ratios will be reviewed.

ZSRP Response (HP 5a) – In the response to HP RAI 3 (as received in July 2016), it was not ZSRP intention to propose designating H-3, Sr-90, and Ni-63 as insignificant. ZSRP was simply stating in the response that based on the characterization data, the dose significance of those radionuclides was low enough that they could have been considered as insignificant. They are retained as ROC due to the potential that they could be present during compliance surveys at positively detectable concentrations. There is no change to the list of ROC provided in Zion LTP Rev 0 which includes H-3, Sr-90 and Ni-63. The ROC for the site are Co-60, Ni-63, Sr-90, Cs-134 and Cs-137. H-3, Eu-152 and Eu-154 are added as additional ROC for the Containment basements.

ZSRP Response (HP 5b) In response to PAB 1(a), ZSRP commits to continuing characterization of the Auxiliary Building basement, the exposed steel liner in the Containments and the Under-Vessel concrete. For these buildings, all concrete cores will be analyzed for the full initial suite including H-3, Sr-90, and Ni-63. As stated in the response to PAB 1(a), the continuing characterization plans will be provided to NRC for information and the continuing characterization results provided to NRC for evaluation. In addition to the Auxiliary Building and Containment, the response to PAB 1(a) also lists all other areas that will undergo continuing characterization.

ZSRP Response (HP 5c) – Section 5.1 of LTP Chapter 5, Rev 1. has been revised to state the following; "Soil samples and concrete cores will be collected during FSS to confirm the HTD to surrogate radionuclide ratio used for the surrogate calculation. Only HTD radionuclides included as ROC (H-3, Ni-63, Sr-90, for Containment and Ni-63 and Sr-90 for all other structures and soils) will be analyzed in the FSS confirmatory samples. Concrete cores will be collected from the Auxiliary Building basement, SFP/Transfer Canal, and the Under-Vessel areas in Containment where concrete will remain. The number of cores collected and analyzed for ROC HTD will be ten percent (10%) of the FSS ISOCS measurements. The concrete core locations will be selected from the floor and lower walls in the survey unit to alleviate safety concerns from working at heights and to focus on the areas expected to contain the majority of residual radioactivity. For soil, ten percent (10%) of the FSS samples collected from open land survey units will also be analyzed for ROC HTD radionuclides. Additionally, if levels of residual radioactivity in an individual soil sample exceed the SOF of 0.1, then the sample(s) will be analyzed for ROC HTD radionuclides. For soil samples or concrete cores with positive results for both a HTD ROC and the corresponding surrogate radionuclide (Cs-137 or Co-60), the HTD to surrogate ratio will be derived. The maximum ratio (see section 5.2.11) will be used unless specific survey information from continuing characterization supports the use of a surrogate ratio that is specific to the area. In these cases, the area-specific ratios as determined by actual survey data will be used in lieu of the maximum ratios. The area-specific ratios used and the survey data serving as the basis for the ratios will be documented in the release record for the survey unit."

ZSRP Response (HP 5d): As stated in response to HP 5(c), the HTD ROC will be analyzed during FSS. The ratio of a ROC HTD radionuclide to the corresponding gamma surrogate will be calculated if both radionuclides are positively detected in a given sample. Each calculated ratio will be compared to the ratio assigned for surrogate analysis in Zion LTP Rev 1, Chapter 5, section 5.2.11, Table 5-15. The assigned surrogate ratio is the maximum ratio calculated from the individual characterization core samples from the Auxiliary Building and Containment. The mean, maximum and 95% upper confidence level surrogate ratios as presented in Zion LTP Rev 1, Chapter 5, section 5.2.11, Table 5-15 are calculated in TSD 14-019, Revision 2, section 4 (which is provided with these RAI responses). Each ratio calculated from FSS results, i.e., those with positive results for both a ROC HTD and the corresponding gamma emitting radionuclide, will be compared to the assigned ratio. The maximum ratio (see section 5.2.11) will be used unless specific survey information from continuing characterization supports the use of a surrogate ratio that is specific to the area. In these cases, the area-specific ratios as determined by actual survey data will be used in lieu of the maximum ratios. The area-specific ratios used and the survey data serving as the basis for the ratios will be documented in the release record for the survey unit.".

ZSRP Response (HP 5e) – The analysis of the full initial suite HTD radionuclides during continuing characterization will include H-3. Cs-137 is the surrogate gamma emitting radionuclide for H-3. The process for evaluating the H-3 and Cs-137 results from continuing characterization will be the same as described in response to HP(5d). The ratio of H-3 to Cs-137 will be calculated for each sample that contains positive results for both H-3 and Cs-137. The maximum ratio (see section 5.2.11) will be used unless specific survey information from continuing characterization supports the use of a surrogate ratio that is specific to the area. In these cases, the area-specific ratios as determined by actual survey data will be used in lieu of the maximum ratios. The area-specific ratios used and the survey data serving as the basis for the ratios will be documented in the release record for the survey unit.". H-3 will also be included in the ROC HTD analysis of samples during FSS. The analysis of the H-3 to Cs-137 ratios in the FSS samples will also be conducted as described in response to HP 5(d).

6. **NRC Comment (HP 6)**: The previous HP RAI 6 comments (as provided to the licensee in May 2016) note that there is an apparent discrepancy between recommendations from the licensee's TSD-14-022 (Revision 0) document and the LTP with regard to additional core sampling to validate the limited core data currently available or to provide new data in areas that are considered to have a unique operational history or contamination profile. The licensee's response, as provided in July 2016, indicates that such core samples may not be taken and that the necessity to validate the geometry for ISOCs efficiency calibration is addressed as Step 4.2.7 of ZS-LT-300-001-001 (Revision 2), "FRS Package Development." This procedure simply directs the surveyor to "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," and that "if the geometry appears to be significantly different from that which was assumed in TSD 14-022, then inform the C/LT Manager." There appears to be no definition or procedure to direct the surveyor in making this assessment or a description of what constitutes a significant change from assumptions. As such, the proposed approach does not provide an adequate justification as to why the core samples recommended by TSD 14-022 may not be necessary. Details on the methods and procedures the STS surveyor will follow to assess differences in geometry should be provided.

It is additionally important that the NRC understand the usage of core samples on a per survey unit basis, and details on the ISOCS geometry utilized within a survey unit should be presented in any Final Status Survey Report (FSSR) provided to the NRC.

Basis:

Per 10 CFR 50.82, the license termination plan must include a site characterization.

NUREG-1757, Vol. 2, Rev. 1, Section 4.2 (Scoping and Characterization Surveys), provides objectives of characterization surveys, which include:

- Determining the nature and extent of residual radioactivity.
- Developing input to the FSS design.

Per the acceptance criteria/information to be submitted, as described in NUREG-1757, Vol. 2, Rev. 1, Section 4.4 (Final Status Survey Design), licensees should provide:

- A description of the instruments, calibration, operational checks, sensitivity, and sampling methods for in situ sample measurements, with a demonstration that the instruments and methods have adequate sensitivity.

Path Forward:

a. Provide the procedure or plan that defines how the STS surveyor will assess whether or not the geometry of remaining residual radioactivity is significantly different from that which was assumed in TSD 14-022.

b. Define what constitutes a "significantly different" geometry.

c. Define the conditions under which the C/LT Manager will be informed of differing geometry profiles, and provide procedures that address actions the C/LT Manager will take.

d. Commit to taking all additional core samples as recommended in TSD 14-022 "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 licensee should provide a description of the number of core samples that will be taken to assess ISOCs geometries and the rationale for choosing the location and number of samples.

e. Commit to describing the ISOCS geometry utilized in each structural survey unit in the FSSR.

ZSRP Response (HP 6a) – There are two aspects of the concrete geometry that will be reviewed during FSS design to determine if there are significant differences from the Exponential Circular Plane (ECP) geometry selected in TSD 14-022 to perform the efficiency calibration for general areas. As listed in TSD 14-014, section 7, there are four areas that required further characterization to confirm that the ECP applies or, if a different geometry should be used for the efficiency calibration.

There are two geometry considerations; 1) the uniformity, or smoothness of the surface, and 2) the distribution of contamination with depth.

The ECP efficiency calibration assumes a smooth surface. This assumption will be used if remediation does not result causing significant non-uniformities in the concrete surface, such as trenches, deep gouges, etc. that would produce a "wall edge", which causes significant photon shielding between the source at the bottom of the trench or gouge and the ISOCS detector. An assessment will be performed using the ISOCS geometry composer to determine a set of measurable parameters for the engineer to apply in the field to assess if the surface geometry is significantly different from the ECP assumption of smooth surface. The parameters will be added to the Procedure ZS-LT-300-001-001 (Revision 2), "FRS Package Development". A standard acceptance criteria for instrument variability applied to source checks is +/- 20%. A lower value of 10% will be applied in setting the parameters for designating a remediated area as non-uniform. The 10% criterion will apply to the difference between the efficiency values for the non-uniform geometry and the efficiency values for the ECP geometry. If the efficiency value for the non-uniform geometry is more than 10% lower than the ECP geometry, then an area-specific efficiency calibration geometry will be applied to the affected area. A description of the condition of the surfaces measured by ISOCS during FSS, and the geometry applied for the efficiency calibration in the affected area will be described in the FSS Final Report.

The second geometry consideration is the distribution of contamination with depth. During survey design, the cores collected from the areas recommended in TSD 14-022 will be reviewed. The actual measured values in the new cores, the 0.5 inch core slices, will be used in the ISOCS geometry composer directly to determine the actual efficiency based on the core data. The differences between actual efficiency and the ECP efficiency will be evaluated. As for the assessment of surface uniformity, if the efficiency based on core data is more than 10% lower than the ECP efficiency, the core data will be used as the basis for the efficiency calibration in the affected area. A description of the core assessment and the geometry applied for the efficiency calibration in the affected area will be described in the FSS Final Report.

Procedure ZS-LT-300-001-001 will be updated to include the parameters for evaluating uniformity and the contamination depth profile after the parameters for determining when a surface is "non-uniform" have been selected. The assessment performed to select the parameters is documented in TSD 17-003, Evaluation of Efficiency Calibration Geometries for In-Situ Gamma Spectrometry During FSS, along with the process for evaluating the depth profile efficiency using new cores. The TSD and revised procedure will be provided to NRC when completed.

ZSRP Response (HP 6b) – See response to HP 6a.

ZSRP Response (HP 6c) –The C/LT Manager will be informed if an area has been determined to have a non-uniform surface geometry based on the evaluation parameters to be included in the procedure or if evaluation of new concrete cores indicates that an area-specific geometry for depth profile is required. The C/LT manager's responsibilities are administrative, not technical. Procedure ZS-LT-300-001-001 will be updated as described above to describe the actions that the technical staff will take.

ZSRP Response (HP 6d) – The additional core samples recommended in TSD 14-022 are included in the list of areas requiring continuing characterization provided in the response to PAB 1(a). As discussed in PAB 1(a), the same list will be included in Zion LTP Revision 1, section 2.5.

ZSRP Response (HP 6e) – Zion LTP Revision 1, section 5.11.2, "FSS Final Reports" has been revised to require the following information "Description of surface condition and ISOCS efficiency calibration geometry" in the Final Report.

7. **NRC Comment (HP 7)**: The original HP RAI 5 (as provided to the licensee in May 2016) indicates that there are deviations from MARSSIM survey design, particularly in Class 2 STS survey units. These deviations relate to systematic sampling in Class 2 survey units and to the survey areas sizes. With regard to systematic sampling, the licensee has provided clarification that a systematic random start approach will be used for STS surveys. However, this point should be updated in the LTP – in particular, Section 5.5.2.2 of the LTP currently states that "in STS survey units where less than 100% ISOCS coverage is required, the location of the center of each ISOCS measurement FOV will be determined at random in the area located at a distance equal to the radius of the ISOCS FOV from the boundaries of the STS survey unit." As such, it is not clear that a random start systematic approach is being used for Class 2 STS surveys.

With regard to the assessment of survey unit sizes the original HP RAI 5 indicated that justification for increasing survey unit sizes from the area recommended in MARSSIM should be provided, and that it should account for the increased unmeasured space between sample points and the potential for elevated activity that could remain. The licensee did not address the request on the unmeasured area, and instead notes in their response that "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." As noted in the original RAI, MARSSIM Section 2.5.5 discusses this concept and states that "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 licensee's response to the RAI discusses assumptions and bounding calculations to essentially describe why the licensee views their Class 2 designations as appropriate. However, the licensee has provided inadequate justification to date on why the proposed survey unit size increases (and by extension, fewer samples per area) are acceptable, and should either provide an acceptable justification or commit to utilizing the recommended survey unit sizes in MARSSIM. NRC staff notes that any justification from the licensee on survey unit sizing and the unmeasured areas should include details on the extent of coverage and results from characterization surveys or preliminary decommissioning surveys that will be used to inform the decision. To this end, the licensee has not provided details on the anticipated coverage of preliminary scans and surveys (as was requested in the May 2016 HP RAI 9 dealing with the integration of decommissioning surveys). The licensee only provides a reference to ZS-LT-400-001-002 (Revision 0), and Table 1 of that procedure indicates that 5-10% per area is the minimum coverage for "contamination verification surveys" depending on the area location (e.g., floors, walls, ceilings, etc.). The description of scanning surveys used to characterize the Auxiliary Building also does not define the actual coverage. Rather, the response to HP RAI 5 presents imprecise and open ended language regarding previous scanning such as "accessible," "to the extent practicable," and "to a nominal elevation of approximately six feet up the wall." As such, the licensee has provided an insufficient justification to date that it is appropriate to enlarge the survey unit sizes in Class 2 STS units.

It is additionally worth noting that the licensee has proposed a complex assessment of Class 2 surveys in the Auxiliary Building that warrants a re-evaluation of the survey design prior to implementation. One complexity is that multiple survey units are considered against the basement inventory limit (BIL) - which is accomplished by applying only a fraction of the BIL to each survey unit. In this case, the licensee has indicated that the upper bound of the gray region (UBGR) for the sign test calculation will be based on the fraction of the BIL utilized in each survey unit (as opposed to the full BIL). However, the surveys, as described in the LTP, appear to have been designed using the full BIL as the UBGR in the relative shift calculation, which could potentially result in a different number of measurements. Additionally, the original Class 2 survey designs were based on an assumption for variability (i.e., Section 5.5.2.2 of the LTP indicates an assumed coefficient of variation of 30% was used for both the Containment Buildings and Auxiliary Building), whereas additional characterization and results of preliminary surveys may provide a more accurate representation of the standard deviation prior to implementation. In the interest of performing a comprehensive MARSSIM based survey, it will also be necessary for investigation levels to be adjusted accordingly when the licensee plans to utilize a fraction of the BIL as the effective release criterion in certain areas. For these reasons, a re-evaluation of the survey designs should be performed prior to STS surveys in these areas, and should utilize the adjusted UBGR and an appropriate standard deviation.

Basis:

NUREG-1575, Rev. 1 (MARSSIM) Section 2.5.5 discusses Class 2 survey design and the areas between measurement locations.

Per the acceptance criteria/information to be submitted, as described in NUREG-1757, Vol. 2, Rev. 1, Section 4.4 (Final Status Survey Design), licensees should provide a justification for any test methods not included in MARSSIM.

Path Forward:

a. NRC has historically maintained that the recommended survey unit sizes from MARSSIM be used, and previously acceptable approaches to adjust these sizes have included an additional number of measurements proportional to the size increase. As such, the licensee's proposal to increase survey unit sizes without performing additional measurements will require justification by the licensee and approval by the NRC. Nonetheless, the licensee may choose to provide additional justification to increase survey unit sizes from what is recommended in MARSSIM, but as noted in the comments above, the level of justification provided to date is inadequate, and any additional justification should include details on the extent of coverage and results from characterization surveys or preliminary decommissioning surveys that will be used to inform the decision.

b. A more direct approach by the licensee would be to increase the currently proposed number of samples relative to survey unit area increases above MARSSIM recommendations. Alternatively, the licensee should re-design survey units to meet the MARSSIM recommended sizes, as this would be considered acceptable to the NRC.

c. With regard to the overall design of Class 2 surveys, the licensee should commit to re-evaluate the survey design and number of samples prior to implementation. This evaluation should consider any changes that would occur as a result of a different UBGR/relative shift being used and from actual variability results. Survey investigation levels should also be adjusted to coincide with adjustments to the fraction of the BIL being utilized in a survey area.

ZSRP Response (HP 7a, 7b and 7c) – In response to previous RAI concerns pertaining to the Auxiliary Building walls as a Class 2 survey unit, ZSRP has changed the classification of the Auxiliary Building walls from Class 2 to Class 1. Consequently, the only remaining structures that are classified as Class 2 are the Containment basements above the 565 foot elevation. In addition, ZSRP has revised section 5.5.2.2 of LTP Rev 1, Chapter 5 to state, “In the Class 2 basement structure FSS units (where less than 100% ISOCS coverage is required), measurement spacing will be determined in accordance with section 5.6.4.5.2 of this Chapter. The number of measurements will also be increased to correspond with the MARSSIM recommended survey size for a Class 2 structure (14 measurements for every 1,000 m^2).” Table 5-19 of LTP Rev 1 was also revised to show the adjustment to the increased minimum number of ISOCS measurements in the Containment basements above the 565 foot elevation (with a 2,465 m^2 surface area) from 14 to 35.

8. **NRC Comment (HP 8)**: HP RAI 7 (as provided to the licensee in May 2016) inquired about additional details for piping surveys and notes that there does not appear to be a classification system for piping. The licensee's response provides some discussion on buried piping and classification, but does not address the classification of embedded piping.

During the review of these RAI responses, the NRC became aware of over 3600 ft of embedded floor and equipment drain piping that is planned to remain in the Auxiliary Building (as described in the September 1, 2016 "Zion Station Restoration Project Final Radiation Release Record – Auxiliary Building 542 Ft Embedded Floor and Equipment Drain Pipe Survey Units 05119A and 05119B"). This appears to contrast with previous statements made in Section 5.5.5 of the LTP that "the vast majority of embedded piping will be removed during decommissioning," and that "it is anticipated that the only remaining embedded piping will be the floor drain system piping in the 560 foot elevation floor of the Turbine Building," and also with statements in Section 2.3.3.2 of the LTP that "drain system piping that is embedded in the concrete of the 542 foot elevation concrete floor will be removed and dispositioned as waste." Section 5.2.1 of the LTP also indicated that "LTP Chapter 2, section 2.3.3.7 and Table 2-26 discusses the embedded piping and penetrations located below the 588 foot elevation that will remain and be subjected to STS." However, Table 2-26 only addresses piping penetrations of 4 feet in length, while Section 2.3.3.7 of the LTP acknowledges that some piping may remain but that "in most cases, these sections of pipe will consist of mostly penetrations through the remaining concrete walls of the structure." Additionally, in the response to RAI PAB 3B in the second set of RAIs (as provided to the NRC in July 2016), it is stated that "The piping will be removed from all penetrations, leaving just a sleeve."

A previously provided response to HP RAI 11 from March 2016 was reiterated in the current response by the licensee which indicates that ZSRP is "evaluating the accessibility of the embedded floor drain systems specifically in the concrete floor of the Auxiliary Building 542 foot elevation," and that "ZSRP is in the process of assessing a practicable method for determining the total activity inventory that is defensible and bounding." The original HP RAI 11 from March 2016 also noted 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 in a TSD." However, the July 2016 response to HP RAI 7 indicates that "if a TSD is developed [emphasis added] 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." This statement is contrary to the original commitment to provide a TSD if the "approach proposed for demonstrating compliance in this system is different," as it commits to providing a TSD for review and approval only if the licensee chooses to develop one.

NRC staff notes that the aforementioned Final Radiation Release Record for piping in Survey Units 05119A and 05119B describes a Class 1 piping survey unit that should receive 100% scanning coverage. The previous response from the March 2016 HP RAI 11 notes that "…if the pipe to be surveyed is potentially contaminated (i.e. commensurate with a MARSSIM Class 1 classification), then a static measurement is taken at one foot intervals," and that "based upon the area of detection for the detector used, this will conservatively provide 100% areal coverall of the pipe interior surfaces." In practice, the release record indicates that 936 feet out of the 3684 feet of pipe was considered "inaccessible" and was not surveyed. Additionally, the release record describes an extrapolation of mean concentrations from accessible piping. However, it is not clear how this extrapolation was accomplished, and the level of conservatism in this calculation cannot be evaluated.

Reasons presented for the inaccessibility of certain sections of piping include pipe diameter restrictions or obstructions. In particular, the release record indicates that "of the 936 feet of inaccessible pipe, 553 feet were the small bore equipment drain pipe which has a pipe diameter of 2-inch," and that "the diameter of this pipe was of insufficient size to insert the available 1" x 1" CsI detectors." This contrasts to statements made in the March 2016 HP RAI 11 response that "for the performance of the radiological surveys, it is anticipated that a 1" x 1" detectors (NaI or CsI) will be used for pipe sizes ranging from 2-inch to 8-inch in diameter."

In conclusion, there are apparent discrepancies between the descriptions and proposed disposition of embedded piping provided in the LTP and what is being done in practice. New commitments made on providing a TSD for review and approval are contradictory to the previous March 2016 response, and the approach actually utilized for surveys of embedded piping in survey units 05119A and 05119B differs from what has previously been described (both in coverage and in the extrapolation of results). Therefore, additional details are needed on the extent of all piping to remain at the site and on the classification and survey strategy to be utilized. The survey strategy should describe how release criteria will be established, and the investigation levels related to those criteria should be provided. Methods and calculations on how the licensee will survey and assess contamination in 100% of Class 1 piping areas should be described. Updates to the LTP need to be made to address the licensee's changes to the processes for surveying and dispositioning embedded piping.

Additionally, with regard to the usage of ISOCS for piping surveys, HP RAI 7 indicated that "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." The licensee's response to the RAI indicates that "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)." The fact that surveys have already been performed does not preclude the NRCs request for a technical basis document to utilize ISOCS surveys for piping – one should still be provided.

Basis:

Per the acceptance criteria/information to be submitted, as described in NUREG-1700, Rev. 1, Section 5 (Final Status Survey Plan), licensees should provide methods for surveying embedded piping.

Per the acceptance criteria/information to be submitted, as described in NUREG-1757, Vol. 2, Rev. 1, Section 4.4 (Final Status Survey Design), licensees should provide a description and map or drawing of impacted areas of the site, area, or building classified by residual radioactivity levels (Class 1, 2, or 3) and divided into survey units, with an explanation of the basis for division into survey units (maps should have compass headings indicated).

Path Forward:

a. Provide a listing of all piping (embedded, buried, or penetrations) that will remain on site. This list should include a description of the piping, type of piping (i.e., embedded, buried, or penetration), the survey unit of the piping, the land or structure survey unit in which the piping resides, and the piping classification.

b. Provide the licensee's definitions for "embedding piping," "buried piping," and "penetrations" as they are used for decommissioning planning at the site.

c. Describe the methods on how the licensee will survey and assess contamination in 100% of Class 1 piping areas.

d. Describe survey methodologies and strategies that differ from those previously provided in March 2016 RAI responses.

e. Update the LTP to address changes to the licensee's processes for surveying and dispositioning embedded piping, buried piping, or penetrations.

f. Provide a technical basis document for review and approval of ISOCS surveys of piping.

g. Update the LTP to include the descriptions on surveys of embedded and buried piping as provided in several RAI responses to the NRC.

ZSRP Response (HP 8a) – ZSRP has developed Zion*Solutions* TSD 14-016, "Description of Embedded Pipe, Penetrations, and Buried Pipe to Remain in Zion End State", which is included with this response for NRC review. The purpose of this document is to provide an inventory of the embedded piping, buried piping and penetrations that will remain in the end state (i.e., below 588 foot elevation). The document provides estimated lengths, diameters for end-state piping and estimates the surface areas and void spaces associated with them. The document also provides the current planned end state (e.g., pipe removed from penetration or pipe remains in penetration). Attachment F of TSD 14-016 provides the complete list of all end-state piping (embedded, buried or penetration) and includes all the information requested in RAI HP 8a, including a description of the piping, type of piping (i.e., embedded, buried, or penetration), the survey unit of embedded pipe and penetrations, the basement structure in which a penetration or embedded pipe interfaces or resides, and the classification of all piping.

The location of each buried pipe, and FSS Classification is described in TSD 14-016 but the locations are not correlated to specific open land survey units because the dose assessment in TSD 14-015, and the compliance dose calculation (Equation 6-11 in Zion LTP Rev 1) are independent of buried pipe location.

The dose assessment in TSD 14-015 assumes that all buried piping to remain at license termination is in one contiguous area, regardless of actual physical location, in order to maximize dose. This approach was used primarily to ensure a conservative dose calculation and DCGL but also to eliminate the need to track the location of a given buried pipe. Various buried pipes may be compiled into separate survey units during FSS based on, for example, the systems associated with the piping. The application of the DCGLs, which were calculated assuming all of the buried pipe is in one contiguous area, to a pipe survey unit that contains only a portion of the total buried pipe is conservative. The maximum buried pipe dose used in the compliance dose calculation (LTP Rev 1, Equation 6-11) applies the maximum dose calculated from any buried pipe survey unit regardless of location and surface size.

ZSRP Response (HP 8b) –

The following definitions are provided in Zion LTP Rev 1.

- An embedded pipe is defined as a pipe that runs vertically through a concrete wall or horizontally through a concrete floor and is contained within a given building. The Auxiliary Building and Turbine Building floor drains are examples of embedded pipe.
- A penetration is defined as a remaining system pipe (or the metal sleeve if the system pipe is removed, or concrete if the sleeve is removed or no sleeve was present) that runs through a concrete wall and/or floor, between two buildings, and is open at the wall or floor surface of each building. A penetration could also be a pipe that runs through a concrete wall and/or floor and opens to a building on one end and the outside ground on the other end.
- Buried pipe is defined as a pipe that runs through soil.

ZSRP Response (HP 8c) – ZSRP intends to perform FSS of buried pipe, embedded pipe and penetrations using the survey approach as detailed in the response to HP RAI 11 from March 2016. There are no survey methodologies or strategies to be used that differ from those previously provided in March 2016 RAI Reponses.

In summary, ZSRP intends to use appropriately sized gamma detectors (NaI and/or CsI) inserted into pipe interiors using a simple “push-pull” methodology, whereby the position of the detector in the piping system can be easily determined in a reproducible manner to acquire timed measurements. The gamma detectors are configured in a fixed geometry relative to the surveyed surface, thus creating a situation where a defensible efficiency can be derived. The detectors are then deployed into the actual pipe and timed measurements are acquired at an interval of one measurement for every foot of pipe. A conservative "area of detection" of one-foot is assumed. It was also conservatively assumed that any activity inside of the pipe is uniformly distributed in the area of detection. The detector output represented the gamma activity for each timed measurement in units of gross cpm. The gamma measurement value in units of cpm is then converted to units of dpm using the efficiency factor for the detector applicable to the diameter of the pipe surveyed. Consequently, the total activity from the measurement, in units of dpm is adjusted for the total effective surface area commensurate with the pipe diameter and the assumed "area of detection", resulting in measurement results in units of dpm/100 cm^2. Using the appropriate conversion factors, the results are then converted to units of pCi/m^2. This measurement result represents a commensurate and conservative gamma surface activity for the one foot of pipe surface where the measurement was taken. Consequently, a measurement acquired for every foot of pipe surveyed would equate to 100% survey coverage of the pipe interior surface area.

ZSRP Response (HP 8d) As stated in the response to RAI HP 8c, ZSRP intends to perform FSS of buried pipe, embedded pipe and penetrations using the survey approach as detailed in the response to HP RAI 11 from March 2016. There are no survey methodologies or strategies to be used that differ from those previously provided in March 2016 RAI Reponses. However, a few general responses are provided below to clarify some details regarding the process that has been implemented, and will be implemented in the future, that were discussed in the RAI basis.

First, to remove any ambiguity, if a survey approach for embedded pipe, penetrations, or buried pipe is proposed that is different from the more traditional approach described in HP RAI 11 and provided in Zion LTP Rev 1, ZSRP commits to submit a TSD to NRC for review and approval.

Second, as stated in the March 2016 HP RAI 11 response "for the performance of the radiological surveys, it is anticipated that a 1" x 1" detectors (NaI or CsI) will be used for pipe sizes ranging from 2-inch to 8-inch in diameter." However, in practice this does not necessarily allow every part of a 2 inch pipe to be accessed by a 1" by 1" detector, For example, while attempting to survey the Class 1 embedded floor drain pipe for the Auxiliary Building basement, it was discovered that a small percentage of the pipe interior was obstructed by debris. It is also known that while a 1" x 1" CsI detector has a diameter small enough for insertion into a 2 inch diameter pipe, the detector length prevents the detector from navigating past 90-degree bends in the pipe. This left several additional feet of the Auxiliary Basement floor drains inaccessible due to the configuration of the system. A stated in response to RAI 8c, in situations where obstructions or pipe configuration prevent the insertion or travel of the gamma detector into a Class 1 pipe and 100% areal coverage cannot be achieved, ZSRP will consult with the NRC as to the proposed method for assigning activity to the inaccessible area. This process, i.e., consultation with NRC, was followed after portions of the Auxiliary Basement floor drains were found to be inaccessible.

The method and limitations for the FSS of pipes are described in Zion*Solutions* procedure ZS-LT-300-001-006, "Radiation Surveys of Pipe Interiors Using Sodium/Cesium Iodide Detectors" which has been submitted to the NRC for review. The process specified in procedure ZS-LT-300-001-006 is consistent with the survey approach in the original HP RAI 11 from March 2016 and described in response to RAI 8c.

Finally, the embedded pipe inventory expected to remain at the time of LTP Rev 0 submittal has evolved due to continuing engineering review as decommissioning proceeded. As discussed above in response to RAI 8a, Zion*Solutions* TSD 14-016, "Description of Embedded Pipe, Penetrations, and Buried Pipe to Remain in Zion End State" was developed to definitively determine the inventory of pipe that will remain in the Zion End state. This comprehensive document provides high confidence that the location, specification, and FSS Classification of embedded pipe, penetrations and buried pipe to remain are now known and provides the inputs required to provide specific details and methods for compliance demonstration Chapter 5 and Chapter 6 of Zion LTP Rev 1.

ZSRP Response (HP 8e) – The following sections of LTP Rev 1 have been revised to address the processes for surveying and dispositioning embedded piping, buried piping, or penetrations described in various RAIs:

- Chapter 2, section 2.3.3.7
- Chapter 5, section 5.7.1.9
- Chapter 5, section 5.5.5

For additional information regarding LTP changes in response to RAIs, A "Change Matrix" is provided with LTP Rev 1 which correlates the ZSRP responses to all RAIs (all three sets) to corresponding revisions in LTP Rev 1.

A definitive list of piping to remain at license termination, including specifications such as diameter, length, and location, the system the pipe was associated with, and the FSS Classification is provided in Zion*Solutions* TSD 14-016, "Description of Embedded Pipe, Penetrations, and Buried Pipe to Remain in Zion End State".

ZSRP Response (HP 8f) ZSRP commits that with the exception of the FSS measurements that have already been acquired for the FSS of the Circulating Water Intake Pipe and Circulating Water Discharge Tunnels, the Canberra LabSocs/ISOCS Genie-2000 Portable Gamma Spectroscopy System will not be used to acquire measurements for FSS in any end-state buried pipe, embedded pipe or penetration.

ZSRP Response (HP 8g) See response to RAI HP 8e.

9. **NRC Comment (HP 9)**: The previous HP RAI 8 (as provided to the licensee in May 2016) discussed updates to the LTP to address the appropriate MDC usage, relative to the DCGL for fixed or volumetric measurements. The licensee's response to clarify differences in scan and fixed measurement MDCs was to commit to adding the following text to LTP Section 5.8.1: "The target MDC for field instruments is the maximum acceptable value. The actual MDCs expected to be used during FSS is much lower." This statement makes no commitment on the part of the licensee and does not address original comments to specify appropriate MDC expectations for fixed or volumetric measurements to be consistent with MARSSIM. The difference between the Scan MDC and fixed measurement MDC expectations in MARSSIM is that the fixed measurement MDCs should not exceed the DCGL. However, the text provided by the licensee in Section 5.10.2.1 of the LTP still indicates that fixed measurement MDCs can be as high as the DCGLEMC. As noted in the original RAI from March 2016, MARSSIM recommends lower MDC values be used if possible.

With regard to fixed STS measurements, there is no DCGL, but the concept of adequate detection capability relative to the applicable BIL still applies. The manner in which the licensee will validate this and clearly defined and inspectable criteria should be provided. The licensee's TSD 14-022 document discusses MDCs related to ISOCS, and there is a brief notation in LTP Table 5-15 that "In situ spectroscopy HPGe uses the 'count to MDA' function in order to achieve the required MDC. However, the values that the licensee will use to assess MDC/MDA are not defined.

Basis:

NUREG-1575, Rev. 1 (MARSSIM) indicates in Section 6.5.3 (Instrument Selection) that "the instrument must be able to detect the type of radiation of interest, and the measurement system should be capable of measuring levels that are less than the DCGL."

MARSSIM Section 6.7.1 (Direct Measurement Sensitivity) indicates that "prior to performing field measurements, an investigator must evaluate the detection sensitivity of the equipment proposed for use to ensure that levels below the DCGL can be detected."

Instrumentation selection is discussed in the MARSSIM "Roadmap," where it is noted that "for direct measurements and sample analyses, minimum detectable concentrations (MDCs) less than 10% of the DCGL are preferable while MDCs up to 50% of the DCGL are acceptable."

Path Forward:

a. Revise statements in the LTP to ensure that fixed measurement MDCs will not exceed the DCGL. To be consistent with MARSSIM guidance, the LTP should acknowledge that "minimum detectable concentrations (MDCs) less than 10% of the DCGL are preferable while MDCs up to 50% of the DCGL are acceptable."

b. Provide details on the manner in which the licensee will utilize the "count to MDA" function in order to achieve the required MDC for STS surveys. Define the actual MDC values that will be utilized in this process.

ZSRP Response (HP 9a) – Sections 5.8.1 and 5.10.2.1 of LTP Rev 1, Chapter 5 have been revised to state, "For direct measurements and sample analyses, MDCs less than 10% of the Operational DCGL are preferable while MDCs up to 50% of the Operational DCGL are acceptable."

ZSRP Response (HP 9b) – The entries in Table 5-15 (now Table 5-27 in LTP Rev 1) regarding "HPGE" were revised to be specific to the use of ISOCS during FSS. The notation in Table 5-27 referring to the "count to MDA" did not apply to the use of ISOCS during FSS and was deleted.

Table 5-27 now provides a specific MDC target of "10% of the Operational DCGL". Determination of whether or not the MDC target has been met is visually verified in the field through review of the gamma spectrum analysis report provided at the completion of a spectrum acquisition.

10. **NRC Comment (HP 10)**: The original HP RAI 9 (as provided to the licensee in May 2016) noted that the integration of preliminary scans, judgmental sampling, and investigation levels needs to be better defined for STS and that the potential for elevated areas needs to be more fully considered for STS. The RAI noted that "the licensee appears to rely on the open air demolition surveys throughout the LTP to address potential areas of elevated contamination," and that "the anticipated frequency and coverage of these surveys should be defined." The licensee's response does not define the anticipated frequency and overage of these surveys, but only indicates that "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." The procedure, ZS -LT-400-001-002 (Revision 0), "Contamination Verification Surveys prior to Demolition," was provided for NRC review. NRC staff reviewed ZS -LT-400-001-002 (Revision 0) and noted that recommended minimum survey coverage, as described in Table 1 of the procedure, is set to 5-10% per area depending on the area location (e.g., floors, walls, ceilings, etc.). This level of coverage is not adequate for NRC staff to consider open air demolition surveys to sufficiently locate elevated areas of contamination. The licensee previously states in Section 5.4.3 of the LTP that "scanning coverage for pre-remediation surveys on structures prior to open air demolition could include up to 100% of the accessible surface area depending on the contamination potential," and that "the pre-remediation surveys performed to prepare building surfaces for open air demolition will provide confidence that structural surfaces that have significant elevated activity will be removed." However, the licensee has not committed to actually performing 100% scans of accessible surface area. Furthermore, it is not clear how the licensee would consider inaccessible areas.

The previous HP RAI 9 (as provided to the licensee in May 2016) notes that the original RAI response to TSD 14-022-1 (from March 2016) "acknowledges the proposed coverage for Class 1 areas is actually less than 100% because of no overlap in the FOV for each measurement," and 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." NRC staff asked for details on the integration of all survey types, as they might be useful to meet the 100% coverage requirement for Class 1 areas. This is particularly why the anticipated frequency and coverage of open air demolition surveys was requested, as the licensee relies on them as bounding for elevated areas. Since the licensee has not provided sufficient details on the open air demolition scan coverage in Class 1 areas, the NRC staff does not agree that 100% coverage will actually be obtained in Class 1 STS survey units. Overlapping STS fields of view could be used to truly meet 100% coverage, or additional scan surveys to fill in coverage gaps may be proposed. These types of scan surveys, typical to MARSSIM, are intended to locate elevated areas, and would need to be designed with a Scan MDC appropriate for that purpose.

With regard to judgmental sampling, HP RAI 9 indicated that “the licensee should describe the conditions that would lead to such measurements,” and that “it is not sufficient to simply say these surveys ‘may’ occur as this provides no commitment on the part of the licensee.” The licensee’s response to the first HP RAI 8, as provided in March 2016, only indicates 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 licensee’s latest response indicates that “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,” but commits to providing several judgmental measurements in the Auxiliary Building based on characterization results. The NRC indicated in the original HP RAI 8 (from December 2015) that MARSSIM does discuss considerations for judgmental sampling in both Class 2 and 3 areas, as MARSSIM 2.5.5 states:

“…The level of scanning effort should be proportional to the potential for finding areas of elevated activity: in Class 2 survey units that have residual radioactivity close to the release criterion a larger portion of the survey unit would be scanned, but for survey units that are closer to background scanning a smaller portion of the survey unit may be appropriate. Class 2 survey units have a lower probability for areas of elevated activity than Class 1 survey units, but some portions of the survey unit may have a higher potential than others. Judgmental scanning surveys would focus on the portions of the survey unit with the highest probability for areas of elevated activity. If the entire survey unit has an equal probability for areas of elevated activity, or the judgmental scans don't cover at least 10% of the area, systematic scans along transects of the survey unit or scanning surveys of randomly selected grid blocks are performed.

Class 3 areas have the lowest potential for areas of elevated activity. For this reason, MARSSIM recommends that scanning surveys be performed in areas of highest potential (e.g., comers, ditches, drains) based on professional judgment. This provides a qualitative level of confidence that no areas of elevated activity were missed by the random measurements or that there were no errors made in the classification of the area.”

The discussion in MARSSIM Section 2.5.5 is in the context of scanning, whereas the licensee’s STS approach uses ISOCS measurements to essentially meet both the scanning and discrete measurement expectations from MARSSIM. However, it is impossible to judgmentally “scan” per MARSSIM 2.5.5 when only discrete STS measurements are taken for compliance purposes. Since the licensee’s determination of the required number of measurements and statistical tests for compliance are rooted in MARSSIM, the consideration for judgmental measurements should also be consistent with MARSSIM. It is incumbent on the licensee to adequately justify that judgmental measurements are appropriately considered, and this is why the original NRC RAI requested that the licensee “describe the conditions that would lead to such measurements.”

Another portion of HP RAI 9 notes that “with regard to the STS investigation levels noted in the response to RAI TSD 14-022-1 [from March 2016] and within Attachment 7 of ZS-LT-300-001-

004 [Revision 2], the licensee should incorporate these levels into the LTP." The licensee only commits to putting into the LTP the proposed investigation level for the gaps surrounding Class 1 STS measurements where overlapping does not occur. There are currently no investigation levels for STS actually listed in the LTP, which is inconsistent with expectations from NUREG-1700, Rev. 1 (Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans) that the licensee provide a description of the final status survey investigation levels and how they were determined.

Additionally, it is unclear how the licensee intends to interpret the SOF described currently in ZS-LT-300-001-004 (Revision 2) For example, Section 5.6.1 of that procedure indicates that an investigation should occur as follows: "For STS, if the survey unit fails the statistical test or, if it was determined in step 5.4.6 that the SOF for an individual measurement exceeds the STS Investigation Levels presented in Attachment 7 or, if the Total Mean Dose exceeds 25 mrem/yr or, if the sum of the Mean Inventory Fractions for all STS units in a basement exceeds one, then proceed to step 5.6.4." This statement indicates that "the SOF for an individual measurement" is the trigger for an investigation. It is not clear from descriptions in the text whether the SOF described in the context of an "individual measurement" is related to a fraction of the BIL per unit area, or if this implies that one measurement could potentially exist at levels up to the entire BIL for the basement and still be considered acceptable. As such, investigation levels should be clearly defined as an activity concentration (e.g., pCi/m2) for evaluation in the LTP and as levels that can be confirmed and inspected by the NRC.

Basis:

NUREG-1575, Rev. 1 discusses 100% scan coverage for Class 1 areas in several places, and discusses judgmental considerations for scanning in Class 2 and 3 areas in Section 2.5.5 (as further discussed in the comment).

Per the acceptance criteria/information to be submitted described in NUREG-1700, Rev. 1, Section 5 (Final Status Survey Plan), licensees should provide a description of the final status survey investigation levels and how they were determined.

Path Forward:

a. Clarify how the licensee intends to interpret the SOF for an individual measurement, as described in ZS-LT-300-001-004 (Revision 2). Clarify if the SOF described in the context of an "individual measurement" is related to a fraction of the BIL per survey unit area, or if this implies that one measurement could potentially exist at levels up to the entire BIL for the basement and still be considered acceptable.

b. Commit to overlapping STS fields of view to ensure 100% coverage is attained for Class 1 areas. Alternatively, the licensee may propose to utilize scanning surveys to fill in the gaps between STS measurements. In that case, the elevated measurement criteria being utilized should be defined and Scan MDCs should be established to ensure that those measurement criteria are met.

c. Describe how the licensee considers judgmental sampling in Class 2 and 3 areas and the conditions that would lead to such measurements.

d. Include STS investigation levels in the LTP and describe how they were determined. Investigation levels should be defined as an activity concentration (e.g., pCi/m2) that can be confirmed and inspected by the NRC.

ZSRP Response (HP 10a) – Section 5.5.4 of LTP Rev 1, Chapter 5 has been revised to state, "After a sufficient number of ISOCS measurements are taken in a FSS unit in accordance with the areal coverage requirements specified in Table 5-19, the data will be summarized, including any judgmental or investigation measurements. The measured activity for each gamma-emitting ROC (and any other gamma emitting radionuclide that is positively detected by ISOCS) will be recorded (in units of pCi/m^2). Background will not be subtracted from any measurement. Using the radionuclide mixture fractions applicable to the survey unit, an inferred activity will be derived for HTD ROC using the surrogate approach specified in section 5.2.11. The surrogate ratios that will be used are presented in Table 5-15. A sum of fractions (SOF) calculation will be performed for each measurement by dividing the reported concentration of each ROC by the Operational $DCGL_B$ for each ROC to calculate an individual ROC fraction. The individual ROC fractions will then be summed to provide a total SOF value for the measurement.

As described in section 5.10.3.2, the Sign Test will be used to evaluate the remaining residual radioactivity against the dose criterion. The SOF for each measurement will be used as the sum value for the Sign Test. If the Sign Test demonstrates that the mean activity for each ROC is less than the Operational $DCGL_B$ at a Type 1 decision error of 0.05, then the mean of all the total SOFs for each measurement in a given survey unit is calculated. If the Sign Test fails, or if the mean of the total SOFs in a basement exceeds one (using Operational DCGLs), then the survey unit will fail FSS. If a survey unit fails FSS, then the survey unit may be reclassified, additional remediation will be performed and the FSS performed again.

Once the survey data set passes the Sign Test (using Operational DCGLs), the mean radionuclide activity (pCi/m^2) for each ROC from systematic measurements along with any identified elevated areas will be used with the Base Case DCGLs to perform a SOF calculation for each surface FSS unit in a basement in accordance with the following equation. The dose from residual radioactivity assigned to the FSS unit is the SOF_B multiplied by 25 mrem/yr."

Equation Error! No text of specified style in document.**-1**

$$SOF_B = \sum_{i=1}^{n} \frac{Mean\ Conc_{B_{ROC_i}}}{Base\ Case\ DCGL_{B_{ROC_i}}} + \frac{\left(Elev\ Conc_{B_{ROC_i}} - Mean\ Conc_{B_{ROC_i}}\right)}{\left[Base\ Case\ DCGL_{B_{ROC_i}} \times \left(\frac{SA_{SU}}{SA_{Elev}}\right)\right]}$$

where:

SOF_B	=	SOF for structural surface survey unit within a Basement using Base Case DCGLs
$Mean\ Conc_{B\ ROCi}$	=	Mean concentration for the systematic measurements taken during the FSS of structural surface in survey unit for each ROC_i
$Base\ Case\ DCGL_{B\ ROCi}$	=	Base Case DCGL for structural surfaces ($DCGL_B$) for each ROC_i
$Elev\ Conc_{B\ ROCi}$	=	Concentration for ROC_i in any identified elevated area
SA_{Elev}	=	surface area of the elevated area
SA_{SU}	=	adjusted surface area of FSS unit for DCGL calculation

ZSRP Response (HP 10b) – Section 5.5.2.2 of LTP Rev 1, Chapter 5 has been revised to state, "sufficient measurements will be taken in the Class 1 FSS unit to ensure that 100% of the surface area is surveyed (ISOCS FOV will be overlapped to ensure that there are no un-surveyed corners and gaps)." Table 5-19 of LTP Rev 1, Chapter 5 shows the adjusted minimum number of ISOCS measurements required for each basement survey unit. Therefore, as an example, the Class 1 Auxiliary Building Floor and Walls survey unit that originally required 233 ISOCS measurements was adjusted to 407 ISOCS measurements to ensure that 100% areal coverage included overlap to ensure that there would be no un-surveyed corners and gaps (FOV was based on a 4m x 4m grid system).

ZSRP Response (HP 10c) – Section 5.4.5 of LTP Rev 1, Chapter 5 has been revised to state, "Any areas identified that have the potential to exceed the Operational $DCGL_B$ by ISOCS measurement during the performance of CVS in these areas will be earmarked for remediation. Any areas of elevated activity that could potentially approach the Operational $DCGL_B$ will be identified as a location for a judgmental ISOCS measurement during FSS" Section 5.5.2.1.1 of LTP Rev 1, Chapter 5 has been revised to state, "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 characterization, the results of CVS or professional judgment."

ZSRP Response (HP 10d) – Investigation levels for the FSS of basement structures are presented in section 5.6.4.6 and Table 5-25 of LTP Rev 1, Chapter 5. Measurement(s) will be individually compared to their respective Operational $DCGL_B$. In a Class 3 or Class 2 survey unit, if the result of a measurement exceeds the Operational DCGL (or 50% of the Operational DCGL in a Class 3 survey unit), then the investigation process as specified in LTP Rev 1, Chapter 5, section 5.6.4.6 will be implemented. In a Class 1 survey units for media other than soil (structural surfaces, embedded pipe, buried pipe and/or penetrations), any areas of elevated residual radioactivity above the Base Case DCGL will be remediated. For Class 1 soil survey units, if any areas of elevated residual radioactivity above the Base Case DCGL are identified, then the EMC process as specified in LTP Rev 1, Chapter 5, section 5.5.3 will be implemented.

11. **NRC Comment (HP 11)**: The previous HP RAI 10 (as provided to the licensee in May 2016) noted that there were statements in Section 3.2 of TSD 14-013 (Revision 0) that "there is a potential for the walls above 3 feet to be contaminated in spots where there were localized leaks and by surface contamination," and that "the potential contribution of localized leaks will be limited by the 2 mrem/hr contact dose rate cut-off for open air demolition." The TSD and the licensee's RAI response otherwise indicates that bounding calculations were performed utilizing core samples to determine the Class 2 designation. However, the reason this RAI was originally asked was because statements in TSD 14-013 indicated that upper walls may be contaminated due to leaks and surface contamination, and it was not clear that these known or expected areas of contamination had in fact been evaluated for the sake of classification. These such areas are of particular interest since MARSSIM Section 4.4 indicates that Class 1 areas should include "locations where leaks or spills are known to have occurred." The licensee's response to HP RAI 10 indicates that "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," and that "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." This description is not clear and does not describe the extent of these surveys, while using words like "accessible," "to the extent practicable," and "to a nominal elevation." As such, it remains unclear whether or not all expected or known areas of leaks and contamination on the Auxiliary Building walls have been surveyed.

With regard to the licensee's statement that "the potential contribution of localized leaks will be limited by the 2 mrem/hr contact dose rate cut-off for open air demolition," NRC staff is unable to conclude that this condition can be considered bounding, as the licensee has only defined a minimum scan coverage of 5-10% for "Contamination Verification Surveys," depending on the area, in ZS -LT-400-001-002 (Revision 0).

Basis:

NUREG-1575, Rev. 1 (MARSSIM) Section 4.4 indicates that Class 1 areas should include "locations where leaks or spills are known to have occurred."

Path Forward:

a. Provide additional details on the extent of characterization to assess expected or known leaks or areas of contamination on Auxiliary Building walls.

b. Address the following questions:

- Are there expected or known leaks or areas of contamination greater than 6 feet above the Auxiliary Building 542 Foot elevation floor?

- Have all expected or known areas of leaks and contamination on the Auxiliary Building walls been surveyed?
- What level of survey coverage will be utilized for open air demolition surveys of Auxiliary Building walls?

ZSRP Response (HP 11a and 11b) – In response to previous RAI concerns pertaining to the Auxiliary Building walls as a Class 2 survey unit, ZSRP has changed the classification of the Auxiliary Building walls from Class 2 to Class 1. Consequently, the FSS of the Auxiliary Building walls will require 100% areal coverage. In addition, any areas identified that have the potential to exceed the Operational $DCGL_B$ by ISOCS measurement during the performance of CVS in these areas will be earmarked for remediation. Any areas of elevated activity that could potentially approach the Operational $DCGL_B$ will be identified as a location for a judgmental ISOCS measurement during FSS. ZSRP believes that the concerns expressed in this RAI are addressed by this change in approach.

12. **NRC Comment (HP 12)**: Recent updates to the licensee's decommissioning strategies need to be evaluated in light of the "As Low as Reasonably Achievable (ALARA)" principle. In particular, a formal ALARA evaluation, per guidance in NUREG-1757, should be performed to consider piping that the licensee intends to leave onsite and concrete to be left as backfill.

The current ALARA evaluation provided in Chapter 4 of the LTP centers around a cost/benefit analysis to remove additional concrete from the 542 elevation floor of the Auxiliary Building. This evaluation was also provided along with statements in Chapter 4 of the LTP that "most contaminated piping will be removed and disposed of as radioactive waste," and "any pipe systems or sections of pipe systems that reside below the 588 foot elevation that will be abandoned in place will be inspected and surveyed as described in Chapter 5." However, the licensee has proposed to leave at least 3684 feet of contaminated piping within the Auxiliary Building (as described in the September 1, 2016 "Zion Station Restoration Project Final Radiation Release Record – Auxiliary Building 542 Ft Embedded Floor and Equipment Drain Pipe Survey Units 05119A and 05119B").

With regard to concrete fill, the path forward to HP RAI 1 (as provided to the licensee in May 2016) indicated that "the licensee must also account for potential doses from all impacted materials remaining onsite (including applicable hard-to-detect or insignificant radionuclides)." Supplementary information to HP RAI 1 was provided to ZionSolutions via email on June 14, 2016. This information expanded upon the concerns presented in HP RAI 1 and discussed the distinctions between materials that are indistinguishable from background and those which are only surveyed against criteria for offsite release of materials and equipment. Conclusions provided to the licensee in the June 14, 2016 NRC email indicated that "an evaluation ultimately requires the licensee to definitively establish that soils and concrete dispositioned onsite are truly indistinguishable from background, or else a dose assessment based on survey results should be performed for consideration per 10 CFR 20.1402." The licensee chose to provide a dose assessment rather than demonstrate that soils and concrete dispositioned onsite are truly indistinguishable from background. As such, the licensee must also evaluate these concrete fill materials in the context of ALARA, per 10 CFR 20.1402. The need to consider ALARA for impacted concrete fill materials was also specified in SECY-00-0041 (Use of Rubblized Concrete Dismantlement to Address 10 CFR Part 20, Subpart E, Radiological Criteria for License Termination) which responded to a proposal from Maine Yankee to leave demolished concrete onsite. One of the "Considerations That Need to Be Examined When Evaluating Licensees' Applications Using The Rubblization To Demonstrate Compliance with 10 CFR Part 20, Subpart E" as provided in SECY-00-0041, is whether or not rubblization demonstrates the application of ALARA principles consistent with existing ALARA guidance.

In addition to formal ALARA evaluations, there is an expectation that licensees will utilize "good housekeeping" practices during decommissioning for the sake of ALARA. Appendix N of NUREG-1757, Vol. 2, Rev. 1 indicates that "for ALARA during decommissioning, all licensees should use typical good-practice efforts such as floor and wall washing, removal of readily removable radioactivity in buildings or in soil areas, and other good housekeeping practices. In addition, licensees should provide a description in the FSSR of how these practices were employed to achieve the final activity levels." A previous RAI response from the licensee (from March 2016) notes that for the sake of the FSSR, the licensee will provide a description of how ALARA practices were employed to achieve final activity levels in information that will be provided in the FSS and STS final reports. However, the licensee's current proposal to leave 3684 feet of contaminated pipe in the 542 Elevation of the Auxiliary Building raises questions about the licensee's level of commitment for good housekeeping practices and to the removal of readily removable radioactivity in buildings or in soil areas. A review of Chapter 4 of the LTP notes that methods for cleaning piping are mentioned, such as high pressure water blasting, grit blasting, and chemical or mechanical cleaning. However, statements in Chapter 4 on when remediation will actually occur may indicate that the licensee is not fully considering piping remediation in the context of ALARA. For example, it is only indicated in Section 4.2.1.7 that in-situ remediation of piping will be performed "if radiological conditions inside the pipe are in excess of the release criteria."

With regard to overall good housekeeping practices, the LTP discusses washing and wiping decontamination techniques in Section 4.2.1.6 as follows:

Washing and wiping decontamination techniques are actions that are typically performed during the course of remediation activities for housekeeping and to minimize the spread of loose surface contamination. It is not anticipated that this remediation approach will be employed at ZSRP to reduce the residual activity in structural surfaces for the purpose of meeting the 25 mrem/yr dose criterion but rather, to comply with the open air demolition criteria in ZionSolutions TSD 10-002, "Technical Basis for Radiological Limits for Structure/Building Open Air Demolition" (Reference 4-5) and, to ensure that loose surface contamination is removed prior to evaluating the surface for acceptable concentrations of residual activity.

It was additionally noted in Section 4.4.2.2 of the LTP that "prior to building demolition, all structures will be remediated to meet the open air demolition limits specified in TSD 10-002," and that "all loose surface contamination greater than 1,000 dpm/100cm2 will be removed." This section of the LTP also notes that "the remediation techniques most likely to be implemented to perform this work are vacuuming, pressure washing and hand-wiping."

Upon further review, it appears that the licensee may only be committing to good housekeeping practices, such as washing and wiping of surfaces, in the context of remediation to meet the open air demolition criteria, and may not be considering such practices as an overall approach to ALARA. As such, details are needed on the licensee's actual plans for good housekeeping and ongoing remediation of readily removable radioactivity in the context of ALARA and 10 CFR 20.1402.

Basis:

10 CFR 20.1402 requires that the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA) in addition to meeting the dose criterion

NUREG-1757, Vol. 2, Rev. 1 Section 4.5.2 discusses acceptance criteria for final status survey reports and notes that "a description of how ALARA practices were employed to achieve final activity levels" should be provided.

Path Forward:

a. The original ALARA evaluation described in Chapter 4 of the LTP should be reconsidered in light of changes to the disposition of piping and concrete fill.

b. Details are needed on the licensee's actual plans for good housekeeping and ongoing remediation of readily removable radioactivity in the context of ALARA and 10 CFR 20.1402.

c. All final status survey reports should provide a description of how ALARA practices were employed to achieve final activity levels, including those for piping surveys.

ZSRP Response (HP 12a) – ZSRP has already performed an ALARA evaluation in accordance with Appendix N of NUREG-1757, Vol 2, Rev 1 for the embedded floor drains in the Auxiliary Building 542 foot basement floor. ZSRP also performed an ALARA evaluation in accordance with Appendix N of NUREG-1757, Vol 2, Rev 1 for the use of demolished concrete as clean fill for basement voids. Both ALARA evaluations have been documented in TSD 17-001, ALARA Analysis for Use of Concrete Debris as Fill and Remediation of Auxiliary Building 542 ft. Floor Drains and has been provided to the NRC for evaluation.

ZSRP Response (HP 12b) – ZSRP has revised section 4.2.1.6 of LTP Rev 1, Chapter 4 to state, "ZSRP will implement good housekeeping throughout decommissioning to ensure ALARA, to reduce the residual activity in structural surfaces to comply with the open air demolition criteria in Zion*Solutions* TSD 10-002, *"Technical Basis for Radiological Limits for Structure/Building Open Air Demolition"* (Reference 4-5) and, to ensure that loose surface contamination is removed prior to evaluating the surface for acceptable concentrations of residual activity."

ZSRP will comply with Appendix N of NUREG-1757, Vol. 2, Rev. 1 by using typical good-practice efforts such as floor and wall cleaning, removal of readily removable radioactivity in buildings or in soil areas, and other good housekeeping practices. ZSRP will provide a description in a FSS Final Report of how these practices were employed to achieve the final activity levels.

ZSRP Response (HP 12c) – Section 5.11.2 of LTP Rev 1, Chapter 5 has been revised to require, as part of a FSS Final Report, "Description of how ALARA practices were employed to achieve final activity levels."

13. **NRC Comment (HP 13)**: Attachment 9 to ZS-LT-300-001-004 (Revision 1), as provided in the March 2016 RAI responses, addresses remediation, reclassification, and re-survey actions, and for STS units indicates reclassification is considered in terms of a fraction of the "dose criterion" or the DCGLw. There are no DCGLs for STS, but an analogous criterion would be a concentration based value (e.g., pCi/m2). In a manner similar to the presentation of investigation levels, the current presentation of levels at which remediation, reclassification, or resurvey will occur is unclear. Clarification is needed on what is meant by the "dose criterion" and whether or not a concentration based criterion (e.g., in pCi/m2) is established for this purpose.

It was additionally noted upon further review of Attachment 9 that there are statements with regard to resurvey in Class 1 areas that may indicate the licensee intends to replace systematic population measurement results if elevated areas are remediated. This conflicts with the licensee's commitments from the March 2016 response to HP RAI 17, to update Section 5.6.4.6.2 of the LTP as follows:

"If remediation is required in only a small area of a Class 1 survey unit (defined as an Elevated Radioactivity Fraction (fEMC) that exceeds unity in 5% or less of the survey unit area), then additional measurements will be taken to determine the effectiveness of the remediation and FSS will be re-performed using the same survey design. If remediation is required in a larger area of a Class 1 survey unit (defined as an fEMC that exceeds unity in greater than 5% of the survey unit area), then the FSS will be restarted under a new survey design. Additional guidance regarding the failure and re-survey of a survey unit and is provided in section 8.5.3 of MARSSIM."

A comparison of the proposed Zion text above to that provided in Section 5.6.4.6.2 of the LaCrosseSolutions LTP submittal (Rev. 0), which is heavily based on the Zion LTP, also informed this RAI. The LaCrosse LTP text differs, and says that the "FSS will be repeated in the remediated area and replace the measurement when the remediated elevated area is 5% or less of the survey unit." This discrepancy ultimately brings into question the intent of the licensee for Zion, as the proposed Section 5.6.4.6.2 text (provided in Zion's March 2016 response to HP RAI 17) indicates that the FSS will be re-performed under the same design when the remediated elevated area is 5% or less of the survey unit or re-started under a new design if a larger area requires remediation.

Replacing systematic FSS data for consideration in the statistical test for compliance is inappropriate, particularly if the statistical test would have otherwise failed. Additionally, MARSSIM Section 8.5.3 addresses survey unit failure both when the statistical tests are passed and failed, and considers the average concentration in the survey unit relative to the DCGLw, whereas the licensee's proposed approach appears to center only around the areal size of a remediated area. MARSSIM Section 8.5.3 further concludes that "the DQO Process should be revisited to plan how to attain the original objective, that is to safely release the survey unit by showing that it meets the release criterion," and that "whatever data are necessary to meet this objective will be in addition to the final status survey data already in hand [emphasis added].” As such, the licensee needs to ensure that their chosen path forward after a survey unit fails is consistent with MARSSIM 8.5.3, considers survey unit failures in the context of the statistical tests for compliance, considers the average concentration in the survey unit relative to the DCGLw, and utilizes the DQO process to plan how to obtain the original objective (to safely release the survey unit by showing that it meets the release criterion).

Note: The original response to HP RAI 17 committed to the above referenced changes to LTP Section 5.6.4.6.2 but does not commit to putting a table similar to Attachment 9 to ZS-LT-300-001-004 (Revision 1) into the LTP. The LTP should be updated to contain the approaches for remediation, reclassification, and resurvey, in a format similar to that of Attachment 9.

Basis:

NUREG-1575, Rev. 1 (MARSSIM) Section 8.5.3 discusses the usage of the DQO process after a survey unit fails and includes examples for Class 1 survey units where the nonparametric statistical tests are both failed and passed.

Path Forward:

a. Update the LTP to contain the approaches for remediation, reclassification, and resurvey, in a format similar to that of Attachment 9 of ZS-LT-300-001-004 (Revision 1).

b. Address the discrepancy between Class 1 resurvey strategies shown in Attachment 9 of ZS-LT-300-001-004 (Revision 1) and the revised text provided for LTP Section 5.6.4.6.2, and ensure that guidance from MARSSIM 8.5.3 is considered with regard to the overall DQO process and replacement of systematic population samples/measurements. The licensee should consider survey unit failures in the context of the statistical tests for compliance and consider the average concentration in the survey unit relative to the DCGLw.

ZSRP Response (HP 13a and 13b) – LTP Rev 1, Chapter 5, section 5.6.4.6.1 was revised as follows, “The DQO process will be used as appropriate to evaluate the reclassification/resurvey action if an investigation level is exceeded. In Class 1 open land survey units, any areas of elevated residual radioactivity above the $DCGL_{EMC}$ will be remediated to reduce the residual radioactivity to acceptable levels. In Class 1 survey units for media other than soil (structural surfaces, embedded pipe, buried pipe and/or penetrations), any areas of elevated residual radioactivity above the Base Case DCGL will be remediated. If an area is remediated, then a RASS will be performed to ensure that the remediation was sufficient.”

LTP Rev 1, Chapter 5, section 5.6.4.6.2 was revised as follows, “If the survey unit fails to demonstrate compliance with the release criterion, the data that led to the decision will be reviewed. Upon completion of the review, the DQO process will be used to identify and evaluate potential solutions. The level of residual radioactivity in the survey unit will be determined to help define the problem. Once the problem has been defined, the decision concerning the survey unit will be developed into a decision rule. Additional data, if any, will be acquired to document that the survey unit demonstrates compliance with the release criterion. Alternatives to resolving the decision statement will be developed for each survey unit that fails the tests. These alternatives will be evaluated against the DQOs, and a survey design that meets the objectives will be selected."

These revisions are consistent with MARSSIM sections 5.5.2.6 and 8.5.3 and addresses the discrepancy between Class 1 resurvey strategies shown in Attachment 9 of ZS-LT-300-001-004 (Revision 1) and the text in LTP Section 5.6.4.6.2. In addition, the FSS investigation process presented in these sections is now applicable to both open land and structural FSS. ZSRP feels that sufficient detail has been included in the LTP to preclude the necessity for incorporating the entire Attachment 9 table from ZS-LT-300-001-004.

General RAI

1. Terminology

Comment: The licensee has committed to following MARSSIM, but presents nomenclature and concepts that are not discussed in MARSSIM. For example, Source Term Surveys (STS) are presented instead of Final Status Surveys (FSS), and a Basement Inventory Level (BIL) is presented instead of a Derived Concentration Guideline Level (DCGL). The licensee should clearly describe the relationship of non-MARSSIM terminology to those presented in MARSSIM.

Basis:

NUREG-1575, Rev. 1, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)

Path Forward:

a. Describe the relationship of non-MARSSIM terminology to those presented in MARSSIM. With regard to compliance levels, BILs should be presented on a concentration basis and related to the DCGL concept.

Zion Station Restoration Project (ZSRP) Response (General RAI #1) – ZSRP has revised the LTP to remove reference to the terms Source Term Survey (STS), Final Radiation Survey (FRS) and Basement Inventory Level (BIL). LTP Rev 1 uses MARSSIM terminology and approaches, including the use of DCGLs for the FSS of basement structures.

Environmental RAIs

1. Bird and Bat Collisions

Section 8.6.3.8 of the LTP describes potential impacts to State and Federally- protected species, including birds and bats, as a result of activities associated with the license termination plan and decommissioning. Section 8.6.3.8, however, does not describe the likelihood of bird and bat collisions with decommissioning equipment and intact structures and buildings. Bird and bat collisions may result in injury or mortality. In addition, artificial night lighting can increase the likelihood of such collisions. For example, migratory songbirds are most likely to collide with artificially lighted structures or cranes because of their propensity to migrate at night, their low flight altitudes, and their tendency to be trapped and disoriented by artificial light.

In order for the NRC staff to evaluate potential impacts to birds and bats as a result of the proposed license termination plan, please provide the following:

1. Please provide any data, recorded observations, or studies related to bird and bat collisions at ZNPS. If available, please provide the date, time, number of individuals, species, and impact to each individual (e.g. death, injury) for each recorded collision.
2. Please describe whether artificial lighting would be used at night.
3. Please describe whether any best management practices, such as light source shielding and appropriate directional lighting, would be used to mitigate impacts associated with artificial nighttime illumination and potential bird and bat collisions.

ZSRP Response (Environmental RAI 1) –

1. No studies related to bird and bat collisions were performed. Nor have any observations or evidence of bird and bat collisions been identified.
2. There are no plans to use artificial lighting at night beyond those necessary for Security and Occupational Safety purposes. Current plans call for building demolition or other decommissioning work to occur only on day shift.
3. See responses to 1.2.

2. General Characterization of Species and Habitats on Site

Sections 8.6.3.6 – 8.6.3.8 of the LTP describe aquatic, terrestrial, and threatened and endangered species that may occur at ZNPS. Chapter 8, however, does not describe the studies that provide a basis for determining whether species and habitats occur or do not occur on site. In order to characterize species and habitats that may occur at ZNPS, the NRC staff reviewed the following sources of information:

- Zion*Solution*'s Supplement to the Environmental Report

- Wildlife Habitat Council [WHC]. 2006. Wildlife Habitat Council Site Assessment and Wildlife Management Opportunities at Exelon Corporation's Zion Generating Station. October 2006. ADAMS Accession No. ML16138A062
- AMEC. 2013. Final Environmental Analysis of Alternatives Regarding Intake/Discharge Structure Deposition at the Former Zion Nuclear Generating Station, Zion, Illinois. Prepared for Zion*Solutions* LLC. AMEC Project No. 3205121254. October 2013. ADAMS Accession No. ML15344A355.
- Information from the U.S. Fish and Wildlife Service
- Information from Illinois Department of Natural Resources

Please clarify whether any additional field studies have been conducted to characterize State and Federally protected species and habitats at or within the vicinity of ZNPS.

ZSRP Response (Environmental RAI 2) –

No additional field studies have been conducted to characterize State and Federally protected species and habitats at or within the vicinity of ZNPS. However, each of the environmental permits included the process of a Natural Resource Review (Ecological Compliance Assessment Tool, Eco Cat), the Illinois Historic Preservation Agency, a site walk down of the permit area and guidance from the Illinois Department of Natural Resources (IDNR). The work was completed in accordance with in the frame work of a NEPA process as required by the permitting agencies (i.e., Lake County Stormwater Management Commission, USACE.). Stakeholders were contacted for their input. Additionally, field walks have been completed to verify that threatened and endangered species are not being impacted at each stage of demolition.

The environmental permit process was implemented for the following projects:

- Construction of the Vertical Concrete Casks
- Construction of the Independent Spent Fuel Storage Installation
- Construction of the On-Site Rail Road
- Demolition of the site buildings
- Barge Landing

3. Characterization of Hazardous Waste

Provide summary information about hazardous wastes that were or will be managed and disposed of as a result of decommissioning (estimates of quantities and types of wastes, such as solvents, PCB-containing paints, any hazardous wastewaters, etc.), including management onsite and disposition at offsite facilities like Clean Harbors, Safety-Kleen, or other facilities. If a document already exists that describes these activities, please provide this document for reference. Information can be generally descriptive and does not need to be highly detailed.

The EA needs to assess the potential impacts of the proposed action of approving the LTP, which include associated decommissioning impacts. Waste disposal information in the LTP does not account for hazardous waste management and the impacts of their disposal on the capacity of receiving hazardous waste management facilities.

ZSRP Response (Environmental RAI 3) –

Prior to the start of actual decommissioning activities, the site had been very diligent in the removal of hazardous waste for the 10 plus years the plant had been shut down. As a result, the site is considered a Small Quantity Generator and primarily contracts with a specialized vendor (Set Environmental Inc.) to provide handling and disposal services of hazardous waste for the project. All of our PCB transformers have been removed and sent to TCI of Alabama.

Based on our records, the new weight for Universal & Hazardous material/waste shipments since 2010 is 320,974.7 pounds. This includes the PCB dielectric fluid and transformer carcasses.

In the event hazardous waste that is confirmed to be radioactively contaminated is identified, the materials will be sent to one of Energy*Solutions*' facilities that is licensed to handle the specific waste stream and will be treated and disposed of in accordance with local, state and federal regulations.

4. Disposal of Contaminated Soils

Provide summary information about quantities and types of contaminated soils that were or will be generated as a result of decommissioning and license termination activities, and indicate where such soils will be disposed of (e.g., local landfill). The NRC staff needs to evaluate potential waste management and disposal impacts as a result of the proposed action.

ZSRP Response (Environmental RAI 4) –

Non-radiological contaminated soil has been identified through the Site Remediation Plan (SRP) in four locations: 1) an area to the north of site by the old fire training area contains 690 cubic yards of PCBs and PNAs; 2) an area along the west edge of the former Crib House contains 10 cubic yards of PNAs and mercury; 3) an area in the NGET Parking Lot contains 60 cubic yards of cyanide, and 4) an area southeast of the ISFSI contains 120 cubic yards of SVOCs. The total volume of non-radiological contaminated soil is 1,030 ft^3. These areas will be remediated and, because the soil originates in areas impacted by decommissioning activities, the soil will be disposed of at the ES Clive Disposal Site.

To date, 80,000 ft^3 of radioactive contaminated soil has been disposed of at the ES Clive Disposal Site. There is an estimated 9,000 ft^3 of potentially contaminated soil remaining that will be disposed of at the ES Clive Disposal Site.