November 30, 2016

Mr. John Sauger
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Zion Restoration Project
Zion*Solutions* LLC
101 Shiloh Blvd.
Zion, IL 60099-2797

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION RELATED TO THE LICENSE TERMINATION PLAN FOR ZION NUCLEAR POWER STATION, UNITS 1 AND 2 (TAC NOS. L53045 AND L53046)

Dear Mr. Sauger:

By letter dated December 19, 2014, you submitted a request for approval of the Zion License Termination Plan. We have reviewed your response to our request and have some additional information that will be needed to complete our review. The additional information requested is enclosed. We discussed this supplemental information request with your staff on November 2, 2016, and they indicated that they understood our information needs and that you should be able to provide a response by December 2016.

The NRC staff has provided guidance for licensee's describing methods acceptable to the staff for performing radiological surveys to demonstrate compliance with the License Termination Rule (10 CFR 20, Subpart E). The staff will accept alternate methods and approaches when adequate technical justification is provided. Licensees should consider compliance with the staff and industry widely accepted guidance, e.g. MARSSIM, or plan to provide a comprehensive technical justification for the differing approach for demonstrating compliance.

In accordance with 10 CFR 2.390 of the NRC's "Agency Rules of Practice and Procedure," a copy of this letter will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records component of NRC's ADAMS. ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html.

Should you have any questions regarding this action please contact me at 301-415-3017 or John.Hickman@nrc.gov.

Sincerely,

/RA/

John B. Hickman, Project Manager
Reactor Decommissioning Branch
Division of Decommissioning, Uranium Recovery,
and Waste Programs
Office of Nuclear Material Safety
and Safeguards

Docket Nos. 50-295 and 50-304
License Nos. DPR-39 and DPR-49

Enclosure: Request for Additional Information

cc: w/enclosure Zion Service List

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Zion Nuclear Power Station, Units 1 and 2 Service List

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PAB RAIs

1. **Comment:** 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:
   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.

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

2. **Comment:** 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:
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.

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?

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.

3. **Comment:** 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:
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.

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.

4. **Comment:** 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 ZionSolutions 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:

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.

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

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

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.

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

5. **Comment**: 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:
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.

6. **Comment**: 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:
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.

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.

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.

7. **Comment**: 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:
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).

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.

8. **Comment**: 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: Provide a description of how the factor of 2.11 was generated.

9. **Comment:** 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:
   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.

   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.

<u>Clarifying Comments:</u>

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

- 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.

HP RAIs

1. Comment:
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 NRC 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:
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).

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).

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.

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

2. Comment:

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) are 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 L_D [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 L_D.

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:
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.

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.

3. Comment:
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:
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.

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

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

4. Comment:
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:
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.

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

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

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.

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.

Commit to providing additional characterization results for NRC evaluation.

5. Comment:

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 upgradient from the groundwater flow direction and should not be impacted by the decommissioning activities, but the fact that the well is upgradient 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 FSSes."

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:
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.

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.

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.

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?

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

6. Comment:
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:
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.

Define what constitutes a “significantly different” geometry.

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.

Commit to taking all additional core samples as recommended in TSD 14-022 (Rev. 0) “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.

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

7. Comment:

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, an appropriate standard deviation, and investigation levels that reflect a fraction of the BIL as the effective release criterion.

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:
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.

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.

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.

8. Comment:
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 were considered "inaccessible" and were 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 NRC’s 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:
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.

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

Describe how piping release criteria will be established, and provide the investigation levels related to those criteria.

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

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

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

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

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

9. Comment:
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 $DCGL_{EMC}$. 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 along with clearly defined and inspectable values should be provided. The licensee's TSD 14-022 (Rev. 0) 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:
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."

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.

10. Comment:
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 coverage 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 one 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/m^2) for evaluation in the LTP and as levels that can be confirmed and inspected by the NRC.

Basis:
NUREG-1575, Rev. 1 (MARSSIM) 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, as 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:
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 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.

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.

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

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/m^2) that can be confirmed and inspected by the NRC.

11. Comment:

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

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?

12. Comment:
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 foot 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 foot 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 indicates 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 LTP 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/100cm^2 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 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:
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.

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

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.

13. Comment:

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 $DCGL_W$. There are no DCGLs for STS, but an analogous criterion would be a concentration based value (e.g., pCi/m^2). 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/m^2) 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 (f_{EMC}) 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 f_{EMC} 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 LaCrosse*Solutions* 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 $DCGL_w$, 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 $DCGL_w$, 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:
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).

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 $DCGL_w$.

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.

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.

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.

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.

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:
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.