Comments on Center for Nuclear Waste Regulatory Analysis Report "Structural Performance of Drip Shield Subjected to Static and Dynamic Loading," (IM 20.06002.01.342.510 dated September 2005)

GENERAL COMMENTS:

1. The results appear to be conservative because of the following assumptions:

   a. The Titanium material Ti-7 and Ti-24 is assumed to fail at the true ultimate strength and strain. These metals could however continue to resist forces beyond the ultimate strength during the necking behavior and undergoing larger true stresses and strains (approx. 25 to 30 percent). In view of the uncertainties in material properties and the loadings, temperature etc., There may be no need to revise the assumed material behavior.

   b. Resistance offered by the rubble to the drip shield dome area movement is not considered. This may be important because it would reduce the horizontal movement of the walls and increase the capacity of the wall to resist vertical and horizontal loads. This should be evaluated.

   c. Equivalent widths for Ti-7 plates are determined without considering the rubble restraints (see Appendix A, page A-1, section A.1, last paragraph). The equivalent widths would be greater than what have been determined because of the increase in stiffness. This would underestimate the drip shield capacity. This needs to be examined further to determine the significance of the rubble restraints on the equivalent widths of Ti-7 plates. See also comments 26 and 27 related to sensitivity of the equivalent width results to the assumed rubble mass and the Ti-7 plate thickness.

2. The results may be non-conservative because the evaluation is performed using column sections C10, C11, C12 and beam sections at transition and corner of the dome area (see Table 3-1) as a single Ti-7 plate (27.5 mm) thickness instead of two separate plates (15 mm and 12.5 mm). This should be evaluated for its potential impact on the results.

3. Results of the computer analyses should be verified using simplified hand calculations, such as column section buckling load capacity, moments due to lateral load on column sections considered as a beam, arch behavior of the dome area etc.

4. Failure criterion should be clearly defined for the FEM analyses, as shown for the frame model in Figure 3-3. Is the failure in FEM assumed to occur when the von Mises stress has reached the ultimate strength values of the material in question?

Specific Comments:

1. Page 2-5, Figure 2-5: Identify all elements modeled, including the areas shown in Gray.

2. Page 2-7, last paragraph, and else where in the report: Change "logarithmic" to "true or Cauchy".

3. Page 2-7, Equation 2-2: Revise the equation to delete the part of the elastic strain.

4. Page 2-8: Revise Titles of Figures to be consistent with Table 2-2 for designating the yield stress and the ultimate strength.

5. Page 2-12, Section 2.2.2.1, last line: Discuss the results of the analyses to demonstrate that the friction was adequate at the base to justify the assumption of a pinned condition. Please also include the minimum coefficient of friction needed for this assumption and explain how it is realistically achievable.

6. Page 2-13, section 2.3.1: Evaluate the effects of the wall flexibility on the spring constants for simulation of the rubble resistance to wall movement, and state clearly that the springs are effective only in compression when the wall moves towards the rubble. Also, verify how the calculated spring constants compare with the modulus of sub-grade reaction values for similar material.

7. Page 2-15, Figure 2-9: Show both US Units along with the SI Units. This comment applies to the entire report.

8. Page 2-15, Figure 2-9: Verify the results of the analyses plotted in the Figure to confirm that the Case 5 results spring constants with co-efficient of friction of 0.4 are lower than for case 4 with co-efficient of friction of 0.0.

9. Page 2-16, Figure 2-10a and 2-10b: Identify various parts in the model, including the white colored part.

10. Page 2-18: Revise titles of the Figures to indicate what is shown (von Mises stress) and for which case (Moment-rotation analysis for column section at the drip shield corner). Also, explain the significance of the term “(Ave. Crit.: 75%)” shown in the legend. Verify full report to address this comment.

11. Page 3-2: table 3-1, column 2: Revise “dept” to “depth”.

12. Page 303, line 5: Verify if the slope of the column is 2 percent. Review of the section depths used in Table 3-1 appears to imply a larger slope.

13. Page 3-9, Figure 3-5 and Page 3-18, Figure 3-10: Revise the figures to make the numbers legible.

14. Page 3-18, Figure 3-10 and Page 3-19, Figure 3-11: Show the units of the numbers shown in the figures. Verify the rest of the report to address this comment.

15. Page 3-20, Figure 3-12 (c) and 3-12 (d): Page 3-19, line 1 refers to “orange dots” indicating the onset of structural instability. However, this figure showing the failure conditions do not appear to have any orange dot. Please explain.

16. Page 4-10, Figure 4-9: Revise the figure to exclude unrealistic cases of the “Average Lateral Load to Vertical Load Ratio”. Include a discussion on the realistic limits for this ratio for degraded rocks.

17. Page 5-2, section 5.2.2, last paragraph: Cite references for the Ti experimental data for material damping.

18. Page 5-2, section 5.2.2: State the frequencies at which the damping of 2 percent was used to determine α and β values, and the basis for selecting these frequencies.

20. Page 5-3, section 5.2.4.2, 2nd paragraph: Provide the basis for selecting the reduced vertical rubble loads, and evaluate if a dynamic analysis case without the rubble loads would be useful for providing insight to drip shield performance during a seismic event.

21. Pages 5-3 through 5-13, section 5.2.4.3: Evaluate if the discussion related to various mean annual probability of exceedance (MAPE) values is required to be included in this report. It would be sufficient to state the time-histories and associated MAPE values used for the analyses.

22. Appendix A: The equivalent widths are based on the vertical rubble mass based on 14.5 psi. Verify if the results are also applicable for vertical mass based on approx. 42 psi.

23. Appendix A: Please verify if the sensitivity of the equivalent widths results to thickness of the Ti-7 plate [0.59 inch (15 mm) or 1.09 inch (27.5 mm)] used in the frame model.

24. Provide a detailed discussion on the modeling of the drip shield corner area in the frame model, and how it represents accurately the transfer of forces from the domed area (bulkhead beams) to the wall columns. Since the transfer of forces at the corner takes place through the Ti-7 plate which is located on opposite sides of the center of gravity of sections, it may result in change of stress from compression to tension at the corner. This may result in stress concentration, thus weakening the section.