MAY 29 1985

Project M-39

Please return original concurrence
to FBrown SS 396
Distribution
Project M-39
NMSS R/F
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NUTECH, Inc.
ATTN: Dr. John V. Massey
NUHOMS Project Manager
145 Martinvale Lane
San Jose, California 95119

Gentlemen:

In response to your submittal, docketed December 19, 1984, under Project No. M-39, we have performed a safety review of the design and operation of the dry storage concrete module independent spent fuel storage installation detailed in your submitted "Topical Report for the NUTECH Horizontal Modular Storage System for Irradiated Nuclear Fuel," (NUH-001), Revision 0, dated November 1984. Our detailed comments are enclosed.

Comments on your quality assurance program discussed in Chapter 11.0 "Quality Assurance" of your report will follow under separate cover.

If in revising this report you have questions, please contact us. We will be happy to discuss this matter with you or to arrange a meeting to accommodate such discussion.

Sincerely,

Original signed by
[illegible] P. Roberts

Leland C. Rouse, Chief
Advanced Fuel and Spent Fuel
Licensing Branch
Division of Fuel Cycle and
Material Safety

Enclosure: Detailed Comments

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DETAILED COMMENTS ON NUTECH
TOPICAL REPORT NUH-001

1.0 INTRODUCTION AND GENERAL DESCRIPTION OF INSTALLATION

1.1 Introduction

A helium storage atmosphere is specified within the DSC. What measures has NUTECH taken to assure that the helium initially placed in the DSC will not leak to the atmosphere? What is the maximum leakage rate considering the integrity of all welds and diffusion through the canister? What measures are available to monitor the DSC atmosphere composition?

1.2.1 General Description of Installation

Even though it may be possible to design a single stand-alone horizontal storage module (HSM) or physical arrangements in other than a 4x2 array, the design contained in the current Topical Report is limited to a 4x2 array (see p. 8.2-13). The Topical Report should clearly state which arrangement(s) are being proposed for review and maintain consistency throughout the document.

1.2.2 Principal Design Criteria

1. Are there limits on the kind of external atmosphere allowed for this system in order to control corrosion of exposed surfaces or to control growth of algae or other vegetative matter within the HSM? Please discuss.

2. No mention is made of the duty cycle allowed for the materials (particularly concrete). Please provide some discussion of how the duty cycles are addressed or why they do not need to be addressed.

1.2.4 Safety Features

What are the values for cask movement, cask head and truck transport which were not included in Table 1.2-4?

3.0 PRINCIPAL DESIGN CRITERIA

3.1.1.1 Physical Characteristics

Based on the data on pages 3.1-1 and 3.1-3 it appears that NUTECH has used the Westinghouse fuel assembly array of 15x15/204. Examination of the data in Table 3.1-2 reveals that several fuel arrays are not enveloped by the 15x15/204 array, namely the B&W 15x15/208, the B&W 17x17/264, the CE 15x15/208, 212 and 216, and the CE 16x16/224 to 236. The text and the Tables should be consistent and any fuel assembly types not enveloped by the design criteria case should be deleted or the design modified to envelope all the listed fuel types. In addition to these comments, are there any design parameters of the reference fuel assembly physical characteristics which would lead to a non-conservative analysis?

3.1.2.2 Handling and Transfer Equipment

1. If NUTECH intends to assume that the transfer cask will be handled in the reactor building and during loading of the cask onto the transfer vehicle by a single failure-proof crane, it should state that criterion in this section.

2. In order for the five foot horizontal drop criterion to be valid, NUTECH should specify dimensional criteria for the cask skid and the transfer trailer to show that the maximum conceivable horizontal drop height is five feet or less.

3. What vertical acceleration factors have been measured or will be assumed for design criteria for the transportation of the GE IF-300 cask loaded with the NUTECH DSC while being transported on the trailer? Show that these accelerations have been enveloped by the five foot drop analysis.

3.2 Structural and Mechanical Safety Criteria

Pages 3.2-4, 8.2-53 and 8.2-56 show inconsistent maximum internal pressurization levels of 44 and 39.7 psig. Also associated with these pressures are inconsistent temperature levels of 423^{o} and 413^{o}C. NUTECH should state what the actual design parameters are and use them consistently throughout the Topical Report.

3.2.3.1 Seismic Design

1. It is stated on Page 3.2-10 that a damping value of 2 percent of critical damping should be used for a large diameter piping system under a safe shutdown earthquake. This damping value is taken directly from NRC Regulatory Guide 1.61. Shouldn't this damping value be 3 percent?

2. It is stated on page 3.2-10 that the maximum horizontal ground acceleration selected for the design of the NUHOMS is 0.25g and the maximum vertical acceleration component selected is 0.1g. It is further stated in this paragraph that these ground acceleration values correspond to certain recommendations contained in 10 CFR 72.66(2)(ii). There does not appear to be any reference to a vertical ground acceleration level anywhere in 10 CFR 72.66. There is a reference in 10 CFR 72.66(a)(6)(ii) to a standardized ISFSI design earthquake response spectrum anchored at 0.25g. NRC Regulatory Guide 1.60 states that, depending on excitation frequency, that the vertical component of the design response spectra should be either the same as or 2/3 of the corresponding horizontal design spectra. Shouldn't the maximum vertical acceleration component selected for use in designing the NUHOMS be at least 0.17g rather than 0.1g if the maximum horizontal component is 0.25g?

Additional guidance is given in NUREG-0800, Section 3.7.1 p. 3.7.1-4, "To be acceptable the design response spectra should be specified for three mutually orthogonal directions; two horizontal and one vertical. Current practice is to assume that the maximum ground accelerations in the two horizontal directions are equal, while the maximum vertical ground acceleration is 2/3 of the maximum horizontal acceleration."

3.2.3.2 Seismic System Analysis

On page 3.2-11 it is stated that the concrete coefficient of friction of 1.0 is taken from the ACI 349-80 code. However, this is only valid if concrete is placed against hardened concrete and the interface between the concrete surfaces is clean, free of laitance and "intentionally roughened to a full amplitude of approximately 1/4 inch." In the absence of concrete surface preparation specifications, NUTECH should use 0.6 as stated in ACI 318-83 Section 11.7.4.3. This concern arises again in Chapter 8.

3.2.5.2 Dry Shielded Canister

1. NUTECH has chosen ASME Level A service limits for normal operating conditions and Level D service limits for accident or faulted conditions. The use of Level D service limits, "permit gross general deformations with some consequent loss of dimensional stability and damage requiring repair, which may require removal of the component from service," (ASME, NCA - 2142.2(b)(4)). If Level D service limits are retained for accident or faulted conditions, NUTECH must state in the structural design criteria, that following an accident (such as the 5 foot drop and drop combined with pressure) which could cause damage to the DSC and DSC internal members, the DSC must be disassembled and inspected for damage.

2. If Level D service limits are used, can NUTECH assure that possible deformation within the DSC following an accident will not inhibit the easy retrieval of all fuel assemblies (see Question 8. under 3.3.4 below).

3.3.3.2 Instrumentation

It is stated that there is no need to monitor the DSC internal pressure or temperature. Limiting pressure and temperature values are based on calculations. How does NUTECH assure that the calculational techniques are qualified for use in the design?

3.3.4 Nuclear Criticality Safety

1. Were analyses of reactivity as a function of the number of assemblies in the cannister performed? During loading of the cannister in the pool, does analysis show that an arrangement of fewer than seven assemblies does not have a larger reactivity than the completely loaded cannister? Such a situation might be possible due to reflector effects.

2. Were design clearances and fabrication tolerances considered in the criticality analysis? What are the design clearances that have been provided to ensure insertion and removal of the fuel elements in the guide sleeves? What is the worst case reactivity for a water flooded cannister if the design clearances and fabrication tolerances are taken into account?

3. From the hydrogen and oxygen atomic densities in the KENO input it appears that a water density corresponding to 20 degrees Celsius has been assumed. How does this temperature compare to limits of the fuel pool temperature. If the temperatures are different, has analysis shown that the reported KENO results are conservative?

4. What are the errors or biases due to the cell homogenization procedure? If the biases have not been quantitatively evaluated, has it been shown that the biases are conservative?

5. The design of the DSC apparently considers that some modules may use boron sleeves, while others may not. What controls are employed to ensure that low burnup assemblies are not inadvertently loaded into unborated cannisters?

6. What are the manufacturing tolerances of the boron content of the boral guide sleeves? Were the criticality analyses performed with a nominal boron concentration or a minimum concentration? If there is a difference, what is the magnitude of the effect on reactivity?

7. The dimensions shown in Figure 3.3-2 are inconsistent with the text and the KENO input. Is it correct to assume that the Figure is in error?

8. If Level D service limits are retained for the DSC, how would the multiplication factor be affected, should deformation of the DSC internals occur, when the canister is opened for inspection in the fuel pool? (Refer to Questions in 3.2.5.2 above).

3.3.4.3 Verification Analysis

1. Have other calculations been performed to verify that the implementation of the KENO-IV computer program used for the criticality analysis produces results with expected statistical dispersions?

   If only three benchmark calculations have been calculated for the verification analysis, can a statistically significant determination of the proper and expected operation of the computer code be made?

2. What is the justification for the selection of the BNL critical experiments for the verification analysis and in particular the selection of the three experiments that were calculated? Were other series of critical experiments considered? If not, why not?

3. Table 3.3-5 shows the results of the NUTECH calculations of the benchmarks as the mean value plus two standard deviations. While this is the accepted conservative value for criticality design calculations, it is not the correct value to determine the

computational bias. The mean value should be compared with the experimental results. What are the mean value and standard deviation of the benchmark calculations?

4. The reported results for the three experiments that were calculated differed from measurements by more than 2.3 to 2.4% (see comment in question 2 above). Is this computational error consistent with errors experienced in calculation of these experiments that have been performed by others? What are the reasons for the reported errors in the present calculations?

3.3.7.1 Irradiated Fuel Handling and Storage

The temperature limits on fuel cladding in order to prevent its degradation in storage are based principally on tests in inert atmospheres. What criteria are applied in the design regarding storage atmosphere inside the DSC to prevent degradation and gross rupture per 10CFR72.72(h)?

3.4 Classification of Structures, Components, and Systems

The safety and quality assurance classifications for each of the components of NUHOMS 0708 important to safety should be provided.

4.0 INSTALLATION DESIGN

4.2.3.1 Dry Shielded Canister

1. It is stated the canister body consists of a 0.5 inch thick rolled and welded stainless steel plate. What is the maximum leakage rate for the longitudinal weld? What inspections and/or tests will be performed to assure that actual leakage is below this rate?

2. The canister is partially coated with a dry film lubricant to reduce friction during loading. Will this film attract an insulating layer of dust or dirt which could interfere with heat transfer? How much of the canister will be coated with this material?

5.0 OPERATION SYSTEM

5.1.1.3 Cask Drying Process

1. When backfilling the canister with helium, the valves are closed when the pressure reaches 14.7 psia. What is the temperature of the helium when the valves are closed? How is the temperature measured or inferred? If the helium is not at the final equilibrium temperature, then the pressure will continue to rise as the gas heats up.

2. What is the differential pressure across the canister wall when the helium sniffer leak test is performed?

5.2.2.1 Safety Features

What are the features of the spent fuel storage system which are important to safety that provide for safe operation under both normal and abnormal conditions? What, if any, are the limits selected for a commitment to action?

5.3.2 Component/Equipment Spares

In the event that components are damaged during the life of the installation, what provision is made for installation of spare or alternative equipment to provide for continuity of safety under normal and off-normal conditions?

7.2.1 Characterization of Sources

1. The design basis of the radiation sources for the shielding analysis is fuel assemblies with an average specific power of

37.5 MW(t)/MTHM, 33000 MWd/MTHM and five years post irradiation time. Based on these parameters a design basis neutron and gamma ray source strength have been calculated. Since the burnup parameters are average values, it may be that some combinations of seven fuel assemblies selected for loading into the DSC may have a higher source strength. Is the use of the mean values intended to imply that an arbitrary selection of fuel assemblies from a batch of assemblies satisfying the burnup parameters can be loaded into the DSC? If not, explain how limiting the source strength in any given cannister to the design basis source strength will be accomplished in practice.

2. The flux-to-dose conversion factors shown in Figure 7.2-1 seem to be consistent with the multicollision tissue dose response function at energies greater than 1 MeV, but are a factor of 2 to 10 lower than that response function at lower neutron energies. What is the reference for the flux-to-dose conversion factors that were used?

7.3.2 Shielding

1. Have verification analyses been performed for the computer codes used in the shielding analysis (ORIGEN, ANISN, DOT-IV, QADMOD-G, and SKYSHINE-II)? Please discuss any shielding benchmark validations that have been performed.

2. What was the concrete composition assumed in the shielding analysis? What variation in water content is considered over the service life of the HSM?

3. What is the relative contribution of primary and secondary gamma rays for the gamma ray surface dose rate on the HSM wall or roof?

4. Page 7.3-9 third paragraph defers discussion of the HSM penetration calculation. The deferred discussion is not found later in the report. Please provide a discussion of the penetration calculation.

What was the quadrature order used in the DOT-IV calculation? Justify that the quadrature is adequate to accurately calculate streaming through the HSM air exhaust penetration.

5. The results in Table 7.3-2 indicate that the neutron attenuation through the HSM air exhaust penetration is greater than that for gamma rays. Can this result be explained?

6. Were any measures taken to minimize ray effects in the DOT-IV calculations? Were ray effects evident in the results?

7. Has a verification analysis been performed for the application of the DOT-IV code to this type of shield <u>penetration</u> problem?

8. Are the "Cask - DSC Annular Gap" dose rates reported in Table 7.3-2 averaged over the cask surface, or are they actually dose rates calculated in the gap?

9. What was the angular quadrature used in the Cask - DSC annular gap calculation? Justify that the angular quadrature was fine enough to adequately model radiation transport through the gap. Were ray effects observed in the calculated fluxes? If the dose rate on the surface of the cannister is plotted as a function of distance from the cannister centerline, is streaming through the gap observed in the results?

10. Is there any analysis or data to benchmark the validity of the QADMOD/albedo procedure used for estimating gamma ray penetration through the HSM air exhaust?

11. Were secondary gamma rays in the concrete considered in the vicinity of the air exhaust penetration?

12. With reference to the proper axial positioning of the DSC within the HSM both during normal operation and in case of seismic event (refer to Question 6. under 8.1.1.5 and Question 6. under 8.2.3.2), it should be noted that there could be shielding implications.

7.4 Estimated On-Site Dose Assessment

1. Figure 7.4-1 indicated that the Total Dose drops slightly below the Scattered Dose at approximately 1000 ft. Is this a plotting error or a problem in the computer code?

2. The basis for the dose rates in Table 7.4-1 is not evident in the text. Please explain how the dose rate values were obtained.

8.0 ANALYSIS OF DESIGN EVENTS

8.1.1 Normal Operation Structural Analysis

1. It is stated (Page 8.1-1) that "the mechanical properties of materials employed in the structural analysis of the NUHOMS system are presented in Table 8.1-2." This table only contains properties for stainless steel, carbon steel and lead. A number of other materials are used in the NUHOMS system including concrete, steel reinforcing, boral, etc. The properties for each of these materials should be included in Table 8.1-2 to insure that a consistent set of properties are used for all analyses and that appropriate consideration is given to the effect of temperature in each specific analysis.

2. There is lack of experience on long term storage of spent fuel horizontally. Please address the effects on the fuel of its horizontal storage over long times in the HSM and any related effects on its retrievability.

8.1.1.1 Normal Operation Loads

1. What is the basis for the assumptions of 25% fission gas release in the design internal pressure calculation?

2. On page 8.1-5, the normal average canister gas temperature is stated to be 450°F. However, Table 8.1-13 gives an average helium temperature of 429°F. at 125°F. HSM inlet temperature. Which value is correct?

3. The temperature distribution for the spacer disc (Figure 8.1-2) shows that the temperature at the point of closest approach between the canister and the guide tube is lower than its neighboring points. Is this correct? Please explain.

4. Please explain how the three steady-state temperature distributions were used to determine the effects of thermal cycling. On page 8.2-51, the heat up rate (100°C temperature change) of the insulated loaded DSC is given as 13 hours. Since this is about one-half of a diurnal temperature cycle, have such cycles been included in the cyclic fatigue analysis? If not, how would their inclusion modify the results?

5. On page 8.1-5 the density of normal concrete is given as 150 pounds per cubic foot. This value differs from that shown in Tables 8.1-4 and 8.1-4. Please clarify.

6. Equations 8.1-9 and 8.1-10 on p. 8.1-20 have missing terms. If the equations in the Topical Report were used, the results may be incorrect. Please clarify.

7. The modulus of elasticity is incorrectly taken as 27.0×10^6 psi instead of 26.6×10^6 psi for the design basis temperature of 400°F. Please correct.

8. The temperature distribution within the DSC depends upon the azimuthal orientation of the DSC within the HSM. That is, the analysis assumes that three (3) assemblies are centered on a vertical line passing through the center of the DSC. How will this orientation be assured during loading?

8.1.1.2 Dry Shielded Canister Loads Analysis

1. Thermal variations in the circumferential and axial direction of the canister will result in thermal stresses due to self constraint by the colder canister ends. On page 8.1-22 the statement is made that, "Also, the thermal variation in the circumference and logitudinal directions of the shell are not

considered significant since in the unrestrained condition the shell will expand radially and longitudinally to an equilibrium state." NUTECH should show what the overall deflected shape is in the axial direction, and the deflected shapes of a cross section at the end and the center of the DSC. NUTECH should show what the ASME stress intensities are for the following locations on the DSC: (1) top and (2) bottom elements of shell at top cover plate edge (3) top and (4) bottom elements of shell at center section; (5) top and (6) bottom elements of top cover plate at shell edge. Please include effects of discontinuity between shell and top cover plate.

2. The drawings provided (ADV001.0204 sheets 1 and 2) do not provide enough dimensions to be able to determine what minimum gaps might exist between the boral baskets and the top lead plug. Please supply actual shop drawings instead of conceptual design drawings. This relates to p. 8.1-22 and 8.1-24.

8.1.1.3 Dry Shielded Canister Internal Basket Loads Analysis

Please provide information showing where the 0.75 inch irradiation growth of the fuel assembly came from. The drawings do not permit a verification of calculations of this section of the topical report.

8.1.1.4 DSC Support Assembly Loads Analysis

The first sentence of the Thermal Analysis section p. 8.1-32 is acceptable if an assembly procedure specifying the torque of the nuts is included.

8.1.1.5 Horizontal Storage Module Loads Analysis

1. A reference in the third paragraph of this section (page 8.1-35) is made to NUREG 0880. Shouldn't this reference to be NUREG 0800?

2. Table 8.1-10 (Page 8.1-38) includes values for the ultimate moment and shear capacity of the HSM. The value computed for the

ultimate moment capacity, 4052.0 in-kips, is given on Page 8.1-49. However, no calculation is presented for the ultimate shear value, 59.2 kips. The details of this calculation should be included.

3. Figure 8.1-11 (Page 8.1-39) includes moment and force loads that are applied to the reinforced concrete corbel that supports the DSC Support Assembly. Calculations should be provided for the stresses in the corbel due to these loads and for the ultimate strength capacity of the corbel.

4. Please state your interpretation of ACI 349-80 acceptance criteria for concrete temperatures. An air inlet temperature of 70°F is used to evaluate normal operating temperatures. Please relate this number to meteorological information which could be used to determine site acceptability.

5. The analysis of local concrete temperatures does not include conduction through the thermal shield support bolts or through the support rail to the corbels. How will consideration of this direct heat transfer path affect local concrete temperatures and satisfaction of ACI 349-80 acceptance criteria? Also, how will concrete thermal conductivity be affected by thermal cycling over the license period, and by the presence of rebar in the concrete?

6. If the end of the DSC were to contact the concrete wall, a concrete temperature of the same magnitude as the calculated DSC temperatures would result. What is the clearance between the end of the DSC and the concrete wall and what is the concrete temperature adjacent to the end of the DSC?

8.1.2 Off-Normal Events

Failure of the supports for the thermal radiation shield (due to seismic events, corrosion, etc.) has not been addressed. Please justify that this event is not feasible, or provide an analysis of the consequences. How would such as failure be detected?

8.1.2.2 Blockage of the Horizontal Storage Module Inlet - Cause of Event and Detection

1. Air flow through the HSM with both inlets blocked appears to be a random process with zero mean value. Please provide experimental confirmation based on scaled or appropriate data to demonstrate the assumed magnitude of flow for this case.

2. Please clarify the pressure given on page 8.1-60. The values are not consistent. According to the ASME text booklet "SI Units in Heat Transfer" 1st Ed., 14.504 psi = 1 bar. Also, refer to subsequent units conversions between psi and bar.

8.1.3.1 Thermal-Hydraulics of the Horizontal Storage Module Principles of HSM Cooling System

1. Reference 8.44 referred to here is not given in the reference list.

2. The thermal analysis is based on an assumed axial peaking factor of 1.08. This is an additional limiting design parameter which is not cited in Table 3.1-1. If it is not intended to impose this limit on stored fuel, please justify its conservatism for proposed fuel types, burnup histories, etc.

3. Equations 8.1-37 through 8.1-40 are applicable within restricted domains of $L^3 \Delta T$. Please show that these restrictions are satisfied.

4. What levels of solar radiation were considered in the heat transfer analysis? Of particular concern is the levels associated with the hottest days (T_{air}=125°F).

5. Page 8.1-69 gives the maximum concrete ceiling temperature as 244°F, whereas Table 8.1-12 gives 249°F. This analysis does not consider direct conduction through the supports to the concrete. Is the severe summer condition considered to be an off-normal or transient condition? If so, what is the limiting ambient

condition to be used for determination of whether acceptance criteria on concrete temperature are met? The value of 70°F is quite low for a limiting ambient condition.

8.1.3.3 Thermal-Hydraulic Analysis of the Canister Inside the Transfer Cask Model

1. In equation 8.1-40, the emissivity of the stainless steel transfer cask exterior is taken as 0.80, whereas a value of 0.587 was used for stainless steel surfaces within the DSC (page 8.1-74) and transfer cask (Eqn. 8.1-43). Please justify this use of different values for the emissivity.

2. What is the sensitivity of the calculated results to variation of input parameters, e.g. emissivity, axial peaking factor, apparent thermal conductivity, decay heat, etc.? How is the margin of safety to limiting conditions established?

8.1.5 Design Basis Internal Pressure Loads

Please describe any hydrostatic testing to be performed to assure integrity of the DSC. Has NUTECH considered pressurizing the loaded DSC with helium as a test of DSC integrity? In such a test how would the test pressure relate to the design pressure and the accident pressure discussed in section 8.2.9?

8.2.2.2 Accident Analysis

1. The coefficient of friction between a single, unanchored module is stated to be 1.0 on Page 8.2-7. The ACI 349-80 code states in Sections 11.7.5 and 11.7.9 that the coefficient of friction shall be 1.0 if concrete is placed against hardened concrete and the interface between the concrete surfaces is clean, free of laitance and "intentionally roughened to a full amplitude of approximately 1/4 inch." The ACI 318-83 code states in Section 11.7.4.3 that the coefficient of friction shall be 0.6L for the case wherein concrete is placed against hardened concrete not intentionally roughened (:L: is this relation is 1.0 for normal weight

concrete). Shouldn't a coefficient of friction of no greater than 0.6 be used between the NUHOMS system and the supporting concrete pad, especially since no specific mention is made of the need for roughening the surface of the concrete pad under the NUHOMS system? (See question on section 3.2.3.2).

2. It is noted on Page 8.2-13 that a single HSM will require tie downs for resistance against overturning and sliding under the action of a massive missile impact (i.e., a 3,976 lb automobile). It is further noted on this page that the NUHOMS 0708 concept, which has 8 modules either poured in place or pre-cast, will not slide under the postulated impact. Since it is understood that actual, site specific configurations for the NUHOMS system may have any number of modules, wouldn't it be appropriate to either require tie downs, to permanently anchor the NUHOMS system to its supporting concrete pad or to set the HMS in a key-way imbedded into the pad rather than rely on the use of friction to restrain the HMS from sliding on the pad and potentially exposing contaminated surfaces?

8.2.3.2 Accident Analysis

1. The values of E on pp. 8.2-14 and 8.2-16 are incorrectly taken at room temperature. Please use the value of E at the maximum calculated temperature.

2. The calculations in this section assume the maximum vertical earthquake acceleration to be 0.1g. As noted in Question 3.2.3.2, this acceleration should be increased to at least 0.17g. Each of the calculations in Section 8.2.3.2 that are based on the maximum vertical acceleration should be redone to reflect this increased acceleration and each reference to a vertical acceleration of 0.1g should be changed to 0.17g.

3. The term V_w in Equation 8.2-20 (Page 8.2-19) only includes the volume of one wall of the HSM whereas the term V_r includes the entire weight of the roof. Furthermore, the value for I (74,088 in ^{4}) given on Page 8.2-20 represents the moment of inertia of

only one wall. Shouldn't the calculation for mass presented in Equation 8.2-20 include only one-half of the mass of the roof? Also, shouldn't this calculation include the effect of the DSC and its support?

4. Shouldn't the parameter V_u in Table 8.2-6 (Page 8.2-21) actually be labeled "M_u" as in Table 8.2-3?

5. No mention is made in the sub-sections entitled "DSC Stress Analysis" (Page 8.2-16) and "Horizontal Seismic" (Page 8.2-24) of combining horizontal seismic loads from two directions. Seismic loads from two horizontal directions and the vertical direction should be combined unless a statement can be made that loads from a particular direction can be considered to be negigible (i.e., as was done on page 8.2-20).

6. As a follow-on to the above question, it is noted that no mention is made of the possibility of the cask sliding longitudinally along the rails when loaded seismically. If such a possibility exists, could some part of the HSM structure be impacted by the DSC (e.g., the door), resulting in damage to either the HSM or the grapple on the end of the DSC? If the DSC cannot slide, shouldn't some sort of load be applied to the rails, and consequently to the DSC support assembly?

8.2.4.2 Accident Analysis

1. Reference to Table 3.2-2 for flood loadings is incorrect (p. 8.2-24). Also reference to Table 3.2 is incorrect (p. 8.2-28).

2. A flood level which caused the bottom portion of the DSC to be in contact with water while the upper portion remained in air could cause considerable thermal stress in the canister. Have these loadings been included with the pressure loadings?

8.2.5.2 Accident Analysis

1. The discussion on p.8.2-29 implies that the decelerations used by NUTECH were obtained by multiplying actual drop-test data (obtained by ORNL) by one-sixth to reflect a 5 foot drop height instead of a 30 foot drop height. Examination of the GE Consolidated Safety Analysis Report of the IF-300 shipping cask reveals that NUTECH used decelerations which the Stearns-Rogers Company calculated using a dynamic analysis program, "Dyrec." Since the Stearns-Rogers results envelope the ORNL results, this is a conservative approach. However NUTECH should revise the discussion to reflect their actual process. Also NUTECH should reference the data by appendix.

2. A second related question concerning drop decelerations has to do with the data in appendix V2 of the GE document NEDO-10084-3. Why did NUTECH not use the deceleration for top end vertical drop as reported in this appendix? It is more conservative than the Stearns-Rogers data.

3. NUTECH has not provided a discussion on the possibility of the cask dropping vertically through 5 feet and then tipping over and slapping down. Logically, if the cask could experience a 5 foot vertical drop, then it would almost certainly also experience a tip-over and slap down. In fact, the slap-down case would be more severe than the 5 foot vertical drop because the centers of gravity of the shipping cask and the DSC both exceed 5 feet in the vertical orientation. Please discuss the reason for not including the slap-down case.

4. In order for the statement on p. 8.2-31, "The liner eliminates any secondary impact forces generated by the impact of the two surfaces." to be evaluated, NUTECH should specify what the liner material is and what the dimensions of the liner are. Without these data it is not possible to evaluate what the attenuation or amplification characteristics of the liner might be.

5. It appears that the effect of the 2 inch diameter rods was not considered for the horizontal drop case. NUTECH should discuss this omission, or recalculate the stresses in the spacer disc.

8.2.8 Dry Storage Canister Leakage

The statement that the DSC is designed for no leakage under any conditions cannot be substantiated since very small leakage rates cannot be detected or measured. Helium is difficult to contain, so it would be expected that some decrease in Helium concentration would occur over the lifetime of the canister. Please provide an estimate based on experimental data or analysis of the leakage rate or concentration versus time.

8.2.9.1 Accident Analysis

1. What is the basis for using a value of 25% fission gas release fraction as opposed to the 30% upper bound cited from reference 8.42 (Should read 8.43) and also quoted on page 8.2-54 in Section 8.2.8?

2. Would helium leakage be substantially increased during a pressurization transient? Please address the expected rate of leakage at higher temperature and pressure.

3. As previously mentioned in comment 4 for Section 8.1.1.1, the effect of diurnal temperature variation on DSC fatigue should be considered in addition to the 50 seasonal cycles.

4. What is the maximum gas inventory within one fuel assembly including fill and fission gases? How was this maximum inventory established? Do criteria need to be established on maximum gas inventory of fuel to be stored? Please discuss.

8.2.10 Load Combinations

1. The load combinations presented in Table 8.2-10 (Page 8.2-61) do not consider the effects of either wind, tornado or flood on the

HSM. Shouldn't these loads be considered as required by ACI 349-80. Section 9.2.1? Also shouldn't the material properties be evaluated at the worst thermal case examined, i.e. ambient T=125°F with inlets plugged? (See p. 8.1-70)

2. Please provide an analysis of the HSM corbels, bearing plates, bolts and reinforcing steel for the load combination cases # 7 and 10. The temperature of the corbels should be specified and the material properties for temperature should be used.

3. Note 7 in Table 8.2-10 on p. 8.2-61 implies that the material properties for the thermal accident load are taken at 300°F, however Table 8.1-2 shows that the maximum concrete temperature for the inside roof is 321°F, and the side wall is 344°F. Please clarify.

4. Table 8.2-11 reports DSC support assembly stresses for various load combinations. The note (3) indicates allowable stresses for the SA 36 structural steel at 200°F. NUTECH should show what the temperature of the DSC is where it and the Tee support assembly rails are in contact for the worst thermal case examined, i.e. ambient T=125°F with inlets plugged. (See p. 8.1-70)

10. OPERATING CONTROLS AND LIMITS

10.1 Proposed Operating Controls and Limits

The fuel stored should also have an axial power peaking of equal or less than 1.08 for decay heat, since this parameter was used in the thermal design.

10.2.2.2 Technical Conditions and Characteristics

1. Condition 3 regarding the DSC helium leak rate of the primary weld should apply to all welds on the canister including the axial seam weld. Leak rate as a function of temperature also needs to be addressed.

2. Why is the limiting heat load of 1 kw assembly not included in the list of seven technical conditions and characteristics?

10.2.3 Surveillance Requirements

1. What provisions have been made for inspection of internal air passages for blockage due to buildup of organic matter, insect activity, etc.?

2. What provisions have been made for drainage of any water which enters the HSM through the inlets or outlets? Buildup of water could also cause partial or complete blockage of inlet flow in the absence of drains. What inspections are performed to assure that water does not accumulate in the bottom of the HSM?

3. Surveillance is performed every 48 hours to assure that air is flowing through the module. How will acceptability of the flow rate be determined? How will the flow rate be measured, or how will it be determined that the flow criteria are satisfied.

10.3.1.1 Fuel Specifications

Please clarify which parameters are for an assembly and which are for the canister, e.g. neutron source, weight.

10.3.2.1 DSC Vacuum Pressure During Drying

What is the basis for the one hour time at pressure criteria for the drying operation? Has the possibility of a waterlogged rod been considered?

10.3.2.2 DSC Helium Backfill Pressure

It appears that a hold time at this pressure will need to be specified to assure that thermal equlibrium has been reached.

10.3.2.3 DSC Helium Leakage Rate of Primary Weld

1. Calculation of 631 cm^3 of He appears to correspond to 2 atmospheres of pressure rather than 1.5 atmospheres.

2. The leak rate corresponds to the detection level of the helium sniffer. However, the calculation assumes a single leak at this level. In reality, leakage may occur at several locations along the many feet of weld and by diffusion through the metal matrix of the canister itself. Has this type of leakage been considered? Please address.

10.3.2.7 Maximum Air Exit Temperature

1. If the temperature rise is greater than 100°F and small fans are provided as stated in item 5, the passive nature of the cooling mechanism will be lost. Since the design is based on achieving passive cooling, the addition of fans should either be included in the design or eliminated as a corrective action.

2. The cooling air temperature rise is to be checked twenty-four hours after placement of the canister in the HSM. What features of the design preclude the need for later measurements to assure that the 100°F temperature rise criterion is satisfied. If such assurance cannot be provided, then more frequent measurements may be necessary.

10.3.3.1 Surveillance of the HSM Air Inlets

1. How does this surveillance assure that there is no blockage of the outlets or internal blockage? Does surveillance include any measurement of flow or temperature rise of the cooling air?

2. Page 10.3-17 states that for "normal operations, inspection of air inlets once per week will assure that any local obstructions can be removed". If the HSMs are inspected once per week, how can NUTECH assume that an air blockage would be no longer than 48 hours? This question also relates to section 8.2.7.2.

APPENDIX B

DETAILS OF HEAT TRANSFER ANALYSIS OF THE NUHOMS SYSTEM

B.1 Apparent Thermal Conductivity of the Gas Between the Inner Surface of the Canister Shell and the Outer Surface of the Guide Sleeve

1. On page B.4, it is assumed that the gas behaves the same as the gas in a horizontal annulus. However, on page B.5, a formula said to be applicable for a vertical annulus is used to determine apparent thermal conductivity. Please explain this discrepency. The gas "annulus" is horizontal for drying and vertical for storage.

2. The length of the fuel assembly L is given on page B.5, but does not appear to be used in any of the equations. Is this correct? Why is the number cited?

3. Table 8.1-13 gives the average helium temperature for air inlet temperatures of -40, 70 and 125°F as 315, 389 and 429°F. Table B-2 gives apparent helium conductivity at three values of delta T for average gas temperatures of 80, 160, 440 and 620°F. A value of 1.6 was determined for apparent thermal conductivity by averaging the values in Table B-2. In light of the range of helium temperatures for which analyses were performed, it does not seem appropriate to include the values at 620°F, and particularly at 80°F in arriving at the average value. Justify that 1.6 is a representative value for apparent thermal conductivity.

4. For the calculation of h_{eff} on page B.13, the assumption of delta-T = 300°F is stated, but does not appear to be needed.

5. Contrary to the statement on page B.16, the two-step approach to using the Wooten-Epstein Formula (WEF) appears to be closer to the actual application. The second step is essentially the manner in which the result is used.

6. Corrected values for K_{fuel} for the alternative WEF approach should be provided.

APPENDIX C

SAMPLE COMPUTER INPUT AND OUTPUT FOR THE NUHOMS STRUCTURAL ANALYSIS

STARDYNE Finite Element Analysis Data. Results have been presented in the Topical Report that are based upon STARDYNE Finite Element Analyses. An example of the input and output data from one of these analyses is presented in Appendix C. Portions of the input and output data from some of the other analyses were submitted in response to an earlier question. However, the data submitted to date is not sufficient to permit the checking of stress analysis data for all points on the NUHOMS system that exhibit maximum stresses for the various loading conditions discussed in Section 8. In addition to the STARDYNE results, it is understood that some of the stress analysis data of interest is presented through the use of computerized post-processor tabulations. Therefore, it is requested that a sufficient quantity of STARDYNE and post-processor computer output data be submitted so as to trace the source of the maximum stress in each NUHOMS component evaluated using such analyses. It is not necessary to resubmit previously submitted data nor to submit complete sets of computer output for each analysis. Specific Tables for which the above information is requested are: Table 8.1-7, 8.1-8, 8.2-7, 8.2-9 and 8.2-11.