GENERATED 7/10/00

# NAC-UMS Maine Yankee RAI #2 (6/29/00) Summary

## CHAPTER 4 THERMAL

4-1 Establish the design basis in the SAR, for reduced heat loads under transfer conditions (water, vacuum and helium backfill), for spent fuel cladding and components important to safety.

For each reduced heat load category, provide a discussion and graphical representation of the peak cladding and component temperatures as a function of time. Provide tables that summarize the transfer condition, reduced heat load, time duration, and maximum calculated temperatures with respect to the associated component temperature limit. The regulations require that sufficient information be provided in the SAR to support a finding that the design bases are related to the design criteria [10 CFR 72.24(c)(2)] and are satisfied with an adequate margin of safety [10 CFR 72.24(c)(3)].

*Why appropriate/consistent with SRP: Design basis needs to be established to demonstrate basis for acceptance, for future 72.48 changes, and future NRC reviews of amendments. SRP Section IV, acceptance criteria, states that "cask and fuel materials should be maintained within their acceptance criteria...", and "the thermal performance of the cask should be within the allowable design criteria* ***specified in SAR Sections 2 and 3....*** *" Section V.3 of the SRP states "If the fuel cladding temperature calculation is based on heatup over a limited time period for cask drying operations, verify that limiting conditions for the operations have been imposed in the technical specifications...to ensure that the temperature will remain acceptable during the operations." This RAI is predicated on the staff reaching reasonable assurance, as documented in the SAR, with respect to the applicant's statements, noting that the original 4/18/00 submittal had an erroneous conclusion, and the 5/31/00 supplement also had errors on the same topic.*

*Do we already have the information: The original 4/18/00 submittal erroneously stated that "at heat loads less than the design basis heat load, the rate of component heat up and the maximum temperature reached by a component are less than those resulting from the design basis heat load." The staff saw a potential inconsistency with that statement, and asked for a summary of the temperature changes for reduced heat loads. In a May 31 SAR supplement and answer to our telephone conference call, NAC acknowledged in Response #7 that "there is an increase in the maximum content temperature at the lower heat loads, and that the increased temperatures are a function of length of time that the canister and contents are allowed to remain in the vacuum/helium conditions, not just the heat load." NAC provide temperature information which compared the design basis maximum heat load to all of the reduced heat load configurations for cladding and heat transfer disks. The* ***SAR itself*** *was only revised to note that reduced heat loads can yield higher temperatures under vacuum conditions, and did not establish a limiting component temperature design basis for reduced heat loads. Subsequent RAI's clarified the SAR inconsistencies identified by the staff in this area.*

4-2 Provide a detailed explanation of the administrative and operational controls that assure that the canister loading is within the analyzed constraints of the SAR. The controls discussed should be sufficient to preclude the possibility of a single human error leading to a mis-loading. Alternatively, demonstrate by analysis that fuel cladding and

component temperature limits will not be exceeded in the event of mis-loading one 0.958 kW fuel assembly in the worst location.

The staff seeks assurance that the design and operation of the NAC-UMS preserves an adequate margin of safety for the proposed reduced heat load vacuum drying operations. Extensive canister loading options exist for preferential loading, reduced heat loads, and Maine Yankee site-specific fuel. With the reduced heat load option, the population of assemblies which could result in a postulated mis-loading has also increased. Due to the complexity of the various loading options, administrative and operational controls are increasingly relied upon to ensure that a loading pattern outside of the analyzed design basis envelope does not occur. Compared to the design basis heat load, higher component temperatures are reached under vacuum drying conditions, thus the staff is not assured that the temperature limits will not be exceeded if a mis-loading occurs. Section 72.24(d)(2) requires that sufficient information be provided in the SAR to evaluate the adequacy of structures, systems, and components (SSCs) important to safety to mitigate the consequences of accidents, including manmade events.

*Why appropriate/consistent with SRP: Most complicated loading pattern and scheme that SFPO has reviewed, including preferential loading slots, reduced heat load specifications and specifications tailored for MY fuel. Increased probability of a mis-load, lower margins to component temperature limits and no analysis of the likely consequences of a mis-load in the current application. The VSC-24 CoC has technical specifications requiring double verification of both fuel assembly selection and spent fuel pool ppm boron specs. The Transtor at Trojan included an evaluation of why, considering the available contents at Trojan and the design bases analysis, a mis-loading event is not credible. SRP Chapter 8 "Operating Procedures - Acceptance Criteria", states that "Operating procedures descriptions should identify measures to control processes and mitigate potential hazards that may be present during normal operations. Also, SRP 8.V.1, "Review Procedures - Cask Loading" states "Review the generic procedures ...to verify that tests, inspections,* ***verifications****, ....are specified. "Depending on the types and specifications of fuel assemblies stored in the reactor spent fuel pool, detailed site-specific procedures may be necessary to ensure that all fuel loaded in the cask meets the fuel specifications for the cask design. These procedures can be evaluated only on a site-specific basis, and will generally be evaluated through inspections rather than during the licensing review.* ***The SAR should indicate, however, that such procedures may be necessary.****"*

*Do we already have the information: The application does not contain a mis-loading analysis. As the RAI states, the option of either analyzing the mis-load or demonstrating why the administrative and operational controls are adequate to "preclude" a single-human error from causing a mis-load was presented. The level of commitment to the administrative and operational controls necessary are the same for both the base UMS design and the Maine Yankee amendment. The SAR does specify the development of site-specific procedures, and states that "The procedures shall incorporate spent fuel assembly selection and verification requirements to ensure that the spent fuel assemblies loaded into the UMS are as authorized by the CoC."*

4-3 Revise Figures 4.4.3-5 and 4.4.3-6 to account for the higher temperatures associated with reduced heat loads.

Since these figures represent the "maximum" temperatures of various components during transfer operations, the higher temperatures associated with the lower heat loads should be represented or noted (See related RAI 4-1). For the PWR curves, the vacuum drying cladding temperature can be significantly higher by 80°F even though the final temperature is about the same for the 20 kW loading with helium. For the BWR curves, the vacuum drying cladding temperature can be significantly higher by 143°F and the final temperature would be 31°F higher for the 20 kW loading with helium. Section 10 CFR 72.11(a) requires the SAR to be complete and accurate in all material respects.

*Why appropriate/consistent with SRP: See reference to RAI 4-1. The applicant provides curves entitled "Maximum component temperatures in Transient Operations." Our initial review indicated that these may not be the maximum, and NAC responded on 5/31 acknowledging that, but did not update the curves by either modification or noting it. Furthermore, there remain an error in the 5/31 conclusion about maximum temperatures in the helium backfill condition for BWR fuel types. This type of question is consistent with a round 1 RAI question which identifies inconsistencies in the SAR.*

*Do we already have the information: This is an editorial/omission/oversight. Yes, we have enough information to have been able to determine that the SAR is erroneous. For completeness, and because of the history of inaccuracies already identified, it is included as an item that can be clarified as a result of the first round review.*

4-4 Explain the apparent inconsistency between Section 4.4.3.1 which states that steady-state evaluations are performed for heat loads of 20, 17, 14, 11 and 8 kW and Tables 4.4.3-5 and 4.4.3-6. These tables state, via Note 2, that steady-state conditions are for only heat loads with no time duration.

Specifically, Tables 4.4.3-5 and 4.4.3-6 only identify steady-state conditions for the vacuum heat load of 8kW and for the helium heat load of 17, 14, 11 and 8 kW. Section 72.11(a) requires the SAR to be complete and accurate in all material respects.

*Why appropriate/consistent with SRP: This type of question is consistent with a round 1 RAI question which identifies inconsistencies in the SAR. It is related to the several inconsistencies already identified in this RAI.*

*Do we already have the information: This is an editorial/omission/oversight. Yes, we have enough information to have been able to determine that the SAR is erroneous. For completeness, and because of the history of inaccuracies already identified, it is included as an item that can be clarified as a result of the first round review.*

4-5 State in the SAR that the maximum temperature values listed in Tables 4.4.3-5 and 4.4.3-6 are indeed the maximum calculated values or identify the higher peak temperatures calculated from the design basis analyses.

As written, Note 2 at the bottom of these tables implies that, for conditions prior to reaching steady-state, the temperature may be higher than the listed values. If the

temperatures listed for the "Not Limited" time duration are indeed the maximum, then Note 2 can be eliminated since it would be redundant. Section 72.11(a) requires the SAR to be complete and accurate in all material respects.

*Why appropriate/consistent with SRP: See related RAI 4-4. This question is attempting to ascertain the context of the Tables note with respect to actual component temperatures reached. The note indeed would not be necessary if the steady-state temperatures reached are the maximum, and since the margin to component temperature limit for the heat transfer disks is now much reduced, we are attempting to determine if component temperature limits are exceeded during the transient. This question is consistent with a round 1 RAI question and seeks to clarify information presented in the SAR. Concluding whether component temperature limits are exceeded under both steady-state or transient conditions is worthwhile.*

*Do we already have the information: This is an editorial improvement. We do not have enough information to make a conclusion regarding the maximum temperatures presented under the transient conditions. Indeed, the SAR information appears to contradict such a conclusion by having such a note in the first place. For completeness, and because of the history of inaccuracies already identified, it is included as an item that can be clarified as a result of the first round review.*

4-6 Explain how preferential loading arrangements are bounded by the values shown in Tables 4.4.3-5 and 4.4.3-6 and include an explanation in Section 4.4.3.1, "Maximum Temperatures at Reduced Heat Loads."

As stated in Section 4.4.3.1, the configuration and model used to analyze the reduced heat load is referenced to be in accordance with Section 4.4.1.3, "Two Dimensional Axisymmetric Transfer Cask Models," which states that the heat load is applied as a volumetric heat generation in the active fuel region. No explanation is provided in the SAR which explains how preferential loading for a given basket heat load with hotter fuel in the center was considered in the calculation of reduced heat load temperatures. From the current description, it is implied that a uniform heat distribution was used, and it is not apparent to the staff how this would be a bounding configuration for a preferential loading with higher than average heat load at the center of the basket. For completeness, describe other permissible preferential loading arrangements and how they are bounded by the reduced heat load values shown in the subject tables. Section 72.11(a) requires the SAR to be complete and accurate in all material respects.

*Why appropriate/consistent with SRP: The applicant has implied that the resulting temperature calculations for reduced heat loads, in combination with the preferential loading of hotter fuel assemblies in the "middle ring", assumes a uniform "smearing" of the heat generation throughout the basket. The preferential heat loading is clearly not uniform, and margins to component temperature limits are narrower with the revised application. This is a highly complex loading arrangement, and preferential loading is not currently not directly addressed in the SRP. As such, and with any topic that deviates from the guidance of the SRP, it is subject to close review and is potentially time consuming. Documenting the staff concerns in such occasions, via RAI's, is particularly important since existing SRP review guidance and acceptance criteria do not exist.*

*Do we already have the information: No. The applicant does not appear to have considered the effects of preferential loading at reduced heat loads on the component temperature*

*determinations, with respect to the material limits. This may be very simply resolved and already considered, but it is not evident from the analysis presented. For completeness, and because this aspect is not addressed within the SRP, it is included as an important item that is necessary for the staff to make a safety conclusion, and is appropriate as a first round review question on the docket.*

4-7 Correct the first sentence in the second paragraph of Section 4.4.3.1, "Maximum Temperatures at Reduced Heat Loads," to reflect the data in Table 4.4.3-6 .

The sentence states that the maximum temperatures reached by components are less than those resulting from design basis heat load in the helium backfill condition. Contrary to this statement, Table 4.4.3-6 clearly shows that the BWR 20 kW reduced heat load cladding temperature exceeds the design basis heat load temperature. Section 72.11(a) requires the SAR to be complete and accurate in all material respects.

*Why appropriate/consistent with SRP: This type of question is consistent with a round 1 RAI question which identifies inconsistencies in the SAR. It is related to the several inconsistencies already identified in this RAI (see 4-1, 4-3 and 4-4).*

*Do we already have the information: This is a likely editorial/omission/oversight. Yes, we have enough information to have been able to determine that the SAR is erroneous. For completeness, and because of the history of inaccuracies already identified, it is included as an item that can be clarified as a result of the first round review.*

4-8 Submit the calculations which demonstrate that for PWR heat loads below 8 kW (for vacuum conditions) and PWR heat loads below 17kW (for helium filled canister conditions) that there is no time limit on the duration at which they can remain in these conditions.

Section 72.24(c)(3) states the application must provide information on the design in sufficient detail to support staff findings that the Independent Spent Fuel Storage Installation will satisfy the design bases with an adequate margin of safety.

*Why appropriate/consistent with SRP: This question is more important than it may seem on the surface. As stated previously, the margins are narrower and there have been several errors identified regarding the conclusions presented versus the data presented. For higher heat loads, there is a tech spec limit to the amount of time in transient conditions, in other words, if the calculations are off, it can only be "so bad". However, this analysis identifies the conditions under which no time limits are necessary, and thus, there is no limit to the amount of time in the transient condition. Meanwhile, the component temperature analysis, as one might expect, is still fairly aggressive with respect to the material limits, especially the heat transfer disks under vacuum conditions. This question is consistent with a round 1 RAI question which seeks the key calculations related to the safety conclusions, and also in the context of a compressed review with limited NRC review time to perform independent verification.*

*Do we already have the information: No. An unlimited time frame, of course, is desirable from both an operational and regulatory perspective. But again, the margins are already narrow, and as described previously, there is no LCO protection to limit the consequences of an error.*

4-9 Provide an explanation in the SAR of how assemblies with a variable radial enrichment, as described in Section 4.5.1.1.6, determine the assembly enrichment for use in Technical Specification Tables 12B2-8 and 12B2-9.

The aforementioned technical specification tables are used to determine the spent fuel cooling time requirements and loading arrangements. Enrichment is used as an input for this determination. For thermal considerations regarding variable radial enrichments, the lower enrichment should be used for the cooling time determination, rather than an average enrichment, to ensure enough cooling time for the larger decay heat values associated with lower enrichments. Section 72.24(c)(3) states the application must provide information on the design in sufficient detail to support staff findings that the ISFSI will satisfy the design bases with an adequate margin of safety.

*Why appropriate/consistent with SRP: Lower enriched fuels of same burnup yield a higher decay heat. Current loading tables specify use of the maximum planar average enrichment of such assemblies for selecting the appropriate cooling time for variably enriched fuel assemblies. The treatment of variable radial enrichments is not specifically addressed in the SRP for thermal calculations, although there is extensive experience for BWR applications. This is a unique PWR fuel assembly in our experience. In fact, the SRP states that "Decay is generally calculated using the same computer codes as those used to determine the radiation source terms." The treatment of variably radially enriched assemblies, whether BWR or PWR, does not appear to be addressed in the shielding section of the SRP. Applicant has not provided any justification as to why the use of an average enrichment for such assemblies ensures that the decay heat load per assembly limits are met. Using the minimum enrichment of fuel rods in such assemblies would clearly be bounding and clearly acceptable without additional technical review.*

*Do we already have the information: NAC maintained that we already had the appropriate information. Staff has been unable to confirm that. Today, 7/10/00, NAC provided relevant information that the fuel assemblies discussed are actually low-burnup (<30 GWd) assemblies. It appears that NAC would be correct if that is the case, but they have not communicated via the SAR, or RAI responses, the burnup levels of these assemblies. This is basically a cleanup issue once the burnup level of these assemblies is committed to in the SAR Chapter 12 Tables.*

4-10 Add a statement to Section 4.5.1.1.9, "Standard Fuel Assemblies With Damaged Lattices," to the effect that the damaged fuel assemblies have been analyzed to retain their configuration for all design basis events.

The thermal analysis assumes that the fuel assemblies remain in their as built configuration, except for those that are canned. Since these lattices are damaged and are not canned, it is important to explain their impact in the thermal section where damaged lattices are being discussed. Section 72.11(a) requires the SAR to be complete and accurate in all material respects.

*Why appropriate/consistent with SRP: This type of question is consistent with a round 1 RAI question which identifies the necessary conclusions by the applicant in the technical review area under consideration.*

*Do we already have the information: This conclusion is likely presented adequately elsewhere in the SAR and SER, and thus the staff can probably make a thermal conclusion on that basis.*

*I believe these assemblies are a specific subject of the structural evaluation of intact assemblies with one or more damaged grid spacers with an unsupported span not to exceed 60 inches.*

## CHAPTER 12 TECHNICAL SPECIFICATIONS

12-1 (a) Provide the design basis information on the type of water cooling suggested in Action Statement A.2.1 in LCO 3.1.1.

(b) State and justify the maximum water temperature necessary to adequately cool the canister for 24 hours such that vacuum drying operations can resume.

(c) State the maximum temperature of the spent fuel cladding and heat transfer disk after 24 hours of in-pool cooling and the proposed water cooling, prior to the resumption of vacuum drying operations, using the worst case preferential loading arrangement.

The staff considers that insufficient information has been provided to describe the alternative to in-pool cooling. Spent fuel pools are maintained in a specific temperature range, whereas the proposed alternative appears not to be limited in either temperature, coolant quantity or configuration. No details have been provided which describe how this water cooling would be accomplished or reasonable assurance that it would be controlled in accordance with the design basis. Section 72.24(c) states the application must provide information on the design in sufficient detail to support staff findings that the ISFSI will satisfy the design bases with an adequate margin of safety.

*<u>Why appropriate/consistent with SRP</u>: This is another example of an issue that NAC/NUTUG tried to invoke via the rulemaking process (there were several others to) that the staff did not agree to. Because this issue is related to the Part 50/72 overlap, and not clearly addressed in the SRP, we felt that establishing on the docket some of the initial staff concerns is warranted. We understand that NAC does not intend to pursue this for this amendment, but none the less, it is also a potential ISG type of issue for those facilities who intend to decommission the spent fuel pool. Thus, is it consistent with a round 1 RAI question, and important for establishing the staff's position lacking SRP guidance.*

*<u>Do we already have the information:</u> No. There was no information provided on alternative water cooling specifications.*

# NAC-UMS Maine Yankee Amendment Review Timeline

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| 7/16/99 | NAC-UMS Maine Yankee Amendment submitted. Aggressive one RAI schedule established to support April 16, 2001, desired loading date. |
| 12/21/99 | RAI #1 issued, response requested within 45 days (2/4/00) in order to meet the Maine Yankee loading schedule. |
| 2/4/00 | RAI #1 responses received. |
| 3/17/00 | NAC response to identified final cleanup issues received. |
| 3/27/00 | NAC informed NRC of NUTUG (User's Group) NAC-UMS public comment to allow longer cask vacuum drying times via lower heat loads. |
| 3/29/00 | NAC/SFPO Management conference call - NRC cannot make such significant changes to the NAC-UMS via the rulemaking process without going back out for public comment. Gave NAC the option to:<br><br>(1) retain the existing schedule to support Maine Yankee's (MY) published loading date, or<br><br>(2) accept review and schedule implications of a late-stage modification to the MY amendment request. |
| 4/7/00 | NAC informed NRC of choice to pursue changes to MY amendment. |
| 4/18/00 | Received revised amendment request (< 1 year from published loading date) |
| 6/5/00 | NAC team completes initial NAC-UMS public comment responses. Thermal reviewer initially identifies MY amendment concerns for a higher probability of a mis-load and an apparent decrease in the existing margins to component temperature limits. |
| 6/7/00 | NAC/SFPO Management initial conference call on potential thermal issues with revised request, review and schedule implications. |
| 6/14/00 | MY/NAC/SFPO Management conference call: Discussed potential thermal issues, NRC to complete thermal review of modified request and issue RAI in 2 - 3 weeks, schedule impact and requested NAC letter to confirm desired continuation of the review. |
| 6/16/00 | NAC letter received requesting continued review on a priority basis of supporting Maine Yankee's published 4/16/2001 loading schedule. |
| 6/29/00 | Issued RAI #2 (see attached summary) on MY NAC-UMS amendment request, noting that a revised schedule will be issued pending acceptance review of the RAI responses. |