March 23, 2005

Mr. Evan Rosenbaum
Project Manager
Holtec International
555 Lincoln Drive West
Marlton, NJ 08053

SUBJECT: HI-STORM 100, AMENDMENT 3, ACCEPTANCE REVIEW (TAC NO. L23799)

Dear Mr. Rosenbaum:

On December 30, 2004, Holtec International (Holtec) submitted an application in accordance with 10 CFR Part 72 for an amendment to Certificate of Compliance (CoC) No. 1014 for the HI-STORM 100 Cask System. This amendment proposed to: (a) add a new underground variation of the HI-STORM Cask System, designated as the HI-STORM 100U, and (b) increase the maximum licensed thermal capacity of the HI-STORM 100 Cask System to 35.5 kW and 38 kW for boiling water reactor and pressurized water reactor spent nuclear fuel stored, respectively, under a single region storage arrangement. Upon receipt of this application, based on the complexity of the material submitted, the uniqueness of the underground system, and the knowledge of prior unresolved technical issues associated with the request for an increase in the licensed thermal capacity, the U. S. Nuclear Regulatory Commission (NRC) staff, hereafter referred to as the staff, performed a technical “acceptance review” versus a less comprehensive “acknowledgment review.” The staff informed you of our decision to conduct a technical acceptance review during our meeting on January 19, 2005.

The staff met with you on February 16, 2005, wherein you presented the staff with an overview of the HI-STORM 100U design and the changes to the Final Safety Analysis Report (FSAR) associated with this new variation of the HI-STORM Cask System. At that meeting, the staff raised several concerns regarding the design of the underground overpack, most notably the ability of the unreinforced concrete to withstand the loadings imparted upon it. In accordance with your request, the results of the staff’s acceptance review and other structural issues are further discussed in Enclosure 1.

In a March 11, 2005, letter to the staff, Holtec informed the staff that significant enhancements can be made to the design of the underground overpack. In light of this, Holtec requested the staff to suspend further review of the amendment request while the amendment application is revised and updated to reflect the proposed enhancements. Holtec also requested the staff provide the results of the technical acceptance review for consideration when developing the design enhancements. Consistent with your March 11, 2005, letter, the staff has suspended all review activity on your application and closed TAC No. L23799.

Related to the staff review of the HI-STORM 100 Amendment 2, in a public meeting on August 4, 2004, the staff informed you of issues identified regarding the Holtec approach to the thermal analyses and methodology used to demonstrate the viability of the HI-STORM 100 Cask

System when loaded to the higher thermal capacities requested. These issues were initially identified during the review of your application for Amendment 2 to the HI-STORM 100 CoC and apply equally to Amendment 3. Due to these issues, in a letter dated August 13, 2004, you subsequently withdrew the Amendment 2 request for an increase in the maximum licensed thermal capacity. In a letter dated September 17, 2004, the staff provided you with a summary of the outstanding thermal issues identified during the staff's review of the Amendment 2 application. In your December 30, 2004, Amendment 3 application, the request for an increase in the maximum licensed thermal capacity of the HI-STORM 100 Cask System was resubmitted for staff review and approval with additional technical justification and bases. In an effort to resolve the staff's concerns regarding the Holtec thermal analyses and methodologies, we met with you on January 19, 2005. Two outstanding thermal issues remain unresolved to this date regarding your request for an increase in the maximum licensed thermal capacity of the HI-STORM 100 Cask System. As requested in your March 11, 2005, letter, the results of the staff's acceptance review of the proposed revised thermal analyses are further described in Enclosure 2. To further assist you with resolution of the outstanding thermal issues the staff has provided you, in a March 21, 2005, letter, additional information on the Ventilated Storage Cask (VSC) -17 in NUREG/CR Report "Analysis Package for the VSC-17 Ventilated Concrete Cask," prepared by the Pacific Northwest National Laboratory.

In addition to the structural and thermal disciplines, the staff identified several other technical issues which are briefly described in Enclosure 3 for your consideration. Note that these issues and those described in Enclosures 1 and 2 do not constitute the results of a comprehensive technical evaluation but are only the results of the staff's technical acceptance review.

At your request, the staff would be willing to meet with Holtec through a public pre-application meeting, but prior to submittal of the enhanced Amendment 3 application, to discuss the structural and thermal issues described in Enclosures 1 and 2.

Please reference docket number 72-1014 in future correspondence related to this action. You may contact me at (301) 415-1179, if you have any questions.

Sincerely,

/RA/

Christopher M. Regan, Senior Project Manager
Licensing Section
Spent Fuel Project Office
Office of Nuclear Material Safety
and Safeguards

Docket No. 72-1014
TAC No. L23799

Enclosures:
(1) Acceptance Review of Structural Discipline for Holtec HI-STORM 100 Cask System Amendment 3
(2) Acceptance Review of Thermal Discipline for Holtec HI-STORM 100 Cask System Amendment 3
(3) Acceptance Review of Other Disciplines for Holtec HI-STORM 100 Cask System Amendment 3

System when loaded to the higher thermal capacities requested. These issues were initially identified during the review of your application for Amendment 2 to the HI-STORM 100 CoC and apply equally to Amendment 3. Due to these issues, in a letter dated August 13, 2004, you subsequently withdrew the Amendment 2 request for an increase in the maximum licensed thermal capacity. In a letter dated September 17, 2004, the staff provided you with a summary of the outstanding thermal issues identified during the staff's review of the Amendment 2 application. In your December 30, 2004, Amendment 3 application, the request for an increase in the maximum licensed thermal capacity of the HI-STORM 100 Cask System was resubmitted for staff review and approval with additional technical justification and bases. In an effort to resolve the staff's concerns regarding the Holtec thermal analyses and methodologies, we met with you on January 19, 2005. Two outstanding thermal issues remain unresolved to this date regarding your request for an increase in the maximum licensed thermal capacity of the HI-STORM 100 Cask System. As requested in your March 11, 2005, letter, the results of the staff's acceptance review of the proposed revised thermal analyses are further described in Enclosure 2. To further assist you with resolution of the outstanding thermal issues the staff has provided you, in a March 21, 2005, letter, additional information on the Ventilated Storage Cask (VSC) -17 in NUREG/CR Report "Analysis Package for the VSC-17 Ventilated Concrete Cask," prepared by the Pacific Northwest National Laboratory.

In addition to the structural and thermal disciplines, the staff identified several other technical issues which are briefly described in Enclosure 3 for your consideration. Note that these issues and those described in Enclosures 1 and 2 do not constitute the results of a comprehensive technical evaluation but are only the results of the staff's technical acceptance review.

At your request, the staff would be willing to meet with Holtec through a public pre-application meeting, but prior to submittal of the enhanced Amendment 3 application, to discuss the structural and thermal issues described in Enclosures 1 and 2.

Please reference docket number 72-1014 in future correspondence related to this action. You may contact me at (301) 415-1179, if you have any questions.

Sincerely,
/RA/
Christopher M. Regan, Senior Project Manager
Licensing Section
Spent Fuel Project Office
Office of Nuclear Material Safety
and Safeguards

Docket No. 72-1014
TAC No. L23799
Enclosures: (1) Acceptance Review of Structural Discipline for Holtec HI-STORM 100 Cask System Amendment 3
(2) Acceptance Review of Thermal Discipline for Holtec HI-STORM 100 Cask System Amendment 3
(3) Acceptance Review of Other Disciplines for Holtec HI-STORM 100 Cask System Amendment 3

DISTRIBUTION: This Letter Closes Tac No. 23799 *See previous Concurrence **ML050830056**
NRC File Center Docket File 72-1014 SFPO r/f SBaggett **E:\Filenet\ML050830056.wpd**

OFC	SFPO	E	SFPO	E	SFPO [SC]		SFPO [SC]	
NAME	CRegan *		EZiegler *		LCampbell *		GBjorkman *	
DATE	3/ 21 /05		3/ 21 /05		3/ 22 /05		3/ 23 /05	

OFC	SFPO [SC]	
NAME	RLewis	
DATE	3/ 23 /05	

C = COVER, E = COVER & ENCLOSURE, N = NO COPY **OFFICIAL RECORD COPY**

ENCLOSURE 1

ACCEPTANCE REVIEW OF STRUCTURAL DISCIPLINE FOR HOLTEC HI-STORM 100 CASK SYSTEM AMENDMENT 3

The following structural issues were identified during the technical acceptance review of the HI-STORM 100 Cask System Amendment 3 application. In general, the proposed unchanged Certificate of Compliance (CoC), Section 7, "Design Features," states that, "Features or characteristics for the site, cask, or ancillary equipment must be in accordance with Appendix B to this certificate." The Amendment 3 application, in Appendix B, Section 3.4,"Site-Specific Parameters and Analyses" describes only a free-standing Cask System and an anchored cask system, but the buried unanchored cask system (HI-STORM 100U) proposed in the Amendment 3 application is not addressed. It is noted that 10 CFR 72.236 (b) requires that the design bases and design criteria must be provided for structures, systems, and components important to safety. As defined in 10 CFR 72.3 the design bases information should identify the specific functions to be performed by a structure, system, or component of a facility or of a spent fuel cask and the specific values or ranges of values chosen for controlling parameters as reference bounds for the design. The Amendment 3 application does not provide for any additional parameters and ranges of values for providing reference bounds for the HI-STORM 100U Cask System design for use at various sites. The staff recognizes the Holtec Amendment 3 CoC is a proposed revision and that it is incumbent upon the staff to develop the final CoC. However, in order to facilitate staff development of the final CoC that satisfies the applicant's needs, the applicant should be clear and provide the information necessary to develop the final CoC. Additionally and more specifically, details and information regarding the design of the Ventilated Vertical Module (VVM) are not complete as illustrated by the following issues:

Issue 1: Consideration of Differential Loading.

The HI-STORM 100U Cask System is available for use by a general licensee and apparently there is no consideration of the potential that there may be soil layers within the approximately 15.5 feet high column of soil materials the Vertically Ventilated Module (VVM) will be embedded into and which may respond differently under various loadings such as seismic loads. The design does not appear to provide for differential loading and movement between the reinforced concrete base mat and the unreinforced concrete monolith and the steel module cavity because there are no structural ties to the base mat.

Issue 2: Lateral Loading of the Vertical Ventilated Module.

It is not clear how the VVM unreinforced concrete has been analyzed and designed to resist the lateral loads that can be present within the buried environment such as the active soil pressures, hydrostatic pressure or differential lateral pressures. This is especially of concern in the 5 inches thick by 40 inches wide and 15.5 feet high section of unreinforced concrete that must protect the inlet ducts from collapse and blockage or closure.

Issue 3: Use of Unreinforced Concrete.

The cited design basis for the unreinforced concrete VVM is American Concrete Institute (ACI) Code 318.1-89 (92) and as stated in Section 1.2.3 of that Code, "Plain concrete shall not be used for structural members where special design considerations are required for earthquake or blast, unless specifically permitted by the legally adopted general building code." It appears that the design basis for the unreinforced VVM would be in question and that an unreinforced VVM would not be permitted. It is noted that the Amendment 3 application states that, "Although the licensing basis qualification of the concrete monolith is carried out assuming plain concrete (in the manner of the above ground HI-STORM 100 design), a user may elect to install reinforcing steel in accordance with the guidelines of ACI 318-95 for reinforced concrete to realize even greater structural strength in module arrays." This leaves the proposed design incomplete and unspecified. It should also be noted that the unreinforced concrete in the proposed VVM is not like that of the above ground HI-STORM 100 Cask System design in that it is not confined internally and externally by steel shells.

<u>Issue 4:</u> Corrosion Protection of Rebar.

It is stated that, "The carbon steel rebar in the VVM base mat is provided with 3-1/2 inches of cover, however, the rebar may be galvanized or coated with epoxy in accordance with the applicable ACI code if the specific site environmental conditions warrant the need." The Amendment 3 application does not provide criteria that would be used by a general licensee to determine the corrosion protection treatment necessary.

<u>Issue 5:</u> Chemical Effects on Concrete.

In the proposed design using unreinforced concrete embedded in each site's specific soil, groundwater, and other environmental conditions, there does not appear to be any criteria regarding chemical and other effects on the concrete other than to indicate some protective coating will be used. For example, Type II cement that is currently specified for steel encapsulated concrete applications per the ACI Code may not be adequate in certain types of soils. It does not appear that the design basis and supporting criteria are adequate for the general licensee to correctly implement the VVM concept.

ENCLOSURE 2

ACCEPTANCE REVIEW OF THERMAL DISCIPLINE FOR HOLTEC HI-STORM 100 CASK SYSTEM AMENDMENT 3

The following thermal issues were identified during the technical acceptance review of the HI-STORM 100 Cask System Amendment 3 application. Two outstanding issues remain unresolved in the thermal discipline. These issues relate to the modeling assumptions and input data used in the thermal analysis of the storage casks. The issues are described in addition to a summary of the applicant's proposed approach to address them. Key items have been underlined for emphasis. The staff's determination regarding the applicant's proposed approach is described along with a recommended path forward.

Issue 1: Hydraulic resistence calculation for In-cell flow of helium in PWR and BWR MPC storage cells.

The applicant submitted to the Nuclear Regulatory Commission (NRC) Holtec Report No. HI-2043285, "Pressure Loss Characteristics for In-Cell Flow of Helium in Pressurized Water Reactor (PWR) and Boiling Water Reactor (BWR) Multi-Purpose Canister (MPC) Storage Cells." Separate FLUENT Computational Fluid Dynamics (CFD) models were built by the applicant for the water rod bottom and top regions, in-channel region, and annulus (channel-to-cell area) region to address the issue of hydraulic resistence of the in-cell flow of helium (Issue 1).

1.1 In-Channel Model

The applicant's FLUENT model explicitly represents each fuel rod, fuel spacer grids, and water rods in a quarter symmetry model. Applying a series of pressures and using the resulting mass flow rates from the FLUENT calculation, the applicant obtained average velocities for this region. However, the average velocity obtained by the applicant is larger than the average velocities experienced by the heated fuel rods because the averaging procedure combines both gas velocities from inside the water rods and the velocities across the heated rods. Based on the CFD models provided by the applicant for the in-channel region, the staff noted that the wall shear stresses experienced by the heated rods are approximately 50% higher than the wall shear stresses experienced by the inner wall of the water rods. The applicant's averaging procedure will result in flow resistance parameters that may be non-conservative. This can be seen by the following comparison. The FLUENT porous media pressure drop model is used for this purpose.

FLUENT porous media flow resistance model is as follows:

$$\frac{\Delta P}{L} = D\mu V + C\left(\frac{1}{2}\rho V^2\right) \qquad (1)$$

where:

ΔP is porous media pressure drop
V is superficial fluid velocity
L is length of porous media
μ is fluid viscosity
ρ is fluid density
D is viscous resistance parameter
C is inertial resistance parameter

For the type of flow (laminar) inside the storage canister, the dominant contributor to pressure drop is mostly due to viscous effects. Only the first term of Equation (1) is used to illustrate this.

From the applicant's FLUENT calculation it follows that:

$$V_{avg} > V_{heated\ rods} \qquad (2)$$

where

V_{avg} is the in-channel average velocity
$V_{heated\ rods}$ is the average velocity through the heated (fuel) rods.

Using Equation (1) to calculate the flow resistance parameters we have for the viscous resistance parameter:

$$D = \frac{\left(\frac{\Delta P}{L}\right)}{\mu V} \qquad (3)$$

Based on Equation (2), it follows that:

$$D_{avg} < D_{heated\ rods} \qquad (4)$$

Therefore, as shown by Equation (4), the applicant's approach to obtain the flow resistance parameters is non-conservative because the method artificially decreases the resistances on the fuel region. This region is critical because this is where heat is generated and transferred to the surrounding rod environment. Therefore, the applicant should obtain the flow and heat transfer characteristics for the heated region such that a conservative result is reached.

Based on the wall shear stresses of the fuel rods predicted by the applicant's FLUENT in-channel model, the staff calculated a friction factor f = 102/Re. This value is consistent with the methodology of E.M. Sparrow and A.L. Loeffler, in "Longitudinal Laminar Flow Regime Between Cylinders Arranged in Regular Array," American Institute of Chemical Engineering Journal, Volume 5 Number 3, pages 325-330, September 1959. Therefore, the staff concludes that the applicant should use this friction factor to obtain the porous media flow resistance parameters for the heated region.

Porous Media Flow Resistance Calculation

We have for the Porous Media Flow Resistance Model

$$\frac{\Delta P}{L} = D\mu V + C\left(\frac{1}{2}\rho V^2\right) \qquad (5)$$

Pressure drop for a laminar flow pipe is:

$$\frac{\Delta P}{L} = \frac{32\mu}{D^2}V \qquad (6)$$

where a friction factor

$$f = \frac{F}{\text{Re}} \qquad (7)$$

with F = 64

has been considered.

For an array of solid rods, we cannot assume the value for F, but based on literature (see for example E.M. Sparrow and A.L. Loeffler, in "Longitudinal Laminar Flow Regime Between Cylinders Arranged in Regular Array," American Institute of Chemical Engineering Journal, Volume 5 Number 3, pages 325-330, September 1959), for a square array, F is around 100, depending on p/d and the porosity of the array where d is the fuel rod diameter and the p is the fuel rods pitch.

Using Equation (2) and neglecting the inertial term (since the dominant contributor to pressure drop is mostly due to viscous effect), the pressure drop for an array of solid rods is:

$$\frac{\Delta P}{L} = D\mu V \qquad (8)$$

where D is defined as follows (based on Equation (6)):

$$D = \frac{F}{2{d_h}^2} \qquad (9)$$

Using the geometric information of the BWR GE 10X10 and the PWR 17X17 fuel assembly types and the applicant's FLUENT results (Holtec Report No. HI-2043285, "Pressure Loss Characteristics for In-Cell Flow of Helium in Pressurized Water Reactor (PWR) and Boiling Water Reactor (BWR) Multi-Purpose Canister (MPC) Storage Cells."), the staff calculated the viscous resistance parameter of the porous media. The results are summarized in Tables 1 through 4.

In-channel Flow Resistance Calculation for the BWR GE 10x10 Fuel Assembly Type:

Table 1. Data Obtained from FLUENT Calculation				
Region	Wall shear stress (Pa)	Average Velocity (m/s)	Density (kg/m)	Viscosity (kg/m-s)
Fuel Rods only	0.002608	0.07606	0.675	$2.86X10^{-5}$
Fuel Rods +grid straps	0.005246	0.09691	0.675	$2.86X10^{-5}$

Table 2. Calculated Data				
Region	Friction Factor (f)	Re	F=fxRe	D (pitch weighted) $1/m^2$
Fuel Rods only	5.343	18.44	98.5	$1.35X10^{6}$
Fuel Rods +grid straps	6.62	8.14	53.9	$7.22X10^{6}$

Flow Resistance for the PWR 17x17Fuel Assembly Type:

Table 3. Data Obtained from FLUENT Calculation				
Region	Wall shear stress (Pa)	Average Velocity (m/s)	Density (kg/m)	Viscosity (kg/m-s)
Fuel Rods only	0.002613	0.0944	0.675	$2.86X10^{-5}$
Fuel Rods +grid straps	0.00521	0.1091	0.675	$2.86X10^{-5}$

Table 4. Calculated Data				
Region	Friction Factor (f)	Re	F=fxRe	D (pitch weighted) $1/m^2$
Fuel Rods only	3.48	30.06	104.6	544003
Fuel Rods +grid straps	5.19	12.41	64.4	$2.62X10^{6}$

1.2 In-channel and annulus model for BWR fuel types

To define the porous media flow resistance parameters for the MPC storage cells, the applicant developed detailed three-dimensional FLUENT models of a BWR and a PWR fuel assembly. For the BWR case, separate models were prepared for the rodded area within the channel and a model of the channel-to-cell area. Pressure boundary conditions were imposed on these models covering a range of pressure drop of up to 5 Pascal. The obtained mass flow rates from the separate models were combined together and the values used to calculate the in-cell velocity. This approach may not be adequate because averaging can result in in-channel flow resistances that are smeared to other regions which may not be critical to heat transfer as explained in the previous section.

Furthermore, since buoyancy is produced through density variations, helium will be preferentially flowing upwards through the in-channel heated region. These two regions (in-channel area and area between the fuel assembly and the MPC-68 fuel cell) will exhibit different thermal-hydraulic characteristics and, therefore, cannot be averaged, unless such averaging has been demonstrated to be conservative.

The use of the porous media approximation is based on the assumption of having a uniform region that, as is the case of the in-channel heated region, except for the presence of the water rods, provides for a geometry which is adequate for porous media representation. This uniformity in the geometry is lost when the applicant combined the in-channel (heated region) and the area between the fuel assembly and the MPC-68 storage fuel cell in a single porous media zone.

Properly weighted flow resistance parameters of the in-channel region (obtained as described in Section 1.1) can be applied also to the channel-to-cell flow area in order to use the porous media approximation to represent the MPC storage cell. This will ensure that the flow resistance of the critical region (fuel rods) is not under-estimated.

Issue 2: Determination of HI-STORM 100 air annular flow regime.

The applicant submitted Holtec Report HI-2043258, "Identifying the Convection Correlation in Fluent for Ventilation Air Flow in the HI-STORM System." In this report the applicant described their development of a two-dimensional model of the VSC-17 ventilated concrete cask. However, the model developed does not include the internals of the canister. The canister is modeled as a solid body with an arbitrarily imposed thermal conductivity of 2 W/m-K. The VSC-17 model developed by the applicant cannot be used to validate the heat transfer model of the HI-STORM 100 cask system because the assumptions applied to the HI-STORM 100 model are not same as the assumptions used to model the VSC-17.

Based on the analysis of the VSC-17, the applicant presented the following conclusions:

1) The FLUENT correlations (flow regime models and options) are conservative for simulating thermal performance of ventilated casks.

2) Assuming laminar flow in the annulus results in a significant separation between measured and computed temperature profiles.

3) Correlation A (k-ε turbulence with standard wall functions) provides the closest result to the measured data. Correlation A overpredicts the temperature by as much as 10.4%. Therefore, correlation A is recommended for simulating design basis heat transfer in the HI-STORM 100 annulus.

Staff's comments on the VSC-17 analysis provided by the applicant are as follows:

1) The simplified model developed by the applicant does not include the necessary details for performing a fair comparison of the different flow options (laminar, turbulent, etc.) with the available measured data.

2) If the purpose of the analysis model is to produce conservative results based on the different FLUENT flow options, then this purpose is fulfilled. However, if as stated by the applicant in its conclusions, the purpose of the model is to recommend a given model for demonstrating the design adequacy of the HI-STORM 100 cask system, then the staff finds this unacceptable because the assumptions used by the applicant to model the heat transfer characteristics of the HI-STORM 100 cask system are not the same as the assumptions used in the VSC-17 analysis.

In a letter dated January 31, 2005, the applicant submitted additional analyses for NRC staff review. According to the applicant's analysis based on laminar heat transfer correlations, the cask outer surfaces would be dissipating approximately 6081 Watts to the environment through a combination of natural convection and radiation heat transfer. Two separate calculations are then provided based on laminar heat transfer correlations and on turbulent heat transfer correlations.

According to the applicant's calculation, the air flowing through the annulus would need to remove 8.818 kilo-Watts (kW) of energy. The results for the two different assumptions (laminar and turbulent) are provided next and summarized in Table 1.

a) <u>Laminar Flow</u>

Heat Dissipated by the annulus air flow = 3.133 kW (Alternate Method)

Heat Dissipated by the annulus air flow = 8.53 kW (Applicant's FLUENT 2D Model)

b) <u>Turbulent Flow</u>

Heat Dissipated by the annulus air flow = 7.67 kW (HI-2043258)

Heat Dissipated by the annulus air flow = 10.066 kW (Applicant's FLUENT 2D k-epsilon model with standard wall functions)

Heat Dissipated by the annulus air flow = 9.821 kW (Applicant's FLUENT 2D k-epsilon model with enhanced wall treatment)

When comparing the above the staff has the following questions:

1) Why does the applicant's calculation based on laminar heat transfer correlations for constant wall temperatures differs so much from the FLUENT 2D axisymmetric model developed by the applicant?

2) How could a calculation based on constant wall temperature be used to predict a flow regime of an air annulus flow which is axially varying in temperature and heat flux at the wall at the same time?

One observation from the applicant's own calculations, is that it appears to the staff that the FLUENT predictions based on the laminar flow resulted in the best comparison against the applicant's calculated value of the air flowing through the annulus which is 8.818 kW vs 8.53 kW (predicted by the applicant's 2D model of the VSC-17).

Table 1. Holtec's Analysis of the VSC-17 Ventilated Concrete Cask
Heat Removed by Air Flowing Through Annulus (kW**)**

Assumed Flow Regime	FLUENT Analysis	Alternate Method
Laminar Flow	8.5300	3.133
Turbulent Flow (k-epsilon model with standard wall functions)	10.066	7.672
Turbulent Flow (k-epsilon model with enhanced wall treatment)	9.821	7.672

In a letter dated February 18, 2005, the applicant provided an updated analysis adding the following features to the analysis:

1) Multi-assembly Sealed Basket (MSB) Internal Radiation
2) MSB Lid Neutron Shield Attachment Ring
3) Orthotropic Basket Thermal Conductivity

To include radiation from the basket to the MSB inner wall and from the top of the basket to the MSB lid, the applicant included 3-inch and 2-inch gaps, respectively. Constant assumed thermal conductivity was imposed for the radial and axial directions. According to the applicant, this modified model corresponds to Run # 6 of the VSC-17 Electric Power Research Institute (EPRI) Report. Run #6 in the EPRI report is described as corresponding to "vacuum" conditions inside the MSB. The applicant provided a comparison of the MSB measured temperature against their FLUENT predicted results. The applicant did not provide a comparison of measured temperatures on the cask liner. Using the applicant's analysis, the staff obtained these temperatures from the FLUENT data base and compared them with the measured data.

The staff observed that it appears the predictions based on the turbulent model are under-predicting the MSB outer shell temperature. Larger differences are seen for predicted temperatures on the liner wall. These larger differences on the predicted liner wall temperatures are caused by an overestimation of the heat taken by the air as it flows upwards in the annular gap.

According to the applicant, both laminar and turbulent flow regime options predict the same peak measured temperature. The staff's review of the FLUENT case file revealed that the applicant uses a different radial conductivity for each of the options.

ENCLOSURE 3

ACCEPTANCE REVIEW OF OTHER DISCIPLINES FOR
HOLTEC HI-STORM 100 CASK SYSTEM AMENDMENT 3

The following technical issues were identified in the materials and shielding areas as a result of the staff's technical acceptance review and may be addressed in an enhanced submittal of the Amendment 3 application to preclude the need for a Request for Additional Information from the staff.

Materials

Issue 1: Guidance Regarding Helium Leak Testing.

The staff notes that the applicant has inappropriately applied the helium leak test guidance provided in Interim Staff Guidance (ISG) -18. The intent of that guidance was to eliminate the helium leak test requirement for the large, multi-pass structural lid weld only, and not all the ancillary smaller welds employed for the various penetration covers. A revision to the appropriate section(s) of the Safety Analysis Report and/or Technical Specifications is needed to reflect that helium leak testing is still required of all other welds is necessary.

Issue 2: Assessment of Corrosion Mitigating Measures.

A detailed plan for assessing what kind of corrosion mitigating measures will be necessary for protecting the rebar should be provided. The Amendment 3 application provides only general or vague mention of this consideration. A discussion should include how a need for such measures will be determined (such as through soil resistivity/chemistry surveys), and the results incorporated into a specific mitigation plan for any given Independent Spent Fuel Storage Installation (ISFSI) site. Because it may be expected that a very wide variety of soil chemistry/moisture conditions can be encountered at different proposed ISFSI sites, an engineered plan for addressing local conditions is needed. The staff observes that the discussion in American Concrete Institute (ACI) Code 201.2R and 222R is instructive, but lacks a well defined method for performing a site assessment to determine the severity of and need for rebar corrosion protection.

Shielding

Issue 1: Deletion of Technical Specification 5.7.4.

The applicant has deleted Technical Specification (TS) 5.7.4 in the proposed Technical Specifications. However, no explanation is provided to explain or justify this deletion. The removal of TS 5.7.4 affects not only the HI-STORM 100U, but all the previously approved HI-STORM 100 overpack designs as well. Therefore, the reasons for deletion of TS 5.7.4 should be provided and justified.

Issue 2: Uncertainties in Source term Calculations.

The applicant has proposed an increase in the burnups for the cask system. However, there is no change in the proposed shielding source terms as would be expected with a proposed increase in burnup. Staff reviewed the previous amendment's Safety Evaluation Report (SER) and found that the proposed source terms were calculated using the new burnups being proposed in the Amendment 3 application. It was also noted, however, that the approval of the source terms relied upon the fact that the calculated source terms were for contents that exceeded the burnups that were approved in Amendment 2, which added a margin of conservatism to the analyses. While this and other conservatisms were introduced into the analyses, there are also uncertainties in the source term calculation, both in the shielding and heat load source terms. A source of these uncertainties arises from the applicant's calculations for burnups up to 75 GWD/MTU, which exceed the range of burnups for which SAS2H has been validated; SAS2H has been validated for burnups up to 45 GWD/MTU. Now that the applicant is seeking approval of the burnups that were used to calculate the source terms of the previous analysis, the uncertainties in the source term calculations should be addressed, quantitatively as well as qualitatively, and the source terms (both shielding and heat load source terms) appropriately adjusted to account for those uncertainties.

<u>Issue 3:</u> **Dose Calculations.**

The applicant did not perform a dose versus distance calculation for a HI-STORM 100U single cask or sample cask array. Instead, the applicant argued that the calculations for an above ground cask (cask array) would bound the calculations for the underground cask type. While dose rates resulting from the cask side have been decreased, the dose rates from the cask top have increased. Also, while one can qualitatively argue whether or not the overall result is a decrease in dose (a dose bounded by an above ground cask), it isn't known how much the dose (to the public) is decreased. Additionally, the dose calculations for both the above ground and underground systems will be affected by any adjustments to the source terms that result from Shielding Issue 2 above.

Furthermore, the applicant's approach to the dose analysis for a single cask or sample cask array is used as a guide for general licensees to perform a 10 CFR 72.212 evaluation for using the cask. The applicant currently provides no methodology for a cask user to follow for performing this evaluation. A dose versus distance calculation for a single cask and sample cask array should be provided to demonstrate the method to be used by a general licensee in performing a 10 CFR 72.212 evaluation and to demonstrate that the system adequately meets the shielding requirements of 10 CFR Part 72. These dose calculations will also need to incorporate any adjustments to the shielding source terms that result from Shielding Issue 2. The dose calculations for the above ground systems should also be adjusted to account for changes to the source terms resulting from analysis performed per Shielding Issue 2 .

<u>Issue 4:</u> **Soil Properties and Assumptions for Shielding Analysis.**

The applicant performed a shielding analysis for a single loaded overpack. Yet, the description of the model is incomplete. The soil properties and assumptions about the soil used in the applicant's model need to be described.