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MPC&D 08-090

November 5, 2008

U.S. Nuclear Regulatory Commission
Attn.: Document Control Desk
Washington, DC 20555

Docket No.72-11
Rancho Seco Independent Spent Fuel Storage Installation
License No. SNM-2510

RANCHO SECO INDEPENDENT SPENT FUEL STORAGE INSTALLATION PROPOSED LICENSE AMENDMENT NO. 3

Attention: Randy Hall

In accordance with 10 CFR 72.56 "Application for Amendment of License," we are submitting Proposed Amendment No. 3 to the Rancho Seco Independent Spent Fuel Storage Installation (ISFSI) Technical Specifications.

Attachment 1 to this letter provides a copy of the proposed amendment to page 2.1-1 of the Technical Specifications. This page will replace the existing page 2.1-1. Attachment 2 provides an evaluation and justification for the proposed amendment. Attachment 3 provides copies of the thermal, criticality, seismic, and shielding calculations.

ISFSI Technical Specification Section 2.1.1 "Fuel Stored at the ISFSI" states that only "intact" spent fuel assemblies may be placed in an FO-DSC[1] or FC-DSC[2]. Technical Specification Section 1.1 defines an intact fuel assembly as an assembly with no known or suspected cladding defects greater than hairline cracks or pinhole leaks. A fuel assembly with known or suspected cladding defects greater than hairline cracks or pinhole leaks was intended to be stored in an FF-DSC[3].

After transferring the spent fuel into dry storage, Rancho Seco management determined that, contrary to Technical Specification Section 2.1.1, at least one fuel assembly stored in an FC-DSC appeared to have cladding damage greater than a hairline crack. An investigation determined that five other assemblies stored in FC-DSCs, also have the

[1] Fuel Only Dry Shielded Canister (FO-DSC)
[2] Fuel with Control Component Dry Shielded Canister (FC-DSC)
[3] Damaged Fuel Dry Shielded Canister (FF-DSC)

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potential for having cladding damage greater than a hairline crack or pinhole leak. The six assemblies are stored in five FC-DSCs.

Based on the nature, extent, and quantity of clad defects of the six fuel assemblies (using worst-case assumptions), as well as the storage of more significantly damaged assemblies in the FF-DSC and the static nature of storage, it was concluded that there was no imminent concern for the continued safe storage of the fuel in a non FF-DSC.

SMUD, along with the canister designer Transnuclear, have evaluated the long-term aspects of continued safe storage of the effected canisters. Storing these spent fuel assemblies with cladding damage greater than hairline cracks or pinhole leaks at the Rancho Seco ISFSI will have no adverse affect on the continued safe storage of the spent fuel and the safe operation of the ISFSI. Storing spent fuel with cladding damage greater than a hairline crack will not have an adverse affect on public health and safety or the environment.

Granting this Technical Specification amendment will allow us to maintain the spent fuel stored in its current configuration. Having to repackage the fuel is not practicable since we no longer have a spent fuel pool. Further, allowing us to maintain the spent fuel stored in its current configuration will reduce occupational exposure, reduce the generation of radioactive waste, and eliminate the risk of possible fuel handling accidents if required to repackage the fuel.

We have also sent a copy of this proposed amendment to the Radiological Health Branch of the California State Department of Health Services. If you, or members of your staff, have questions requiring additional information or clarification, please contact Bob Jones at (916) 732-4843.

Sincerely,

Steve Redeker
Manager, Plant Closure & Decommissioning

Cc: Randy Hall, NRC Headquarters
NRC, Region IV
Radiological Health Branch of the California State Department of Health Services

Attachments

Attachment 1

Revised Technical Specification Page 2.1-1

2.0 FUNCTIONAL AND OPERATING LIMITS

2.1 Functional And Operating Limits

2.1.1 Fuel Stored At The ISFSI

The spent nuclear fuel to be stored in HSMs at the Rancho Seco ISFSI consists of the following:

a. INTACT SPENT FUEL ASSEMBLIES as characterized in Table 2-1.

b. DAMAGED SPENT FUEL ASSEMBLIES having 15 or less fuel pins per assembly with known cladding damage.

c. Fuel assembly control components as described in Table 2-2.

Only intact Rancho Seco spent fuel assemblies may be placed in an FO-DSC or FC-DSC[1].

Rancho Seco control rod assemblies, burnable poison rod assemblies, axial power shaping rod assemblies (gray or black), neutron sources, retainer clips, and orifice rod assemblies may be placed only in an FC-DSC within an INTACT SPENT FUEL ASSEMBLY[1].

DAMAGED SPENT FUEL ASSEMBLIES having 15, or less, fuel pins with known cladding damage may be placed in an FF-DSC. INTACT SPENT FUEL ASSEMBLIES may also be placed in the FF-DSC.

No control components or neutron sources may be placed in an FF-DSC.

[1] Note: Six fuel assemblies with known or suspected cladding defects greater than hairline cracks or pinhole leaks were determined to be stored in five different FC-DSCs. Analysis has shown that storing these spent fuel assemblies, with cladding damage greater than a hairline cracks or pinhole leaks, at the Rancho Seco ISFSI will have no adverse affect on the continued safe storage of the spent fuel and the safe operation of the ISFSI.

Attachment 2

Safety Evaluation

Background

In mid 1996, a visual inspection of the spent nuclear fuel was performed in accordance with Rancho Seco Administrative Procedure RSAP-0112 "Fuel Assembly Visual Inspections." The inspection was performed to assess the condition of the fuel and to determine the extent of cladding damaged on the visible fuel pins. All fuel inspections were systematically video taped and submitted to Records for long term record storage.

RSAP-0112 defined five classifications for the spent fuel. The criteria for defining damaged fuel was cladding failures with breeches greater than 25% of the circumference of the fuel pin and at least the length of a fuel pellet ($\approx$ 0.34 inches across the cladding and 0.7 inches along the cladding).

The results of the inspection were used to determine which assemblies would be inserted into the Failed Fuel (FF) canister. Based on a review of the video, and an independent review by Electric Power Research Institute (EPRI), there were a total of 10 assemblies specifically earmarked for insertion into the FF canister.

The inspection criteria in RSAP-0112 were based upon the best available guidance at the time. However, these criteria had evolved over time and by the time the ISFSI FSAR was issued the criteria used to inspect and classify the fuel was inconsistent with ISFSI Technical Specification Section 2.1.1 "Fuel Stored at the ISFSI."

Investigation

Based on the differences in the definition of damaged fuel in RSAP-0112 and in the final definition in the 10 CFR Part 72 Technical Specifications, it was determined that a potential existed that damaged assemblies may have been placed in a fuel canister licensed only for intact assemblies.

The focus of the investigation was on those assemblies that could contain flaws that exceeded pinholes and hairline cracks but were less that 0.34 inches across or less than 0.7 inches high. Based upon a re-review of the videotapes, six fuel assemblies were identified as potentially having flaws greater than pinholes leaks or hairline cracks.

ISFSI Technical Specification Section 2.1.1 states that only "intact" spent fuel assemblies may be placed in an FO-DSC[1] or FC-DSC[2]. Technical Specification Section 1.1 defines an intact fuel assembly as an assembly with no known or suspected cladding defects greater than hairline cracks or pinhole leaks. A fuel assembly with known or suspected cladding defects greater than hairline cracks or pinhole leaks was intended to be stored in an FF-DSC[3].

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[1] Fuel Only Dry Shielded Canister (FO-DSC)

[2] Fuel with Control Component Dry Shielded Canister (FC-DSC)

[3] Damaged Fuel Dry Shielded Canister (FF-DSC)

After transferring the spent fuel into dry storage, Rancho Seco management determined that, contrary to Technical Specification Section 2.1.1, at least one fuel assembly stored in an FC-DSC appeared to have cladding damage greater than a hairline crack. An internal investigation determined that five other assemblies stored in FC-DSCs, also have the potential for having cladding damage greater than a hairline crack or pinhole leak. The six assemblies are stored in five FC-DSCs.

In addition, Transnuclear sent a representative to review the video records of the spent fuel assemblies that had been categorized as having pinhole leaks or cracks acceptable for storage in a regular FO- or FC-DSC. SMUD also sent copies of the records to Areva NC Fuel Division to determine if more information could be gleaned on the six assemblies. The reviews did not result in any additional information and it was agreed that the interpretation made by SMUD during their review was conservative.

Initial Evaluation

The design of fuel assemblies with integrated spacer grids provides an inherently robust configuration that precludes damage during storage conditions. Although the defects in the subject fuel pins are larger than allowed by the Technical Specifications, they are still relatively small. There is no credible mechanism that would result in the loss of fuel pellets during storage. The much larger defects found in the fuel assemblies stored in the FF-DSC have never resulted in the loss of fuel pellets up to and during canister loading. This lack of fuel pellet loss was confirmed during the draining of the fuel pool, refueling canal, and reactor vessel during decommissioning because no fuel pellets were discovered at final drain down. Design loads during storage conditions are minimal and will not result in credible failures.

Another significant consideration is that the functional design differences between the FF-DSC and the FO- and FC-DSCs relate not to storage but to transportation and individual fuel assembly handling during canister loading and unloading operations. The FF-DSC has individual internal removable sleeves for each fuel assembly with bottom screens and a top closure to limit movement of loose fuel pellets from up to 15 fuel pins. The sleeves also allow handling assemblies that may have structural damage that prevents handling them "bare." None of the six assemblies has structural or cladding damage that could be expected to result in loose pellets. The total number of pins affected in any FC-DSC canister is two or fewer thus is bounded by the loose fuel pellet analysis (15 pins) performed for the FF-DSC.

Accordingly, based on the nature, extent, and quantity of clad defects of the six fuel assemblies (using worst-case assumptions), as well as the storage of more significantly damaged assemblies in the FF-DSC and the static nature of storage, it was concluded that there was no imminent concern for the continued safe storage of the fuel in a non FF-DSC.

Calculation Results

SMUD and Transnuclear performed calculations to evaluate the long-term aspects of continued safe storage of the effected canisters. Transnuclear completed calculations to evaluate the impact on thermal, shielding, seismic, and criticality analyses. The results are discussed below.

Thermal

The thermal evaluation uses the HEATING7.2 computer program to determine the maximum fuel cladding temperature for the FC-DSCs that were loaded with fuel assemblies with cladding defects exceeding pinholes and hairline cracks. The evaluation concluded that the maximum fuel cladding temperature for those DSCs is 544°F. This cladding temperature is below the current allowable limit of 752°F[1] for normal storage conditions. Hence, there is no adverse impact from loading damaged fuel assemblies into an FC-DSC because the previously calculated maximum fuel cladding temperature of 701°F remains bounding.

Shielding

The shielding calculation evaluates the impact on the source term from loading these damaged fuel assemblies in an FC-DSC. A comparison of the source term for the damaged fuel assemblies with the design basis assembly source term shows that the design basis source term remains the bounding condition. Therefore, storage of the damaged assemblies in FC-DSC canisters does not affect the design basis dose rates.

Criticality

The criticality analysis determined the effect of loading damaged fuel assemblies in an FC-DSC. The fuel configurations evaluated ranged from modeling a row of de-cladded fuel rods within the guide sleeves to modeling a 2" – 40 X40 array of fuel pellets at the bottom of the DSC. These configurations conservatively cover all postulated damage ranging from cracking of the cladding to complete cladding damage of several fuel rods.

The maximum k_{eff} for the FC–DSC in the as-loaded configuration with two damaged assemblies was calculated to be 0.9151. This value is well below the design basis maximum k_{eff} of 0.9298. These results demonstrate that the loading of damaged fuel assemblies with damage greater than pinhole or hairline crack does not result in any significant impact on the criticality of the system.

Seismic

[1] ISG – 11 "Cladding Considerations for the Transportation and Storage of Spent Fuel," Revision 3.

The seismic evaluation determined the effect of loading fuel assemblies with known or suspected cladding defects greater than a pinhole or hairline cracks on the seismic analysis of the FC– DSCs.

As discussed in Rancho Seco ISFSI FSAR Volume II, Section 8.3.2 an earthquake with accelerations of 0.25g in both horizontal directions and 0.17g in the vertical direction was used as the design basis seismic event for the Rancho Seco ISFSI site. These accelerations were applied to the loaded DSC and Horizontal Storage Module (HSM) while in the storage mode and the evaluation showed that they will not tip over. The evaluations documented are independent of the condition of the fuel assemblies loaded in these DSCs. The DSC in storage conditions will sit on the DSC support rails inside the HSM even after the seismic event and the HSM/DSC will not tip over during a seismic event. Therefore, the seismic evaluation results documented in Rancho Seco FSAR for the FC– DSCs loaded with damaged fuel assemblies (one or two assemblies per DSC with limited damaged) in the loaded configuration is not affected.

Conclusion

Storing these spent fuel assemblies with cladding damage greater than hairline cracks or pinhole leaks at the Rancho Seco ISFSI will have no adverse affect on the continued safe storage of the spent fuel and the safe operation of the ISFSI. Storing spent fuel with cladding damage greater than hairline cracks or pinhole leaks will not have an adverse affect on public health and safety or the environment.

Attachment 3

Calculations

TRANSNUCLEAR AN AREVA COMPANY	**Form 3.2-1** **Calculation Cover Sheet** **TIP 3.2 (Revision 2)**	**Calculation No.:**	13302.0404
		Revision No.:	0
		Page:	1 of 10

DCR NO:	N/A	**PROJECT NAME:**	SMUD General Services
PROJECT NO:	13302	**CLIENT:**	SMUD, Sacramento Municipal Utility District

CALCULATION TITLE:

Thermal Evaluation of FC DSC loaded with Damaged Fuel Assemblies.

SUMMARY DESCRIPTION:

CONTROLLED COPY #: I-01
UNCONTROLLED IF PRINTED

1) Calculation Summary

This study evaluates the effects of loading damaged fuel assemblies on thermal performance of FC DSCs. FC DSCs are designed to store intact fuel assemblies only. This study also determines the maximum fuel cladding temperature based on actual decay heat load.

2) Storage Media Description

N/A

If original issue, is licensing review per TIP 3.5 required?

Yes ☐ No ☒ (explain below) Licensing Review No.: N/A

This study is performed to support an exemption request to NRC for loading of damaged fuel assemblies in FC canisters and hence no licensing review is needed.

Software Utilized:	**Version:**
HEATING	7.2b
Calculation is complete: Originator Name and Signature: Venkata Venigalla	Date: 03/13/2008
Calculation has been checked for consistency, completeness and correctness: Checker Name and Signature: Slava Guzeyev	Date: 3/13/2008
Calculation is approved for use: Project Engineer Name and Signature: Ian McInnes	Date: 3/20/08

REVISION SUMMARY

REV.	DATE	DESCRIPTION	AFFECTED PAGES	AFFECTED DISKS
0	3/20/08	Initial Issue	All	All

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1.0 PURPOSE

FC DSC is designed to store intact/undamaged fuel assemblies (FA) only. Fuel assemblies with cladding breaches less than 0.34 inches across the cladding and less than 0.7 inches high along the cladding were initially classified as Class C assemblies [6] and were loaded into FC DSCs. However, due to the difference in definition of damaged fuel from the time the loading was completed to the current definition, these FC DSCs are considered now as loaded with damaged FAs with cladding defects exceeding pinholes and hairline cracks.

This calculation determines maximum fuel cladding temperature for FC DSCs loaded with damaged FAs and also evaluates the oxidation of damaged FAs during vacuum drying operations.

2.0 REFERENCES

1. *"FO/FC DSC Thermal Analysis for Storage Conditions"*, Transnuclear, Inc., Calculation No. NUH005.0451, Rev.4.

2. USNRC, SFPO, "Cladding considerations for the Transportation and Storage of Spent Fuel", Interim Staff Guidance ISG-11, Rev. 3.

3. *"Transient Thermal Analysis of FO/FC Canister during Vacuum Drying"*, Transnuclear, Inc, Calculation No. 13302.0403, Rev.0.

4. USNRC, SFPO, "Potential Rod Splitting due to Exposure to an Oxidizing Atmosphere during Short-Term Cask Loading Operations in LWR or Other Uranium Oxide Based Fuel", Interim Staff Guidance ISG-22, Rev. 12.

5. USNRC, SFPO, "Classifying the Condition of Spent Nuclear Fuel for Interim Storage and Transportation Based on Function", Interim Staff Guidance ISG-1, Rev. 2.

6. Sacramento Municipal Utility District, Rancho Seco ISFSI, "Interim Disposition", PDQ 05-0003.

7. Sacramento Municipal Utility District, Rancho Seco ISFSI, "Vacuum Drying Durations and DSC Loading Data", July 26, 2007.

8. Computer Code, HEATING7, Version 7.2b, "A Multidimensional Heat Conduction Analysis with the Finite Difference Formulation," NUREG/CR-200, Volume 2, Revision 4, Section F10, ORNL/NUREG/CSD-2/V2, 1993.

3.0 ASSUMPTIONS AND CONSERVATISM

Assumptions noted in [1] are valid for this study.

It is assumed that no additional damage, significant to alter the thermal performance of the FAs will occur due to DSC drop accident.

All FAs in DSC are assumed to be having the effective thermal conductivity equal to that of the damaged FAs.

4.0 DESIGN INPUT

Due to the difference in definition of damaged fuel from the time the DSC's at Rancho Seco were loaded to the current applicable definitions, a study was performed which determined that damaged fuel assemblies with cladding defects exceeding pinholes and hairline cracks were loaded into FC DSCs [6]. This study concluded that six damaged fuel assemblies were loaded into five casks. The cladding breaches on the damaged fuel assemblies were less than 0.34 inches across the cladding and less than 0.7 inches high along the cladding [6]. Table 4-1 presents details of the damaged fuel assemblies with cladding breaches.

Table 4-1 Details of Damaged Fuel Assemblies [6].

Fuel Assembly	Estimated Flaw Size	Canister Number
2G6	0.25" X 0.04"	FC24P-P16
OEL	0.75" long with 0.2" hole	FC24P-P10
ODY	0.2" hole	FC24P-P10
17G	Unknown	FC24P-P17
1C34	1" X 0.1"	FC24P-P18
1C04	0.3" holes (two)	FC24P-P03

Since each of the cladding breach is greater than pinhole/hairline crack, it can be concluded that the fuel Cladding is grossly breached for the fuel assemblies mentioned in Table 4-1 [5].

The DSC component materials properties are from [1] except for the effective thermal conductivity (ETC) of damaged FAs and poison plates. The poison plate material properties are obtained from [3]. Section 5-2 presents the ETC values used for damaged FAs.

The maximum time for onset of fuel oxidation is 100 hrs [3].

5.0 METHODOLOGY

5.1 Thermal Model

The HEATING7.2 [8] computer program is used to perform the thermal analysis of DSC. The HEATING7.2 DSC model from section 3.4 of [1] is used in the current analysis. The HEATING7.2 model of the DSC is a two-dimensional model of a cross-section of the DSC located mid-length along the axis of the DSC. This mid-length cross-section of the DSC gives the maximum spacer disc temperature gradients and maximum clad temperatures [1]. The HEATING7.2 model is shown in Figure 5-1. Detailed description of the various regions in this model can be found in Section 3.4 of [1].

To evaluate the maximum temperature of FC DSCs with damaged fuel assemblies this calculation considers the configuration wherein the DSC is in a horizontal position in HSM. The maximum cladding temperature of FC DSC in HSM was reported to be 701.1°F at 70°F ambient temperature [1] for normal operating conditions. This cladding temperature is for a heat load of 18.34 kW which is highly conservative compared to the maximum heat load of 8.156 kW [7] that was loaded with damaged fuel in a single DSC (FC24P-P16) at Rancho SECO ISFSI. The DSC shell temperatures used for the above mentioned case were evaluated for a 24 kW heat load which increases the conservatism in the model. Therefore, the actual cladding temperature in the DSC will be much lower than 701.1°F [1]. However, it is essential that the effects of the damaged fuel load on the maximum cladding temperature be evaluated.

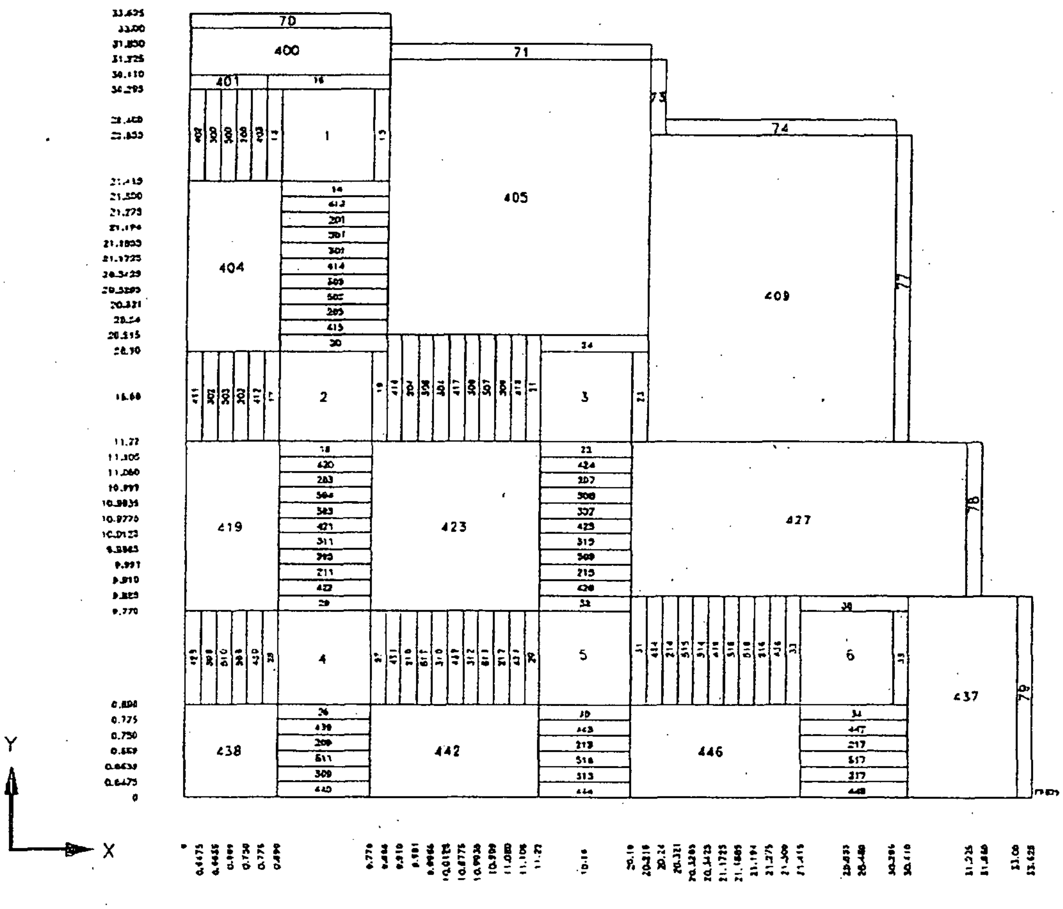

Figure 5-1 Heating Model of DSC [1]

5.2 Effect on Effective Thermal Conductivity of Fuel Assembly

Heat is dissipated from the cask through a combination of conduction, convection and radiation modes of heat transfer. However, considering that the cladding is grossly breached it can be conservatively estimated that changes in the fuel rod geometry can affect the temperature distribution. Defective spacers or grids might change the fuel rod pitch and hence have an impact on calculated effective fuel conductivity. However, since it has been observed that there was no significant damage to spacer grids, fuel rods, or end fittings [6] and the fact that the fuel was handled as intact during the loading shows that the geometric form of the package contents was not substantially altered. Hence there is no effect on the effective thermal conductivity of the fuel assemblies due to the damage specified in Table 4-1.

However there is uncertainty in emissivity due to the change in the cladding surface. To account for the uncertainty in FAs the fuel cladding temperature is calculated by reducing the effective fuel conductivity by 20%. This is a very conservative assumption since it is applied to all the FAs in the DSC considering that a maximum of only two damaged FAs were placed in an FC DSC [6]. The maximum heat load for DSCs with damaged FAs is 8.156 kW [7]. This heat load is used to compute the maximum fuel cladding temperature in DSCs with damaged FAs. Out of the 24 FAs loaded in each canister, the center four assemblies have the greatest effect on the peak fuel cladding temperature. Therefore, the fuel loading configuration with the highest average heat load at the center four assemblies of the canister was selected as the bounding case for this steady state analysis [7]. Table 5-1 presents the average heat loads of the center four assemblies of DSCs. Table 5-2 presents the ETC values for damaged and intact FA [1].

Table 5-1 Heat Load in Center Four FAs and Total Heat Load for DSCs with Damaged FAs [7].

	Fuel Assembly Location in DSC [7]				Average Heat Load Per Center Four FAs	Total DSC Heat Load
DSC # [7]	9	10	15	16	[W]	[kW]
FC24P-P03	435.2	507.4	487.7	424.2	464	8.145
FC24P-P10	310.1	427.2	505.7	461.1	426	8.137
FC24P-P16	313.2	410.6	382.4	300.9	352	8.156
FC24P-P17	513	427.2	508.2	424.2	468	8.132
FC24P-P18	310.1	503.3	316.2	427.2	389	8.141

Table 5-2 ETC of Damaged FAs.

	Intact FA	Damaged FA
Temperature	Thermal Conductivity	80% Thermal Conductivity
[°F]	[Btu/min-in-°F]	[Btu/min-in-°F]
400	2.222E-03	1.78E-03
500	2.917E-03	2.33E-03
600	3.610E-03	2.89E-03
700	4.440E-03	3.56E-03
800	5.417E-03	4.33E-03
900	6.258E-03	5.01E-03
1000	7.639E-03	6.11E-03

Based on data shown in Table 5-1, the maximum average heat load per center four FAs is 468 W (for DSC# FC24P-P17). This value is applied in model for center 4 FAs.

The maximum total heat load per DSC with damaged fuel assemblies is 8.156 kW (for DSC# FC24P-P16) [7] based on data shown in Table 5-1. This value is conservatively applied to the model.

The heat load of FAs outside the center 4 FAs is 0.3142 kW. Therefore, the heat load (4*0.468 kW) + (20*0.3142 kW) = 8.156 KW in the current model is in agreement with the maximum actual heat load of DSCs with damaged FAs [7].

The volumetric heat density $\dddot{Q}$ is calculated assuming all the heat is generated in the active fuel portion of the fuel assemblies. It is calculated using the following formula:

$$\dddot{Q} = \frac{Q * P * 3412 \frac{Btu/hr}{kW} * \frac{hr}{60\,\text{min}}}{W * W * H},$$

Where Q = Heat Load per Fuel Assembly = 0.468 kW, 0.314 kW

P = Peaking Factor = 1.08 [2]

W = Width of the Fuel Compartment = 8.9 inches

H = Height of Active Fuel = 141.8 inches

The decay heat used for four fuel assemblies at the center of the basket is

$$\dddot{Q} = \frac{0.468kW * 1.08 * 3412 \frac{Btu/hr}{kW} * \frac{hr}{60\,\text{min}}}{8.9in^2 * 141.8in} = 0.0026 \frac{Btu}{\text{min}-in^3}.$$

The decay heat used for the remaining fuel assemblies is

$$\dddot{Q} = \frac{0.314kW * 1.08 * 3412 \frac{Btu/hr}{kW} * \frac{hr}{60\,\text{min}}}{8.9in^2 * 141.8in} = 0.0017 \frac{Btu}{\text{min}-in^3}.$$

Based on the DSC model run results, the maximum fuel cladding temperature for DSCs loaded with damaged FAs is 544°F for normal conditions with an ambient temperature of T_{amb} = 70°F.

5.3 Effect on Fuel Oxidation during Vacuum Drying

The currently damaged fuel assemblies were initially classified as "Class C" fuel and therefore were handled normally during loading operations. During pre-vacuum drying operations, the fuel assemblies were exposed to air, an oxidizing atmosphere. Oxidation of fuel pellets from UO_2 to U_3O_8 can propagate preexisting cracks and holes on the fuel cladding [4]. This necessitates the need wherein the vacuum drying process must be completed before the incubation time limit of 100 hrs [3], needed for onset of oxidation within the fuel assemblies. The maximum vacuum drying time for DSCs with damaged fuel is 56.2 hrs [7]. This is within the time limit determined for the onset of oxidation.

6.0 CONCLUSIONS

The maximum fuel cladding temperature for DSCs loaded with damaged FAs and placed in HSM is 544°F. This shows that the fuel cladding temperature remains much below the current allowable limit of 752°F [2] for normal conditions. Hence there is no effect of loading damaged FAs on the maximum fuel cladding temperature of 701°F reported in [1].

A review of the vacuum drying times for canisters with damaged assemblies reveals that maximum duration was 56.2 hrs for FC24P-P10 [7]. This is below the oxidation time limit of 100 hrs calculated in [3]. This shows us that no further propagation of fuel cladding cracks during vacuum drying process occurred.

7.0 LISTING OF COMPUTER FILES

The HEATING run summary, associated files and macros are listed in Table 7-1 and Table 7-2 below. The input, output, database and results files are contained in an optical disc, which accompanies this calculation.

Table 7-1 HEATING7.2 Run Summary

Run Name	Description	Date and Time	OP / CPU
FCHSM70-DAM	Steady-State Analysis of DSC with Damaged Fuel	03/11/08 15:58	MSDOS/ AMD-K6(tm)-2/450 MHz

Table 7-2 Associated Files and Macros

File/Macro	Description
FCHSM70-DAM.OUT	Run Summary
FCHSM70-DAM-PLOT	Unprocessed Output File
FCHSM70-DAM-MAP.TXT	Processed Nodal Temperature File.

Seismic Evaluation:

An evaluation performed by the Sacramento Municipal Utility District (SMUD) at the Rancho Seco Plant determined that some of the fuel assemblies that were loaded in the FO– / FC– DSCs contained cladding defects that were greater than a hairline crack or a pinhole. This evaluation, documented in reference [3], concludes that 5 DSCs out of the 20 loaded FO– /FC– DSC contained such damaged assemblies with one DSC being loaded with a maximum of 2 suspected damaged assemblies. The spent fuel parameters (initial enrichment, burnup and cooling time) of the loaded fuel assemblies and the position of these fuel assemblies within each DSC are described in reference [1] and [2] respectively. This information is utilized to perform a seismic evaluation with bounding representation of the damaged assemblies, as loaded within the FO– / FC– DSC.

The purpose of this evaluation is to determine the effect of loading fuel assemblies with known or suspected cladding defects greater than a pinhole or hairline cracks on the seismic analysis of the NUHOMS®-24P FO– / FC– DSCs. The NUHOMS®-24P FO– / FC– DSCs are designed to be loaded with intact B&W 15x15 fuel assemblies. The NUHOMS®-24P FF– DSC is designed to be loaded with failed B&W 15x15 fuel assemblies.

An earthquake with accelerations of 0.25g in both horizontal directions and 0.17g in the vertical direction is used as the design basis seismic event for the Rancho Seco ISFSI site (Rancho Seco FSAR Volume 1, Section 3.2.3 and NRC SER Section 4.3.1). These accelerations were applied to the loaded DSC and HSM while in the storage mode and the evaluation documented in the Rancho Seco ISFSI FSAR Volume II, Section 8.3.2 showed that they will not tipover (SER Section 15.3.1). The evaluations documented are independent of the condition of the fuel assemblies loaded in these DSCs. Since the DSC in storage conditions will be on the DSC support rails inside the HSM even after the seismic event and the HSM/DSC will not tipover during a seismic event, the seismic evaluation results documented in Rancho Seco FSAR for the NUHOMS®-24P FO– / FC– DSCs loaded with damaged fuel assemblies (one or two assemblies per DSC with limited damaged) in an as loaded configuration is not affected.

REFERENCES

1. Design Input Document - Transnuclear file No. DI-13302-01, "DSC Loading Data," listing the parameters of the Spent Fuel as loaded for each DSC.
2. Design Input Document - Transnuclear file No. DI-13302-02, "Location of Fuel Assemblies in Loaded DSCs," identifying the fuel assembly and its position within each of the loaded DSCs.
3. Design Input Document - Transnuclear file No. DI-13302-03, "Evaluation of Damaged Assemblies," providing details of the extent of damage.