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Monthly Letter Status Report

Reporting Period	January 2003
Name and Address	Organization 6141, Mail Stop 0718 Sandia National Laboratories P. O. Box 5800 Albuquerque, NM 87185-0718
JCN	J5412
Title	Vulnerability Assessments for Transportation and Storage of Radioactive Materials
Principal Investigator	Ken B. Sorenson
Project Period of Performance	March 2002 through September 2004

Technical Progress

Program Review Meeting. NRC staff discussed program status with SNL staff during a series of meetings held at SNL on January 27-30, 2003. On Monday 27 January, Stephanie Bush-Goddard met with the SNL consequence modeling team to discuss consequence modeling issues. On Tuesday and Wednesday, 28 and 29 January, Charles Interrante, Bernie White, Jack Guttman, Stephanie Bush Goddard, and Dave Dancer attended the first meeting of the external review panel for the Source Term Guidance document. On Wednesday afternoon and Thursday 29 and 30 January, Bernie White, Mahendra Shaw, Ron Parkhill, and Robert Shewmaker discussed structural modeling issues with the SNL staff conducting the jetliner impact analyses, and Chris Bajwa and Antonio Dias discussed thermal modeling issues with the SNL staff conducting the jet fuel pool fire analyses. Topics discussed at individual meetings are presented in the topic area summaries presented below.

Discussions of Structural Topics. Before the structural meetings were held, NRC requested that the following topics be covered during their visit on 29 and 30 January:

- A review of the ( ) work and a discussion of how we will proceed and expect to wrap it up.
- An explanation of how we planned to finish the work on the first storage and transportation cask. This was to include a brief explanation/review of all the analyses we have done.
- A discussion of the planned approach on the future casks, particularly the NUMOMS.

The discussion on Wednesday afternoon began with an overview of the ( ) calculations. This included a presentation by Marlin Kipp and was followed by a discussion. During the discussion of these analyses, it was decided that the influence, if any, of cask tie-downs on cask damage should be examined. Next the general status of the analysis of jetliner

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impact onto the HI-STORM and NAC-UMS casks was discussed. Bernie White began these discussions by presenting NRC's picture of the state of the analyses and the work needed to complete this task.

The discussion of jetliner impact analyses continued on Thursday. Jeff Smith gave an informal vu-graph presentation that summarized the global jetliner impact and jetliner hard component calculations that had been performed and the calculations that remained to be completed. On Thursday afternoon, SNL plans for the analysis of the NUHOMS-24P, TN-68, and VSC-24 casks were presented by Greg Bessette, and Dave Stevens of ARA described his preliminary ANSY/LS-DYNA work on the NUHOMS cask. During the ensuing discussions, NRC recommended (1) that SNL proceed to 3D analyses of these casks as rapidly as possible, and (2) that if problems modeling concrete with CTH continued, pressure loads predicted by the CTH calculations be used as input for PRONTO damage calculations for concrete storage casks. Following this discussion most of the NRCstructural staff went to Kenneth Gwinn's office and reviewed the PRONTO analyses of the HI-STORM storage cask.

Jetliner Impact Draft Report. Revision of Section 2 on jetliner impact and Section 3 on jet fuel pool fires in response to NRC comments continued. The new jetliner CTH calculations that were performed at were written up. This writeup will be added to Section 2 of the Jetliner impact report

Global Jetliner Impact Calculations. SAR data for the TN-68, VSC-32, and NUHOMS casks was reviewed to support the development of models of these casks for use in the CTH global jetliner cask crash calculations. An analysis plan for the modeling of the NUHOMS 32P cask was prepared and documented in a set of PowerPoint slides. During the program review meetings, this analysis plan was discussed with NRC staff. During these discussions, application of the approach to the TN-68 and VSC-24casks was also discussed.

Construction of CTH models of the TN-68 and VSC-24 casks was initiated. Work on the Zapotec benchmarking calculation of the ETR drawbar cask air blast test continued.

Plots of cask velocity as a function of time and cask velocity as a function of cask-to-cask separation distances were constructed using the results of the CTH analysis of the jetliner impacting the cask at its top. The velocity for this case is lower than that for direct impact on the side of the cask at its midline. Since jetliner impact is more likely toward the top of the cask, these velocities may be more representative actual cask exit velocities during jetliner attack sabotage scenarios.

Jetliner Component Impact Calculations. The following two PRONTO calculations were completed: and an impact of the landing gear strut onto the of the HI-STORM cask at an attack angle of Modeling using PRONTO of the impact of a jetliner engine onto the HI-STORM cask was begun. The calculation of the damage caused by the impact of a jetliner landing gear strut onto the of the HI-STORM cask was temporarily placed on hold because of contact and material stretching problems encountered when a model of the MPC was added to the calculation. Documentation of the results of the calculations

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completed to date continued. An analysis of the HI-STORM cask canister with its internals represented by a homogeneous lumped mass was performed that examined an impact onto a rigid surface at [redacted] in the [redacted]

Using impact test data from the J79 jet fighter engine tests scaled by the ratio of the mass of a [redacted] to the mass of the J79 engine, a Riera loading function curve (force vs. time data) was developed for use in calculations that examine the impact of a [redacted] onto a spent fuel transport or storage cask. This Riera curve was then used in a finite element analysis that simulated a [redacted] impact on the NAC UMS cask. The cask body was unconstrained (floating in space) and the force from the Riera curve was applied as a time varying pressure over a 28.8 in^2 area at the center of the cask body. Using the force vs. time history from the Riera curve, a hand calculation (spreadsheet) was done to determine the translational and rotational displacement of a HI-STORM over-pack, [redacted]

A finite element analysis was performed using the finite element code PRESTO to determine the rigid body motion of a HI-STORM cask when it is struck by a jetliner engine. The calculation modeled used the jetliner engine as n homogeneous, isotropic, linear elastic steel cylinder. The mass density of the cylinder was adjusted to provide the correct engine weight and the stiffness (Young's Modulus) of the cylinder was increased by a factor of 10 to increase its rigidity. The force from the impacting engine was applied as a pressure load to the [redacted] of the HI-STORM cask [redacted] using the recently developed Riera curve. The initial position of the cask was upright, resting on a rigid plane and the contact between the bottom of the cask and the rigid plane was modeled using a coulomb friction model with a coefficient of friction ranging from 0.0 to 0.3.

Small Plane Survey. As requested by NRC, a spreadsheet containing the distribution of commercial aircraft operating in the United States, was prepared and sent to NRC. The data in the spreadsheet was extracted from the FAA database. In the spreadsheet, the columns contain the aircraft manufacturer and model, series, number of aircraft in each series, total aircraft in all series, percentage of series with respect to entire fleet, and percentage of series with respect to manufacturer model. Totals for each column are provided.

[redacted] **Calculations.** SAR drawings for next casks to be subjected to [redacted] analyses were reviewed. The performance of CTH calculations that examine the response of the NAC-UMS cask to [redacted] using the [redacted] These calculations are using a revised lead material model that is based on the experience gained from the modeling of the GE Drawbar [redacted] test data.

Jet Fuel Pool Fire Calculations. A half symmetry CAFE-P/Thermal model of the HI-STORM cask overpack and the MPC canister was created and run. Two cases were run, one was a fuel pool co-centric with a standing storage cask simulating a fire that fully engulfed the cask for one hour and the second one was a fuel pool adjacent to a standing cask and a 5m/s wind blowing from the side of the fuel pool. This second model was also run for one hour. In addition to the modeling work, some rewriting was done on the thermal section of the document due the end of

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January. Review of the SAR for TN-68 cask continued in order to develop the data (dimensions, thermophysical properties etc) needed to model the thermal behavior of this cask using the P/Thermal code

As requested by Chris Bajwa, a two-dimensional axi-symmetric model of the basket and the HI-STAR cask was modeled in PATRAN/Thermal to corroborate the validity of the homogenized spent-fuel-and-basket model used in the CAFE-P/Thermal fire calculations. The agreement between the temperatures reported in the cask SAR and those obtained from these verification calculations was good. Therefore, the heat transfer results obtained from the CAFE-P/Thermal simulations are believed to be correct. The thermal response of the canister will now be used to assess the thermo-mechanical response of the cask canister to fires.

The following pool fire modeling topics were discussed with NRC staff during their visit to SNL on 29 and 30 January: CAFE-P/Thermal results for the HI-STORM cask, jet fuel pool fire durations, the thermal-mechanical response of storage cask canisters, and comparison of fire temperatures predicted by VULCAN and CAFE.

Calculations. The CTH calculations that modeled a precision attack on a single fuel rod were documented. SCAP code was used to re-run the SCAP calculations that modeled a the NUHOMS cask was rerun with an additional concrete barrier on the outside of the cask. SCAP code input needed to model a sabotage attack that uses a is being developed.

Fission Product Release. The detailed MELCOR model of the NAC UMS cask was completed and a steady state simulation of the cask was performed using the model. The results of this calculation are being compared to data in the NAC UMS SAR.

Development of a FORTRAN model of a volumetric heat source, that could be used to model a thermite sabotage scenario, was begun. Once developed, the model will be used by the MELCOR code, to calculate fission product release and transport during sabotage scenarios that involve large thermal loadings on the cask contents.

Consequence Modeling. Work continued on the development of a calculational methodology for the use of MACCS2 to perform Screening Calculations for SNF sabotage scenarios. Because none of the "off-the-shelf" MACCS2 input files provided suitable cask inventories and release fractions for sabotage scenarios, new data files are being developed. Because it yields a maximum release, an unclassified YMP FEIS transportation sabotage scenario for an attack on a truck cask carrying PWR fuel is being used as a starting point for development of the inventories and release fractions for the Screening Calculations.

The SNL consequence modeling team met with Stephanie Bush-Goddard and discussed issues related to the modeling of the radiological consequences that would be caused by RAM package sabotage scenario source terms. The following issues were discussed:

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calculations envisioned in November have now been completed. However, because the results of these calculations have raised new questions, calculations not envisioned in November are being performed. It is expected that all of the new or revised calculations will be completed by mid. February and that a revised draft of the jetliner crash report covering HI-STORM and NAC-UMS calculations will be sent to NRC at the end of February.

Plans for Next Reporting Period

Work on Tasks 1 through 8 will continue.

Property Acquired

No equipment with a value greater than $500 was purchased during the current month.

Travel

None

Budget Status

The following table presents program costs ($K) by task for the current month and for the fiscal year to date:

Task	Title	Current Month	Fiscal Year to Date
1.1	Jetliner Crash into an ISFSI	221.4	631.1
1.2	Small Plane Crash into an ISFSI	2.9	11.9
1.3	ANSYS/LS-DYNA Jetliner Model	14.6	25.7
1.4	Jetliner Crash into a Spent Fuel Rail Cask	0.0	3.8
1.5	Small Plane Crash into a Spent Fuel Rail Cask	0.0	0.0
1.6	Small Plane Crash into Other Radioactive Material Packages	0.0	0.0
2.0	Weapons, Radioactive Materials, Consequences	79.5	148.4
3.0	Models for Other Spent Fuel Transportation Casks	0.0	1.6
4.0	Models for Other Spent Fuel Storage Casks	12.2	12.2
5.0	Threat Assessment for Sabotage Scenarios Involving Storage Casks	0.0	0.0
6.0	Threat Assessment for Sabotage Scenarios Involving Transportation Casks	10.3	56.8
7.0	Models for Transportation Packages for Other Radioactive Materials	0.0	0.0
8.0	Threat Assessment for Sabotage Scenarios Involving Other Packages	0.0	0.0
	Code Demonstrations	0.0	0.0
	NRC Support	21.5	46.2
	NISAC[a]	0.0	0.2
	TOTAL	362.5	937.8

a. DOE waived this load beginning the month of October 2002; the $0.2 K was incurred the last two days of September.

The financial reporting for this month is based on the 189 submitted at the end of February of 2002. Total FY2002 spending was $1170.1 K. $1741.9 K was carried over into FY2003. $362.5 K was spent during January of FY2003. Total FY2003 spending to date is $937.8 K.