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Monthly Letter Status Report

Reporting Period	November 2002
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 Planning. A computational matrix for the remainder of the program was constructed. Analysts at SNL, ORNL, LANL, and ARA who can perform needed calculations were identified and contacted as to their availability.

Jetliner Impact Draft Report. Revision of Section 2 on jetliner impact and Section 3 on jet fuel pool fires in the first draft of the jetliner impact report in response to NRC comments continued. In particular, a flow chart and a general description of the analysis methodology is being prepared and Section 3 was extensively reorganized.

Task 1.1: Jetliner Crash into an ISFSI.

CTH and Zapotec Analyses. The CTH aircraft impact calculations performed to date can be divided into two groups, an initial sensitivity study and the final analysis. The end goal of the CTH analysis is to analyze the global cask response and provide a set of initial conditions for follow-on, more detailed structural analyses that will assess damage from cask-to-cask interaction. The initial study scoped out the analysis effort and outlined a best approach for modeling the aircraft impact problem. These initial calculations assumed an aircraft impact [ ] The conclusions drawn from the initial study formed the basis for determining model inputs for the final analysis. The final analysis, which considered a reduced set of calculations representing the bottom line, assumed an aircraft impact [ ] This impact velocity is the standard defined for the RAM Package Vulnerability Study. Ex 2 Ex 2

Thin shell structures pose difficulties for CTH analyses. A very fine mesh is required to adequately model the response of shell structures, usually requiring a minimum of 3 to 5 cells across the shell thickness. The run times associated with achieving this mesh resolution are

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impractical. Furthermore, the use of a coarse mesh for modeling a shell structure (or a layered structure such as a steel-lead-steel cask) will generally result in significant over-prediction of the shell deformations since the stiffness cannot be captured. In principal, Zapotec can avoid this problem, because Zapotec calculates the pressure loading on the shell structure from an Eulerian analysis, with the actual shell structure response modeled using conventional Lagrangian finite element methods. In essence, the Eulerian analysis, which does not require a highly resolved mesh to capture the shell structure, provides an external load function for the Lagrangian analysis. The use of Zapotec for blast analyses is currently being investigated.

Zapotec benchmark calculations are also underway in support of the [redacted] recently performed at SNL, which subjected a [redacted] Ex 2

Comparison of Zapotec predictions to the test results shows that Zapotec appears to significantly over-predict the reinforced concrete target deformations. The reasons for the differences between test and analysis are being investigated.

Zapotec analyses for several simple problems are also being run by ARA support staff to gain experience conducting Zapotec analyses and to benchmark the code. To date, ARA has run two problems. The first involves earth penetration and is useful for benchmarking the load application portion of the Zapotec coupling algorithm. The second problem involves modeling two colliding blocks of the same material, which is useful for assessing momentum transfer between colliding bodies. These problems were chosen to exercise various aspects of the code using a much simpler problem setup (as compared with the aircraft impact problem). The earth penetration problem compared well with the test results. The colliding blocks problem shows differences in the momentum transfer between two identical bodies. This discrepancy is being investigated.

Lastly, ARA is also conducting a Zapotec analysis of the global impact of the representative jetliner onto the HI-STORM cask for comparison with the CTH analysis results.

PRONTO Analyses. Performance of additional [redacted] PRONTO impact calculations for the HI-STORM cask continued (3 calculations are underway and 2 more will be run). Ex 2

Several [redacted] PRONTO analyses were conducted to simulate the effect of a landing gear strut impacting a NAC UMS cask. Two strut orientations [redacted] and two boundary conditions for the cask body, unsupported and supported by a rigid unyielding surface, were considered. All but one of these calculations assumed that the yield strength of the steel in the landing gear strut was 300 ksi. Ex 2

The [redacted] was run twice, once with and once without a rigid surface supporting the cask. Neither of these runs generated stresses in the outer steel layer of the cask shell that [redacted] In addition, the exit velocity for the calculation without a supporting surface was so small that cask movement due to strut impact is clearly not of concern (Note that a global jetliner impact calculation might show higher cask-exit velocities, since the impact energy would no longer be so localized). Because the 300

Portions Ex 2

ksi yield strength for the steel in the landing gear strut used in these calculation is so high that the strut does not deform on impact, the [redacted] without a supporting surface was repeated assuming that the yield strength of the steel in the landing gear strut was 50 ksi. This change caused the end of the strut to deform significantly on impact with the cask, which decreases the energy available to deform the cask and increases the volume of cask steel that absorbs this deformation energy.

Two [redacted] were run. Both calculations assumed that the cask was supported by a rigid surface. When the first calculation predicted large strains in the outer steel layer of the cask shell, the calculation was repeated adding an element death criteria based on equivalent plastic strain. Using a very conservative limit of 0.60 for the allowed plastic strain, the results of this calculation confirmed that the [redacted] of the cask shell [redacted]

Results from these analyses will be included in the December draft of the vulnerability study jetliner impact report.

Boeing Contract. No Work done this month.

Jet Fuel Fire Modeling. Documentation of the VULCAN calculations that examined a windblown fire that partially engulfs the HI-STORM cask was begun.

Cask Response to Thermal Loads. No Work done this month.

Fission Product Transport. The preliminary NAC UMS MELCOR input model was reviewed by a non-Sandia MELCOR expert. The review identified several code problems that need to be addressed in order to model fission product release from this cask. First, the MELCOR core model treats thermal release of fission products due to core melting and release driven by the oxidation of Zircaloy but it doesn't treat release from spent fuel rods failed by mechanical loads (i.e., release caused by rod blowdown). Second, the PWR core model can not treat fuel tubes and the BWR core model needs steel material properties to model a steel fuel tube. Third, the BWR core model can't conduct heat from the fuel tubes to the cask canister as is done in the NAC UMS cask by the aluminum heat transfer discs. These problems will be discussed further at a meeting to be held in early November.

Consequence Modeling. Work continued in three areas: (1) development of a method for analyzing the close-in (< 500 m) dispersion and deposition of radioactive particulates; (2) development of modifications to the Chanin and Murfin methodology for the estimation of the economic costs of sabotage events; and (3) implementation into MACCS2 of the SNF radionuclide set used in the Yucca Mountain FEIS (instead of the full-power non-aged accident inventories of NUREG-1150 that are the radionuclide set normally used with MACCS2).

Task 1.2: Small Plane Crash into an ISFSI.

Small Plane Survey. No work done this month.

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completed during December. After these results are added to the second draft of the report that will be submitted before the end of December, a third draft will need to be written that responds NRC comments on the second draft. If this third draft is sent to NRC in mid January, a final draft that has been revised by a technical editor and that reflects NRC comments on the third draft should be completed sometime during February of 2003.

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	169.5	298.9
1.2	Small Plane Crash into an ISFSI	1.2	9.0
1.3	ANSYS/LS-DYNA Jetliner Model	10.6	11.0
1.4	Jetliner Crash into a Spent Fuel Rail Cask	3.8	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	23.2	49.1
3.0	Models for Other Spent Fuel Transportation Casks	0.8	0.8
4.0	Models for Other Spent Fuel Storage Casks	0.0	0.0
5.0	Threat Assessment for Sabotage Scenarios Involving Storage Casks	0.0	0.0
6.0	Threat Assessment for Sabotage Scenarios Involving Transportation Casks	24.3	41.6
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	13.1	17.3
	NISAC[a]	0.0	0.2
	DOE Added Factor [b]	0.0	0.0
	TOTAL	246.5	431.6

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

b. DOE waived this load beginning the month of May 2002.