9/10/02

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Monthly Letter Status Report

Reporting Period	July 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 Review Meeting. NRC staff reviewed the RAM package vulnerability study during a two-day meeting held at SNL on 14-15 August 2002. The agenda for this meeting is attached to this monthly report.

Task 1.1: Jetliner Crash into an ISFSI.

CTH and Zapotec Analyses. Approaches that could be used in CTH to model friction between the Hi-Storm cask and the concrete pad on which it rests were examined and discussed. Possible approaches include bounding the effects of friction by performing a calculation without the pad and a second calculation that uses a pad of infinite extent. An alternative approach involves selection of material properties for the pad that prevent the pad from rotating with the cask as the cask starts to tip over (e.g., arbitrary assignment of a very high density and a low fracture strength to the pad material). Writing of the report sections that will describe the CTH calculations that examine the impact of a large jetliner onto the Hi-Storm cask was begun."

PRONTO Analyses. Work continued on the full 3-D representation of the Hi-Storm cask that is needed to support the modeling of the [redacted] of the front landing gear strut onto the [redacted], and (2) a [redacted] of the landing gear strut onto the cask lid. Incorporation of the contents of the Hi-Storm cask's canister into the PRONTO model of the cask continued. When completed the canister model will allow the resistance to overpack collapse during impact accidents to be treated during the PRONTO calculations. Ex 2

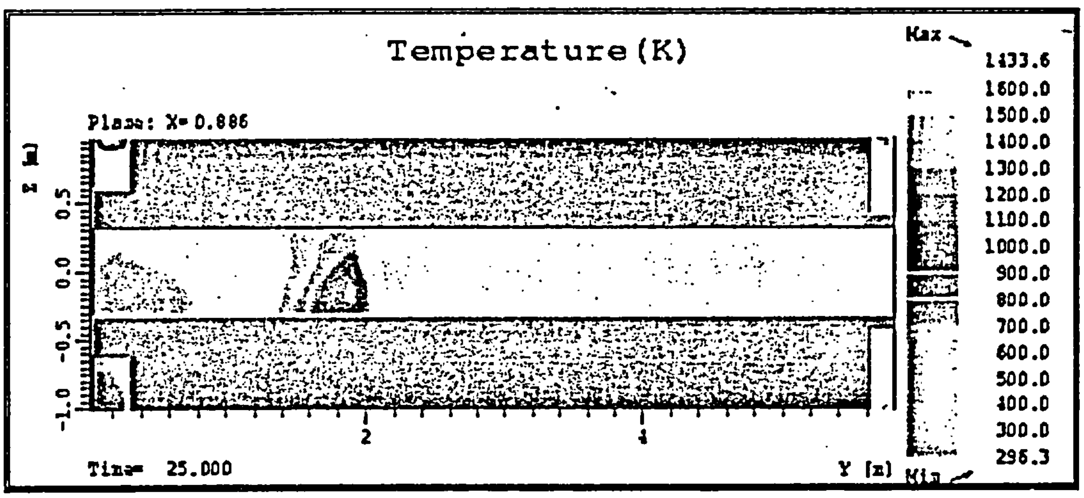
Boeing Contract. Boeing, NRC, and SNL lawyers discussed the coverage afforded to Boeing by the Price-Anderson Act. As a result of these discussions, Boeing suggested that several

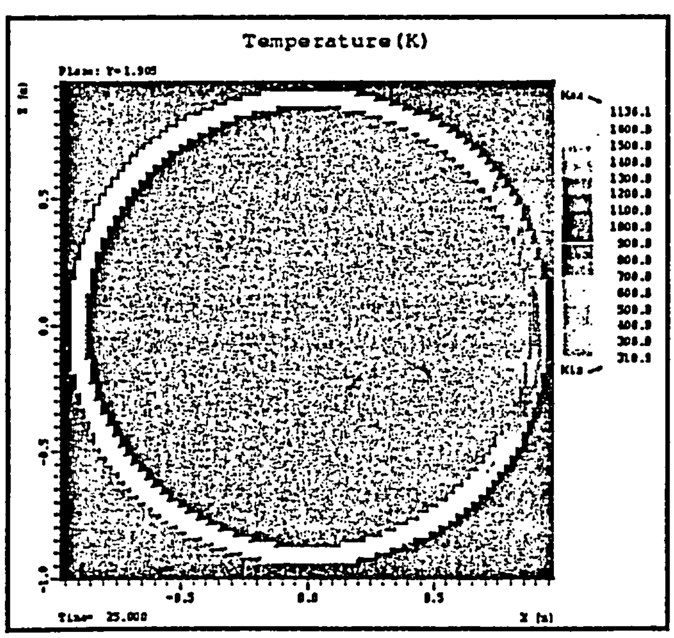
Portions Ex 2

changes be made to the proposed SNL contract with Boeing. These changes were made and the revised contract was sent to Boeing for review.

Computational Support. ARA contractor personnel completed their comparison of [redacted] predictions to CTH predictions. The comparisons showed that CTH and [redacted] predictions agree well so long as they are made in the physical regime where the [redacted] code is intended to be used. Ex2

Jet Fuel Fire Modeling. The three-dimensional, quarter symmetry Vulcan CFD code calculation that models a JP8 jet fuel fire that partially engulfs a Hi-Storm storage cask lying on its side were continued. This calculation changes the orientation in the fire of the Hi-Storm cask from vertical to lying on its side (tipped over) with the four vent paths in the cask oriented at [redacted] to the ground which should promote maximum buoyant flow of gases through the channels that connect these vents. The following two figures show results at 25 seconds. Ex2





 Portions Ex2

The first figure presents a temperature map for a vertical slice through the cask that cuts through four of the eight vents and also through a portion of the channel that connects these vents (note that this slice does not lie on a cask diameter). The second figure is a slice through the cask at 1.9 m from the end of the cask that is engulfed in the fire (the left end of the cask in the first figure). The figures show that the maximum temperatures attained inside the channels at 25 seconds range from about 1200 - 1500 K. They also show that these temperatures are highly localized (do not occur uniformly throughout the vent channels).

The maximum vent channel temperatures shown in these figures are significantly higher than the maximum vent channel temperatures obtained for the fully engulfed cask. The higher temperatures are caused by air flow into the vent channels through the vents that are not engulfed by the fire. Entry of air into the channels allows the excess fuel in the channels to burn which releases heat and thus causes vent channel temperatures to rise significantly. Inspection of the time dependence of these vent channel temperatures shows that the maximum temperature region migrates through the vent channel like a wave front. This temperature front corresponds to the interface between the fuel and the oxygen. As time progresses, the temperature front begins to settle midway through the duct, which may indicate that steady state flow inside the duct is being attained.

Finally, because we are only using three cells across the vent channel gap, it is possible that we are not resolving the fuel-air mixing in the vent channels as well as we would. This grid limitation may explain why we are seeing highly localized temperature maximums strictly at the interface between the air and the fuel fronts. This may mean that the current calculation is over estimating the temperatures in these regions.

Cask Response to Thermal Loads. A series of quasi-static analyses were conducted of the Hi-Star canister using the finite element code ABAQUS. The canister is subjected to an internal pressure, which results from a change in the canister temperature. In each analysis the canister is assumed to be at the specified temperature. The pressure inside the canister is increased slowly to the maximum pressure corresponding to the assumed temperature. This is done to account for the path dependency of the plastic deformation of the canister shell. The canister was modeled in three different positions: outside the over-pack, partially outside the over-pack, and inside the over-pack. Table 1 lists the temperatures and positions used for these calculations.

Table 1. ABAQUS analysis of Hi-Star Canister

Temperature (°C)	Canister Position
1000	Outside over-pack
1000	One quarter of canister outside over-pack
1000	Inside over-pack
800	Inside over-pack
600	Inside over-pack

The results of these calculations are still being analyzed. A complete analysis will be presented in the Interim Report of 9/30/02.

Fission Product Transport.

The MELCOR input model for the NAC canister was modified to allow the opening of one or two flow paths at the time when cask containment is lost due to a sabotage attack. This modification will allow sabotage scenarios that lead to loss of cask containment without substantially changing the surface-to-volume ratios of cask interior spaces to be easily modeled. This modified model was then used to examine the impact of hole size (leakage path cross-sectional area) on fission product release. During the performance of these calculations, both the default MELCOR $Zr\text{-}O_2$ oxidation correlations and a new set of low-temperature correlations were used.

Consequence Modeling. The review of the implementation of the Mills pool fire plume rise model in MACCS was completed. The review did not find any coding errors. Testing of the model as implemented in MACCS showed that the model tracks available plume rise data closely, especially near-field data. The results of the calculations that compared plume rise for pool fire plumes to various pool fire models were discussed with Steve Hanna of the Harvard School of Public Medicine, who is a plume rise expert, with Mike Mills, the author of the Mills pool fire model, and with Keven McGrattan, the author of the NIST report on plume rise from pool fires. Steve Hanna recommended that the Briggs treatment of final plume height for rise under unstable atmospheric conditions be used in MACCS. Mike Mills concurred with this suggestion. Kevin McGrattan indicated how atmospheric lapse rate should be input to the NIST model. Also, at the suggestion of Steve Hanna, plume rise models were compared to French field test data taken in the early 70's, which measured plume rise from a circular grid of burners that had a diameter of about 72 m. Because these burners were positioned about one meter above the ground, each burner probably functioned as a point source. Thus, the behavior of the melding of all of these individual burner plumes is well modeled using the Briggs point source plume rise model.

The two 1999 cleanup cost reports obtained last month were studied to determine if there was any need to modify the methods outlined in Chanin and Murfin (1996) and SAND96-0957 for the estimation of cleanup costs for ground contaminated by radioactive materials. Review of these two reports did not identify any need to modify the methods developed previously. Therefore those methods will be used to estimate cleanup costs for sabotage scenarios.

Task 1.2: Small Plane Crash into an ISFSI.

Small Plane Survey. No work done this month.

Task 1.3: ANSYS/LS-DYNA Jetliner Model. No work done this month.

Task 1.4: Jetliner Crash into a Spent Fuel Rail Cask. No work done this month.

Task 1.5: Small Plane Crash into a Spent Fuel Rail Cask. No work done this month.

Task 1.6: Small Plane Crash into Other Radioactive Material Packages. No work done this month.

computer. Moreover, since almost all SNL PRONTO analysts are already working on NRC vulnerability studies, deployment of additional SNL resources able to perform the needed finite element calculations may not be possible soon enough to allow the needed work to be completed by the end of October at the latest.

Plans for Next Reporting Period

Work on Tasks 1 through 8 will continue.

Property Acquired

No equipemt 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	158.2	551.9
1.2	Small Plane Crash into an ISFSI	11.9	30.2
1.3	ANSYS/LS-DYNA Jetliner Model	8.0	101.1
1.4	Jetliner Crash into a Spent Fuel Rail Cask	0.0	0.0
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	8.5	60.1
3.0	Models for Other Spent Fuel Transportation Casks	0.0	0.7
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	39.9	63.8
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	23.6	123.2
	NISAC	11.2	33.1
	DOE Added Factor [a]	0.0	4.8
	TOTAL	261.2	968.8

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

The financial reporting for this month is based on the 189 submitted at the end of February of 2002. $261.2 K was spent during August of FY2002. Total FY2002 spending to date is $968.8 K.