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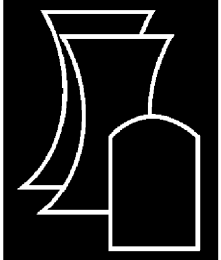

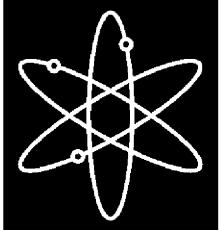

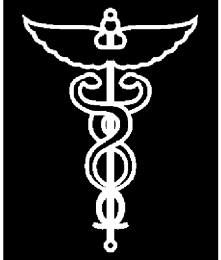

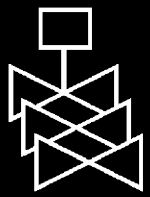

Spent Fuel Transportation Package Response to the Baltimore Tunnel Fire Scenario

Final Report

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Spent Fuel Transportation Package Response to the Baltimore Tunnel Fire Scenario

Final Report

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ABSTRACT

On July 18, 2001, a freight train carrying hazardous (non-nuclear) materials derailed and caught fire while passing through the Howard Street railroad tunnel in downtown Baltimore, Maryland. The United States Nuclear Regulatory Commission (USNRC), one of the agencies responsible for ensuring the safe transportation of radioactive materials in the United States, undertook an investigation of the train derailment and fire to determine the possible regulatory implications of this particular event for the transportation of spent nuclear fuel by railroad.

The USNRC met with the National Transportation Safety Board (NTSB) to discuss the details of the accident and the ensuing fire. Following these discussions, the USNRC assembled a team of experts from the National Institute of Standards and Technology (NIST), the Center for Nuclear Waste Regulatory Analyses (CNWRA), and Pacific Northwest National Laboratory (PNNL) to determine the thermal conditions that existed in the Howard Street tunnel fire and analyze the potential effects of those conditions on various spent nuclear fuel transportation package designs.

The Fire Dynamics Simulator (FDS) code developed by NIST was used to determine the thermal environment in the Howard Street tunnel during the fire. The FDS results were used as boundary conditions for the COBRA-SFS and ANSYS® computer models developed to evaluate the thermal performance of different package designs. The staff concluded that larger transportation packages resembling the TransNuclear Model No. TN-68 and HOLTEC Model No. HI-STAR 100 would withstand a fire with thermal conditions similar to those that existed in the Baltimore tunnel fire event with only minor damage to peripheral components. This is due to their sizable thermal inertia and design specifications in compliance with currently imposed regulatory requirements.

For the TN-68 and the NAC International Model No. LWT (legal weight truck) transportation package, the maximum temperatures predicted in the regions of the lid and the vent and drain ports exceed the seals' rated service temperatures, making it possible for a small release to occur, due to CRUD that might spall off the surfaces of the fuel rods. While a release is not expected to occur for these conditions, any release that could occur would be very small due to a number of factors. These include (1) the tight clearances maintained between the lid and cask body by the closure bolts, (2) the low pressure differential between the package interior and exterior, (3) the tendency of such small clearances to plug, and (4) the tendency of CRUD particles to settle or plate out.

USNRC staff evaluated the radiological con-sequences of the package responses to the Baltimore tunnel fire. The analysis indicates that the regulatory dose rate limits specified in 10 CFR 71.51 for accident conditions would not be exceeded by releases or direct radiation from any of these packages in this fire scenario. All three packages are designed to maintain regulatory dose rate limits even with a complete loss of neutron shielding (as documented in their respective SAR analyses.) While highly unlikely, the NAC LWT could experience some decrease in gamma shielding due to slump in the lead as a consequence of this fire scenario, but a conservative analysis shows that the regulatory dose rate limits would not be exceeded.

The results of this evaluation also strongly indicate that neither spent nuclear fuel (SNF) particles nor fission products would be released from a spent fuel transportation package carrying intact spent fuel involved in a severe tunnel fire such as the Baltimore tunnel fire. None of the three package designs analyzed for the Baltimore tunnel fire scenario (TN-68, HI-STAR 100, and NAC LWT) experienced internal temperatures that would result in rupture of the fuel cladding. Therefore, radioactive material (i.e., SNF particles or fission products) would be retained within the fuel rods.

There would be no release from the HI-STAR 100, because the inner welded canister remains leak tight. While a release is unlikely, the potential releases calculated for the TN-68 rail package and the NAC LWT truck package indicate that any release of CRUD from either package would be very small - less than an A_2 quantity (see Section 8.2.)

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FIGURES

TABLES

APPENDICES

ABBREVIATIONS

APDL	ANSYS® Parametric Design Language
BTF	Baltimore Tunnel Fire
BWR	Boiling Water Reactor
CFD	Computational Fluid Dynamics
CoC	Certificate of Compliance
CNWRA	Center for Nuclear Waste Regulatory Analyses
CRUD	Chalk River Unknown Deposit (generic term for various residues deposited on fuel rod surfaces, originally coined by Atomic Energy of Canada, Ltd. (AECL) to describe deposits observed on fuel removed from the test reactor at Chalk River.)
DOT	Department of Transportation
FDS	Fire Dynamics Simulator (computational fluid dynamics computer code)
FEA	Finite Element Analysis
HLW	High Level Waste
IAEA	International Atomic Energy Agency
ISO	International Organization for Standardization (The International Organization for Standardization has decreed the use of the initials ISO for reference to the organization, regardless of the word order of the organization's name in any given language. This defines a uniform acronym in all languages.)
MPC	Multi-Purpose Canister
NIST	National Institute of Standards and Technology
NTSB	National Transportation Safety Board
OFA	Optimized Fuel Assembly
PB	Personnel Barrier
PNNL	Pacific Northwest National Laboratory

PWR	Pressurized Water Reactor
SFPO	USNRC Spent Fuel Project Office
SNF	Spent nuclear fuel
USNRC	United States Nuclear Regulatory Commission