SPENT FUEL INTEGRITY ANALYSIS IN TRANSPORTATION CASKS, PROVIDED BY STRUCTURAL INTEGRITY ASSOCIATES

CLASSROOM INSTRUCTORS

Dr. Joe Rashid, P.E.

Accreditations/Industry Leadership:

- Society membership: ASME Fellow, ANS, ASTM Committee 26.13, and MRS
- P.E. Nuclear
- Received ASME Service Award in 1990
- Appointed by the NRC to serve on the Expert Elicitation Panel for NUREG-1150

Background:

- Dr. Joe Rashid, P.E.Ph.D, M.S., and B.S. Engineering Mechanics, University of California, Berkeley) has over 45 years of experience in the fields of computational mechanics, nuclear fuel technology, and materials behavioral modeling and failure analysis. He has authored over 100 journal articles and conference papers in these fields. His work includes modeling and simulation of LWR fuel behavior under normal operations and design basis accidents, spent fuel dry storage and transportation evaluations, and safety analysis of nuclear power plant structures under beyond-design-basis loading, including aircraft impact. He has served on a number of expert panels and peer review committees dealing with severe reactor accidents and aging and degradation of nuclear plant structures. (See page 3 for highlights of information related to his Accreditations/Industry Leadership).

CONTACT INFORMATION

Joe Rashid
Shane A. McManus

jrashid@structint.com
smcmanus@structint.com

(619) 354-5600
(303) 542-1426

INTENDED AUDIENCE

Licensed Senior Reactor Operators, nuclear engineering staff, fuel handling staff and individuals involved with spent fuel storage who seek better understanding of spent fuel storage integrity issues.

TYPE

Classroom Training

DURATION

One day (7 PDH)

LEARNING OBJECTIVES

Cladding failures, with the potential for reconfiguration of the cask's fuel contents to a critical geometry, in combination with water in-leakage to optimum-moderation levels, has raised the specter of criticality for spent fuel transportation.

Spent fuel casks must comply with NRC's licensing requirements of 10 CFR Part 71 for transportation and handling, which are governed by two drop events: a 9-meter drop of a cask protected by impact limiters and a 0.3-meter drop of a bare cask onto a flat, essentially unyielding, horizontal surface where the cask strikes the surface in a position for which maximum damage is expected.

This course focuses on the evaluation of spent fuel conditions under long-term dry storage and hypothetical transportation accidents. Topics include the evaluation of fuel rods/cladding damage mechanisms and damage states during dry storage, and use of these damage states as initial conditions for detailed dynamic impact analysis and failure evaluation of cask/fuel rods under the transportation conditions.

The behavior of high-burnup spent fuel during long-term dry storage and subsequent transportation has been the subject of research and evaluation at EPRI for many years. We have played a significant role in supporting these R&D efforts. Through this course, participants will gain an improved understanding of potential challenges to the integrity of spent fuel stored in transportation casks as well as the evaluation methods that are used to address these challenges.

Topics Covered:

- Regulatory requirements for spent fuel casks
- Concepts in drop analysis with regards to the cask and the fuel contained in the casks
- Impact of water ingress and its impact on potential fuel inside the cask

KEY INDUSTRY DOCUMENTS

1. 10 CFR, Part 71: Packaging and Transportation of Radioactive Materials
   I. 71.71: Normal conditions of Transport
   II. 71.73: Hypothetical accident conditions
2. 10 CFR, Part 72: Licensing requirements for the independent storage of spent nuclear fuel, high-level radioactive waste, and reactor-related greater than Class C waste
   I. 72.128: Criteria for spent nuclear fuel, high-level radioactive waste, and reactor-related greater than Class C waste and other radioactive waste storage and handling
3. ISG-11 REV3, Interim Staff Guidance 11, Revision 3 "Cladding Considerations for the Transportation and Storage of Spent Fuel" (NRC 2003)
4. RIS-2015-XX: NRC DRAFT REGULATORY ISSUE SUMMARY 2015-XX CONSIDERATIONS IN LICENSING1 HIGH BURNUP SPENT FUEL IN DRY STORAGE AND TRANSPORTATION
5. SAND90-2406: Sanders, T. L, Seager, K. D., Rashid, Y. R., et al., "A Method for Determining the Spent-Fuel Contribution to Transport Cask Containment Requirements," SANDIA Report, SAND90-2406, TTC-1019, UC-820, November 1992
6. "Fuel Assembly Database System (FADB)," Oak Ridge National Laboratory for U.S. Department of Energy, Office of Civilian Radioactive Waste Management (OCRWM), July 1992
7. ASTM STP 1295: Kammenzind, Bruce F., et al., "Hydrogen Pickup and Redistribution in Alpha-Annealed Zircaloy-4," Zirconium in the Nuclear Industry"
8. Spent Fuel Reports – EPRI Spent Fuel Program:
   - 1001207, December 2000: "Creep as the Limiting Mechanism for Spent Fuel Dry Storage"
   - 1001281, January 2001: "Fracture Toughness Data for Zirconium Alloys – Application to Spent Fuel Cladding in Dry Storage"
   - 1003135, November 20001: "Creep Modeling and Analysis Methodology for Spent Fuel in Dry Storage"
   - 1009276, Dry Storage of High-Burnup Spent Fuel – Responses to Nuclear Regulatory Commission Request for Additional Information and Clarification, November 2003
   - 1009694, June 2004: "Development of a Metal/Hydride Mixture Model for Zircaloy Cladding with Mixed Hydride Structure"
   - 1009693, December 2004: "Failure Criteria for Zircaloy Cladding Using a Damage-based Metal/Hydride Mixture Model"
   - 1009929, June 2005: "Spent Fuel Transportation Applications: Fuel Rod Failure Evaluation under Simulated Cask Side Drop Conditions"
   - 1011816, September 2005: "Application of Critical Strain Energy Density to Predicting High-Burnup Fuel Rod Failure, Response to Comments from the Nuclear Regulatory Commission Staff"
   - 1011817, December 2005: "Spent Fuel Transportation Applications: Global Forces Acting on Spent Fuel Rods and Deformation Patterns Resulting from Transportation Accidents"
   - 1013447, October 2006: Report 1009694, June 2004: "Spent-Fuel Transportation Applications: Modeling of Spent-Fuel Rod Transverse Tearing and Rod Breakage Resulting from Transportation Accidents"
   - 1013448, December 2006: "Spent Fuel Transportation Applications: Longitudinal Tearing Resulting from Transportation Accidents – A Probabilistic Treatment"
   - 1015049, June 2007: "Spent-Fuel Transportation Applications – Normal Conditions of Transport"
   - 1015048, December 2007: "Spent Fuel Transportation Applications – Assessment of Cladding Performance, A Synthesis Report"