

Reasons for Conducting a Spent Fuel Transportation Risk Assessment Aug. 20, 2009

Doug Ammerman



Goals

- **Background: role, mission, issues & considerations?**
 - NRC's safety & outreach responsibilities
 - Continuing review
 - Potential shipments
 - Safety not at issue
- **Purpose: how will it be used?**
 - Solicit and respond to public comment
 - Answer 6672-related questions
 - Provide updated benchmark for environmental assessments
 - Explain level of safety in spent fuel transport
- **Objective: outcome?**
 - Publish as a NUREG (not NUREG/CR)
 - Further quantify consequences and probabilities of severe accidents
 - Provides current information for: public, media, industry, States, NRC and other federal agencies





What it Isn't

- It is a risk study, not a safety study
 - Greater attempt to use central estimates (e.g., material properties) instead of conservative/bounding values
 - Must consider very low probability events
- It is an accident study, not a vulnerability study
 - Purposeful malevolent attacks are not considered



Report Layout

- Three levels of detail
 - Public summary: ~8 pages
 - Body of report: includes method, data, and results
 - Appendices: provides technical detail
- Outline
 - Introduction
 - Incident free transport
 - Transport accidents
 - Impacts
 - Fires
 - Source term
 - Consequences
 - Conclusions

What was NUREG/CR-6672?

- Reexamination of spent fuel shipment risks
 - Incident-free shipment risks
 - Severe accident risks
- Used Modal Study severe accident analysis methods where possible
 - Accident probabilities from event trees, speed and fire duration distributions
 - Cask impact response by finite element calculations
 - Cask thermal response by heat transport calculations
 - Source terms from Lorenz experimental results
- Compared new risk estimates to those published in NUREG-0170, NRC's RAM transport EIS

Comparison of Study Methodologies

	EIS NUREG-0170	Modal Study NUREG/CR-4829	NUREG/CR-6672
Severity Fractions	Expert Judgement	Event Trees	Event Trees
Cask Closure and Fuel Rod Severe Accident Response	Not Modeled	Inferred from shell response	Modeled
Fission Product Transport Rod-to-Cask Deposition in cask	Not Modeled	Lorenz data Neglected	Lorenz data Transport Calc.
Source Terms	Expert Judgement	Calculated	Calculated
Routes	2 Generic	Not Examined	200 Generic, 4 real
Consequences Incident-Free Accident	RADTRAN1 Population Dose LCFs	Not Calculated	RADTRAN5 Population Dose Population Dose



Scope of NUREG/CR-6672

- Two Transportation Modes: Truck, Rail
- Four Spent Fuel Casks
 - Steel-Lead-Steel Truck
 - Steel-Lead-Steel Rail
 - Steel-DU-Steel Truck
 - Monolithic Steel Rail
- Two Reactor Fuels: PWR, BWR
- Present results mainly for PWR spent fuel transported by rail in a steel-lead-steel rail cask

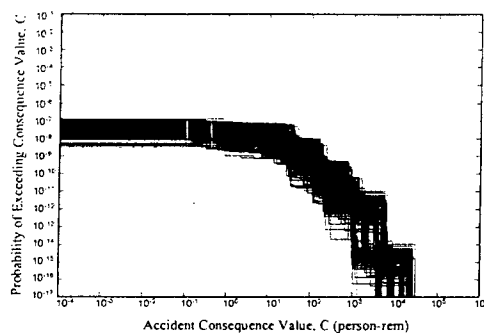


Source Term

- Assumed 5-yr cooled high-burnup spent fuel
- Calculated both rod-to-cask release fraction and cask-to-environment release fraction
 - Gases
 - Volatiles
 - Particulates
 - CRUD

Risk Analysis

- Distributed many of the environmental factors
- Used Latin Hypercube Sampling
- Produced "horse-tail" plots for CCDFs



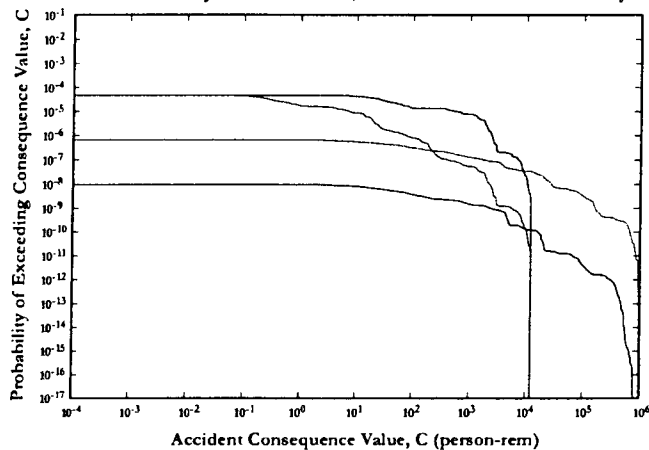
LOCKHEED MARTIN

9



Comparison of Results

Rail Accident Population Dose CCDFs
 NUREG-0170 Model I and Model II Source Terms
 Model Study Source Terms, Source Terms for this Study



LOCKHEED MARTIN

10



Comparison of Results (cont.)

**Mean Accident and Incident-Free Shipment
Population Dose Risks (person-rem)
for the Steel-Lead-Steel Rail Cask
24 PWR Assemblies, 200 Generic Routes**

Study	Accident Risk	Incident-Free Shipment Risk
NUREG-0170 Model I	1.9×10^{-2}	3.2×10^{-2}
Modal Study	1.9×10^{-3}	Not calculated
NUREG-0170 Model II	4.9×10^{-4}	3.2×10^{-2}
NUREG/CR-6672	9.4×10^{-6}	2.0×10^{-2}

CONCLUSIONS of NUREG/CR-6672

- The examinations of cask response performed by the Modal Study and this study both show that only the most severe rail accidents can cause release
- NUREG-0170 Model I Accident Dose Risks are about 10 times larger than those predicted using Modal Study accident source terms and about 1000 times larger than those predicted using the source terms developed by this study
- NUREG-0170 Incident-Free Shipment Doses are slightly larger than those predicted by this study
- Similar results were obtained for BWR fuels, transport by truck, and other casks
- Therefore the validity of the NUREG-0170 incident-free shipment risk estimates are confirmed and the NUREG-0170 accident risk estimates are shown to be very conservative