SAND2007-6473P

Mitigation of Nuclear Transport Sabotage

Richard H. Yoshimura
Robert E. Luna (Consultant)

Sandia National Laboratories
Albuquerque, New Mexico

DOE-IRSN Permanent Coordinating Group (PCG)
Annual Meeting on International Safeguards and Physical Protection

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company,
for the United States Department of Energy's National Nuclear Security Administration
under contract DE-AC04-94AL85000.

Outline

- Introduction
- IRSN Proposal
- Proposal Details
- US Response to Proposal
  - Phase 1
  - Phase 2
  - Phase 3
  - Phase 4
- Summary

Sandia National Laboratories

Introduction

- **The French IRSN and the US NNSA/Sandia National Laboratories have a mutual interest to mitigate the consequences of sabotage against nuclear/radioactive materials in transport.**
- **IRSN has an active program for the study of the consequences of sabotage of nuclear material transport.**
- **Based upon experiments and computer models, IRSN has developed a systematic approach for evaluation of the consequences of high-energy-density device (HEDD) weapon attack against transport casks with spent fuel.**

Sandia National Laboratories

IRSN Proposal

Based on its experience and mutual NNSA interest, IRSN has proposed a joint IRSN/NNSA program with the following objectives:

- **Define sabotage scenarios when based on potential consequences higher than common protective measures are needed;**
- **Identify possible additional protective measures;**
- **Evaluate the consequences of sabotage in order to identify mitigation requirements.**

Sandia National Laboratories

Proposal Details

Jointly with NNSA expand IRSN's experience into technical solutions to prevent and/or mitigate the consequences of sabotage of transport casks.

- **Phase 1 – IRSN and NNSA review and inventory known means of sabotage prevention/mitigation.**
- **Phase 2 – Review IRSN consequence evaluation approach and results of Phase 1 to identify new approaches for prevention and mitigation.**

Sandia National Laboratories

Proposal Details - Continued

- **Phase 3 – IRSN/NNSA jointly select potential attack modes and potential protective/mitigation measures.**
- **Phase 4 – IRSN/NNSA jointly define and each conduct a computer simulation/parametric study to evaluate one or more of the protection/mitigation approaches identified in Phase 3.**

Sandia National Laboratories

US Response to Proposal

- **Shipments in the US are similar to France, but in different proportions.**
- **France has a well-developed nuclear power and recycling program, so it has more experience and material.**
- **Both countries have similar interests in protecting nuclear material during transport and in mitigation of the consequences of a successful attack.**
- **Both US and France have similar transport regulations and transport casks, therefore, the study results should have application for both countries.**

Sandia National Laboratories

US Response - Phase 1

Survey of existing work

- **For the most productive results from a joint program, we believe that appropriate focus is needed on shipments that:**
  - **would present greatest potential for adverse consequences, and**
  - **be vulnerable to attack modes that are most easily staged and executed.**
- **We propose that preliminary screening should focus on three factors:**
  - **Target materials and transport packages**
  - **Attack mode**
  - **Potential consequences**
- **We recommend that the survey of existing work guide the effort.**

Sandia National Laboratories

US Response - Phase 2

Methodology for Evaluation of Consequences

NNSA/SNL will review and comment on IRSN's Phase 2 Report. SNL's experience in consequence evaluation includes

- **HEDD Scenarios**
  - **Empirical models based on SNL and German (GRS) SNF experiments.**
  - **Semi-analytical methods have been pursued using CTH and MACCS codes.**
  - **Fully analytical models are needed, but suitable parameterization of effects within the cask are lacking.**

Sandia National Laboratories

US Response - Phase 2 (cont'd)
Methodology for Evaluation of Consequences

- **HE Attack Modes**
  - **Finite element models of cask response to bulk HE have been performed.**
  - **Breaching charge effects have been assessed by empirical methods and by CTH; particulate generation mechanisms need investigation.**
- **Capture and Process Modes**
  - **Preliminary, but speculative analysis, completed.**

Sandia National Laboratories

US Overview - Phase 3

Selection of attack modes & mitigation measures

- **Attack modes can have a relatively broad spectrum**
  - **Stand-off Attacks**
  - **Blast**
  - **Theft for Sabotage at Another Site (varies in complexity and needed technology; likelihood of success should be evaluated)**
- **Potential consequences can be evaluated based upon quantity, physical and chemical form (defined by number of A_2s in package).**
- **Proposed mitigation measures to be based on potential consequences.**

Sandia National Laboratories

US Overview - Phase 4

Evaluation of proposed protective/mitigation measures

- **IRSN and NNSA jointly select protective and mitigation measures for computer evaluation of effectiveness.**
- **Jointly conduct effectiveness analysis of certain protective/mitigation measures using**
  - **Parametric studies**
  - **Numerical simulation**

Sandia National Laboratories

Summary

- **France and the US have a common interest in mitigating the consequences of the sabotage of nuclear material during transport;**
- **IRSN has proposed a joint project with NNSA to:**
  - **Define sabotage scenarios where based on potential consequences higher than common protective measures are needed;**
  - **Identify possible additional protective measures;**
  - **Evaluate the consequences of sabotage in order to identify mitigation requirements.**

Sandia National Laboratories

Summary (cont'd)

- **The US welcomes the IRSN proposal and an opportunity to engage in a cooperative effort to reduce the risk of sabotage of nuclear material in transport.**
- **NNSA/Sandia National Laboratories have studied the IRSN proposal and propose a Common Program of Work that defines tasks, who is responsible for the tasks and deliverables.**
- **We welcome discussion of and agreement on the proposed Common Program of Work.**

Sandia National Laboratories

Common Program of Work

Phase	Program	Deliverable	Duration (Months)
1	Each participant will construct an inventory of potential attack methods and related means of mitigation, in particular those having been the subject of tests and have possible application to the case of transport casks.	Synthesis Report by Each Participant	4 Total
	• NNSA/SNL will provide a literature study and construct an inventory of potential attack and mitigative measures.	Survey Table	1.5
	• NNSA/SNL will screen the inventory of potential attack modes using a risk-based tool to identify the more important potential threats either by likelihood and by consequence.	Ranking by Highest Risk	1.5
	• NNSA/SNL will prepare a report on this aspect of the study.	Report Preparation	1

Sandia National Laboratories

Common Program of Work

Phase	Program	Deliverable	Duration (Months)
2	IRSN will publish a report that provides IRSN's approach to evaluating consequences, or any known method, to evaluate new methods of mitigation.		1 Total
	• NNSA/SNL will provide comments to the IRSN report.	Analyze and Prepare Comment Report	0.75

Sandia National Laboratories

Common Program of Work

Phase	Program	Deliverable	Duration (Months)
3	Jointly participants select a potential attack modes (based on risk measures) and mitigative solutions, presenting already known methods and one or two potential new methods.	Joint Report	2.5 Total
	• Participants meet and select specific scenarios and mitigative measures to evaluate.		0.5
	• NNSA/SNL will evaluate the pros and cons of the selected mitigative measures and recommend and prioritize several higher payback mitigative measures.		2

Sandia National Laboratories

Common Program of Work

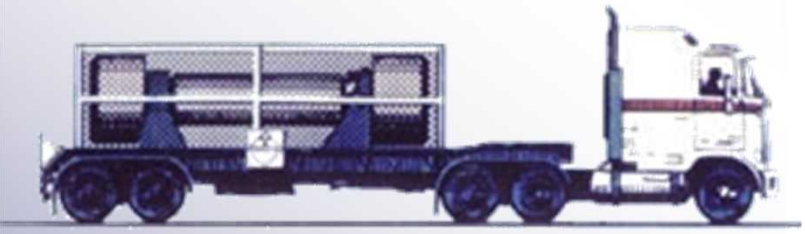
Phase	Program	Deliverable	Duration (Months)
4	IRSN/NNSA jointly define and each conduct a computer simulation/parametric study to evaluate one or more of the protection/mitigation approaches identified in Phase 3.	One Technical Report Per Study	6.5 Total per study

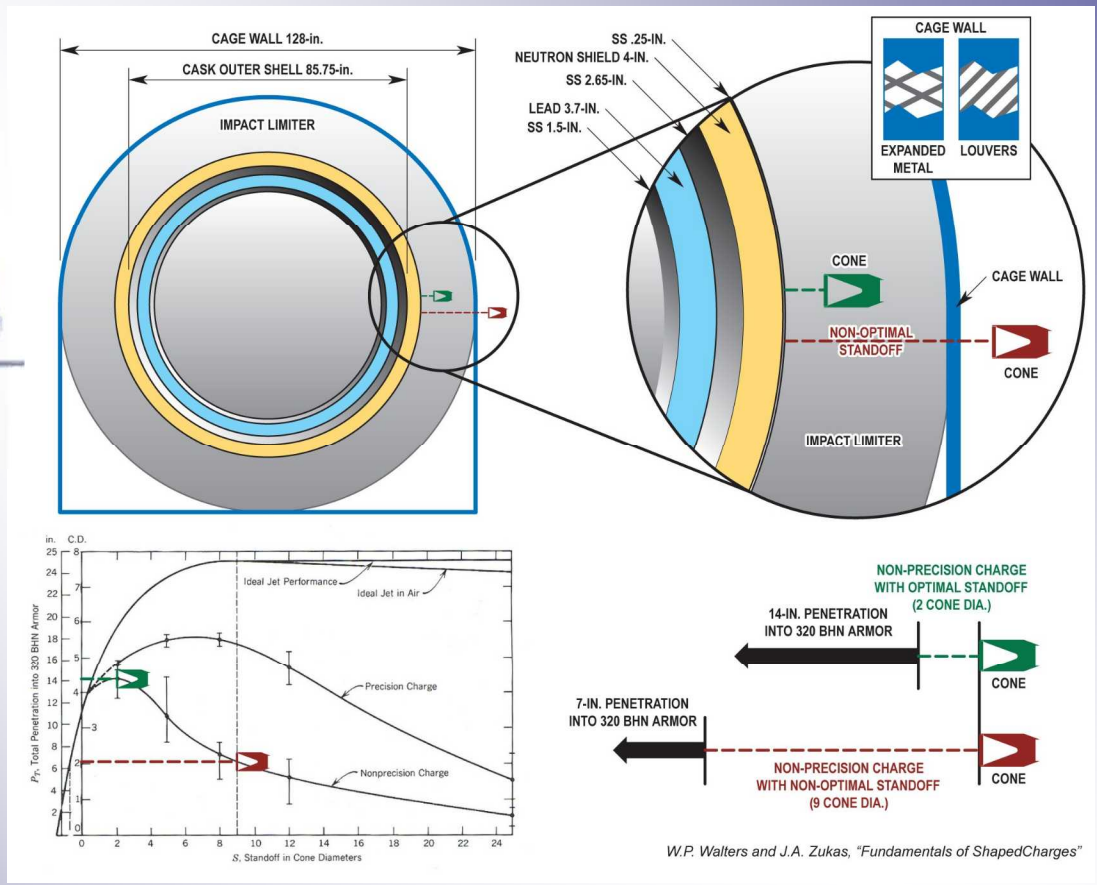
Sandia National Laboratories

Example Study

Sandia National Laboratories

Countermeasure Evaluation
Strong Cage
(i.e., pre-detonation/exclusion shield)





Sandia National Laboratories