The Estimation of potential Consequences from the Sabotage of Nuclear Material Transports
Contents

- Motivation: Estimation of potential Consequences from Sabotage of Nuclear Material Transports
- Examples for Sabotage
- From Sabotage of Nuclear Material Transports to potential Consequences
- Research Projects
- Prospects
Transportation Threat Examples

Unauthorized Removal

Sabotage
Motivation

- Likelihood of terrorist sabotage attack against transports of nuclear material
- Sabotage attack could generate a particulate radioactive matter from the inventory of the cask
- Airborne release to the environment
- Potential Radiological consequences?!
Motivation

Nuclear Security Series Publications, INFCIRC 225, Rev. 5:

- Radioactive material has to be protected against unauthorized removal since it could have significant consequences if dispersed or used otherwise for a malicious purpose.
- …the State should define protection requirements that correspond to the level of potential radiological consequences.

Assessing radiological consequences important for graded approach!
Examples for Sabotage

- Explosives
  - Directly put on the transport configuration
  - On a vehicle next to the conveyence
- Conical Shaped Charges (CSC)
- Explosively Formed Projectiles (EFP)
Conical Shapes Charge

- Highly sophisticated weapon
- Can be shot from a high distance
- High penetration depth
Explosively Formed Projectile (EFP)

- Not very sophisticated
- Standoff distance: Few meters to hundreds of meters
- Penetrates armour: 0.4 - 0.8 times the diameter
Examples for EFP´s

EFP´s are built easily:

- Explosive
- Pipe (like drainpipe, …)
- Layer (copper, …)

Different sizes:

- Roadside Bomb
- Pocket – EFP
- …
From Sabotage to potential Consequences

Weapon

Overpack

Inventory

Cask

Transport Configuration
From Sabotage to potential Consequences

First step:

- Damage Pattern of:
  - Cask
  - Inventory

- Airborne Release Fraction (ARF) of inventory (respirable aerosols)

- Aerosol transport process from the inside of the cask to the environment
From Sabotage to potential Consequences

Second step:
- Determination of dispersion of respirable particles
- Dose calculation
Performing experiments to:

- Understand the mechanisms of different sabotage attacks on transport casks
  - Obtain empirical correlations of kind of sabotage and ARF
- Verify numerical simulations

Create a predictive model to assess radiological consequences of sabotage attacks on various transport configurations
Research Projects of GRS

- Conical Shaped Charge: Different research projects of GRS in collaboration with Fraunhofer-Gesellschaft, IRSN and Sandia National Laboratories

- Explosives: Actual research project in collaboration with FhG ITEM and FhG EMI, funded by BMUB

- Explosively Formed Projectile: Actual research project in collaboration with FhG ITEM and FhG EMI, funded by BMUB
Explosives: Experimental Setup

Small-Scale experiments

- Experiments were performed at Fraunhofer EMI, Germany
- Experimental Setup was designed and installed by Fraunhofer ITEM, Germany
Targets
What was measured?

- Concentration of respirable fraction inside the cask
- Temperature
- Pressure

Helping to model the potential outflow of gases
Qualitative Results
Qualitative Results

Smaller charge:

Bigger charge:
EFP: Experimental Setup

Small-Scale experiments

- Experiments were performed at Fraunhofer EMI, Germany
- Experimental Setup was designed and installed by Fraunhofer ITEM, Germany
Projectile

- Bell-shaped flyer plates embedded in a sabot
- Shot with a powder gun
Cask Mock-Up

- Closed box
- Stainless-steel wall segments of variable thickness
Targets

Three different kinds of targets were used:
What was measured?

- Actual impact velocity of EFP directly in front of cask
- Concentration of respirable fraction inside and outside the cask
- Temperature inside the cask
- Pressure inside the cask

Helping to model the potential outflow of gases
Qualitative Results

Pictures of the high speed camera:

- Projectile flying towards the cask mock-up with the stainless-steel wall segment
Qualitative Results
Prospects

- Working on models to quantify the pattern of damage of:
  - Cask
  - Inventory

- With this: Determination of the source term, i.e. release fraction defined as the fraction of the inventory released as (respirable) aerosols
Thanks for your attention!