Defense in Depth used in the Physical Protection of Nuclear Power Plants
1. Introduction

2. The fundamental principle „I“: Defense in depth
   - Defense in depth and the Design Basis Threat
   - Defense in depth and a physical protection concept

3. Defense in depth – safety functions –

4. Defense in depth – physical protection functions –

5. Defense in depth and consequence analyses

6. Conclusions
Convention on the Physical Protection of Nuclear Material and Facilities

● Fundamental Principle I: Defense in Depth

The State’s requirements for physical protection should reflect a concept of several layers and methods of protection (structural or other technical, personnel and organizational) that have to be overcome or circumvented by an adversary in order to achieve his objectives.

● How to accomplish this fundamental principle?

● How is the adversary defined and what are his objectives?
Defense in Depth and the Design Basis Threat (DBT)

- As well defined DBT is the starting point for a defense in depth physical protection of a NPP
  - Demonstrators
  - Malvolent demonstrators
  - Insider
  - Terrorist attack (outsider)
  - Co-operation outsider - insider

- Objectives
  - Theft of nuclear material
  - Sabotage (major release of radioactive material from the NPP)
Defense in depth and a physical protection concept

- General is realised:
  - Outer protected area
  - Inner protected area
  - Vital areas inside inner protected areas
  - Technical and personell protection measures to accomplish the requirements

- In particular:
  We protect a facility against single objectives of an adversary

- Examples:
  - Malvolent demonstrators -> special anti demonstrator fence
  - Terrorist -> structural barriers
  - Insider -> separation of safety related redundances
  - Attack with a truck -> vehicle barrier
Protection against violent demonstrators
Protection against Terrorists (Outsider)
Protection against an Insider

Scheme of Physical Separation of Redundancies for an Older German NPP (PWR)
Protection Against an Attack with a Truck

Crash test of a vehicle barrier
- Many of these single protection measures has been tested.
- All single protection measures has been assessed for each facility.
- The result of a test or an assessment of a single protection measure is always **yes** or **no**, independent of the importance of the single protection measure in a physical protection concept.
- Examples
Concrete wall test

The wall after use of explosives and rework with flame cutter
Barrier door test

Barrier door after use of explosives
Performance Test

intrusion tool
ladder
• The physical protection of a NPP is based on many different single protection measures, structural and other technical, personnel and organizational measures, installed and organized in different areas of the facility. Is this the common understanding of defense in depth as qualitatively defined in the fundamental principle „I“ in the convention?

• Different protection measures have a different importance in a physical protection concept. It depends on the consequences for the safety of the facility and

Different attacks by adversaries require different physical protection measures with regard to the safety of the facility

• Categorization of protection measures and attacks by adversaries?
Logic Flow diagram of defence in depth
or security functions

Objective: Prevention of abnormal operation and failure
e.g. breakdown of a TV-camera
Success: - Normal Operation
e.g. change of TV-camera

Objective: Control of abnormal operation and detection of failures
e.g. breakdown outside detection system
Success: - Prompt return to Normal Operation
e.g. personnel contingency measures

Objective: Control of Accidents within the Design Basis
e.g. terrorist attack within the DBT
Success: - Observance of the Acceptance Criteria established for Design Basis Accidents
The Design Basis Threat

Objective: Control of severe plant conditions including prevention of accident progression
and mitigation of consequences of severe accidents
Terrorist attack beyond DBT, e.g. terrorists are inside protected area
Success: - limited core damage and confinement preserved, no need of prompt off-site
protective measures
Limited core damage could be possible

Objective: limit dose levels to people to acceptable values through implementation of off-site
protective measures
Success: compliance with established dose limits
Conclusions

1. A broader defense in depth approach allows a categorisation of different events by adversaries

2. A broader defense in depth approach facilitates a better possibility in the assessment of the importance and the relevance of single protection measures in physical protection concept

3. The overlapping area between safety and security is more clear

4. The normal „DBT-method“ with the defined adversaries and the corresponding protection measures is much more easier then the broader defense in depth approach