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Assessment of Physical Protection Systems for the Decommissioning Phase of German NPPs

Germany's decision to phase out

- Consensus to phase out since 2000
- Lifetime extension of German NPPs 2010
- Fukushima March 2011



German NPPs – in operation

Brokdorf	KBR	
Emsland	KKE	(*)
Grohnde	KWG	
Gundremmingen	KRB B	
	KRB C	
Isar	KKI 2	(*)
Neckarwestheim	GKN 2	(*)
Philippsburg	KKP 2	



(*) in operation until 31.12.2022 (AtG)

German NPPs – non operational

Biblis	KWB A
	KWB B
Brunsbüttel	KKB
Grafenrheinfeld	KKG
Isar	KKI 1
Krümmel	KKK
Neckarwestheim	GKN 1
Philippsburg	KKP 2
Unterweser	KKU

non-operational since 06.08.2011
 KKG since 27.06.2015



Decommissioning guideline 2016

- reduced risk potential
- with or without nuclear fuel elements
- nuclear facilities nearby

- until removal of nuclear fuel elements:
 - heat release from fuel pool
 - coolant loss from fuel pool
 - handling and storage of nuclear fuel elements

- description of nuclear security measures (security report)

Decommissioning of NPPS – phases

- operation
 - power operation
 - post operation phase
- residual operation
 - decommissioning
 - shutdown
 - safe enclosure
 - dismantling
 - with nuclear fuel elements
 - without nuclear fuel elements
 - decontamination
 - removal of other radioactive material

Remaining risk potential during the decommissioning

- nuclear fuel elements
 - fresh fuel
 - spent fuel
- other radioactive material
- remaining threats
 - sabotage
 - theft

Possible procedures

- DBT for all phases
- DBT for nuclear fuel elements
- DBT for other radioactive material

- different risk potential for sabotage and theft

- Graded security concept
 - large amount of nuclear fuel
 - small amount of nuclear fuel
 - without nuclear fuel
 - completing decontamination, other radioactive material

Graded Approach using the 19 Security Functions from Deterministic Security Analysis (DSA)

no modification

Security function nr. 1

- Obstruction of an intrusion of a **violent group of people** into the NPP area

Threat:

- Interference of violent protesters

Security measures (examples):

- Massive fence (steel or concrete, 2.5 m height)
- Paved road for respond forces inside the fence



no modification

Security function nr. 2

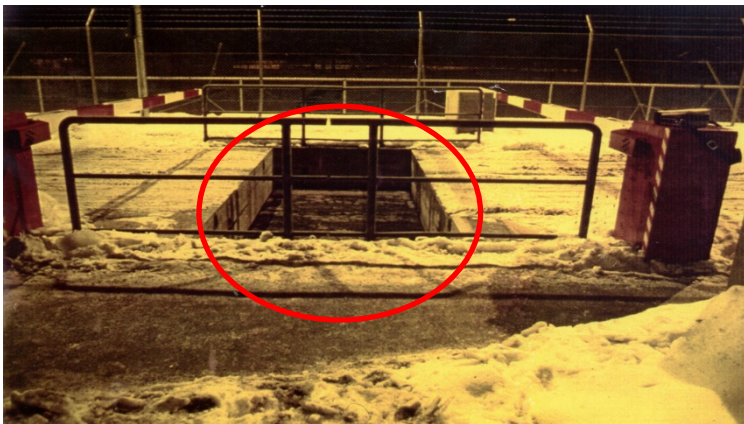
- Prevention of violent intrusion into outer protected area using a heavy duty vehicle

Threat:

- Unauthorizes entry into the NPP area (car bomb, further potential equipment)

Security measures (examples):

- Tested **vehicle barrier** around the area against intrusion of a heavy duty vehicle with selected weight



no modification

Security function nr. 3

- **Surveillance** of the area in front of the outer boundary, detection of adversary preparations

Threat:

- Preparation of an attack (e.g. to get into the protected area)

Security measures (examples):

- Open area in front of the outer boundary
- Lighting
- Roving patrols (Security Guard Service)



system-dependent consideration

Security function nr. 4

- Prevention of the triggering of situations that can not be handled by the safety systems, prevention of other major radiological release resulting from **interference from outside the protected areas**

Threat:

- Disturbance of the cooling water supply (explosives)
- Subaqueous blast waves against the intake pipe for cooling water

Security measures (examples):

- Protected cooling water supply within the protected area
- Measures to decrease pressure from blast waves within the cooling water channels

no modification

Security function nr. 5

- Reliable **detection**, identification and localization of intruders along the outer boundary

Threat:

- Intrusion without alarm

Security measures (examples):

- Fence system with technical detection, camera surveillance and lighting
- Patrolling security guards



no modification

Security function nr. 6

- **Adequate conditions** for the security guard service and the response forces **within the outer protected area** and along the boundary of the inner protected area

Threat:

- Adversary entered the outer protected area

Security measures (examples):

- Clear arrangement of the buildings
- Avoid hiding options within the NPP area
- Alarm lighting system

system-dependent consideration

Security function nr. 7

- **Delay** of the intrusion of adversaries into the inner protected area until the end of the responds time

Threat:

- Violent intrusion attempt into safety relevant buildings to trigger a nuclear melt down

Security measures (examples):

- Barriers around safety relevant buildings that resist attacks (according the potential weapons in the DBT) for a definite minimum of time



no modification – but possible with analysis and verification

Security function nr. 8

- Reliable and complete overview of the security status from a central and protected place, activation and controlling of security systems, communication with responds forces

Threat:

- Violent interference

Security measures (examples):

- **Central alarm station** within a protected building,
- Minimum of two persons in the central alarm station



no modification – but possible with analysis and verification

Security function nr. 9

- Secured possibility to open the **access** to the inner protected area **from outside**

Threat:

- Break down of the central alarm station

Security measures (examples):

- Protected set of keys outside the central alarm station

system-dependent consideration

Security function nr. 10

- A qualified, reasonable equipped **Security Guard Service** in addition to structural and other technical security features

Security measures (examples):

- minimum education for security guards, trustworthiness determination, frequent further courses

no modification

Security function nr. 11

- Protection of the security guards at the main entrance against violent attacks

Threat:

- Violent attacks against security guards in the **guard building**, gunfire from outside

Security measures (examples):

- Bullet proved and intrusion delayed construction of the part of the building, where the guards work,



no modification

Security function nr. 12

- **Control**, identification, documentation and allowance of the entry of persons, goods and vehicles according the authorization at the gates of the outer boundary (**protected area**), possibility of blockage and prevent the entry of unauthorized goods

Threat:

- Entry of unauthorized persons or vehicles and materials (weapons, explosives)

Security measures (examples):

- Entry control and contraband detection of persons and materials through manual search, x ray inspection and detection (metal, radiation, explosives)



no modification – but possible with analysis and verification

Security function nr. 13

- **Control**, identification, documentation and allowance of the entry of persons to the **inner area** according to the authorization, possibility of blockage and prevention of the entry of unauthorized goods

Threat:

- Unauthorized entry of persons to the inner protected area and entry of contraband to an inner protected area

Security measures (examples):

- Entry control and contraband detection



no modification

Security function nr. 14

- Prevent and detect **theft** of nuclear material (quantity and type)

Threat:

- Violent theft of nuclear material

Security measures (examples):

- Storage of unirradiated nuclear material within the barriers of protected buildings (inner protected area)

no modification – but possible with analysis and verification

Security function nr. 15

- Prevent, obstruct and detect interferences of an **insider** that could
 - Trigger incidents beyond the design basis or influence the handling of incidents within the safety design basis (sabotage)
 - Through collaboration, facilitate the entrance of adversary from outside into the inner protected area or prevent from alarming the responds force

Threat:

- Insider triggers a nuclear melt down

Security measures (examples):

- Measures to prevent that a single insider is able to trigger an incident and also manipulate necessary safety systems

no modification

Security function nr. 16

- Recognition of **hostage and extortion** at the outer boundary, delay of further action to be carried out

Threat:

- Facilitate entrance to inner protected area by hostage and extortion

Security measures (examples):

- Emergency Alarms
- Arrangement of code words to reveal a hostage situation

no modification

Security function nr. 17

- Preserving of a sufficient level of security also if security systems are jammed or broken (planned **substitute measures**)

Threat:

- Failure in the Physical Protection System because of broken Security Systems

Security measures (examples):

- Strategy for breakdown cases
- Storage of a sufficient number of spare parts

no modification

Security function nr. 18

- Employment of **trustworthy personnel**

Threat:

- Potential vulnerability of the plant because of the employment of untrustworthy or criminal personnel

Security measures (examples):

- Federal trustworthiness determination of the personnel in nuclear facilities

no modification

Security function nr. 19

- To have technical and organizational **infrastructure** available to support the impact of the **response forces**

Threat:

- Violent interference

Security measures (examples):

- Available onsite headquarter within the facility with all needed equipment (e.g. communication)
- Heliport at the facility
- Joined training of response forces and security guards

Specifics

Phase with nuclear fuel elements

- Separation of buildings with consideration of Inner Area
- Additional security measures for interfaces
- Protected Area needed without any changes
- Optional relocation of Central Alarm Station

Phase without nuclear fuel elements

- Adjustment of security concept
- Reduction in defence in depth – concept
- Change in access control procedures
- Additional locks for material and vehicles
- Detection of barriers with technical means or with personnel

Be prepared

- decommissioning is coming for each and every NPP
- there is no best way
- Development of an unified standard for evaluation and assessment is needed even for different approaches and procedures