Safety analysis in design and assessment of the physical protection of the OKG NPP

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Background

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OKG in a nutshell…

~ 10 % of the electric power production in Sweden

O1 (1972)
492 MW

O2 (1974)
586 MW

O3 (1985)
1450 MW

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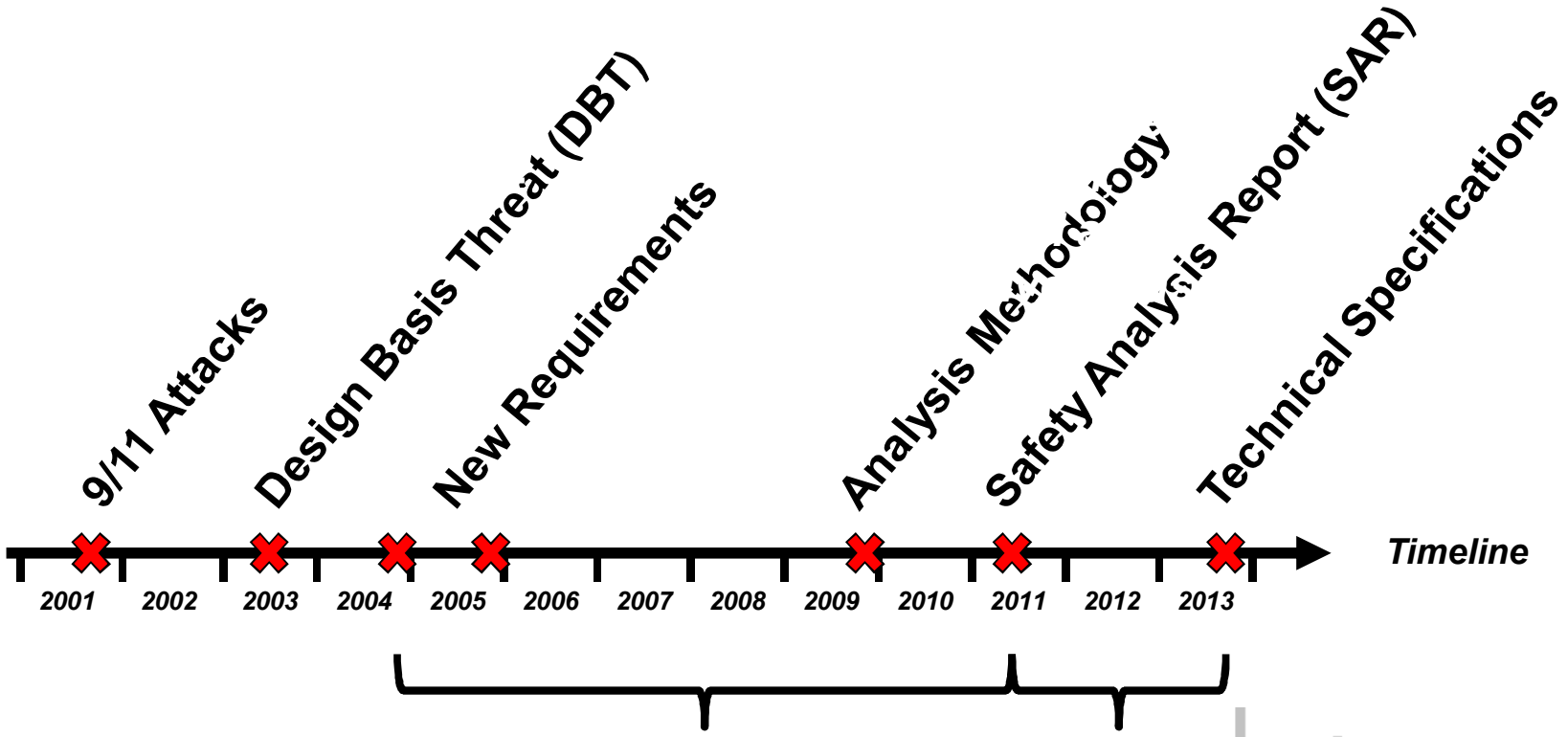
History – Security upgrade



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The integrated approach

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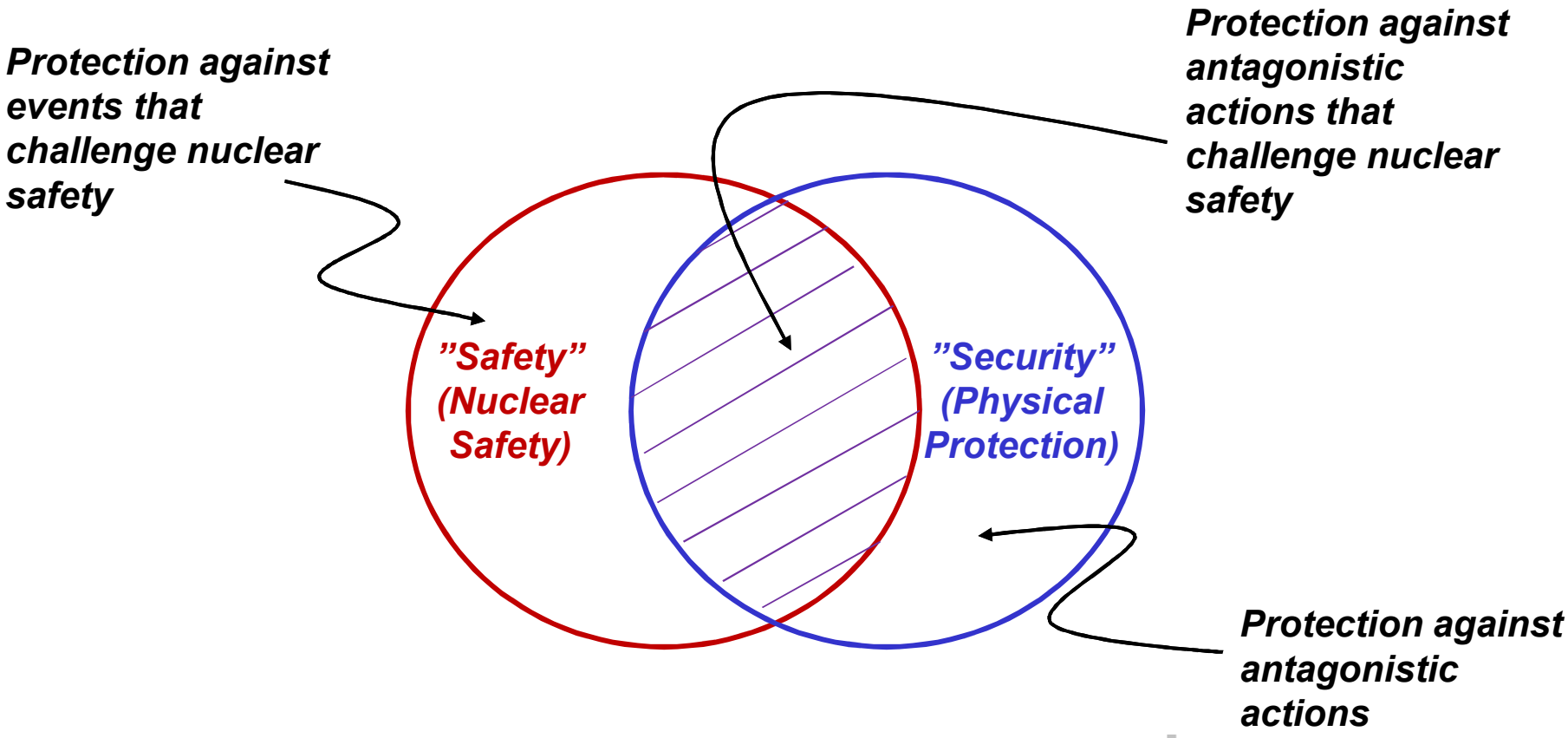
The relationship between Safety and Security



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Deterministic Safety Analysis (DSA)

Conventional DSA

- Identify initiating events and associated event classes
- Identify event specific boundary conditions
  - Mode of operation
  - Deterministic requirements
  - Event specific degradation
- Identify event specific acceptance criteria

DBT-based DSA

- Identify DBT-based scenarios
- Identify scenario specific boundary conditions
  - Mode of operation
  - "Pessimistic postulates"
  - Scenario specific degradation
- Select scenario specific acceptance criteria

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Probabilistic Safety Analysis (PSA)

Conventional PSA

- Identify initiating events and associated event frequencies
- Identify event specific boundary conditions
- Select probabilistic safety goals

DBT-based PSA

- Identify DBT-based scenarios
- Identify scenario specific boundary conditions
- Select relevant acceptance criteria

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Finding an analysis ”Template”

Internal (area) events

- Potentially degrading barriers and safety functions
- Spatial dependences may be important
- PSA informed DSA may be useful

Antagonistic actions

- Potentially degrading barriers and safety functions
- Spatial dependences may be important
- PSA informed DSA may be useful

⇒ **Arrange DBT-based analysis according to the structure for “internal events” analysis.**

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Application 1 - *Design*

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A fictive DBT

- **Antagonist 1 –** ***A non-violent group of activists seeking public attention to convey an anti-nuclear message***
- **Antagonist 2 –** ***A terrorist cell seeking to create public fear, by causing a nuclear accident***

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Scenario 1 - *Specification*

- **Motif/Objective:** ***A non-violent group of activists seek public attention through a demonstration at the site. Attempts to penetrate protective barriers may occur.***
- **Abilities:** ***The activists have access to publically available information. If they try to penetrate protective barriers, they will only use "burglary type" tools.***
- **Pessimistic postulates:** ***Assume that the activists will try to penetrate protective barriers.***
- **Acceptance criteria:** ***Consequences must not exceed the limits defined for the event class "normal operation". (It must be possible to continue operation within the limits of the technical specifications.)***

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Scenario 1 - *Analysis*

- **Vulnerability analysis:** ***Acceptance criteria are violated if the activists are able to provoke a reactor shut down. This will occur if the activists threaten safety relevant equipment.***
- **Protective measures:** ***Place safety relevant equipment in the restricted (protected) area. Install security alarm capability, to detect unauthorized access.***
- **Conclusion:** ***Given that the physical protection of the restricted area will resist "burglary type" tools, normal operation may continue as long as there is no security alarm. Thus, given that the protective measures are implemented, the acceptance criteria for scenario 1 are met.***

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Scenario 2 - *Specification*

- **Motif/Objective:** ***A terrorist cell seek to create public fear, by causing a nuclear accident through the detonation of a bomb.***
- **Abilities:** ***The terrorists have access to publically available information and to insider information regarding routines for normal operation. They will use explosives to force protective barriers, and to damage safety relevant equipment. Offsite power may or may not be taken out in the attack.***
- **Pessimistic postulates:** ***Assume that offsite power is non-available.***
- **Acceptance criteria:** ***Consequences must not exceed the limits defined for the event class "unanticipated events. (Safe shut down must be achieved. Some outage time is accepted for repairs.)***

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Scenario 2 – *Analysis (1/3)*

- **Vulnerability analysis:** ***The acceptance criteria will be violated if the terrorists are able to detonate a bomb in an area where it is likely to cause core damage or damage to spent fuel. The PSA models for the power plant may be used to identify such areas. If any "weak spots" are found, they may need additional protection if the terrorists are likely to be able to identify them as targets.***

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Scenario 2 – *Analysis (2/3)*

- **Protective measures:** ***Exclude sensitive information regarding dependencies from all documents describing routines for normal operation, to prevent terrorists from identifying targets for the bomb. Still, some "weak spots", e.g. the main control room, may be identified based on publically available information. By placing safety relevant equipment in the restricted (protected) area, installing security alarm capability to detect unauthorized access, and implementing sufficient obstructing and delaying measures, it is possible to delay the detonation until the attack may be interrupted by arriving security forces.***

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Scenario 2 – *Analysis (3/3)*

- **Conclusion:** ***By implementing administrative routines to protect sensitive information, by implementing an adequate physical protection of safety relevant equipment, and by making arrangements for security alarms and action plans in case of an attack, the security arrangement as a whole will be sufficient to enable safe shut down and prevent core damage. Thus, given that the protective measures are implemented, the acceptance criteria for scenario 2 are met.***

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Design of the physical protection – Summary

- The DBT is transformed into a set of scenarios that define the design requirements.
- The scenarios provide guidance on how to select relevant protective measures.
- The DBT-based analysis (evaluation of all scenarios considering the selected protective measures) verify that the physical protection as a whole is sufficient.

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Application 2 – *Management support*

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Safety evaluation (1/2)

- **A structured method for categorizing safety concerns*: Safety significance depend on the degree of influence on the "defense in depth".**
  - **"Negligible" (no actions necessary)**
  - **"Low" (permanent corrective measures may be considered if practicable)**
  - **"Medium" (risk reducing measures necessary, plant operation acceptable for some limited time until corrective measures have been implemented)**
  - **"High" (immediate risk reducing measures or plant shut down should be considered)**

***IAEA Safety Reports Series No. 12, Vienna (1998)**

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Safety evaluation (2/2)

- **Safety significance is determined by reevaluating affected DSA.**
- **Introducing DBT-based DSA ⇒ The method for safety evaluation may be applied to security concerns.**
- **Safety/Security integration ⇒ Prioritization between risk reducing measures is facilitated.**

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Application 3 – *Operational support*

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Requirements in the Technical Specifications (1/2)

- DBT-based analysis results
- FMEA

} ⇒

- Minimal requirements for credited security measures (functional level)

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Requirements in the Technical Specifications (2/2)

- Minimal requirements
- Compensating measures

⇒

- New section in the technical specifications

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Concluding remarks

- **Safety/Security integration advantages**
  - **Common language ⇒ Interdisciplinary acceptance**
  - **Extended nuclear safety applications (design & assessment)**
  - **More informed requirements in the technical specifications**
- **Disadvantages**
  - **Initial “threshold” in communication with stakeholders. Requires attention and resources.**

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Thank you!

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