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1. Background - definitions

- **Safety**: prevention of accidents and mitigation of consequences should accidents occur
- **Security**: (for NI) protection of NI from malevolent actions (theft or sabotage)
- **Safeguards**: actions and inspections to MS with the aim of the application of the NPT.
- **Sabotage**: Malevolent act against a NI (either by intruders or stand-off) with the aim to cause uncontrolled release of radioactive material
Outline of Presentation

1. Background
2. Objectives of the Guidelines
3. Scope
4. Key Steps in the Methodology
   - Threat Evaluation
   - TT-1 and TT-2 Specification
   - Safe shutdown/success path
   - Capacity evaluation, plant walkthrough, decision process
5. Conclusions
2. Objectives of the Guidelines

- Provide a methodology that results in a systematic study to verify survivability of the basic control, cool and contain functions of nuclear installations.

- Utilize existing techniques of safety margin assessment for beyond design basis events.

- Provide at least one safe shutdown or success path for selected threat scenarios (this depends on the RB requirements)
1. Background

- September 11, 2001 changed the threat perception
  - Sophistication of planning
  - Suicidal nature of the act

- Regulators required immediate security upgrades

- Regulators also asked for robustness reviews

- IAEA Document process started for a systematic approach to verify survivability
3. Scope

- Applies to complex nuclear facilities: power plants, research reactors, fuel fabrication, etc.
- Events considered:
  - intrusion into the site
  - initiated outside the site area: aircraft, missile, etc. (i.e. stand off attacks)
  - malevolent vehicle
  - multiple modes
- Out of scope:
  - theft, economic loss
PROTECTION OF NUCLEAR FACILITIES AGAINST SABOTAGE

Threat Assessment

Consequences

TT-1

TT-2

Extreme Load Evaluation

State’s Responsibility

Response

State’s Security

Sabotage Protection Design & Evaluation

• Detection
• Delay
• Response/Recovery

Emergency Response

Acceptable Risk
PROTECTION OF NUCLEAR FACILITIES AGAINST SABOTAGE

Threat Assessment

Consequences

TT-1

TT-2

Vital Areas Identification

- System Design
- Facility Layout
- Safety Measures
- PPS

Emergency Response

State's Responsibility

State's Security

Acceptable Risk

System Design & Evaluation

• SSC capacity evaluation
• SA Crisis management
PROTECTION OF NUCLEAR FACILITIES AGAINST SABOTAGE

Threat Assessment

Consequences

TT-1

Extreme Load Evaluation

State’s Responsibility

Response

State’s Security

Acceptable Risk

Sabotage Protection Design & Evaluation

Vital Areas Identification

• System Design
• Facility Layout
• Safety Measures
• PPS

Detection
• Delay
• Response/Recovery

SSC capacity evaluation

SA Crisis management

Emergency Response
<table>
<thead>
<tr>
<th>Tier</th>
<th>Category (Example)</th>
<th>Evaluation Acceptance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ultra-light or small general aviation aircraft</td>
<td>Design basis – minimal releases &amp; repairable damage</td>
</tr>
<tr>
<td>2</td>
<td>Commercial airliners &amp; business jets</td>
<td>Margin assessment techniques – low releases</td>
</tr>
<tr>
<td>3</td>
<td>Very large commercial airliners</td>
<td>Severe accident management techniques – limit releases &amp; bring to permanent safe state</td>
</tr>
</tbody>
</table>
Consequence Evaluation

• Potential Impact on nuclear facility:
  • operating unit,
  • storage of spent fuel & wastes,
  • transportation (within the facility)

• Safety of Plant Personnel and the Public
  • Radioactive release
  • Potential exposure to plant personnel
  • Potential exposure to the public
  • Potential damage to the environment
  • Collateral effects (explosions, hazardous materials release, … )

• Others
  • Loss of output of facility
  • Loss of public confidence in NPP safety and security
TT-2 Events: Stand off type attacks

- Input: List and Specification of TT-2 Events from Box 4
- Refine Definition
  - Site characteristics
  - Plant characteristics
  - Type and number of co-located facilities
- Screen Out events
  - Magnitude/distance
  - Probability (conditional)
Example of Site Characteristics: Topography

G2 & G1

Muhleberg
Extreme Environment Matrix: the start of a family of “load” tables

<table>
<thead>
<tr>
<th>Threat Scenario No.</th>
<th>Threat Scenario Description</th>
<th>Impact</th>
<th>Blast</th>
<th>Heat/fire</th>
<th>Hazardous Materials Release</th>
<th>Smothering</th>
<th>Flooding</th>
<th>Other</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Boeing 767 fully fueled crash into NPP site</td>
<td>1,2</td>
<td>None</td>
<td>1</td>
<td>None</td>
<td>None</td>
<td>None</td>
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### Extreme Environment Matrix

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</tbody>
</table>
### TABLE 3-2 IMPACT PARAMETER DEFINITION MATRIX

<table>
<thead>
<tr>
<th>Missile Type/No.</th>
<th>Description</th>
<th>Mass/Weight</th>
<th>Shape/configuration</th>
<th>Impact angle</th>
<th>Impact velocity</th>
<th>Relative hardness</th>
<th>Fire</th>
<th>Explosion</th>
<th>Other</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Boeing 767 fuselage fully fueled</td>
<td>200,000 kgm</td>
<td>Flexible</td>
<td>Less than 30 deg to horizontal</td>
<td>350 knots</td>
<td>Flexible</td>
<td>1</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>Boeing 767 engines as projectiles</td>
<td>3,500 kgm</td>
<td>3 meters diameter/rigid cylinder</td>
<td>Less than 30 deg to horizontal</td>
<td>350 knots</td>
<td>Rigid</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
TABLE 3-3 EXPLOSION/BLAST PARAMETER DEFINITION MATRIX

<table>
<thead>
<tr>
<th>Explosion No.</th>
<th>TNT Equivalent</th>
<th>Stand Off Distance</th>
<th>Incident</th>
<th>Reflected</th>
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</thead>
<tbody>
<tr>
<td>1</td>
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</tbody>
</table>

PRESSURE PULSE
# Heat/Fire Parameter Definition Matrix

## Table 3-4 Heat/Fire Parameter Definition Matrix

<table>
<thead>
<tr>
<th>Fire No.</th>
<th>Description</th>
<th>Combustible/ignition</th>
<th>Quantity</th>
<th>Heat Potential/Temperature</th>
<th>Duration of Burn</th>
<th>Other</th>
<th>Building/yard</th>
<th>Quantity</th>
<th>Type</th>
<th>Ignition likelihood</th>
<th>Burn duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jet fuel fire from Boeing 767</td>
<td>Yes</td>
<td>50,000 kgm.</td>
<td>1200 deg F</td>
<td>1-6 hrs.</td>
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</table>
## Hazardous Material Release Definition Matrix

### TABLE 3-5 HAZARDOUS MATERIAL RELEASE DEFINITION MATRIX

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Material Description</th>
<th>Quantity</th>
<th>Smothering effect – personnel</th>
<th>Smothering effect – components</th>
<th>Lethal or disabling effect – personnel</th>
<th>Duration</th>
<th>Penetration extent</th>
<th>Other</th>
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<tbody>
<tr>
<td>1</td>
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</tbody>
</table>
## Extreme Environment Evaluation: End Product

<table>
<thead>
<tr>
<th>Plant Area</th>
<th>Engineering Environmental Load Description</th>
<th>Impact</th>
<th>Blast</th>
<th>Heat/fire</th>
<th>Hazardous Materials Release</th>
<th>Smothering</th>
<th>Flooding</th>
<th>Other</th>
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</thead>
<tbody>
<tr>
<td>Building 1</td>
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<td>Yard 1</td>
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</table>
4. Key Steps: Safe Shutdown Path

- **Vital Areas Identification**
  - System Design
  - Facility Layout
  - Safety Measures
  - PPS

- **SSC capacity evaluation**

- **SA Crisis management**

- **Detection**
- **Delay**
- **Response/Recovery**
Safe Shutdown Path

Basic Philosophy:
(DBT or BDBT ?)

- Define one or more safe shutdown paths to:
  - Shutdown the facility & maintain safe shutdown
  - Provide for heat sinks
  - Contain radioactive materials
  - Provide monitoring & control functions

- Selection criteria:
  - Able to demonstrate margin or capacity
  - Include physical protection systems
  - Minimize number of vital areas
  - One safe shutdown path required, but redundant paths beneficial
| SSEL No. | SSC Name | SSC ID No. | Description | Threat Scenario No. | Building | Elevation | Room/Compartment | Vital Area | Impact | Blast | Heat/fire | Smothering | Flooding |
|----------|----------|------------|-------------|---------------------|----------|-----------|-------------------|------------|--------|-------|-----------|------------|----------|---------|
4. Key Steps: Capacity evaluation, plant walkthrough, decision process

- **Capacity Evaluation:**
  - by engineering standards, analysis, expertise
  - experimental & experience data
  - testing
  - liberalized acceptance criteria

- **Plant Walkdown**
5. Conclusions

• These guidelines provide a methodology whereby nuclear facility operators will have the capability to:

  • select relevant threat scenarios including TT-1 and TT-2
  • highlight existing strength & robustness
  • identify vulnerabilities
  • For existing plants, decide on upgrades or other means to reduce public risk
  • document the process
Decision Process

• Methodology includes 4 major decision points:
  • Spectrum of threats
  • Division of threat responsibilities
  • Evaluation of: SSCs, physical protection systems, operator action
  • Use of off-site features & capabilities & emergency response measures

  to arrive at an overall position of acceptance

• Iteration between all decision points may be required to arrive at acceptable solutions

• Regulatory Body involvement essential in the decision process
Recent Requirements for Large ACC

- USA: Considered beyond design basis – include impact and subsequent fire
- Malevolent scenario but it is not classified as ‘threat’
- NPP should demonstrate that BOTH the reactor core and the spent fuel are protected through EITHER cooling OR containment functions.
Recent Requirements for Large ACC

• Canada considers similar scenario and calls it a ‘beyond design basis threat’
• EC demand the consideration of a similar scenario for new NPPs under the obligation of the states vis-à-vis the Euratom Treaty – article related to protection of the investment
• Olkiluoto 3 and Belene NPP have considered such a scenario in their design