Design Extension Conditions for Interim Storage Facilities in Germany

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IAEA Technical Meeting on

Design Extension Conditions for Storage Facilities

for Power Reactor Spent Fuel

Wien 27.06-01.07.2016

Foreword

— **Design Extension Conditions as defined by the IAEA are in principle called „Steßtest“-conditions in Germany.**

— **Beside the design basis accidents, there are also a set of beyond design basis accidents covered in the licensing process**

  - **Those are not to be mistaken as the DEC**

— **The DEC are to be understood as events even exeeding those beyond design basis accidents.**

Investigations towards DEC for FCF‘s performed in Germany

- **The Nuclear Waste Management Commission (ESK) performed investigations for all FCF’s in Germany and provided the results in two separate Reports**
  - ESK-Stresstest für Anlagen und Einrichtungen der Ver- und Entsorgung in Deutschland
    - **Teil 1: Anlagen der Brennstoffversorgung, Zwischenlager für bestrahlte Brennelemente und Wärme entwickelnde radioaktive Abfälle, Anlagen zur Behandlung bestrahlter Brennelemente (14.03.2013)**
    - **Teil 2: Lager für schwach-und mittelradioaktive Abfälle, stationäre Einrichtungen zur Konditionierung schwach- und mittelradioaktiver Abfälle, Endlager für radioaktive Abfälle (18.10.2013)**

- **The Federal Office for Radiation Protection (BfS) performed a investigation which results were presented at the CSNI Workshop on Safety Assessement of Fuel Cycle Facilities, Toronto (2011)**
  - Dry Interim Storage of Radioactive Material in Germany C. Drobniewski; J.Palmes (2011)

Investigations of the ESK (1)

- **The ESK assembled a set of of relevant impacts and the respective assessment criteria.**
- **The set of impacts include earthquake, flood, heavy rainfall, other weather impacts, loss of power supply, internal/external fire, airplane crash and detonation waves.**
- **The assessment criteria are divided in several stress levels (“Stresslevel”) and safety levels (“Schutzgrade”) distinguishing between natural and civilisatory impacts.**

➢ **The operators of the spent fuel storage facilities were given a questionary to provide documents to the ESK to enable the assessment.**

Investigations of the ESK (2)

— **Example: Earthquake**

— **The main questions for the impact “Earthquake” included:**

- **the assessed earthquake for the license and its basis**
- **information on the behaviour of the facility for stronger earthquakes than the design base earthquake (if available)**
- **assessed concurrent scenarios and available disaster remediation measures.**

— **The assessment levels are:**

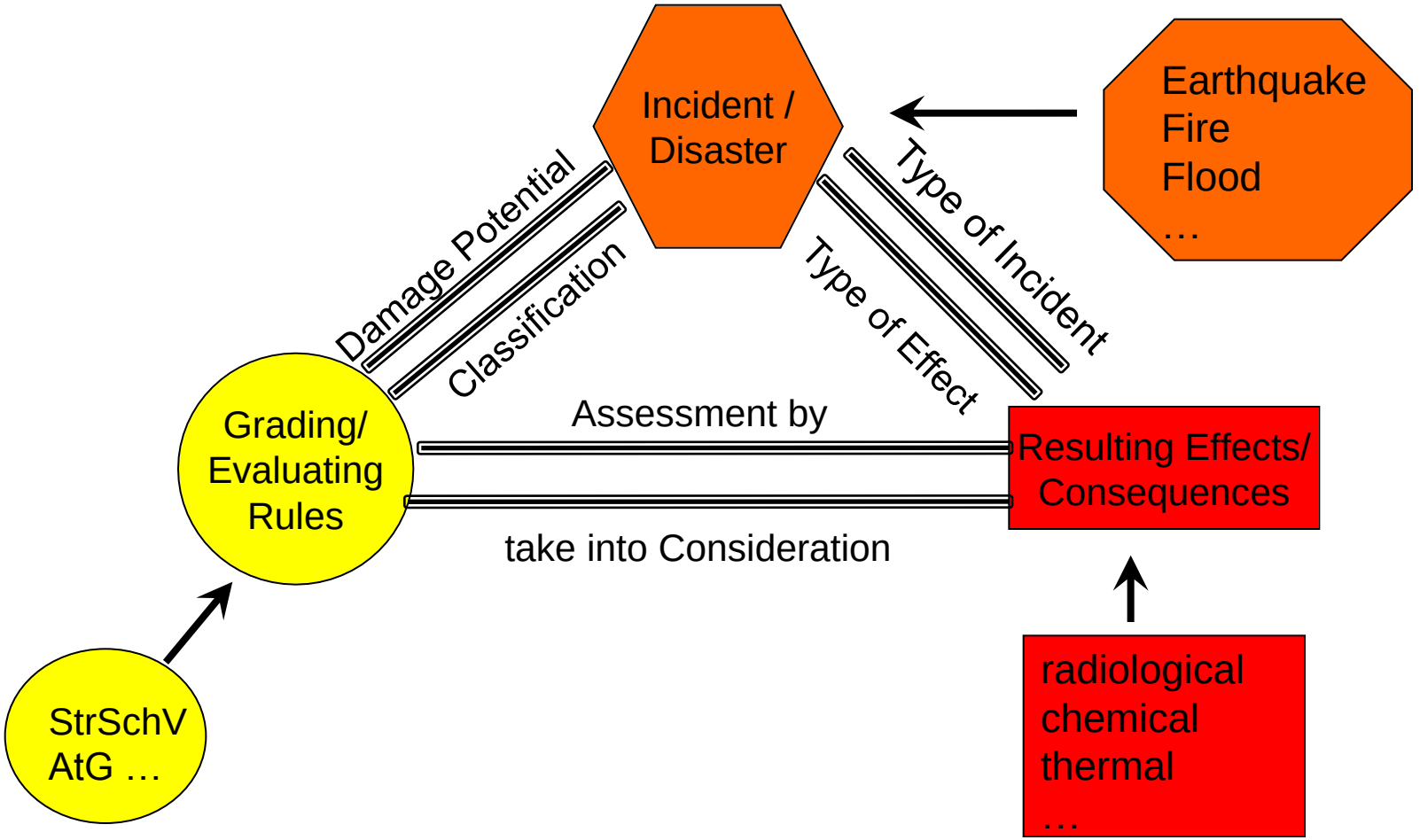
- **Base level - the design base earthquake**
- **Stress level - design base earthquake Intensity +1**

Investigations of the BfS (1)

- **The BfS investigated a set of events that exceed the design-basis accident conditions.**
- **Goal: Identify and assess safety margins of the storage facilities.**
- **Treatment of scenarios on a qualitative level, especially to identify the scaling of accident consequences in dependence of the accident/disaster extent to identify cliff-edge effects if applicable.**

➢ **After a screening of scenarios to consider, the event list included Flooding, Earthquakes and subsequent events, Fire and external Explosions.**

Investigations of the BfS (2)



Investigations of the BfS (3)

Assessing the Impacts (Example Earthquake):

— **Chemical Impact: none**

— **Mechanical Impact:**
- **Toppling of casks – already considered in handling accidents and conservative below effects of a airplane crash onto a cask.**
- **Burying of casks with debris – dropping of Building parts onto the cask is conservatively below the effects of an airplane crash.**

— **Thermal Impacts:**
- **Burying of casks with debris – reduced thermal conductivity and convectional cooling of the casks.**
- **Timeframe for reaching a final heat up temperature is several weeks but safely below critical values.**
- **Special arrangements have to be made when recovering the casks due to increased neutron radiation (loss of moderation material)**

Resulting Consequences:

— **Save below dose limits for several weeks of buried casks.**

Results from the ESK Investigations (1)

- **The dry interim storage as it is realized by the storage facilities in Germany is a robust concept which relies mainly on the properties of storage cask.**
  - **Due to this fact, even for DEC no severe disaster remediation actions will become necessary.**
- **The documents provided by the operators and local authorities show that the storage facilities provide enough reserves in the design to achieve even the safety in the highest stress levels / safety levels in most cases.**

Results from the BfS Investigations (1)

Accident/ Disaster	Radiologic consequences compared to limits	Feasible as accident/disaster	Not radiological impact to surrounding area
Flood	Very limited to none	Unlikely in the extreme extent	Severe flood damage in a large surrounding area
Earthquake (toppling)	Safely below limits	Yes	Depending on the structural integrity, high damage to buildings in the area
Earthquake (burying)	Safely below limits for a timeframe of several weeks[1]	Yes	Devastating effects on even strong concrete buildings and therefore for most civilian buildings
Fire	Below limits, limits are reachable for long durations (several hours)	No[2]	Only close vicinity will be affected
Explosion	Safely below limits	No [2]	Only close vicinity will be affected

[1] Depending on the time buried the release scales.
[2] The amount of burnable/explosive material is not feasible originating from an accidental situation.

Summary

- A wide range of DEC (nature based events as well as man-made accidents) were covered by the investigations by the ESK and the BfS.
- The ESK used a fixed set of stress levels/ safety levels to assess and judge the facilities based on the provided documents.
- The BfS approach was driven by the investigation towards cliff-edge effects and the inquiry of safety margins starting from results proven in the licensing process.
- Both ways complement each other and provide an reliable basis for the assessment of DEC.
- The results show that the interim storage facilities for spent fuel in Germany providing a high level of safety margins.