EN S REG
European Nuclear Safety Regulators Group

Topical Peer Review II
Fire protection
at nuclear installations

Topic of interest:

Compartmentation

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Transversal topic

Compartmentation

Aspects to be discussed

1. Methods for determining and re-assessing suitable fire barriers
2. Effects of fire related compartmentation on the level conservatism/realism of Fire PSA (comparison)
3. Cases where the use of 'state-of-the art' compartmentation is not fully possible and compensatory fire protection means are needed.

Expected outcome of discussion

- Overview/benchmarking of approaches regarding the analysis of the fire related building compartmentation and their application for installations design with older standards related regulations, corresponding FHAs/Fire PSAs, existing fire protection concepts
- Better insights from national approaches to share experience and identify potential good practices or challenges

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1. Methods for determining and re-assessing suitable fire barriers

Approaches reported in NARs :

- ✓ European countries use the compartment approach.
- ✓ However, the approaches to compartmentation are vary depending on NARs and types of installations:
  - Some countries clearly tie their compartmentation approaches to nuclear and radiation safety.
  - The countries without large NPPs/RRs fleet of facilities with lower nuclear/radiological risk (like SFSF, WSF or late stage of decommissioning) looks using conventional non-nuclear fire safety requirements (or with some nuclear/radiation safety “flavor”).
  - Mixed approach is used among the EU states
- ✓ The particularmethods on fire barriers suitability determination and reassessment has large variety, depends much on national approaches, experience and methodology developed. They include:
  - identification of areas (rooms) fire loads, ignition sources,
  - evaluation of fire durations, fire spread and relocation,
  - events sequences, failure modes, calculations methodology and computer codes

Czech Republic (NPPs): Buildings into 3 groups **according to the expected impact (nuclear safety or radiation protection jeopardized)**

Austria (RR): No nuclear compartmentation (uses a **conventional approach**)

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1. Methods for determining and re-assessing suitable fire barriers

Questions regarding the methodologies:

1. What are the general approaches or methodologies (from nuclear and radiation safety point of view) on:
   - ✓ Categorisation of buildings, areas and compartments according to the safety goals
   - ✓ Compartmentation (incl. fire cells)

2. Which approach do you use to demonstrate the suitability of fire barriers
   - ✓ Is it based on calculated or prescribed fire duration?
   - ✓ Is it based on deterministic/confirmed by PSA?

3. Applicability of the graded approach

4. What are the triggers, reasons for reassessment other than PSR?

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2. Effects of fire related compartmentation on the level conservatism/realism of Fire PSA (comparison)

Summary

- Where an adequate fire compartmentation with appropriate fire compartment boundaries by suitably qualified fire barriers is present (as part of a typically conservative design approach), a conservative Fire PSA can pessimistically assume a failure of the whole fire compartment.
- For a realistic Fire PSA, the fire compartments can be further subdivided in virtual units (often called fire influence zones where it can more realistically assumed that a fire in a pre-defined time period cannot spread to all zones in the whole compartment and thus a failure of all components in the compartment does not have to be assumed. This may (not in all cases) significantly affect the Fire PSA results.

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2. Effects of fire related compartmentation on the level conservatism/realism of Fire PSA (comparison)

The analysis of the fire related building compartmentation by suitable and reliable fire compartment (or fire cell, where applicable) boundaries rating varies between the countries.

- **Examples of Belgium and Netherlands**

Belgium: The FHA consists of the following approaches:

- **Fire Containment Approach (FCA):** to assess the fire barriers and is an iterative calculation. Numerical characterization based ISO 834. All the safety equipment inside the impacted room are lost when the first ignition occurs.
- **Fire Influence Approach (FIA):** More accurate and less conservative approach than FCA and uses state-of-the-art fire modelling techniques to evaluate the consequence of a fire on the targets (FHA equipment) inside the same compartment. This method is (computer)time intensive, and therefore used only in specific cases (large and/or complex volumes). The FIA is also used in case the FCA, the System Analysis and the Classification (see below) are not sufficient to demonstrate that the safety objectives are met.

Netherlands (Borssele NPP): two configurations for use in the fire protection analyses of redundant safety systems equipment that is identified as part of a safety function:

- **Containment approach:** A fire compartment of the KCB has a fire resistance of at least 60 minutes (F60) according to the rules of the Buildings Decree (Bouwbesluit).
- **Influence approach:** A fire cell has a lower fire resistance than F60. In this case, extra fire measures are required ((automatic) extinguishing equipment, detection, etc.).

The containment approach is the preferred approach; the influence approach is an alternative for it. The influence approach is applicable in about 54 % of all cases

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2. Effects of fire related compartmentation on the level conservatism/realism of Fire PSA (comparison)

Questions impacts on conservatism/realism of Fire PSA:

1. **Which countries apply the influence approach? For which types of installation/generation?**

2. **What are the reasons for using the influence approach, knowing that the containment approach is recommended by the standards?**

3. **How do you verify there is a sufficient margin when you use an influence approach? What are the potential issues/risks of too much realism?**

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3. **Cases where the use of ‘state-of-the art’ compartmentation is not fully possible and compensatory fire protection means are needed**

Summary report:

- Particularly, for older installations, compromises and slight adjustments may sometimes be justified based on reasonable practicability, if e.g. compliance with recent regulations is not fully possible due to operational reasons and improvements of fire barriers are often not possible
- In order to ensure the same fire protection level, credit is typically given to additional compensatory means (e.g. encapsulations of unprotected fire loads to physically separate them from potential ignition sources, protective intumescent/ablative coatings of cables) not representing a qualified fire barrier, but representing an effective upgrade to the original design together with additional active protection means
- Example of additional active protection means: could be the use of suitable fire suppression means, either for successfully extinguishing a fire in an early stage, when it is not fully developed, or cooling the potential target to prevent its failure. This implies that, where a full compartmentation is not possible a comparable protection level can be reached by appropriate compensatory means (e.g. separation/segregation of fire compartments and, as far as applicable, of fire cells).

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3. Cases where the use of ‘state-of-the art’ compartmentation is not fully possible and compensatory fire protection means are needed

Questions on cases when compartmentation is not fully possible/performed and compensatory measures/means (to be) implemented:

1. **What are the particular examples (e.g. areas) where compartmentation is not fully possible?**

2. **Which general approaches are used to compensate for the lack of compartmentation? Which particular compensatory fire protection means and measures do you apply?**

Please elaborate for NPPs, RRs, Fuel fabrication facilities, Decommissioning, Waste, & SFS installations

Thank you for your participation and contributions!