ENSREG
European Nuclear Safety Regulators Group

Topical Peer Review II

Fire protection at nuclear installations

Topic of interest:

Analysis of radiological consequences

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Analysis of radiological consequences

Background

As stated in the TPR Technical Specification, the defence in depth principle includes the need to "mitigate secondary fire effects and maintain safety functions identified as necessary in case of fire, including mitigation of the radiological consequences of the fire" by suitable protection means.

In the presence of radioactive materials, a fire can lead to radioactive substances being released into the nature.

Fire safety analysis

Analysis of radiological consequences

Aspects to be discussed

1. State of knowledge on the different phenomena to be analyzed.

2. Specific provisions to limit radiological releases in the event of fire and associated qualifications.

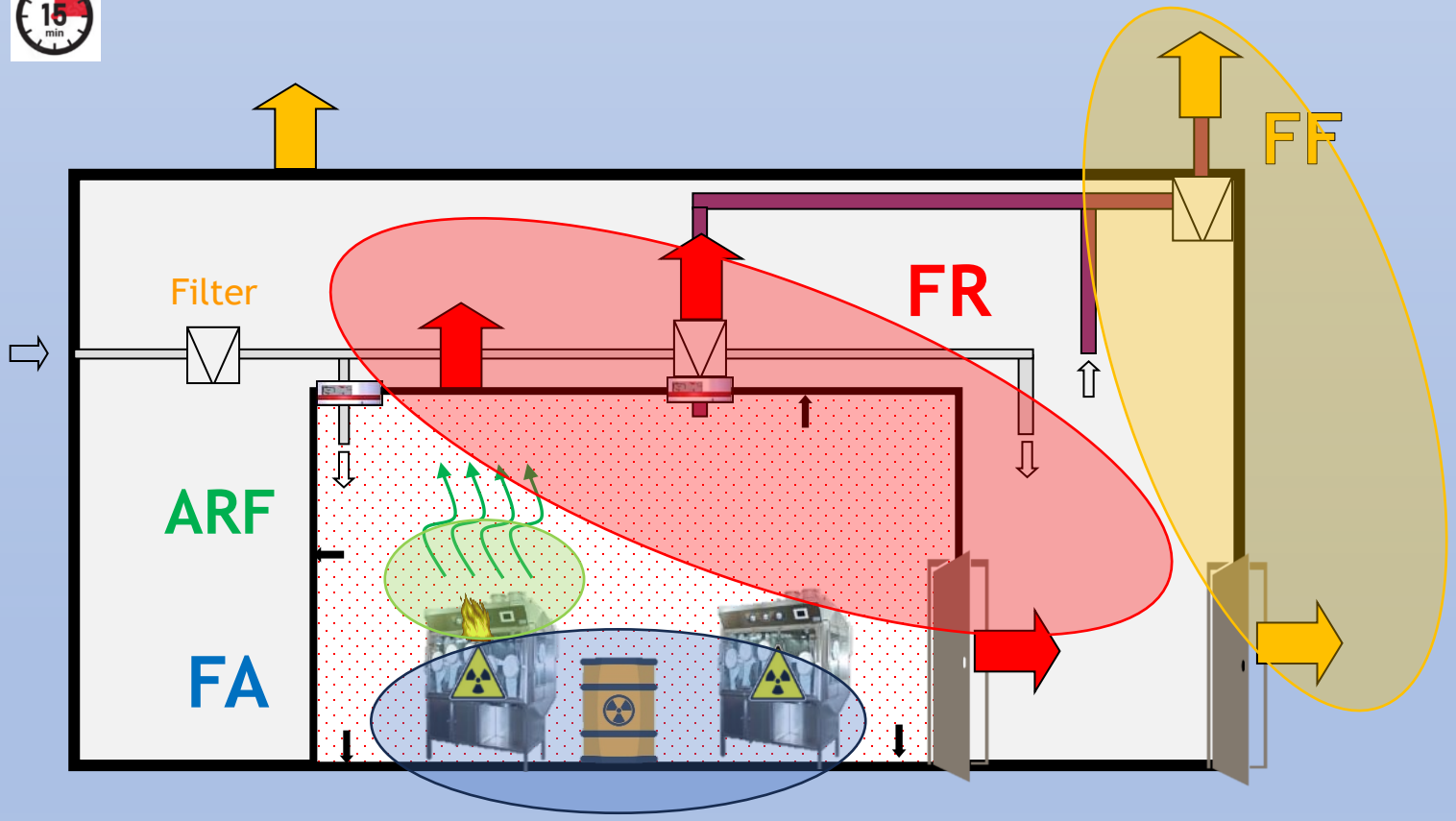
Expected outcome of discussion

- Overview of analysis practices and sharing data/needs of R&D
- Better insights from national approaches to share experience and identify potential good practices or challenges

Fire safety analysis

Analysis of radiological consequences

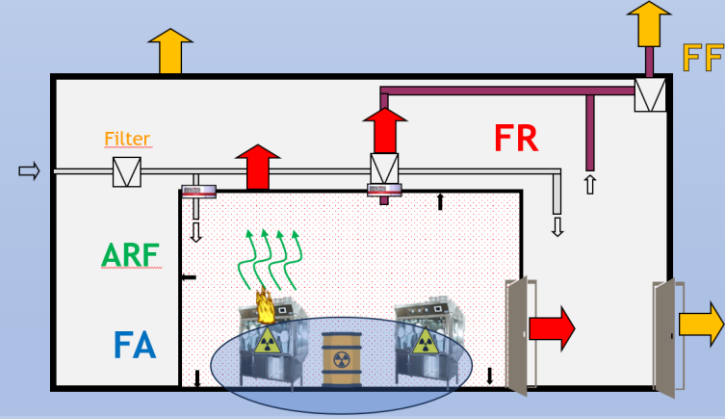
Different phenomena to be analyzed (example)



- **FA: Fraction of the radioactive materials (RM) affected by the fire**
- **ARF: Airborne release fraction of the "affected RM"**
- **FR: Aerosols fraction of the "affected RM" dispersed outside the "burning area"**
- **FF: Aerosol fraction of the "dispersed RM" released outside the facility**

Which countries have dedicated documents about fire radiological consequences analysis parameters?

Analysis of radiological consequences



1. State of knowledge on the different phenomena to be analyzed

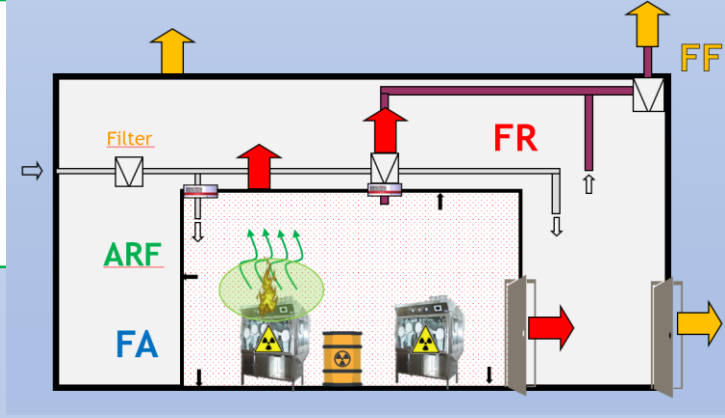
- FA: Fraction of the radioactive material affected by the fire
  - Size of the burning area (building, fire cell, room, equipment…)?
  - Benefit of fire extinguishing features?
  - Failure of waste packages due to fire?

Approaches reported in NARs:

- ✓ *conservatively, the maximum amount of uranium powder is involved in the event*
- ✓ *accordingly with the third level of defence in depth, concept is assumed that fire extinguishing systems fail and that firefighters do not respond quickly enough which causes fire development*
- ✓ *there are no materials in the storage areas that could release a quantity of heat that could impair the protective function of the stored waste containers*

Should the fraction of radioactive materials affected by the fire be conservative (failure of active means, justified fire resistance of passive means, etc.)?
What are the typical values for this parameter?

Analysis of radiological consequences



1. State of knowledge on the different phenomena to be analyzed

- ARF: Airborne release fraction of the radioactive materials affected by the fire

Approaches reported in NARs:

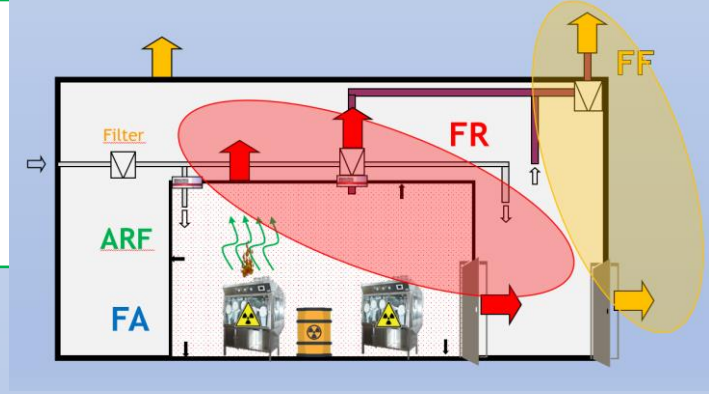
- ✓ The fraction of uranium released into the atmosphere is 0.01 (value defined from the operating experience and research)
- ✓ This evaluation notably takes into account the fraction placed in suspension IAEA-TECDOC-1162

Probably a fundamental parameter [IAEA-TECDOC-1162"] (hypothetical uranium fire scenario)

- *Non-volatile solids* *[ARF=0.0001]* *(0.7 mSv)*
- *Uranium and plutonium metal* *[ARF=0.001]* *(7 mSv)*
- *article attached to flammable trash in a fire* *[ARF=1]* *(7 000 mSv)*

What is the origin of the ARF values used?
How are the values used in the studies justified?
Is there any research that is being carried out on this parameter?
What are the typical values for this parameter?

Analysis of radiological consequences



1. State of knowledge on the different phenomena to be analyzed

- FR: Aerosols fraction of RM released outside the “burning area”
- FF: Aerosol fraction of RM, released outside the “burning area”, released outside the facility

- Deposition/redeposition of airborne particles in the building (walls, floor…)
- Filtration efficiency/filter clogging by soot
- Effectiveness of static containment knowing that the pressure effects of a fire disrupt air flows
- Ventilation management

Approaches reported in NARs:

- ✓ This evaluation takes into account the re-deposition onto the walls of the facility
- ✓ The control of aerosol releases consists of placing the largest number of independent physical barriers between the radioactive materials and the environment
- ✓ The released activity is filtered via the HEPA filters of the exhaust air system

How is the effectiveness of containment “barriers” (static and/or dynamic containment) determined? What are the typical values for these parameters?

Analysis of radiological consequences

2. Specific provisions to limit radiological releases in the event of fire and associated qualifications

- The control of radiological releases usually consists in placing the largest number of "barriers" between the radioactive materials and the environment (static and dynamic)

Approaches reported in NARs:

- ✓ The casks with spent nuclear fuel is the main barrier limiting the release of radioactivity
- ✓ Fire dampers are there to prevent the spread of fire and not to prevent the spread of contamination.
- ✓ Buildings containing radioactive materials shall be fire-resistant and have a controlled ventilation system to ensure no external radioactivity release after a fire
- ✓ Filters are qualified to function at 200° C for 2 hours + regular clogging and temperature measurements during the fire

What are the <u>fire qualified</u> containment measures used (filters, ducts, dampers, doors…)?
Do some installations have specific containment systems during the fire (smoke scrubber, fire containment cell, etc.)?

Fire safety analysis

Analysis of radiological consequences

Expected outcome of discussion

- Overview of analysis practices and sharing data/needs of R&D
  - proportion of radioactive materials involved in the fire
  - airborne release factors of the radioactive material(s) involved
  - effectiveness of the ventilation systems despite the fire/filters clogging by soot
  - combination between static and dynamic containment
  - Specific provisions to limit radiological releases in the event of fire and associated qualifications

- Better insights from national approaches to share experience and identify potential good practices or challenges

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Thank you for your participation and contributions !