

SITRON – SITE Risk Of Nuclear installations

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SITRON Project participants and stakeholders

Participants

- Risk Pilot
- Lloyd's Register
- VTT
- IFE Halden (2018)

Financiers

- Forsmarks Kraftgrupp AB
- Ringhals AB
- SSM
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- NKS (2018)

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Why site risk analysis?

- Licensing of nuclear power plants is made per unit
- Same limitation applies to probabilistic safety assessment (PSA)
 - Though unit dependencies should be taken into account in PSA
- Operational experience world-wide shows that multi-unit disturbances are not uncommon
- Especially after Fukushima Daichii accident, there has been internationally great attention to study site risk
 - No international consensus yet with regard to
 - Applicable risk criteria for a site
 - Method (compared to a single-unit PSA)



picture from SKI Report 02:27

Benefits of multi-unit sites

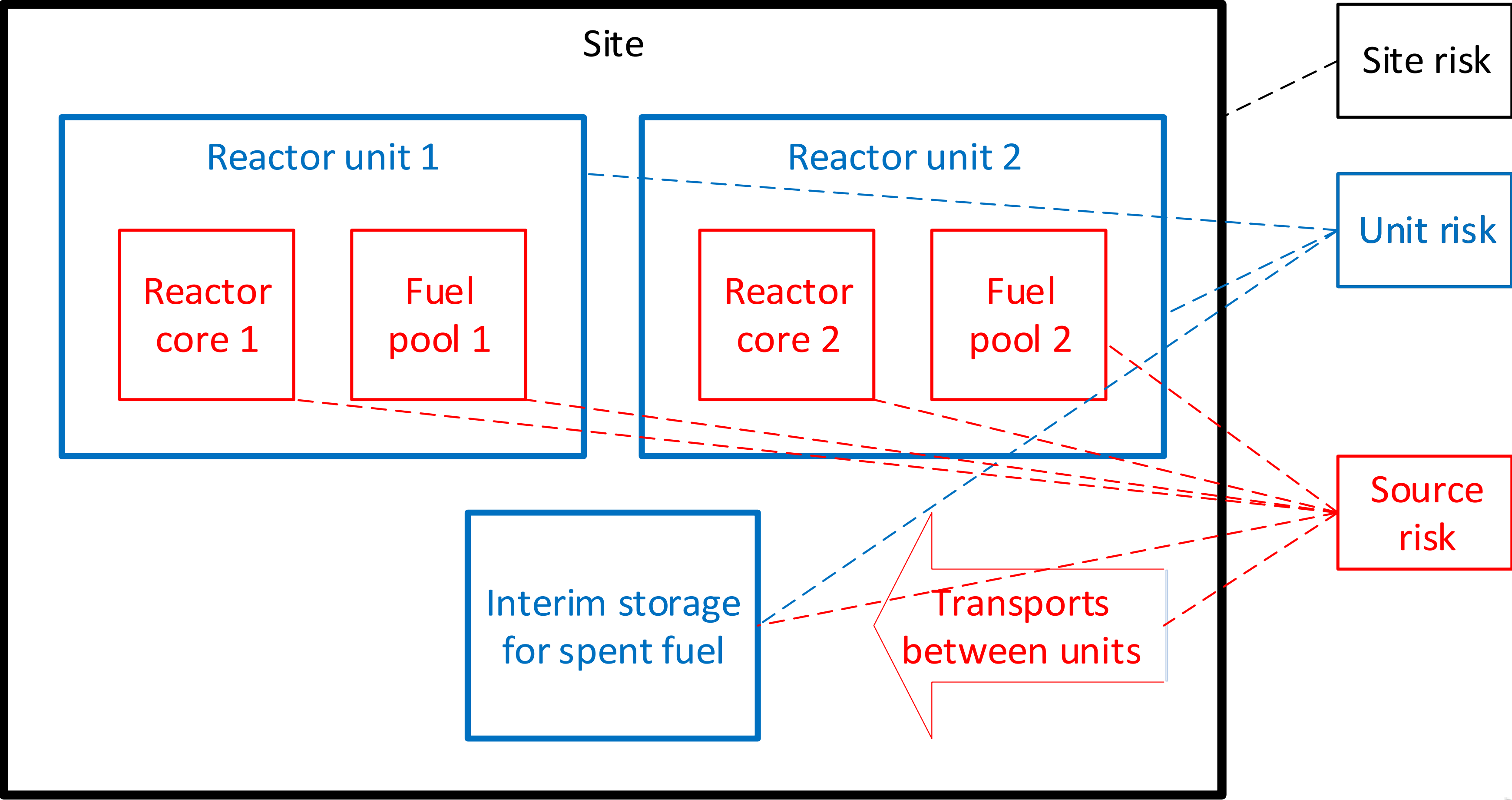


- Less land use per MWe
- Cost-effectiveness of shared systems and structures
- Less personnel per MWe
- Units can support each other in activities, e.g. in an emergency situation
- When truly comparing risks between sites, benefits of multi-units should be taken into account

Objectives with SITRON

- To search for practical approaches for Nordic utilities to assess the site level risk
 - Safety goals and risk criteria
 - PSA applications for a multi-unit site
- To develop methods to assess risk for multi-unit scenarios
 - Methods to identify, analyse and model dependencies between the units
 - Test the approach through pilot studies

Site risk concepts

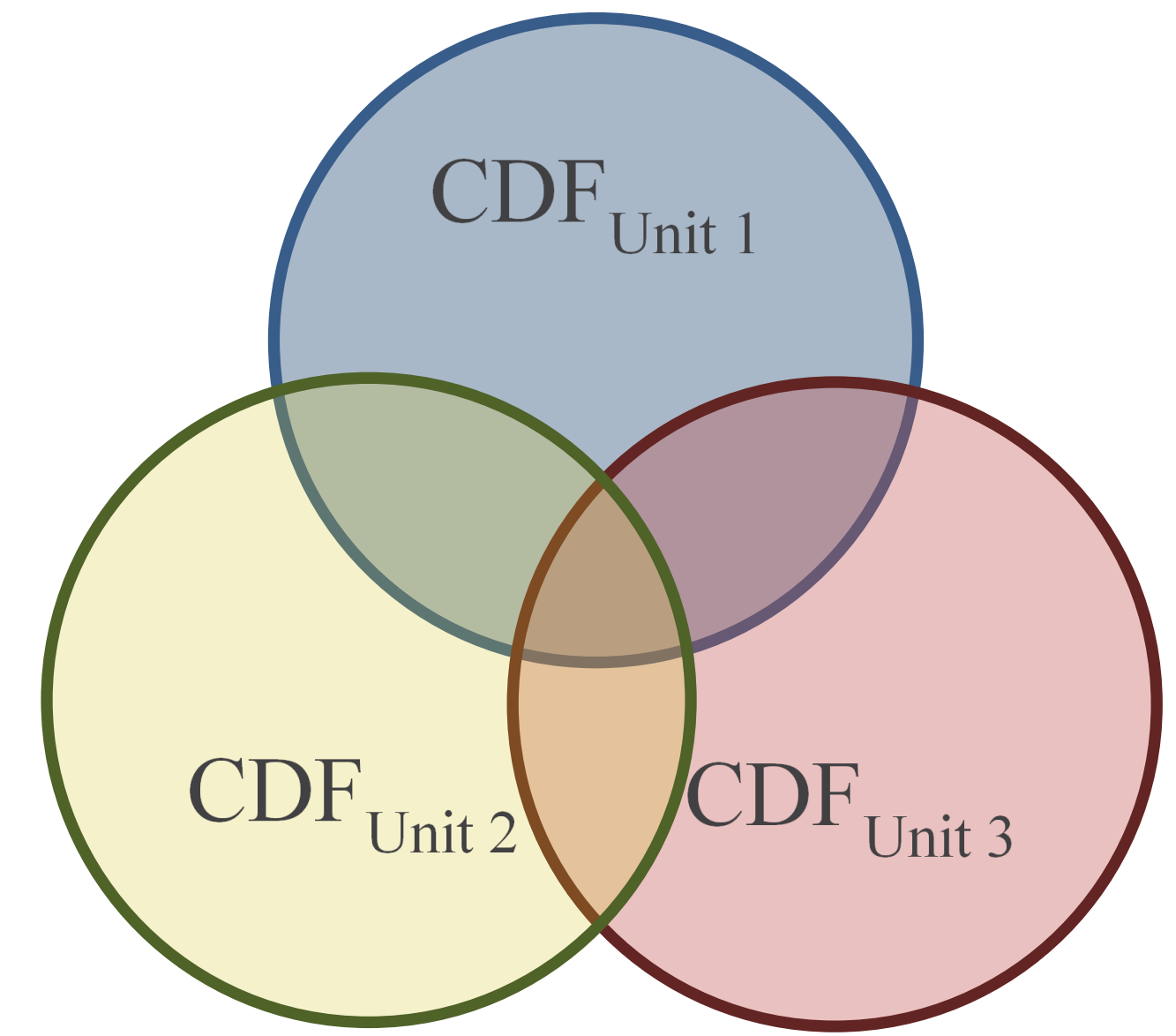


Safety goals for a multi-unit site

- Only few countries apply site level safety goals (UK, Canada)
 - Level 2/3 PSA related risk metrics (radioactive release, societal risk)
- No consensus yet => open issue

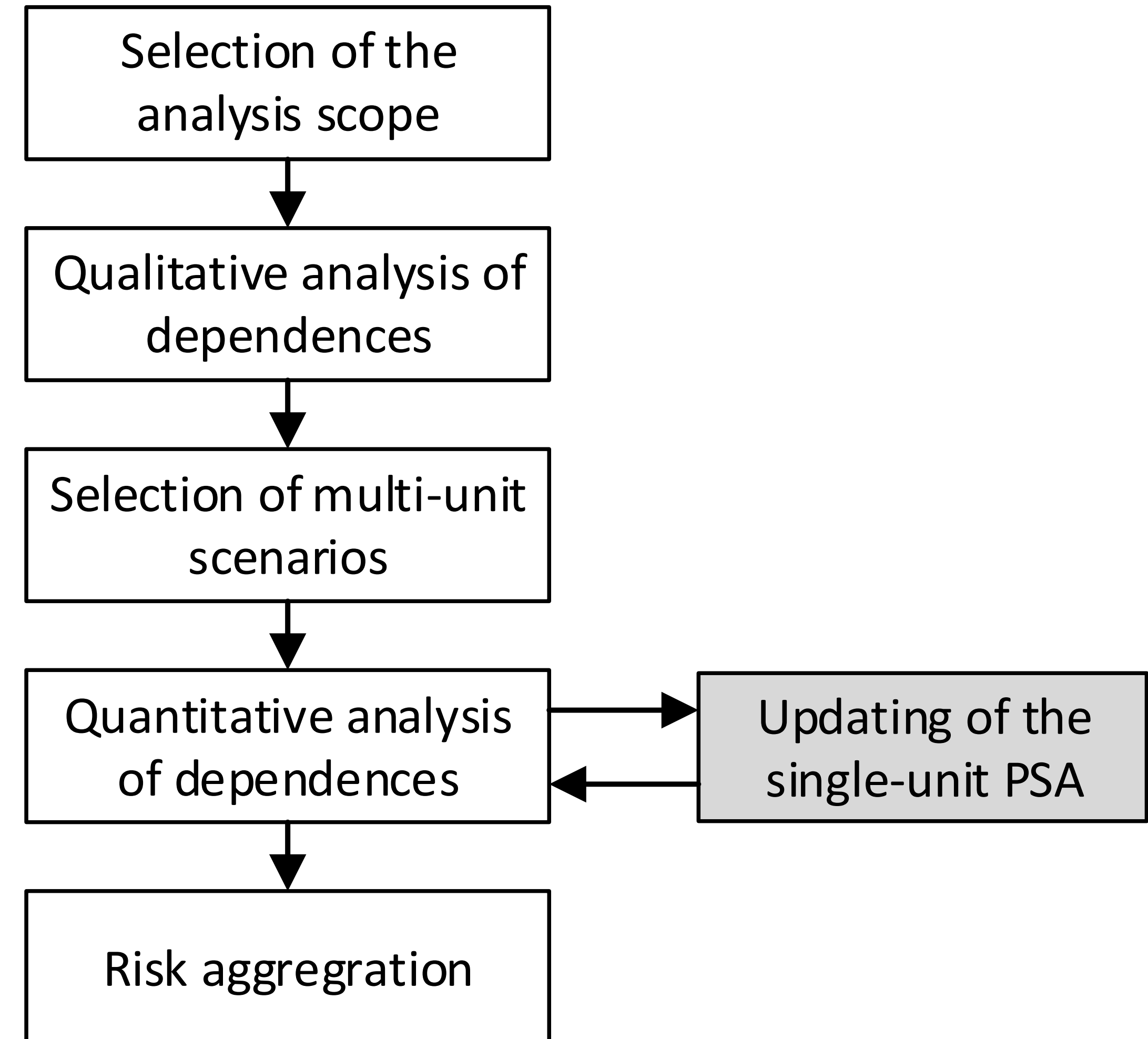
Multi-unit risk metrics

- In site PSA, accident end states are combinations of single unit accident end states
- Level 1 PSA
 - SCDF = Site core damage frequency
 - MUCDF = Multi-unit core damage frequency
- Level 2 PSA
 - Same release categorisation can be applied as in single-unit PSA
 - release size = sum of source terms
 - timing = earliest time point
 - SRCF = Site release category frequency



Site PSA method

- Current single-unit PSAs are already pretty good
- Additional efforts needed for a site PSA
 - Complement identification of dependencies
 - Screening of relevant dependencies
 - Data analysis
 - Quantification
 - Interpretation of results
- Applications of site PSA

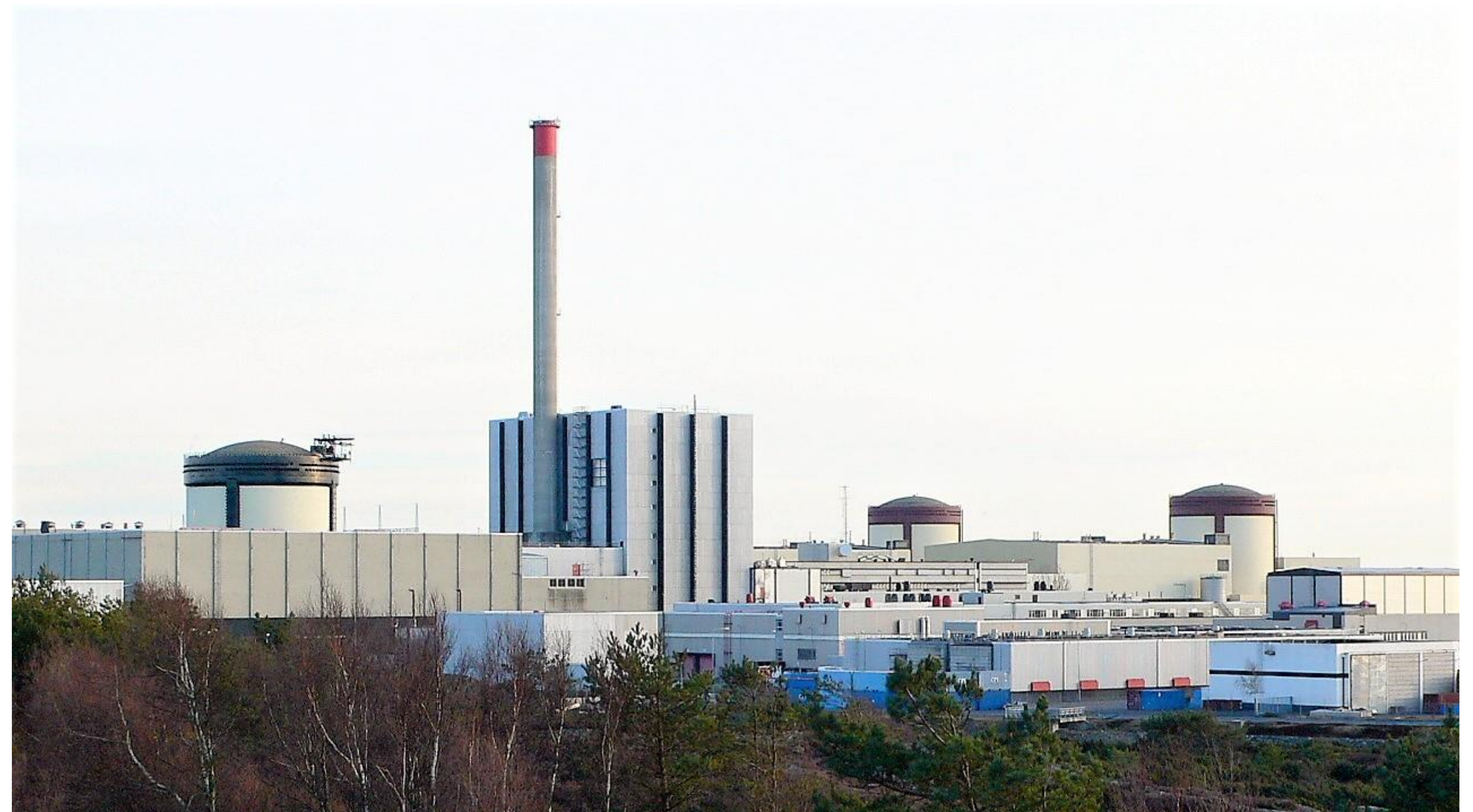


SITRON Pilot studies

Forsmark 1&2 (BWR units)



Ringhals 3&4 (PWR units)

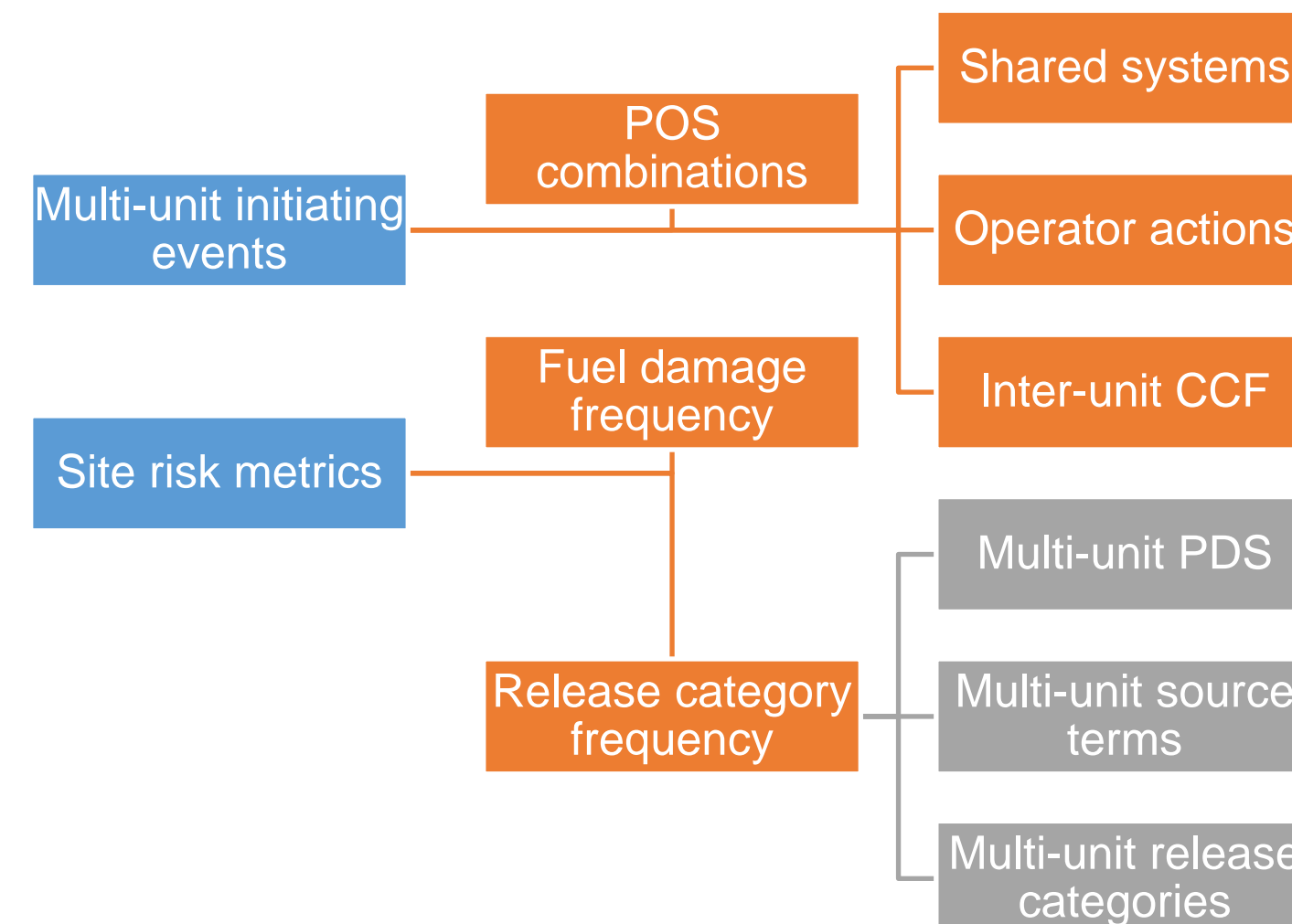


Pilot study findings

- Multi-unit initiating events can be limited to external hazards
 - Loss-of-offsite power
 - Loss-of-ultimate heat sink
- Units have several shared systems with different degree of importance
- By screening, the number of multi-unit scenarios can be limited considerably
- Inter-unit Common Cause Failures can be important contributors, but there is a large uncertainty
- Human reliability analysis is maybe the most interesting and useful part of site PSA
- Inter-unit dependencies are more important in level 1 PSA than in level 2 PSA

Site PSA model management

- Besides general method development, procedures are needed for documenting the site PSA, managing possible modifications made to the single-unit PSA models, and managing the data and computation
- A database system is needed to manage the analysis process
- Site PSA will rely on well documented and maintained single-unit (existing) PSAs



Role of Technical support centre in multi-unit scenarios

- Technical support centre (TSC) is the part of the emergency response organisation (ERO) that is in charge or will contribute to operational decisions at the plant during a severe accidents
- The exact tasks as well as the specific implementation of TSC is utility or even site-specific
- Possible challenges
 - Unclear command and control issues
 - Communication and coordination issues
 - Decision making issues
 - Training issues

SITRON survey of TSCs at Nordic sites

- The EROs and the role of the TSC in the Nordic countries NPPs differ
- Sometimes also reactor units within the same site have differences regarding, e.g., the location and instrumentation of the different control centres
- Emergency Manager is the ultimate decision maker for the entire site
- Access to relevant plant information is considered to be good
- EROs possess the technical competences and the organizational skills and capabilities required in severe and site-level accidents, as shown in drills and exercises
- Task definitions for the TSC and communication and cooperation could be improved
- TSCs have been considered in a limited way in current PSAs

Conclusions

- Site risk analysis has two purposes
 - Complement single-unit PSAs
 - Provide multi-unit risk metrics
- Safety goals are still connected to units, not at site level
- SITRON method provides a practical and cost-effective way of performing a site risk analysis
- So far, TSCs has been considered only in a limited manner in PSA

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