Addressing Off-site Consequence Criteria Using PSA Level 3 - Enhanced Scoping Study

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Outline

- Background and Purpose
- Scope and organization of project
- Short summary of selected activities
  - Industry survey
  - Risk metrics

- Project is jointly funded by:
  - Nordic PSA Group (NPSAG),
  - Nordic Nuclear Safety Research group (NKS) and
  - Finnish Research Programme on Nuclear Power Plant Safety (SAFIR2014).

Background and purpose

- Increased interest in PSA Level 3 and the Fukushima Daiichi disaster did put even greater focus on this area.
  - Shareholders and insurance companies may have an even stronger interest than regulators.
  - In parallel there are ongoing activities to develop an ANS/ASME PSA level 3 standard and IAEA are also working on a guidance document.

- The objective of this 3 year study is to further develop understanding in Level 3 PSA within the Nordic countries, in order to determine
  - the scope of its application,
  - its limitations,
  - the appropriate risk metrics,
  - and the overall need and requirements for performing a Level 3 PSA

Project scope and organization

- Scope of the project is to provide guidance in following areas:
  - Industrial purpose; what benefits can be achieved?
  - What kind of risk metrics can be used?
  - What requirements would a Level 3 PSA put on existing Level 1 & Level 2 studies?
  - Give Insights on abilities of existing Level 3 PSA tools/codes
  - Monitor international activities in development guides and standards
  - Development of a practical Nordic guidance document on how to perform a Level 3 PSA
- During Phase 1 (2013) the focus has been on following topics
  - Perform an industry and literature survey
  - Look into different risk metrics
  - Participation in IAEA activities related to development of Level 3 guidance

Industry and literature survey

- Main part has been to develop a questionnaire to perform and industry survey in order to support the project as a whole. This survey covered following topics:
  - Risk comparison
  - Needs for Level 3 PSA
  - Advantages and risk communication
  - Challenges with Level 3 PSA

- Some of the findings from the survey is provided in the following slides

Industry and literature survey - Findings

- **Risk comparison**
  - Possible to do but care is needed.
  - Respondents not in full agreement if comparison between NPPs is needed
  - Risk comparison is not a strong driver for performing Level 3.
- **Needs for Level 3 PSA**
  - Objective tool for decision making, e.g. costs and emergency preparedness
  - Difference in opinion regarding on how to define “unacceptable effects”:
    - Nuclear expert – Safety goal
    - Insurance – Deviation from “normal”
- **Advantages and risk communication**
  - If risk can be defined in comparable terms (e.g. monetary) it would be easier to communicate between different stakeholders.
    - Communication paths, next slide
- **Challenges with Level 3 PSA**
  - Several challenges, e.g. choice of risk metrics and how to handle uncertainties that stem from Level 1 and 2 (and within the Level 3)
  - Challenges do not motivate from not performing Level 3.

Industry and literature survey – Communication paths

- Nuclear experts

From → To↓	Experts	Authorities and Government	Media	Health and Envorinment	Private person
Private person	3	4	3	3	2
Health and Envorinment	3	4	1	2	
Media	3	4	2		
Authorities and Government	4	3			
Experts	3				

- Insurance companies

From → To↓	Experts	Authorities and Government	Media	Health and Envorinment	Private person
Private person		5	3		
Health and Envorinment	5				
Media	3	3	1		
Authorities and Government	2	3			
Experts	3				

Appropriate risk metrics

- Main objective during Phase 1 was to discuss different risk metrics and their advantages and disadvantages and thereby contribute to the further work in the project.
- Safety goals (numerical criteria) as such are not discussed.
- Risk metrics of PSA Level 3 have two components:
  - **Probability metric, e.g.**
    - Per unit or site and year (comparable to Level 1 and 2 PSA)
    - Per lifetime, per produced energy over complete fuel cycle
      - May be more relevant if total risk is to be considered
  - **Consequence metric**
    - Health effects – Dose
    - Environmental impact
    - Economic impact (can include every other risk metric)

Appropriate risk metrics – conclusions

- **Health effects — Dose**
  - Identified metrics:
    - Collective dose/individual dose
    - Prompt fatalities (short term)
    - Cancer fatalities (long term).
  - Advantages:
    - Straight forward to calculate.
    - Both short and long term
  - Disadvantages:
    - Do not capture complete impact, e.g. contamination etc not covered.

- **Environmental impact**
  - Identified metrics:
    - Ground contamination level due to Cs-134 and Cs-137
    - Non-usable areal of land and sea
  - Advantages:
    - Same as health effects in many ways
  - Disadvantages:
    - How to evaluate the impact between different of land?
    - Comparison between sites need conversion factors.
    - Release to sea or river is complex, considered not as important as air and land.

Appropriate risk metrics – conclusions

- **Economic impact**
  - Identified metrics: Total cost [€]
  - Advantages:
    - Theoretically all impacts can be covered by single metric.
    - Consistent risk comparisons and cost-benefit analyses
  - Disadvantages:
    - Difficult to agree on what should be included and how to convert different impacts in a monetary scale.

- **Economic impact – Thoughts**
  - Despite the difficulties it should be sufficient to estimate order of magnitude of different types of accidents.
    - TMI with no external release would mean certain economic impact.
  - Other magnitudes can be assumed depending on release dispersion.
  - Despite the difficulties of conversion into monetary values the exercise can be useful.
    - Commonly agreed conversion factors
    - Increased understanding of risk and facilitate communication

Ongoing and future work

- During Phase 1 (2013) focus has been on
  - Industry Survey – User needs
  - Risk metrics – exploring different possibilities
  - Regulation and standards – mainly participation on IAEA work

- During Phase 2 (2014) focus is on:
  - Regulation and standards – participate with IAEA and monitor ANS/ASME
  - Pilot application – one from Sweden and one from Finland
  - Start with guidance document

- During Phase 3 (2015) aim is to focus on:
  - Finalize pilot applications
  - Finalize guidance document

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