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

Presentation at PSAM 12, Thursday 6/26/2014, Honolulu, Hawaii, USA
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

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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

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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
• 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**

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- **Insurance companies**

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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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