Decision-Making in an Uncertain World: Regulatory Challenges

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Outline

- Objectives
- Plant States, Accidents and Decision-Making
- Challenges and Promising Developments
- Conclusions
- Questions
Objectives

• Identify challenges for decision-making when dealing with nuclear accidents ranging from design basis accidents to severe accidents, from the perspective of a regulator

• Contribute to safety improvement initiatives

• Identify areas for research
• Some terminology first...
Decision-making

- Several available classifications, but simple (and sensible) often works best – Rasmussen’s S-R-K
  - Skill, rule and knowledge-based behaviour (SBB)
  - On any given day, a mixture of these behaviours is used
    - incorrect to assume that normal operations are purely SBB and RBB, and that abnormal, unexpected situations are solely KBB
  - SBB and (mostly) RBB are normally supported by operating manuals or emergency operating procedures (EOPs), training and proper supervision
Plant States, Accidents and Decision-Making

- Individual decision-making is important but is not the whole story
  - Individual and crew
    - Event-handling strategies are specified and practiced to ensure robust handling of abnormal operating occurrences (AOOs) and design basis accidents (DBAs)
      - Judicious combination and coordination of event-based and symptom-based EOPs, proper allocation of roles to the operating crew
  - Locus of control for decision-making
    - Up to and including DBAs: essentially the crew, with alerting of emergency response team as warranted
  - Staffing
    - Licensees for power plants are normally required to maintain a predetermined number of qualified personnel, known as the minimum shift complement (MSC)
### Plant States, Accidents and Decision-Making

#### Putting it together … and looking forward

<table>
<thead>
<tr>
<th>Plant States</th>
<th>Normal</th>
<th>AOO</th>
<th>DBAs</th>
<th>Within design basis accidents</th>
<th>Beyond design basis accidents</th>
<th>Beyond design basis accidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability of rad. release</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Accident Management Program</td>
<td>Emerg. Preparadness</td>
</tr>
<tr>
<td>Response to be performed</td>
<td></td>
<td>Local (or mostly)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Locus of control</td>
<td></td>
<td></td>
<td></td>
<td>Possibly more global</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of response</td>
<td>Operating manuals</td>
<td>EOPs (event based)</td>
<td>EOPs (event based)</td>
<td>EOPs (event or symptom based)</td>
<td>EOPs (event or symptom based)</td>
<td>SAMGs</td>
</tr>
<tr>
<td>Type of decision-making</td>
<td>Mostly S, a fair bit of R, at times a bit of K</td>
<td></td>
<td></td>
<td>Some S, some R, at times some K</td>
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<tr>
<td>Staffing</td>
<td>Minimum Shift Complement (MSC)</td>
<td></td>
<td></td>
<td>Sufficient number of qualified staff (includes MSC and some)</td>
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</tbody>
</table>

- **AOO**: Above Operating Aspiration Level
- **DBA**: Design Basis Accident
- **BDBA**: Beyond Design Basis Accident
- **S**: Safe
- **R**: Recovery
- **K**: Kerma
- **EOPs**: Event Operating Procedures
- **SAMGs**: Senior Accident Management Group
- **MSC**: Minimum Shift Complement

Challenges and Promising Developments

• Change in the locus of control, on-site
  – From MSC to another group (at the facility)
• Change in the locus of control, on and off-site
  – From the “local” level to a more “global” level
• Understanding what KBB is and how to best support it
  – How to enable individuals, and the team, to deal as well as possible with the unexpected
  – Integration with accident response (i.e., accident handling)
  – Some scientific knowledge is available, but far more is needed
• How to specify requirements for sufficient number of qualified staff
  – Roles, qualifications vs knowledge, mission time, availability, etc.
Conclusion

• Reviewed existing knowledge on decision-making and accident management
• Identified issues and challenges in the decision-making behaviours for the management of nuclear accidents and associated emergencies
  – changes in the locus of control, on-site and off-site,
  – lack of knowledge about how to best support decision-making at the KBB level, and
  – definition of what is meant by “sufficient number of qualified staff”.
• Opportunity for the regulator and industry to deepen knowledge and improve accident response planning
• Questions?

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