



Methods for Qualitative Evaluation of Likelihood

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Statement of the Problem

- 10 CFR 70.61 performance requirements:
 - High consequence events => “highly unlikely”
 - Intermediate consequence events => “unlikely”
- 10 CFR 70.62(c)(1)(v) requires ISA identify consequences and likelihoods of potential accident sequences
- NUREG-1520, Section 3.4.3.2 states that likelihood evaluation may be:
 - Quantitative (e.g., highly unlikely 10^{-5} /yr/accident sequence); or
 - Qualitative
- No consistent standard of what constitutes acceptable qualitative likelihood method



Method Overview

- One proposed example of a qualitative likelihood method...
 - Acceptable to the staff (if used by applicant)
 - For use by staff in evaluating applicants' ISA Summaries
- Provides means of determining whether reliability and availability qualities of controls are sufficient to support compliance with 10 CFR 70.61
- Relies on qualitative characteristics of systems of IROFS



Method Overview

- For individual IROFS:
 - Safety margin in controlled parameter (compared to variation/uncertainty)
 - Type of control (passive, active, administrative)
 - Type and grading of management measures (surveillance, training, etc.)
 - Failure detection (fail-safe, self-announcing, subject to formal surveillance)
- For systems of IROFS:
 - Defense-in-depth
 - Redundancy
 - Independence



Methodology

- Evaluate whether spectrum of accident sequences is complete
- Determine screening consequences for radiological, criticality, chemical events (NOTE: “Event” here means unmitigated accident sequence, rather than initiating event.)
- Determine accident sequence category:
 - Highly reliable and available multiple, independent controls
 - Single failure with very large safety margin
 - Single rare event with backup administrative control
 - More than two redundant controls
 - (Criticality events: discussed in separate presentation)



Methodology

- Determine qualitative IROFS reliability, based on combination of:
 - Control category (robust passive, less robust passive, continuously active, standby automatic, or administrative)
 - Surveillance category (biennial, monthly, weekly, or failure-evident)
 - *(NOTE: Admin controls generally require reliable hardware, training, and written procedures to be reliable; may also require multiple overchecks.)*
- Final assignment of likelihood: should consider all available information about reliability of IROFS. Should consider:
 - Type and quality of controls
 - Surveillance
 - Duration of failure
 - Effect of other management measures



Methodology

- Additional considerations to consider:
 - Independence (see next slide)
 - Safety margin
 - Mitigative IROFS
 - IROFS boundaries
 - Industry experience
 - Sole IROFS
 - Quality assurance elements
 - Uncertainties



Independence of IROFS

- Lack of independence if failures of both controls can be caused by:
 - Common hardware component
 - Loss of utility function
 - External failures (e.g., support structures, drops, etc.)
 - Credible worker actions (vehicle collisions, improper maintenance)
 - External events (aircraft crashes, earthquakes, floods, fires)
 - Abnormal process conditions (line plugging, high temperature, chemical reactions)
- Independence not strictly required to meet 70.61 (but may be required for criticality (70.64) or by methodology)
- Considered highly desirable due to potential for risk reduction.