FIRE SAFETY REVIEWS OF NUCLEAR FUEL CYCLE FACILITIES

(LICENSED UNDER SUBPART H OF 10 CFR 70)

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Fire Safety Review Objectives

- Assure that the License Application meets the Requirements of the Regulation
- Assure that Fire Induced Consequences are Mitigated or Prevented (Radiological and Chemical) in accordance with the Performance Requirements
- Assure that Good Engineering Practices are Followed (New Facilities)

Subpart H
ISA Requirements

- Perform an integrated safety analysis (ISA)
- Comply with performance requirements of 10 CFR 70.61
- Establish Management Measures
- Facility Changes
- Baseline Design Criteria
- Backfitting
- Reporting Requirements

Risk-Informed Regulations and Guidance

- Subpart H of 10 CFR Part 70 September 2000
- NUREG-1520, "Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility," March 2002
- NUREG-1718, "Standard Review Plan for the Review of a License Application for a Mixed Oxide (MOX) Fuel Fabrication Facility" August 2000
- NUREG-1513, "Integrated Safety Analysis Guidance Document" May 2001
- Interim Staff Guidance

Risk Matrix With Risk Index Values

Severity of Consequences	Likelihood of Occurrence		
	Likelihood Category 1 Highly Unlikely (1)	Likelihood Category 2 Unlikely (2)	Likelihood Category 3 Not Unlikely (3)
Consequence Category 3 High (3)	Acceptable Risk 3	Unacceptable Risk 6	Unacceptable Risk 9
Consequence Category 2 Intermediate (2)	Acceptable Risk 2	Acceptable Risk 4	Unacceptable Risk 6
Consequence Category 1 Low (1)	Acceptable Risk 1	Acceptable Risk 2	Acceptable Risk 3

Consequence Severity Categories Based on 10 CFR 70.61

Table A-5 from NUREG-1520

	Workers	Offsite Public	Environment
Category 3 High Consequence	*RD>1 Sievert (Sv) (100 rem)	RD>0.25 Sv (25 rem) 30 mg sol U intake	
Category 2 Intermediate Consequence	0.25 Sv (25 rem) <RD# 1 Sv (100 rem)	0.05 Sv(5 rem) < RD# 0.25 Sv (25 rem)	Radioactive release > 5000 x Table 2 Appendix B of 10 CFR Part 20
Category 1 Low Consequence	Accidents of lower radiological and chemical exposures than those above in this column	Accidents of lower radiological and chemical exposures than those above in this column	Radioactive releases with lower effects than those referenced above in this column

* RD - Radiological Dose
**CD - Chemical Dose proposed by applicant
Note: > = greater than, < = less than, and # = less than or equal to

Additional Requirements For New Facilities or New Processes at Existing Plants 10 CFR 70.64

- Baseline Design Criteria
  - Quality
  - Standards
  - Natural Phenomena hazards
  - Fire Protection
  - Environmental and Dynamic Effects
  - Chemical Protection
  - Emergency Capabilities
  - Utility Services
  - Inspection
  - Testing and Maintenance
  - Instrumentation and controls
- Defense-in-Depth

Fire Safety Reviews

- License Application Review
- ISA Summary Review
- Onsite Reviews
- Operational Readiness Review

License Application Review

(Chapter 7 of NUREGs 1520 & 1718)

- Facility Fire Protection Program
- Facility Fire Protection Design
- Emergency Response
- Process Fire Safety
- Commitments to Codes and Standards

ISA Summary Review

(Chapter 3 of NUREG 1520 and Chapter 5 of NUREG 1718)

- Completeness of Fire Sequences
- Characterization of Initiators
- Reliability of Controls
- Effectiveness of Controls

Onsite Reviews

- ISA Methods Review
  - Selection of Appropriate ISA Methodology
  - Proper Application of Methodology
- Vertical Slice Reviews
  - For Specific IROFS or Event Sequences
  - Conservatism of Assumptions
  - Evaluation of Fire Hazards Analyses
- Horizontal Review
  - Review Across Disciplines or Processes
  - Evaluate Completeness

Operational Readiness Review

- Required by 10 CFR 70.32(k) for Uranium Enrichment Facilities & 70.23(a)(8) for MOX
- Conducted by NRC Regional Office
- Risk Informed Input from License Reviewers
- Finalized Design and Conformance with License Application is Evaluated

Basic Fire ISA Methods

- Quantitative
  - Fire Initiation Probability
  - Quantitative Reliability of Fire Controls
- Qualitative
  - Fire assumed to occur
  - Reliability of controls assessed through attributes

Identify Items Relied on for Safety (IROFS)

- Structures, Systems, Equipment, Components, and Activities of Personnel
- Active and Passive Engineered Features, Enhanced Administrative Control, Administrative Control

TYPICAL FIRE ACCIDENT SEQUENCE

Event Initiator	IROFS1	IROFS2	Defense-in-Depth	Possible Outcomes
Fire	Suppression System	Combustible Controls	Fire Department	
POE = .01/yr	PFOD =.01	PFOD=0.1	Not credited	No release ------- or ------ Release but Highly unlikely $P=10^{-5}$/yr

Conflicting Concerns

- Fire Safety vs. Glovebox Confinement
- Fire Safety vs. Criticality
- Fire Safety vs. Electrical
- Fire Safety vs. Dynamic Confinement

Fire Related Areas of Interest

- Fire Induced Rupture of UF6 Cylinders
- Fire Induced Release of Toxic gases
- Prevention of Hydrogen Explosions
- Protection of HEPA Filters

Lessons of Experience and Concluding remarks

- Experience based initiation probabilities may not be conservative
- Control reliabilities need to consider all failure modes
- The same control may provide different levels of protection for different scenarios
- The same control may provide different types of protection for different scenarios

Lessons of Experience (cont)

- Diversity and redundancy help to provide high reliability but are scenario specific
- Common cause failures need to be considered in the initiation, prevention, and mitigation of an accident scenario
- Probability of failure on demand and failure rate should not be confused