Integrated Safety Analysis (ISA) Approach and Method

International Isotopes, Inc.

FEP & DUF_6 Deconversion Facility

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General Comments

- Part 40 license following Part 70 licensing requirement
  - Part 70 facilities are inherently higher risk
  - First of a kind safety analysis and licensing application for a Part 40 facility
  - Should be a graded approach to address hazards for a Part 40 licensee
    - No graded approach considered with respect to any analysis or documentation

ISA Methodology

- Follows methodology specified in 10 CFR Part 70, Subpart H
  - Uses NUREG-1520 and NUREG-1513 as guides for format and content
    - Specifically with respect to documentation and flow of analyses (NUREG-1520 used as an outline)
  - Relies on experience base from other NRC regulated facilities
  - Reviewed recent LES ISA Summary and other licenses for comparison

ISA Methodology (continued)

- FEP/DUF_6 Deconversion plant is considered a low-hazard nuclear facility
  - Only one postulated criticality safety scenario (getting enriched uranium by mistake)
  - No process related scenarios lead to intermediate or high radiological consequences to workers or the public (excluding criticality, NPH and other external events)
  - No process related scenarios lead to offsite radiological environmental consequences (excluding criticality, NPH and other external events)
  - Primary hazards are from HF or HF reaction product resulting in chemical dose to workers and the public

ISA Team

- ISA team has broad based experience
  - NRC ISA experience at chem-nuclear plants
  - PHA, accident analysis, risk and reliability expertise
  - Expertise in engineering, process and radiological safety, safety analysis, and HF, UF_6, uranium and fluorine chemistry

Key ISA Elements

- Hazard Identification
  - Identification, location, and inventory of potential hazards at the plant site
- Hazard Screening
  - Identifies hazards that have the potential to exceed low consequences categories as specified in 10 CFR 70.61
  - Excludes standard industrial hazards from further detailed analysis

Key ISA Elements (continued)

- Process Hazards Analysis (PHA)
  - What if/checklist methodology
    - Approved method per NUREG-1513
    - Appropriate method based on facility hazards and complexity
  - Identifies scenarios that can lead to intermediate or high consequences to workers and the public
    - Chemical, radiological and environmental consequences

Likelihood Analysis

- Frequency of the initiating event
  - Frequency assignment is based on NUREG-1520 criteria (some limited credit taken for non-IROFS process controls)
- Failure probability of prevention/protection features
  - Failure probability assignment is based on NUREG-1520 criteria (used conservative side of the numbers unless a basis otherwise)
- Failure duration was not used to determine likelihood
  - Nature of the process did not provide a need for duration credit

Initiating Event Frequency Index

- The following values were assigned to initiating event frequencies:

Failure Frequency Index	Based on Evidence	Comments
-6	External Event with frequency of $<10^{-6}$/yr	If initiating event, no IROFS needed.
-5	External Event with frequency of $>10^{-6}$/yr and $<10^{-5}$/yr	If initiating event, no IROFS needed.
-4	No occurrences in 30 years for hundreds of similar systems in industry	Rarely can be justified by evidence.
-3	No occurrences in 30 years for tens of similar systems in industry	Requires multiple failures or failure of a robust passive system to result in adverse consequences.
-2	No occurrences of this type in this facility in 30 years	Applicable for passive system failures.
-1	A few occurrences during facility lifetime	Applicable for routine mechanical failures.
0	Occurs every 1 to 3 years	Applicable for operator errors, loss of power, or other routine system failures.
1	Several occurrences per year	
2	Occurs every week or more often	

Failure Probability Index

- The following values were assigned for failure probabilities of prevention/protection features

Probability Index	Probability of Failure on Demand	Based on Type of IROFS	Comments
-6	10^{-6}		If initiating event, no IROFS needed.
-4 or -5	10^{-4} - 10^{-5}	Exceptionally robust passive engineered control (PEC) IROFS or an inherently safe process, or two independent active engineered controls (AECs), PECs or enhanced administrative controls IROFS	Rarely can be justified by evidence. Further, most types of single IROFS have been observed to fail.
-3 or -4	10^{-3} - 10^{-4}	A single passive engineered IROFS or an active engineered IROFS with high availability	
-2 or -3	10^{-2} - 10^{-3}	A single active engineered IROFS, a single enhanced administrative IROFS, or an administrative IROFS for routine planned operations	
-1 or -2	10^{-1} - 10^{-2}	A single administrative IROFS that must be performed in response to a rare unplanned demand	
-1	10^{-1}	Maximum protection credit given to an non-IROFS engineered or administrative control	Such controls lack the management measures needed for high availability as IROFS

Likelihood Determination

- Used the qualitative likelihood index method to determine likelihood category
  - Order of magnitude method as described in NUREG-1520, Rev 1 (page 3-AA-1 “Likelihood Definitions”)
- Likelihood index value is determined by summing the Frequency index and failure probability index to get an overall likelihood index number “T”

Likelihood Categories Determination

- The three likelihood categories are determined based on the resulting “T” values from each accident sequence

Likelihood Category	Likelihood Index T (sum of index values)
1	$T \leq -5$
2	$T = -4$
3	$-4 < T$

Likelihood Categories Values

- Likelihood values are defined as follows:

Likelihood Category	Event Likelihood
1	Not Unlikely
2	Unlikely
3	Highly Unlikely

Consequence Analysis

- Consequence Receptors
  - Worker, public, and environment
- Consequence Severity Levels
  - Low Consequences = 1
  - Intermediate Consequences = 2
  - High Consequences = 3

Consequence Analysis (continued)

- Three basic consequence types
  - Chemical release, radiological release, and soluble uranium release
- Seven consequence effects
  - Chemical dose to worker and public, radiological dose to worker and public, soluble uranium uptake to worker and public, and environmental damage
- Consequence level criteria is from 10 CFR 70.76
- Consequence are based on hazardous material type, inventory, flow rates, and release methods/fractions

Items Relied On For Safety (IROFS)

- IROFS are the credited prevention/protection features or mitigation features that are relied upon to meet acceptable risk levels for accident scenarios
  - IROFS are identified and assigned as needed during the risk analysis
  - Credit for IROFS as prevention or mitigation is based on the type of IROFS (passive, active engineered, etc.) as described in NUREG-1520
  - No credit is taken for prevention/protection and mitigation for non-IROFS controls

Risk Determination

- Risk is determined by multiplying the likelihood category number by consequence category number to get a total risk index value
  - Risk index values of 4 or less meet the performance criteria in 10 CFR 70.61 and are acceptable
  - Risk index values greater that 4 require additional prevention/protection features and/or mitigation features to reduce the risk to an acceptable level

Risk Index Values

- The following Risk Index values are applied based on the likelihood and consequences of an accident sequence:

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

Risk Tables (Accident Sequences)

- Risk Tables were compiled to evaluate accidents that could result in intermediate or high consequences
  - –Used the PHA as the starting point (initiating event, consequences, potential IROFS, etc.)
    - Refined initiating event frequencies and consequences prior to completing the risk tables
  - –Consistent with the example in NUREG-1520 and modified as needed to meet our needs
    - NUREG-1520 example is more geared toward criticality safety scenarios

Risk Table Methodology

- Evaluated uncontrolled accidents based on initiating event frequency and consequences
  - Likelihood Index “T” based on initiating event frequency
  - Consequences are assumed unmitigated
- Risk acceptability determined based on Risk Index value
  - Risk Index values greater than 4 are unacceptable and require IROFS to meet the performance requirements specified in 10 CFR 70.61

Risk Table Methodology (continued)

- IROFS added to accident scenarios that have unacceptable Risk Index values
  - Prevention/protection IROFS to reduce likelihood category
  - Mitigation IROFS to reduce the consequence category
- Priority was to reduce the likelihood category, if possible

Current ISA Status

- Complete NPH and external event analysis
- Respond to RAIs
- Update ISA Summary to include NPH/External events and other changes (RAI corrective action, design changes, etc.)
- Update License Application sections to reflect above changes