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The Use of SCALE in the Licensing and Inspection of NRC-Regulated Fuel Cycle Facilities

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Overview

- Regulatory Framework
- Licensing
  - Evaluation of Subcritical Margin
- Inspection
  - Event Review
    - Example – Scrubber Event
  - Emergency Response
    - Example – Desiccant Filter Event

Regulatory Framework

- Title 10 of the *Code of Federal Regulations* (10 CFR)
  - Part 70 – Fuel Fabrication, Enrichment
    - Westinghouse (Hopkins, SC)
    - Framatome (Richland, WA)
    - Global Nuclear Fuels (Wilmington, NC)
    - BWXT Nuclear Operations Group (Lynchburg, VA)
    - Nuclear Fuel Services (Erwin, TN)
    - URENCO USA (Eunice, NM)
  - Part 76 – Gaseous Diffusion Plants
    - None

Regulatory Framework

- 10 CFR 70.61(d)
  - "…the risk of nuclear criticality accidents must be limited by assuring that under normal and credible abnormal conditions, all nuclear processes are subcritical, including use of an approved margin of subcriticality for safety."
  - ANSI/ANS 8.1
    - "Before a new operation with fissionable material is begun, or before an existing operation is changed, it shall be determined that the entire process will be subcritical under both normal and credible abnormal conditions."

Licensing – Evaluation of Subcritical Margin

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$$k_{eff} = k_{calc} + 2\sigma_{calc} + \beta + \sigma_{\beta} + \Delta_{AOA}$$

$$\beta = k_{calc} - k_{physical}$$

$$USL > k_{eff} + MMS$$

Licensing – Evaluation of Subcritical Margin

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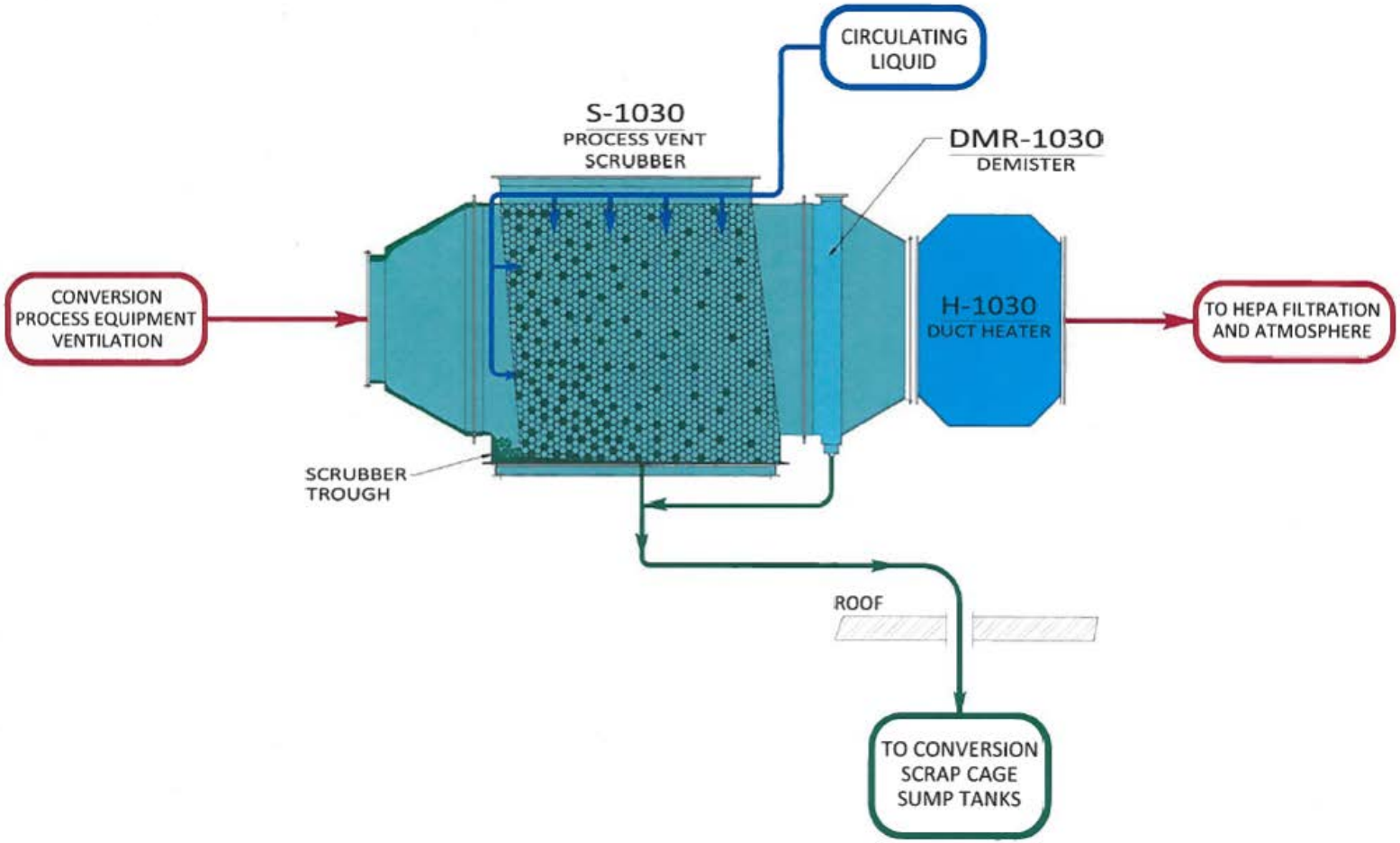
- The Minimum Margin of Subcriticality (MMS) must be justified.
  - Confidence in Bias and its Uncertainty
    - Similarity of Critical Experiments to Application
    - Sufficiency of Data
    - Validation Methodology Rigor
    - Statistical Conservatism
  - Conservatism in Calculational Methods
    - Parametric Treatment

Inspection – Event Review

- Independent Assessments of Event
  - Evaluation of Safety Significance
  - Evaluation of As-Found Conditions

Example - S-1030 Scrubber



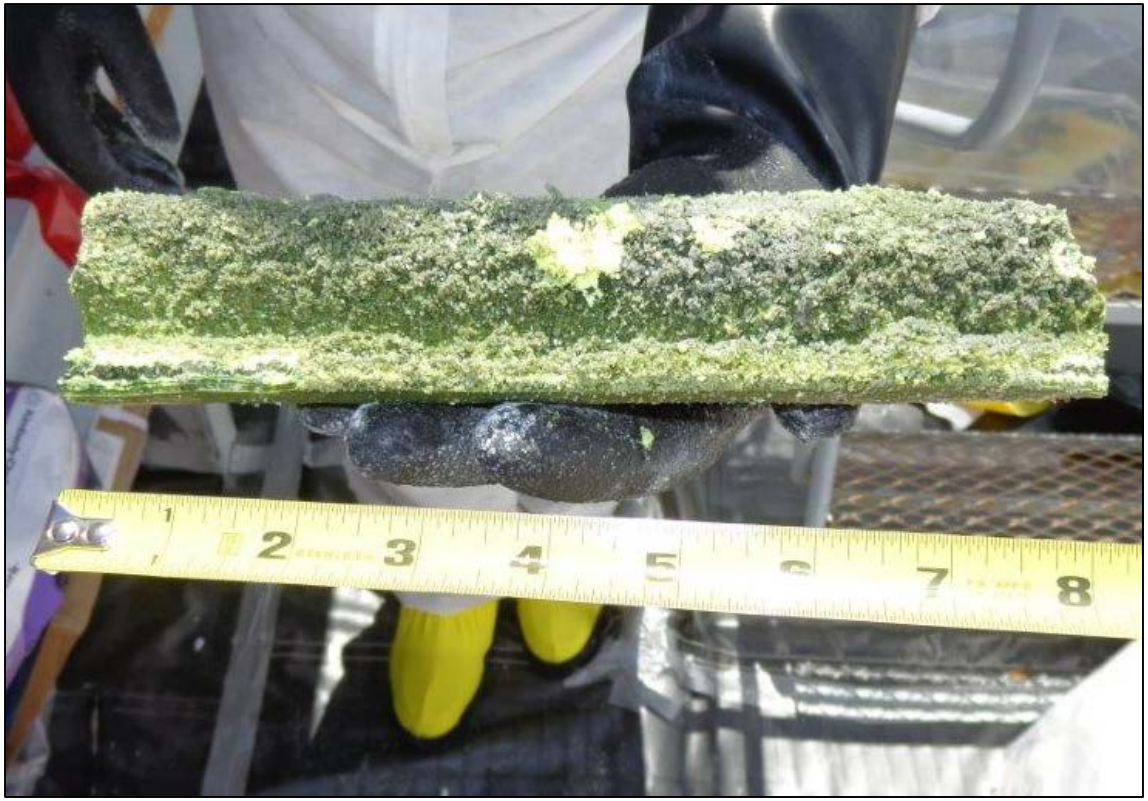
Description of Event

- Sometime between April 28 – May 19, 2016, operators observed a large slab of material fall from the ceiling of the S-1030 inlet transition.
- On July 14, 2016, the licensee discovered a large mass accumulation in the S-1030 scrubber inlet transition and notified the NRC.
- The condition involved 197kg of material, 87kg of which was U.

S-1030 Scrubber

S-1030 Inlet Transition

S-1030 Inlet Transition



Description of Event Cont'd

- July 14, 2016 – Scrubber shutdown
- July 20, 2016 – Scrubber restarted
- July 31, 2016 – The licensee discovered an additional accumulation in the scrubber's packing section and subsequently notified the NRC
- The second condition involved 171kg of material, approximately 82kg of which was U

S-1030 Packing Section

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Use of SCALE

- Two independent assessments were performed:
  - Evaluation of Safety-Significance
    - Informed the enforcement process
  - Evaluation of As-found conditions
- Key Differences in Assessments:
  - Material Composition (and Absorption)
  - Geometry
  - Moderation (and Reflection)

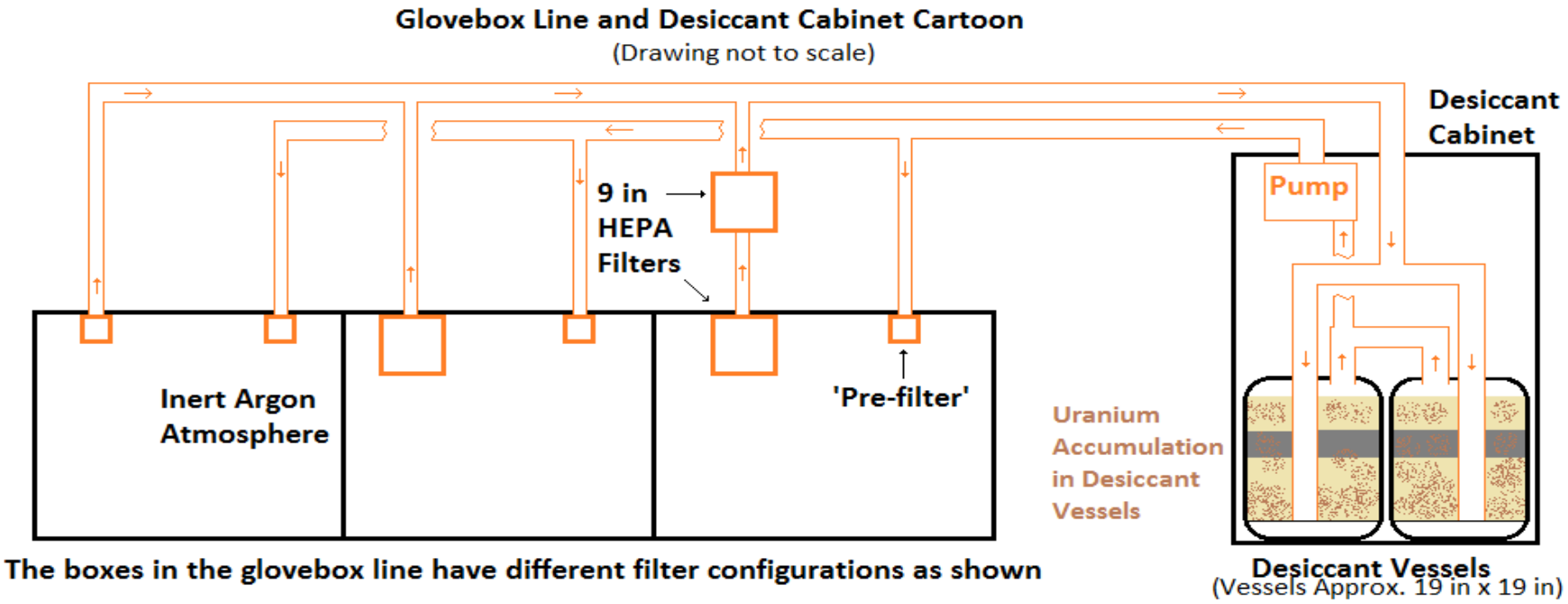
Inspection – Emergency Response

- Independent Assessment of Conditions
  - Is criticality imminent?
  - Is the licensee taking appropriate, conservative measures?

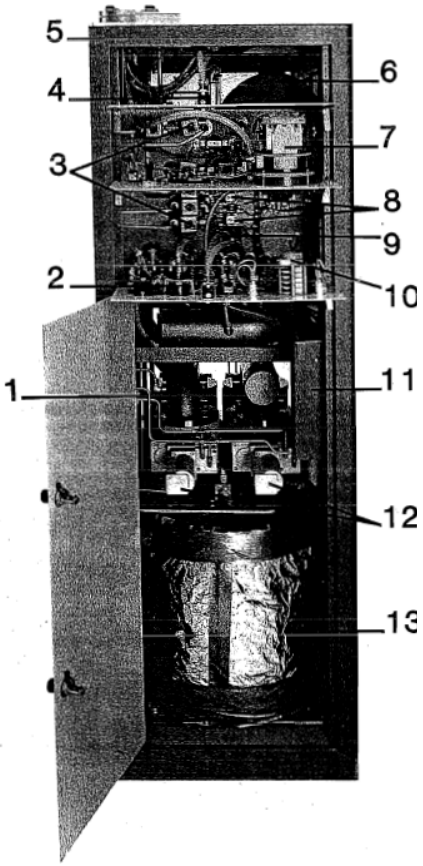
Example – Desiccant Filters

- On July 4, 2017, the licensee notified the NRC of an unanalyzed condition in their Research and Test Reactors (RTR) area.
- The condition involved unexpected accumulation in two large, unfavorable geometry desiccant filters with unknown mass and moderation conditions.
- The system was assumed to be non-uranium bearing and was not routinely surveyed.

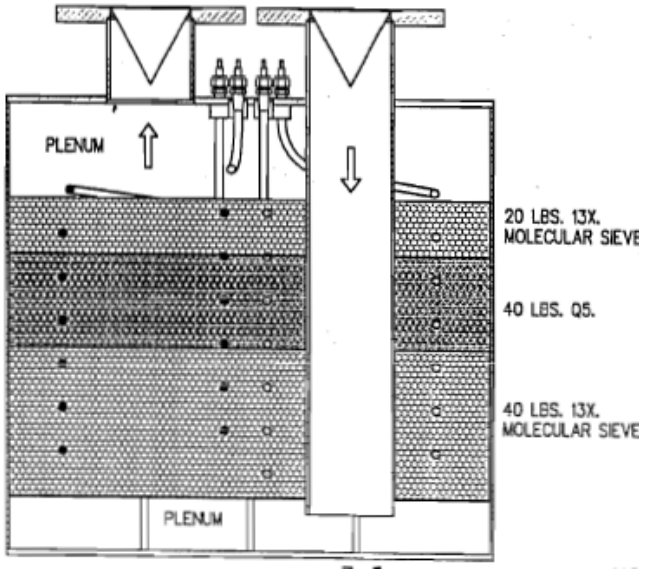
Description of Process



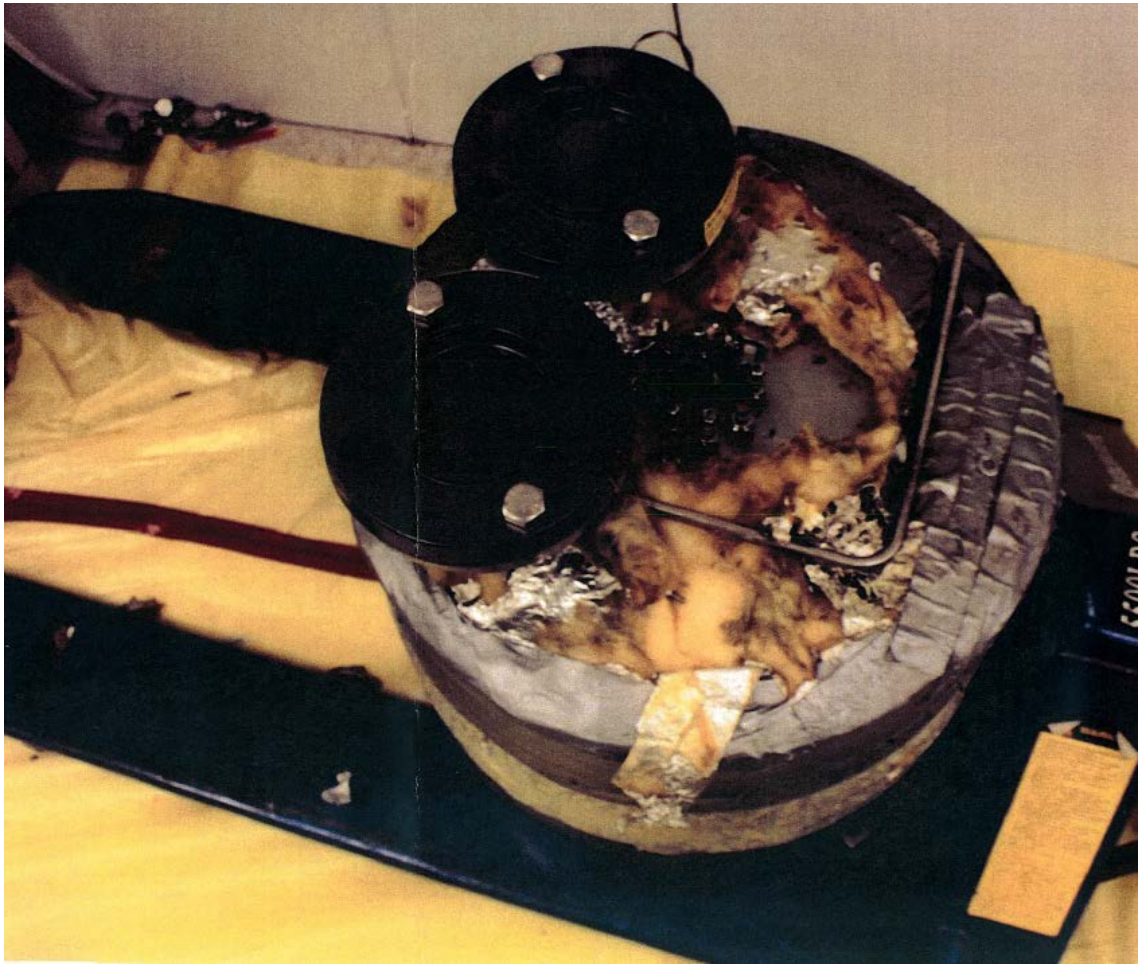
Desiccant Cabinet



1. Solenoid Air Valve
2. Vacuum Gauge
3. Solenoid Valve
4. Flow Indicator Regeneration
5. Cabinet
6. Circulator Blower
7. Solid State Gauge (SSG)
8. Relay
9. Solid State Timer (Heater)
10. Timer-Regeneration
11. Transformer
12. Gate Valve
13. Purifier



Description of Event



Use of SCALE

- An Independent Assessment was Performed
  - Is criticality imminent?
  - Can the system be safely perturbed?
  - Is the licensee taking appropriate actions?

Use of SCALE Cont.

- Independent Assessment to Estimate Minimum Critical Mass of System
  - Known physical parameters were used
    - Geometry, Spacing
  - Unknown physical parameters were optimized
    - Moderation
- Results Compared to NDA Measurements

Questions?

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