Managed and Operated by
Consolidated Nuclear Security, LLC

Y-12 Lessons Learned: Process Drift

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Outline

- Lessons Learned Examples
- Nuclear Criticality Safety
- Process Control
- Conclusion

ANSI/ANS-8.1-2014

American Nuclear Society

nuclear criticality safety in operations with fissionable materials outside reactors

4.1.5 Operational control

Deviations from procedures and unforeseen alterations in process conditions that affect nuclear criticality safety shall be reported to management and shall be investigated promptly. Action shall be taken to prevent a recurrence.

Process Drift: Definition

drift noun

\ ˈdrift \

Definition of *drift*

Merriam-Webster SINCE 1828

5 : the motion or action of drifting especially spatially and usually under external influence: such as

a : the lateral motion of an aircraft due to air currents

b : an easy moderate more or less steady flow or sweep along a spatial course

c : a gradual shift in attitude, opinion, or position *"experience"*

d : an aimless course

especially : a forgoing of any attempt at direction or control

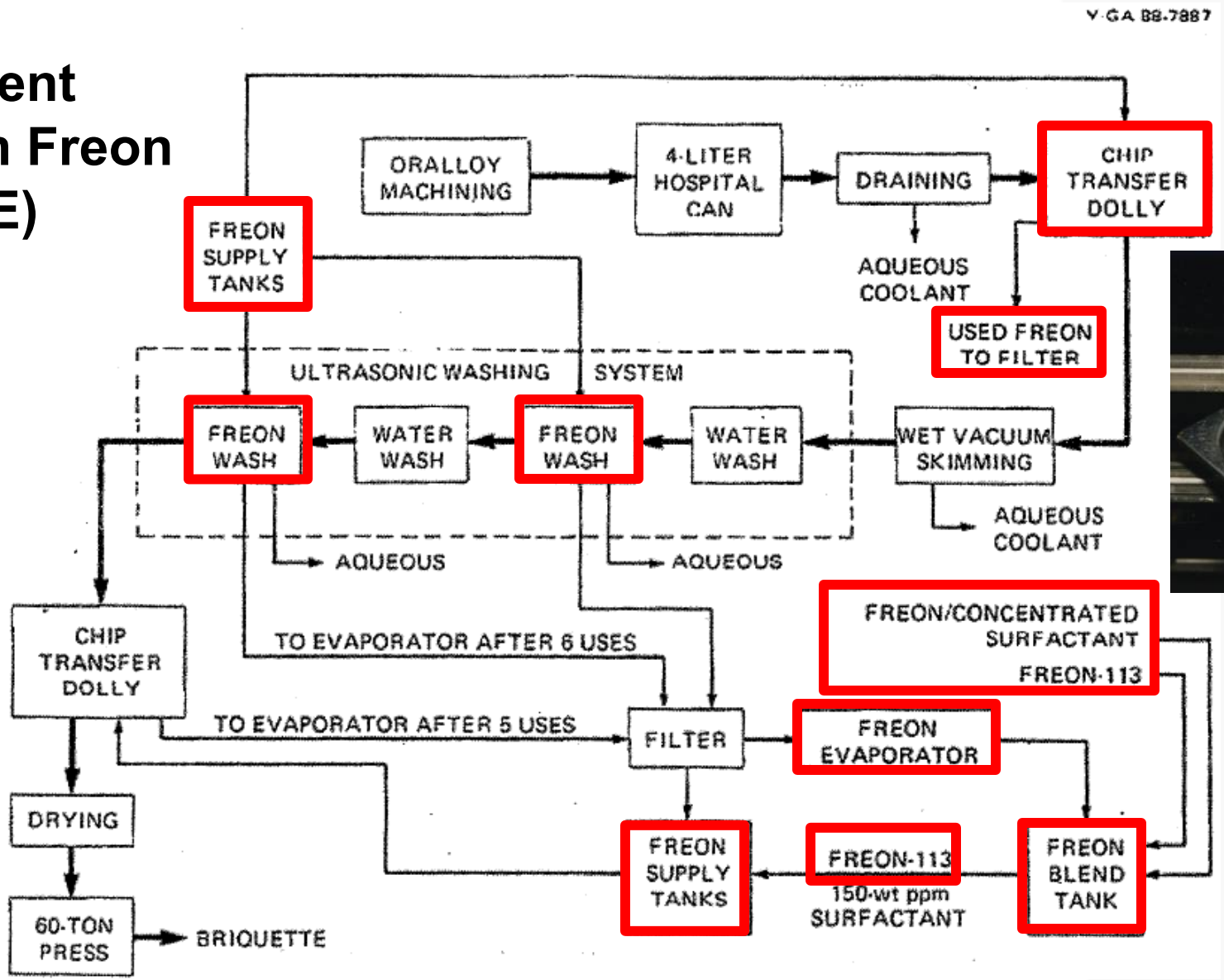
e : a deviation from a true reproduction, representation, or reading

especially : a gradual change in the zero reading of an instrument or in any quantitative characteristic that is supposed to remain constant

Can occur through the approval of changes overtime without re-evaluating entire process

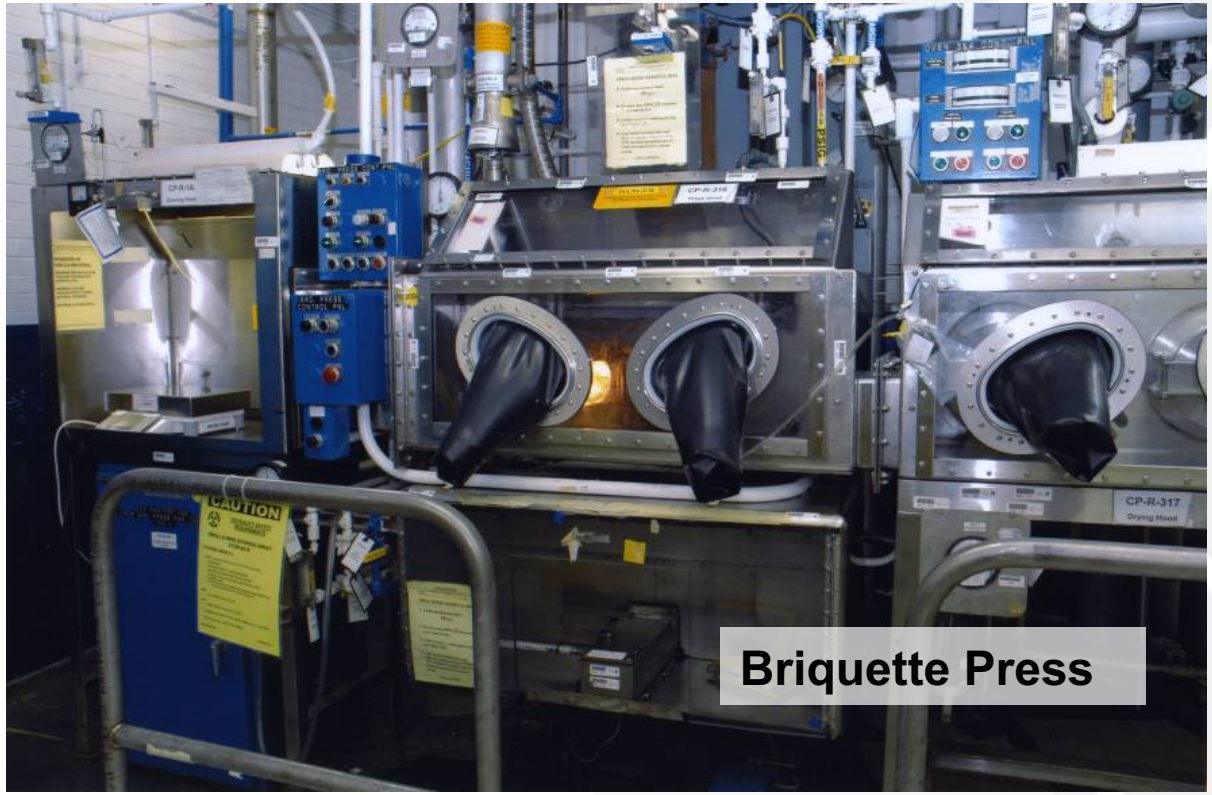
Lessons Learned: Uranium Chip Recovery

Cleaning solvent switched from Freon to Vertrel (HFE)



Lessons Learned: Uranium Chip Recovery

- Briquettes were “wet” and “sticky,” assumed to be dry metal
- Dark “sticky” substance on glass columns in Vertrel recycling process
- Briquettes oxidize in casting furnaces instead of melting
- Vertrel did not remove all excess coolant from the machine turnings, but process continued to operate



Lessons Learned: Uranium Chip Recovery

Briquette Quality

Lessons Learned: Uranium Chip Recovery

Excess moisture in briquettes

Lessons Learned: Holden Gas Furnace Cleanout

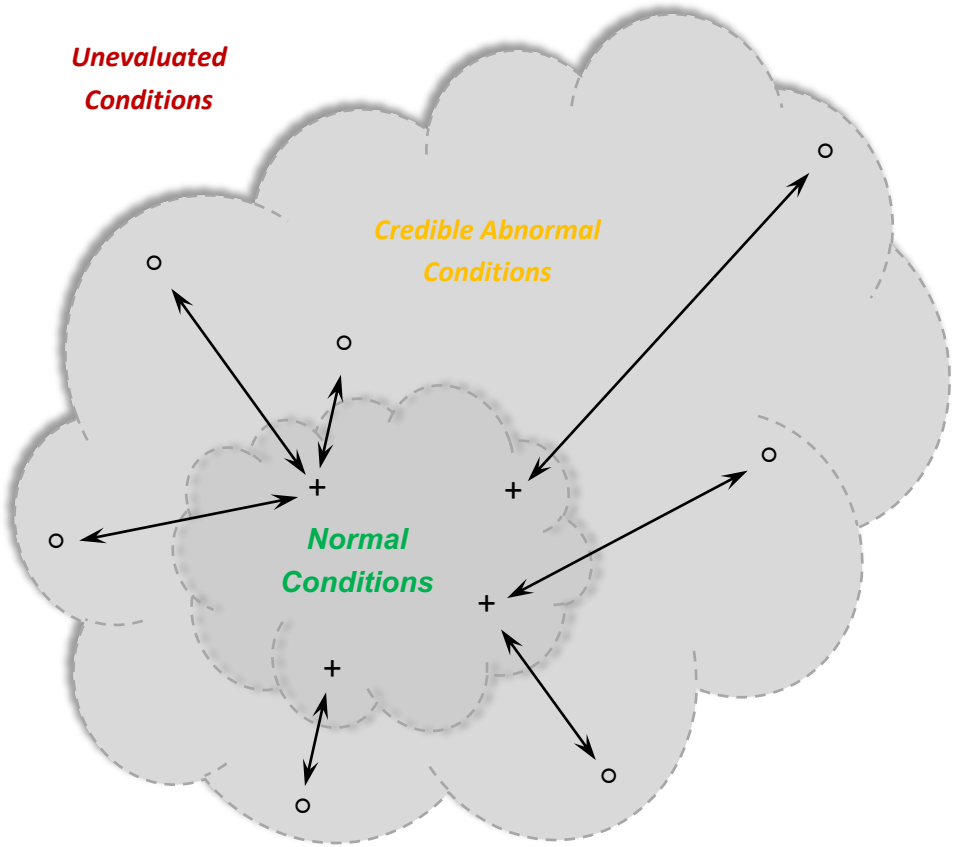
- Furnace allowed to burn materials with varying amounts of uranium
- Cleanout frequency used historical data

Lessons Learned: Holden Gas Furnace Cleanout

- Uranium mass limit exceeded for material removed from bottom of the furnace
- Cleanout frequency not based on type of material being burned
- Cleanout frequency not based on throughput

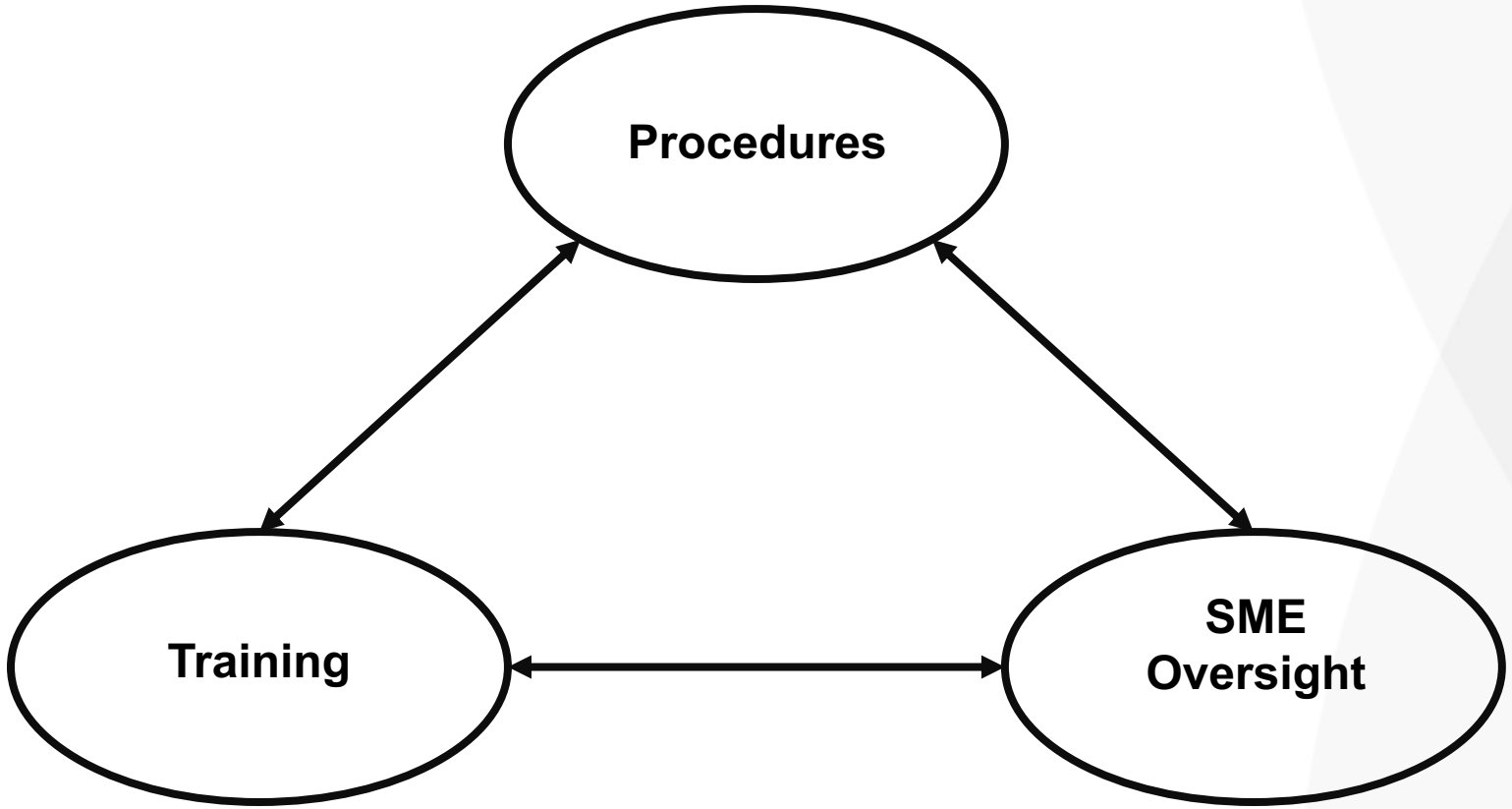
Nuclear Criticality Safety: Analysis

- Abnormal conditions can become normal conditions
- Credible abnormal conditions may be unevaluated
- Evaluate entire process before accepting/addressing process changes



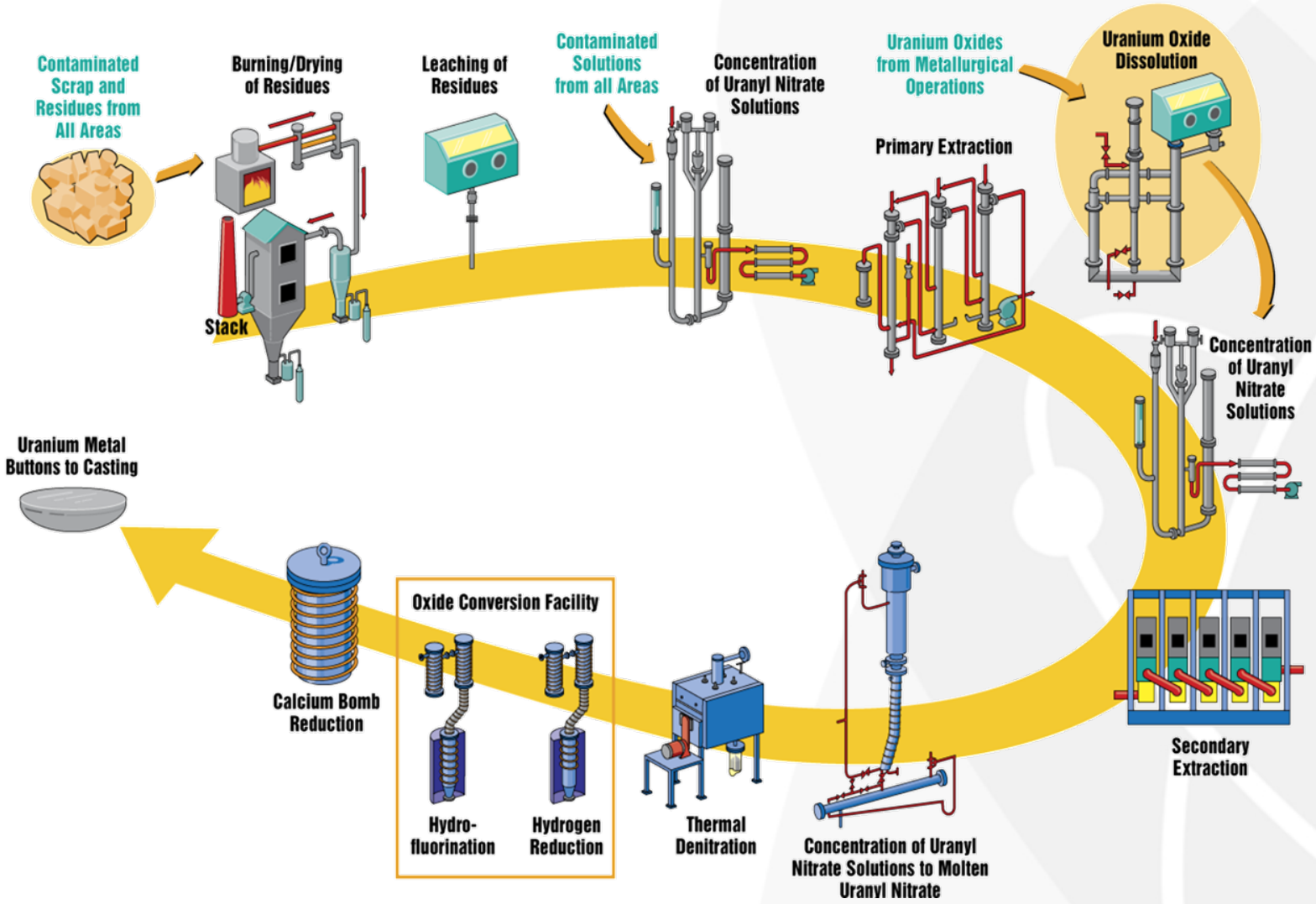
Process Control: Line Management

- Who is responsible for monitoring the process?
- What methods are being used to prevent process drift?
- What are your site's weaknesses?



Conclusion

- The inputs and outputs of each process need to be controlled
- Assumptions need to be verified periodically to prevent creep
- Changes to the process need to be evaluated before they are accepted
  - Change in throughput
  - Processing different material forms
  - etc.
- NCS relies on the process working as intended



How does your site try to prevent process drift from occurring?

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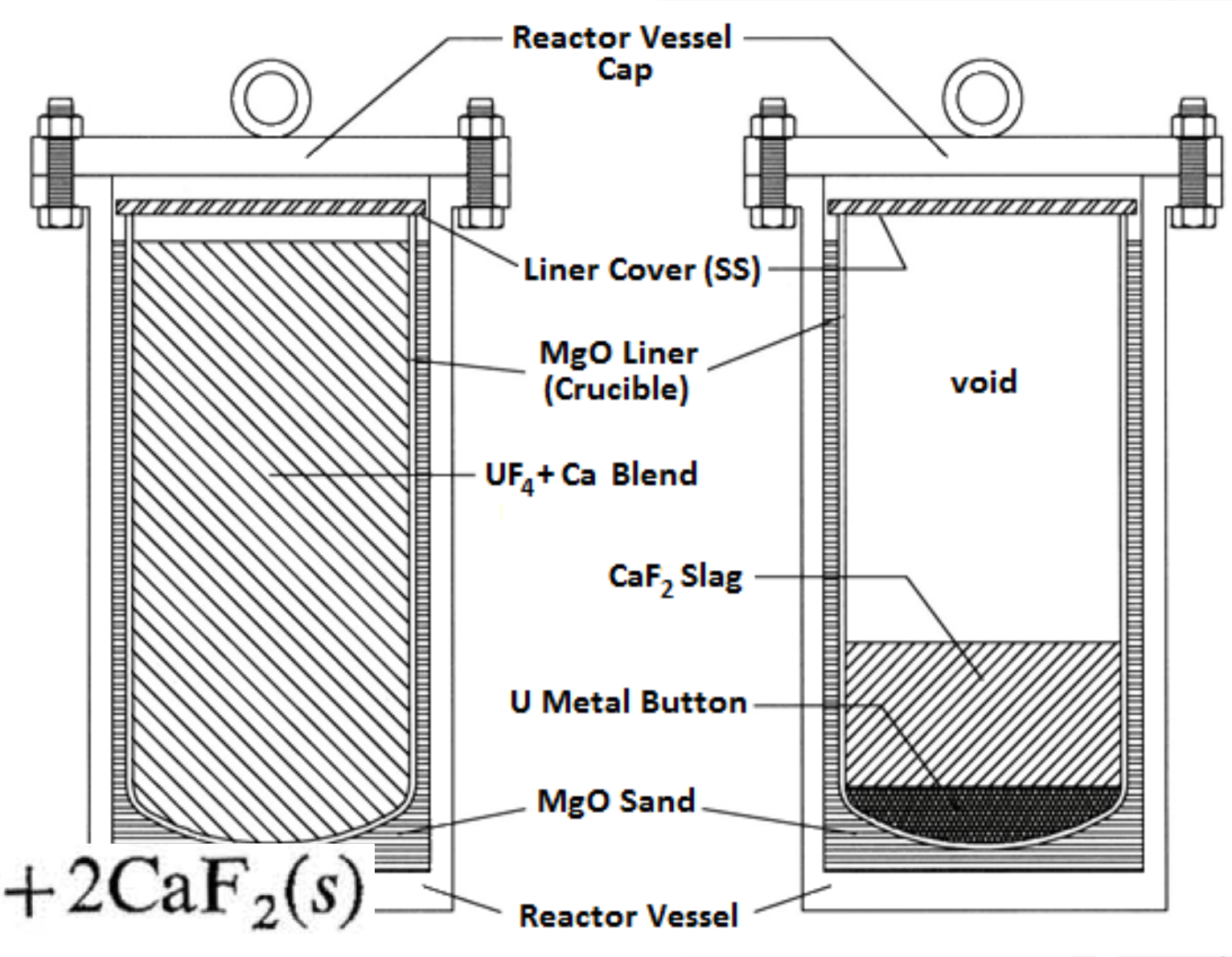
PANTEX PLANT | Y-12 NATIONAL SECURITY COMPLEX

Lessons Learned: Reduction Sand Separator

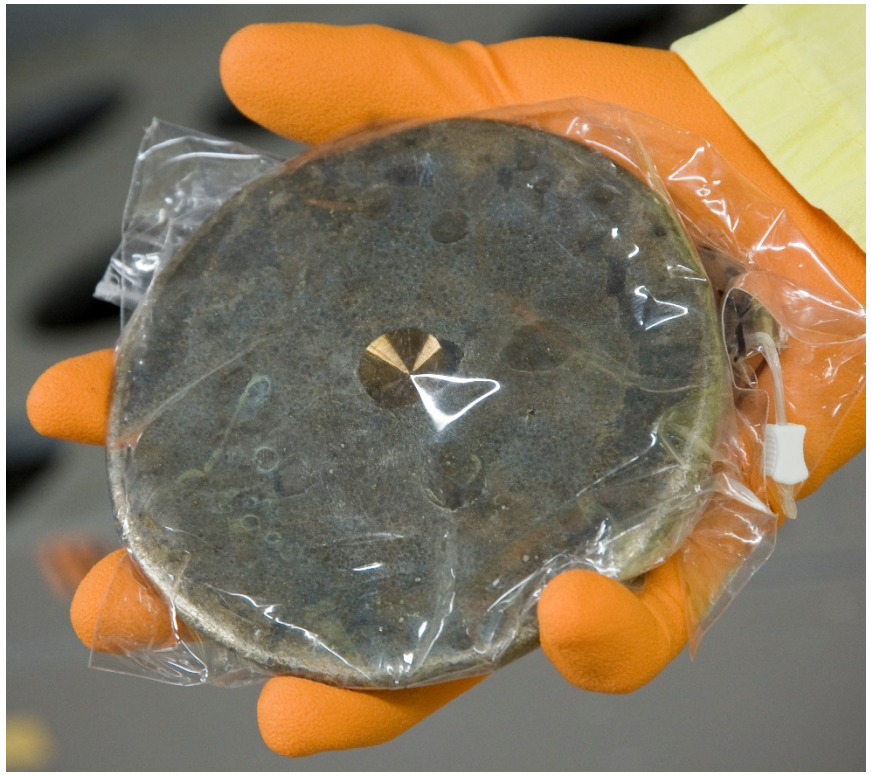
- **Reduction Process**
  - Conversion of UF_4 to uranium metal using calcium
- **New fluid beds were built to produce UF_4**
  - UF_4 product not as good
- **Modifications to reduction furnaces**
  - Changed operating pressure



$$UF_4(s) + 2Ca(s) \rightarrow U(s) + 2CaF_2(s)$$

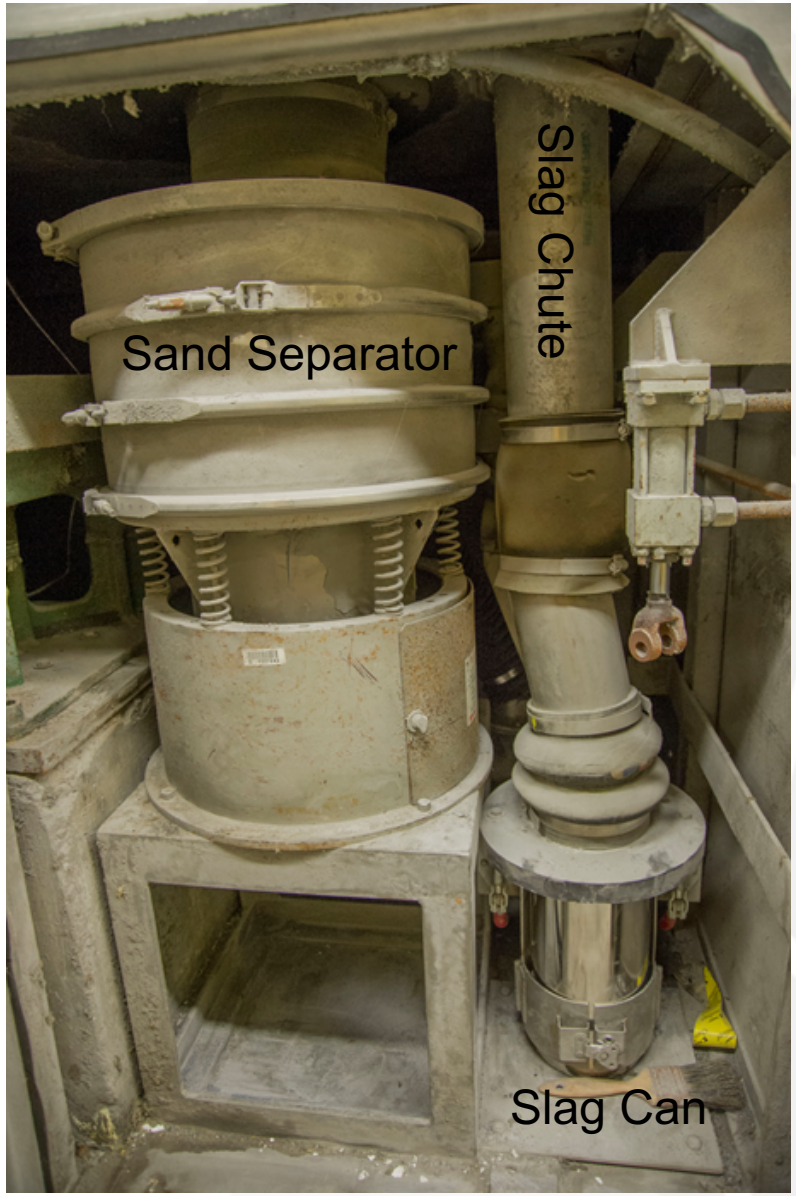
Lesson Learned: Reduction Sand Separator

Button Quality



Lessons Learned: Reduction Sand Separator

- **Process as designed**
  - Button transferred to adjacent hood to be cleaned
  - CaF slag dropped down chute into Slag Accumulation Can
  - Sand swept into the Sand Separator (three tiers)
    - Clinkers (top) and fines (bottom) diverted to the Slag Accumulation Can
    - Sand (middle) is recycled using a vacuum system
- **Process due to poor button quality**
  - CaF slag is transferred with the uranium button, due to its high uranium content



Lessons Learned: Reduction Sand Separator

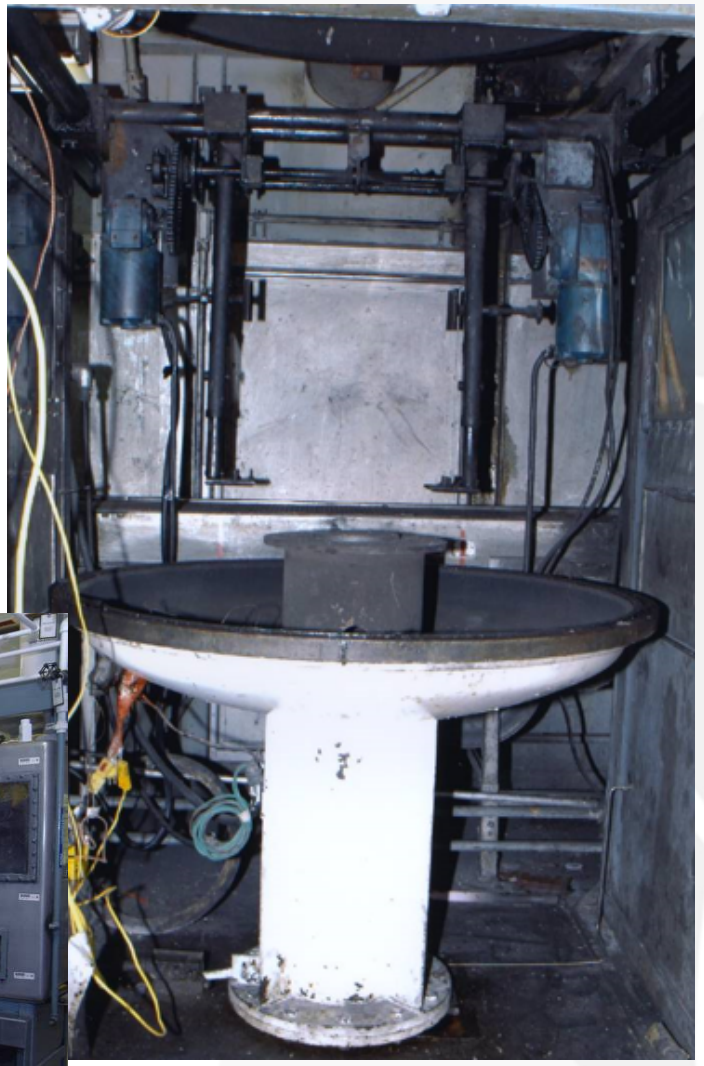
- **Slag Accumulation Can not changed since material was not being sent down slag chute**
- **Sand contained higher amounts of uranium due to poor quality buttons**
- **Material backed up from the Slag Accumulation Can into the sand separator**
- **3.4 kg ^{235}U in all the components**
- **920 g ^{235}U in the sand separator**
- **3C-3 occurrence filed**
  - Single change in process conditions could result in a criticality

Lessons Learned: Accumulations in Casting Lines

- Cleanout of casting lines performed at inventory
- Production of oxide increased from casting briquettes and poor quality metal
- No specific requirements/limits on cleanout activities
- CSE assumed contamination levels of uranium
- Assumed oxide generated was collected as part of each operation

Lessons Learned: Accumulations in Casting Lines

- **Assumptions on distribution and amount of material not accurate**
- **Piles of uranium accumulating in specific locations**
  - Piles of ^{235}U found on the floor of an enclosure
  - Documents assumed material was spread out
- **Bowl of Furnace found with over 1 kg ^{235}U**
  - Documents assumed contamination levels
- **3C-3 occurrence filed**



Nuclear Criticality Safety: Controls

- NCS controls are selected based on a defined process
- Assumptions need to be clearly identified and protected
- Nature of the process vs. explicit NCS control
- Do the supervisors and operators know what is important to NCS?
- The controls chosen are dependent on your site

- **The plenum of the repacking hood is limited to 700 g^{235}U.**

  and/or

- **The repacking hood is limited to processing broken metal pieces.**
- **The repacking hood is required to have a filter in place during operation.**
- **NDA measurements shall be performed bi-monthly on the plenum of the hood.**
- **The plenum of the repacking hood shall be cleaned out if the NDA measurement indicates there is more than 350 g^{235}U.**
- **The ΔP across the filter should be greater than 0.25 inches water column.**
- **etc…**

Process Control: Inputs

- **What are the inputs to the process?**
  - Material forms
  - Amount of material
  - Quality of material

Process Control: Outputs

- **Is the output a desired result?**
  - Quality product should be the end result
  - Are there requirements on the quality of the product?
  - Waste streams should still have quality standards
  - Quality standards can be visual, get feedback from operators
- **Does the material balance?**
  - Amount of material in = amount of material out
  - Where could material be held up in the system
- **What might be downstream effects?**
  - If the product quality is lacking how does it affect downstream processes