Savannah River NUCLEAR SOLUTIONS℠
FLUOR • NEWPORT NEWS NUCLEAR • HONEYWELL

Applications of SCALE for H-Canyon at the Savannah River Site

Joshua Butler
H-Canyon Nuclear and Criticality Safety Engineering
Savannah River Nuclear Solutions, LLC

SCALE Users' Workgroup 2018

Agenda

- H-Canyon Background
- Criticality Safety Evaluations:
  - HFIR Fuel in H-Canyon
  - Safety of Spent Nuclear Fuel Dissolution
  - Acid Concentration in the Mixer-Settler Banks
  - Areal Density Based Fissile Mass Limits

Safety Topic- Heat Stress

- Prevention tips:
  - Maintain fitness
  - Avoid risk factors
  - Hydrate
  - Acclimate
  - Work load and rest
  - Watch out for signs

Disorder	Clinical Features	Treatment
Heat Cramps	Painful spasms of muscles used during work (arms, legs or abdominal).	Rest in a cool area. Give electrolyte drink, if available.
Heat Syncope (Fainting)	Gray-out or black out. Fainting in heat. (no signs or symptoms of heat stroke)	Promptly move to cooler area. Give water or electrolyte drink, if conscious.
Heat Exhaustion	Fatigue, nausea, headache, giddiness, clammy, moist skin, pale complexion.	Promptly move to cooler area. Give water or electrolyte drink, if conscious.
Heat Stroke	Hot dry skin (red or blue). Irritability, confusion, shivering, convulsions, collapse.	MEDICAL EMERGENCY. Aggressively cool victim. Use ice bath or pour ice and water on victim. Call medical immediately.

H-Canyon Background

- Last of its kind
- Began operations in the 1950s
- Changed mission to one of nonproliferation and environmental cleanup
- Started HEU Blend Down campaign in 2003
- Currently use

KENO-VI and SCALE 6.1

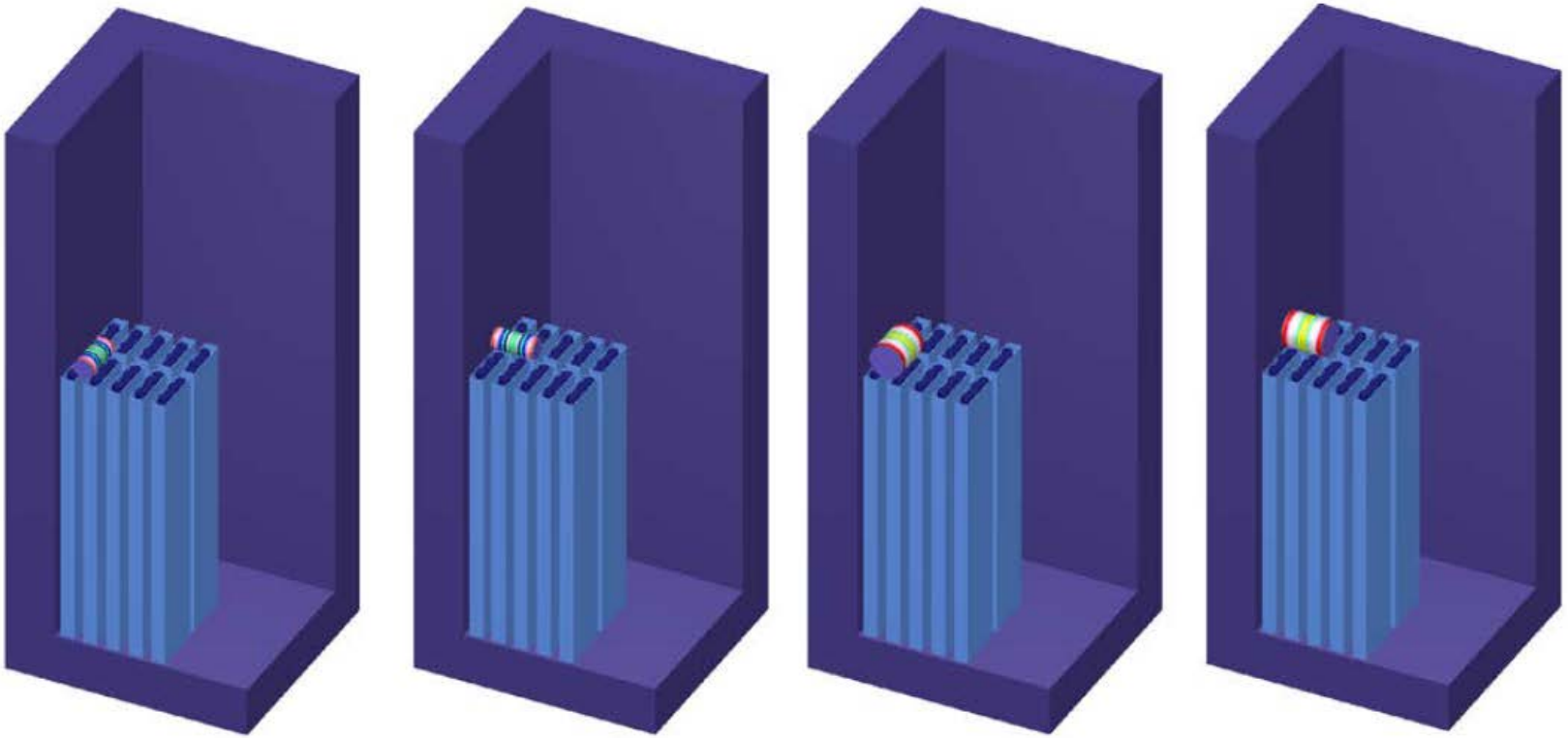
HFIR Fuel in H-Canyon

Receipt, Handling, Storage, and Dissolution of HFIR Fuel in H-Canyon

- SCALE models were used in evaluations for a variety of upset conditions
- Specifically involving storage of HFIR elements in bundle storage rack and dissolution of HFIR material

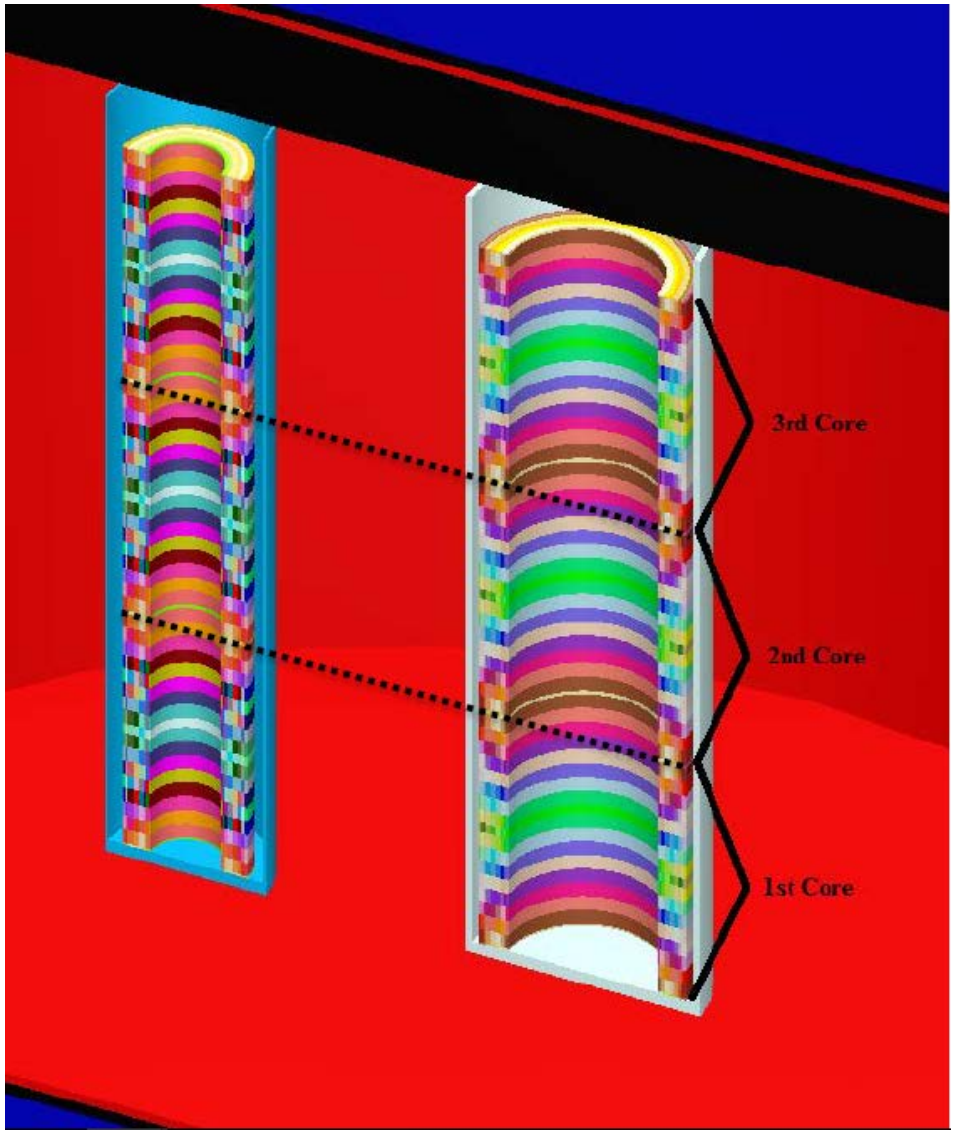
HFIR Fuel in H-Canyon

- Want to verify that HFIR element can be safely stored in the HFIR storage rack under anticipated conditions
- Model shown is of an upset condition where the HFIR fuel element is dropped on the bundle rack



HFIR Fuel in H-Canyon

- HFIR dissolver over-mass upset with three cores



Safety of Spent Nuclear Fuel Dissolution

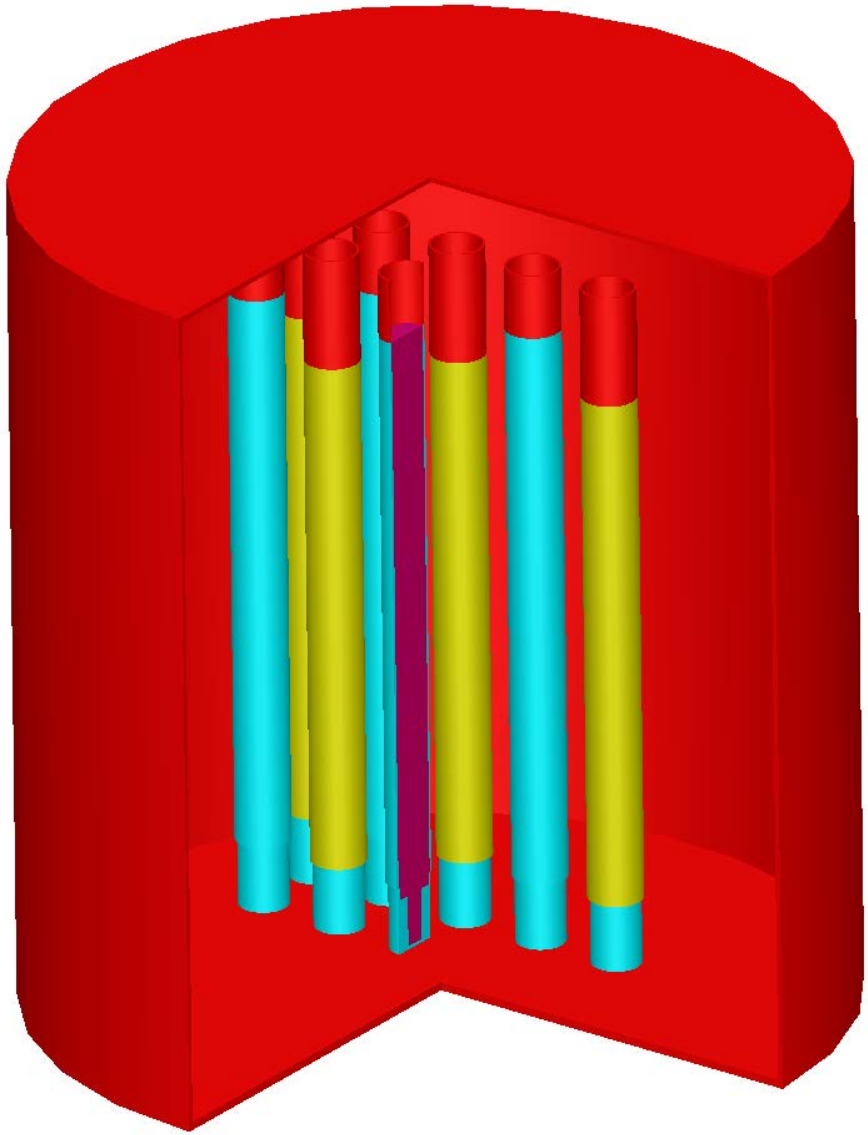
Safety of Spent Nuclear Fuel Dissolution

- Evaluated the dissolution of Spent Nuclear Fuel with and without soluble neutron poison to establish limits for dissolving campaigns
- Newest revision sought to perform a parametric study of the SNF with the 10-well insert and 5-well plug

Safety of Spent Nuclear Fuel Dissolution

- Main SCALE related goals were run cases to investigate increasing the allowable concentration of the bulk dissolving solution and increasing the allowable amount of fissile material that could be charged at one time
- Currently operate with the 10-well insert with 5-well plug installed

Safety of Spent Nuclear Fuel Dissolution



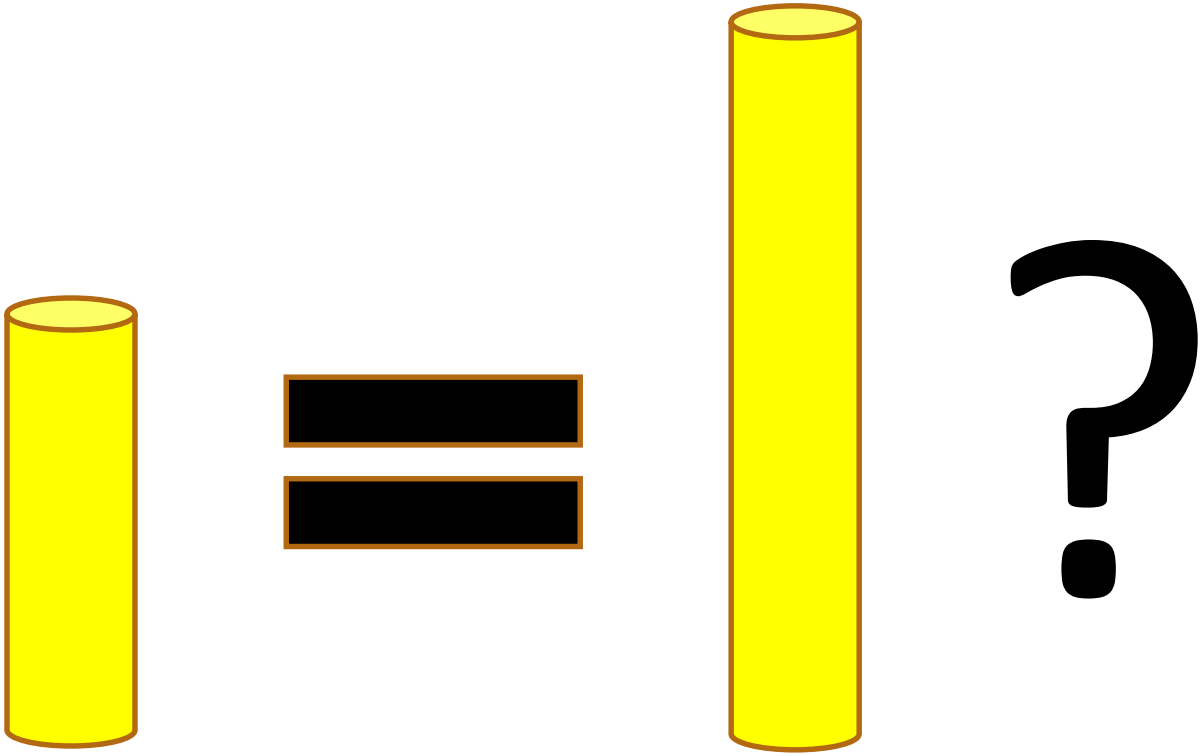
Safety of Spent Nuclear Fuel Dissolution

- Increasing the concentration limit of the bulk dissolving solution will allow less acid to be used during the dissolving process

- Increasing the fissile mass limits of the charge will allow charging on fragments (still need to probe)

Safety of Spent Nuclear Fuel Dissolution

- Results:
- Increase in allowable concentration of bulk solution
- Increase mass limits per well



Acid Concentration in the Mixer-Settler Banks

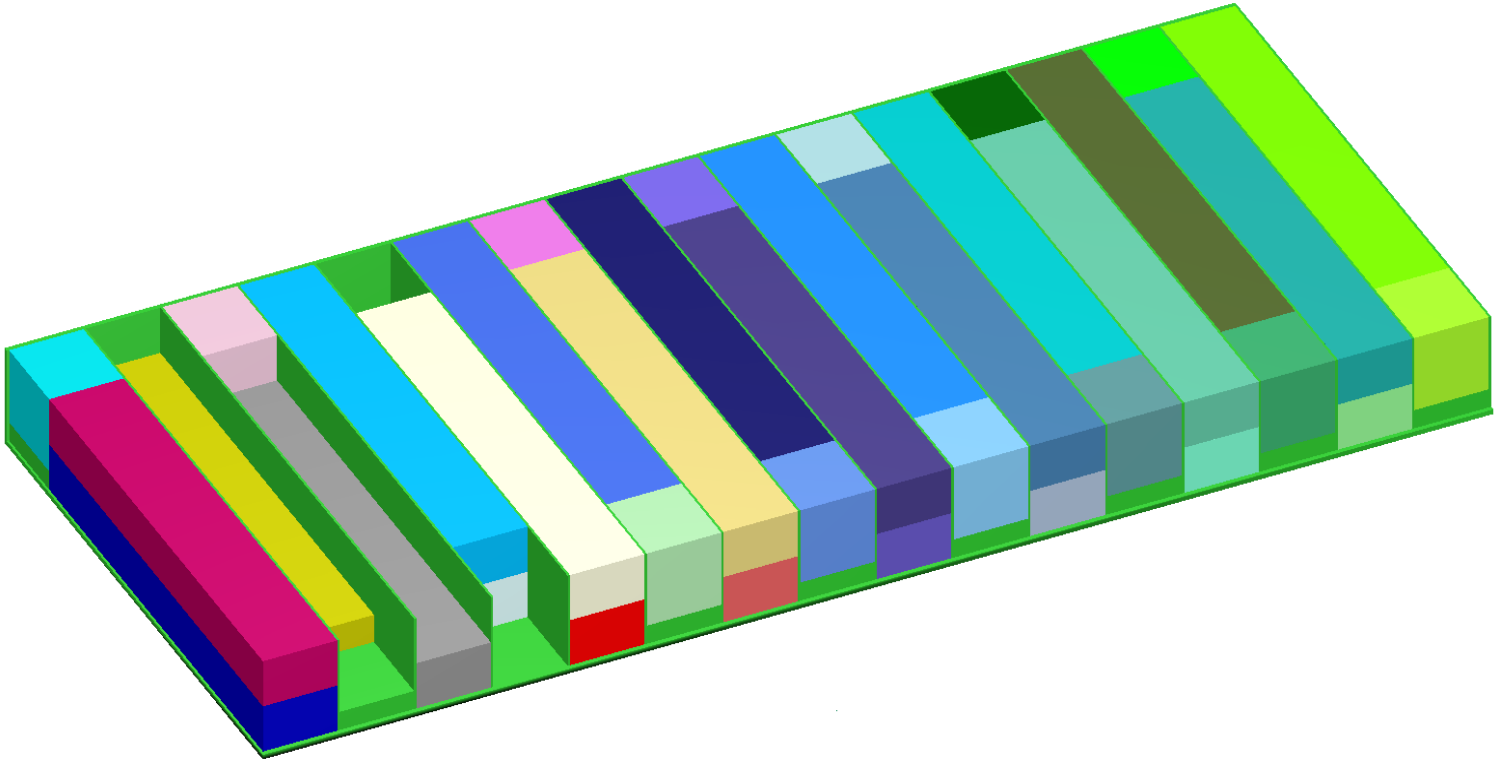
HM-Process Acid Concentration Upsets in the Mixer-Settler Banks

- The current H-Canyon Double Contingency Analysis postulates two scenarios resulting in an inadvertent criticality due to reflux in the mixer-settler banks

- Unique by incorporating chemistry analysis with SEPHIS for compositions of fissile material

Acid Concentration in the Mixer-Settler Banks

- Want to show that criticality is not credible under the postulated conditions
- Declare events “Not Credible” and remove from the current hazards analysis



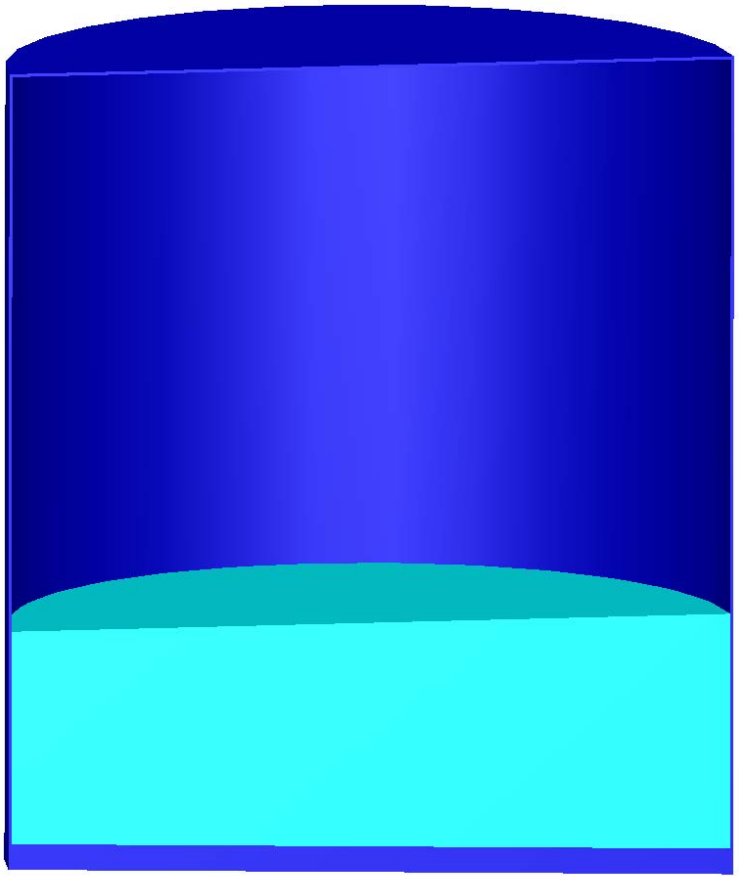
Areal Density Based Fissile Mass Limits

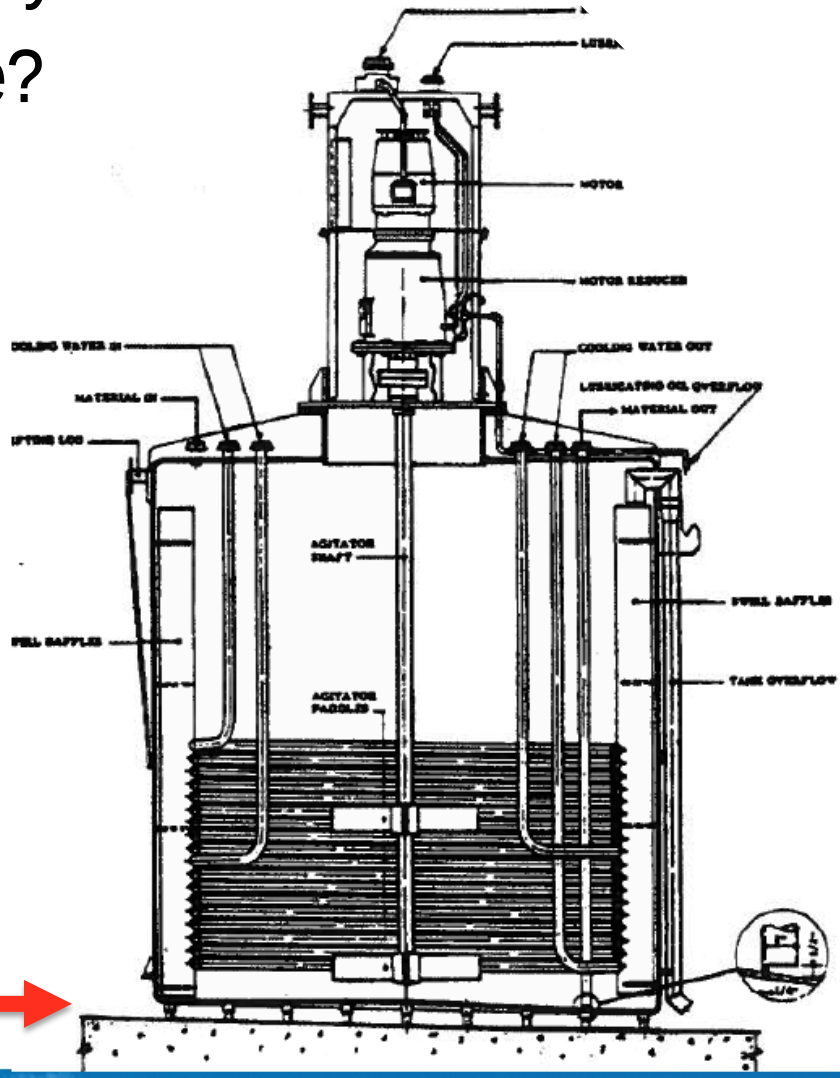
Areal Density Based Fissile Mass Limits for H-Canyon Tanks

- Use a limiting areal density to calculate the amount of uranium allowed in a tank.
- Initial Limit taken from ANSI/ANS-8.1: 0.4 g/cm^2

Areal Density Based Fissile Mass Limits

- Why would we want an areal density based mass limit?
- Why hasn't this already been done?





Areal Density Based Fissile Mass Limits

- Original document evaluated decanters with the next revision incorporating process tanks
- Using an areal density of 0.4 g/cm^2 works for decanters
- However the process tanks break k-safe due to larger diameter/area
- Reduced areal density of 0.33 g/cm^2 stays within k-safe for large tanks other than decanters
- We will see if mass limits based on these areal densities are used by engineering

In Summary

- H-Canyon does a lot of interesting work with fissionable material
- SCALE is an invaluable tool used to perform criticality safety calculations
- Helpful in alleviating operational burden and improving safe production process

Questions?