



## NCS design and evaluation of new high-density storage containers

Amber McCarthy

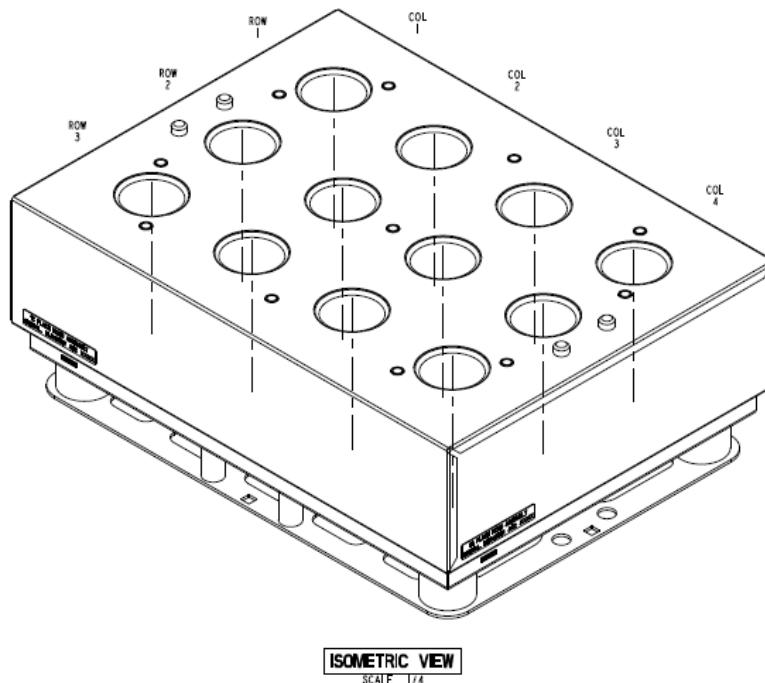
[amber.mccarthy@cns.doe.gov](mailto:amber.mccarthy@cns.doe.gov)

Nuclear Criticality Safety Engineer

# Presentation Summary

## Overview of new container study

- Motivation for study
- Background – Existing RCSB Containers
- Changes in Mission
- NCS Evaluation of an Equivalent System
- Results
  - Varying Interstitial Water Density
  - Dehydrated BoroBond4™
- Conclusions and Future Work



## Motivation for Study

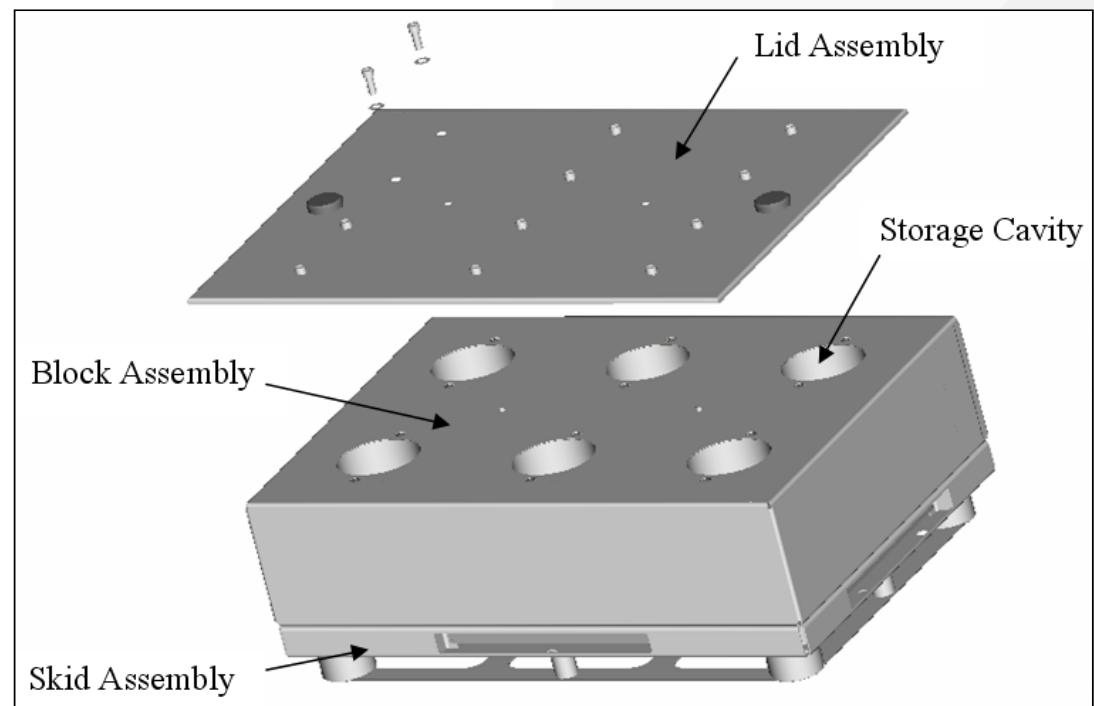
### Highly Enriched Uranium Materials Facility (HEUMF)

- Y-12 national repository for secure, efficient storage of highly enriched uranium
- Storage design – racks configured for both drums and Rackable Can Storage Boxes (RCSBs)
- Construction 2008, operational in 2010



## Background – Existing RCSB Containers

- 3' x 4' x 1' block assembly on a 6" tall skid assembly
- Block has 567kg of solid ceramic material with 6 cavity positions, and 90 kg stainless steel body with 17 kg lid
- Skid is made of 72 kg stainless steel
- Positions are designed to receive one metal can each with up to 20kg loading
- Cans *may* have variable dimensions and must be loaded with material forms that are stable and suitable for long term storage



## Background – Existing RCSB Containers



## Changes in Mission

### Storage utilization

- Increased receipt of off-site shipments – facility designed for Y-12 materials
- Canisters from off-site shipments ( $< \text{Ø } 12.75 \text{ cm}$ ) typically received in ES-3100
- RCSB designed to receive large canisters ( $< \text{Ø } 15.70 \text{ cm}$ )
  - Uranium metal or uranium oxide loadings up to 20kg
- Limited ability to consolidate material
- RCSB not used to full capacity

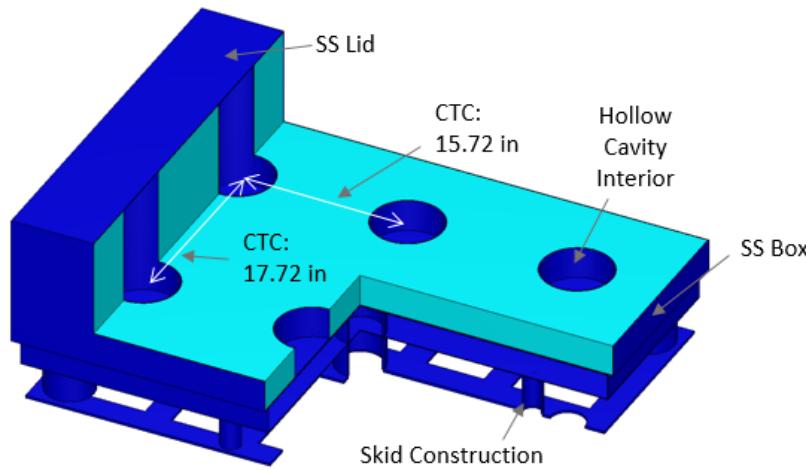


**Proposal:** design a neutronically and mechanically equivalent high density storage container capable of receiving lower masses in the same container footprint used by existing RCSBs

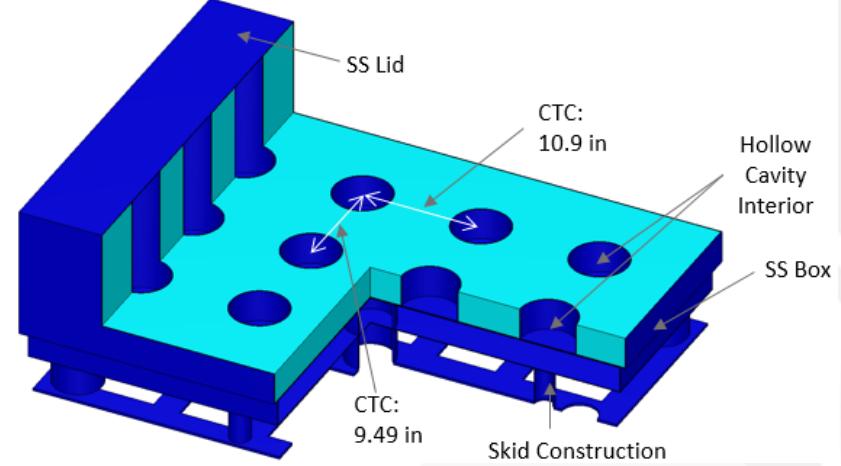
## NCS Evaluation of an Equivalent System

Goal of study: provide proof of concept for test procurement

- SCALE 6.1.3 software perform KENO V.a Monte Carlo calculations
- Large array cases
- Worst case maximum 20kg loadings in RCSB compared to new maximum 10kg loading in new 12-Place design



Current RCSB model overview

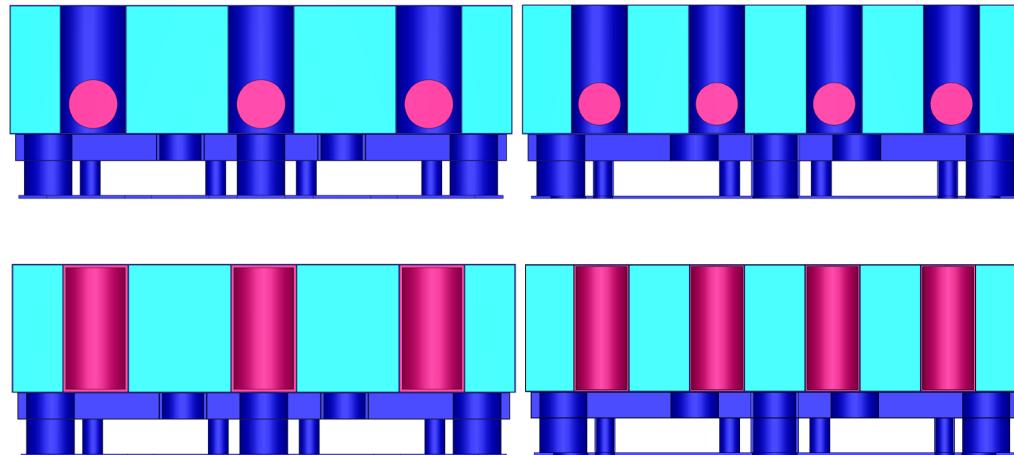


12-Place RCSB model overview

## NCS Evaluation of an Equivalent System

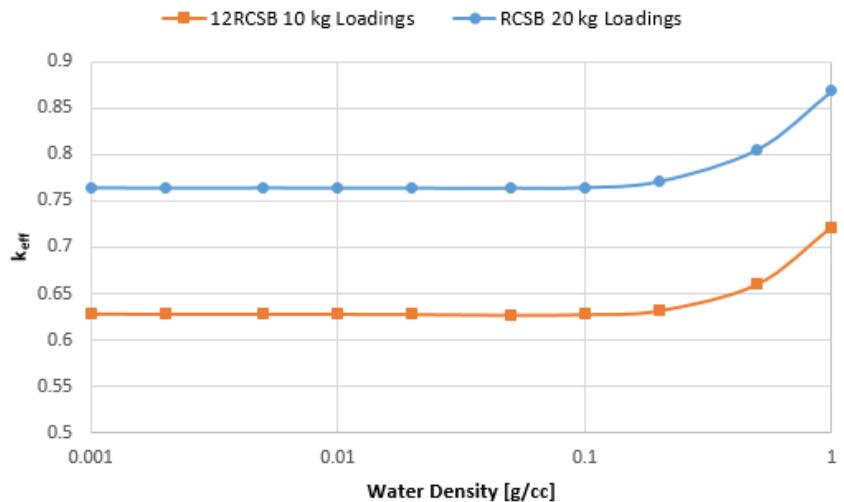
Studies use both sphere and shell models

- RCSB 3x2 cavity arrangement
- 12-Place RCSB 4x3 cavity arrangement
- BoroBond4™ (teal) fissile region (magenta).

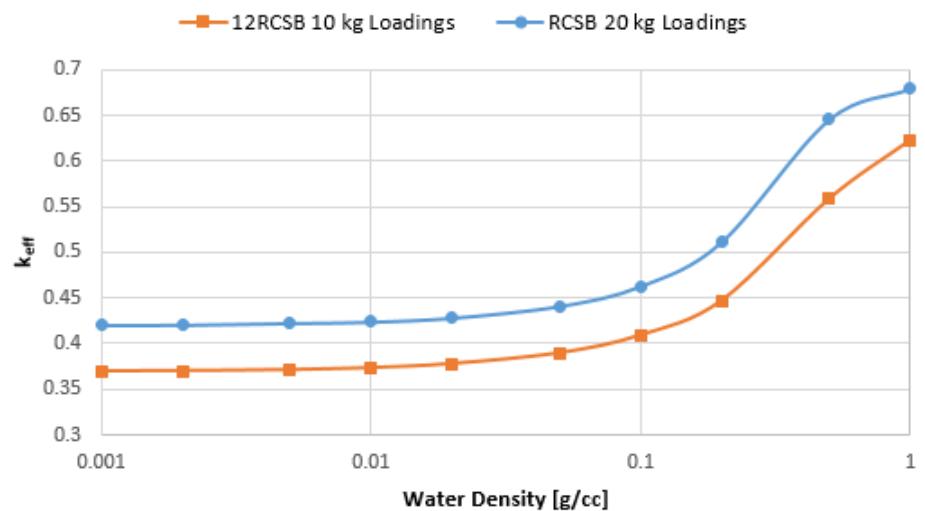


## Results – Varying Interstitial Water Density

Sphere Loadings



Shell Loadings

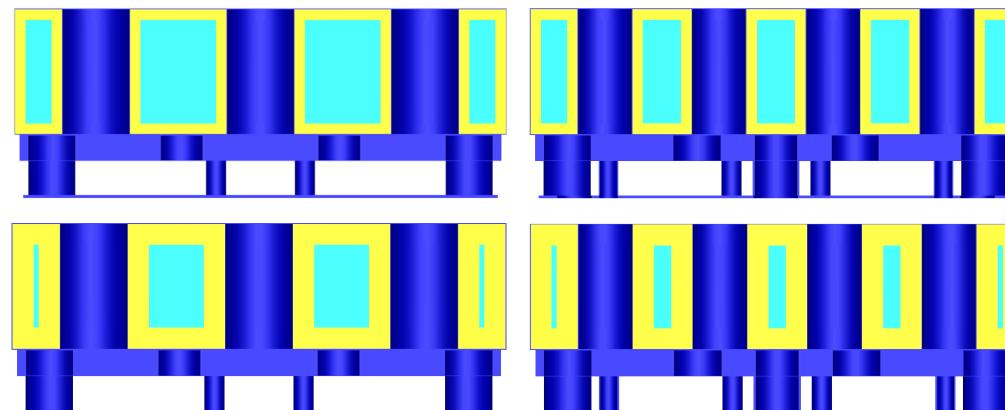


Anticipated behavior: – All cases in 12-place RCSB produce lower  $k_{eff}$   
- Reactivity increases at higher water densities

## Results – Dehydrated BoroBond4™

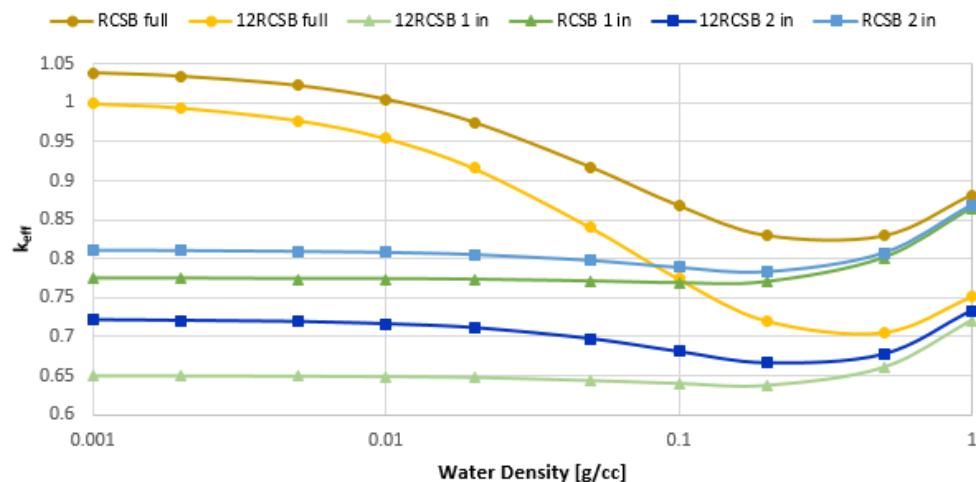
### Fire scenario subject to extreme heat

- BoroBond4™ consists of ordinary Class F Fly-Ash and B<sub>4</sub>C powder distributed throughout the solid crystalline matrix of MgKPO<sub>4</sub>·6H<sub>2</sub>O.
- Dehydrated BoroBond4™ assumes no hydrogen and half the number of oxygen atoms are present
- Depths of 2.54 cm, 5.08 cm, and full dehydration
- Previous computational thermal analysis support potential for 5.08 cm of dehydration under design basis fire scenario (two powered industrial trucks collide in storage bay)

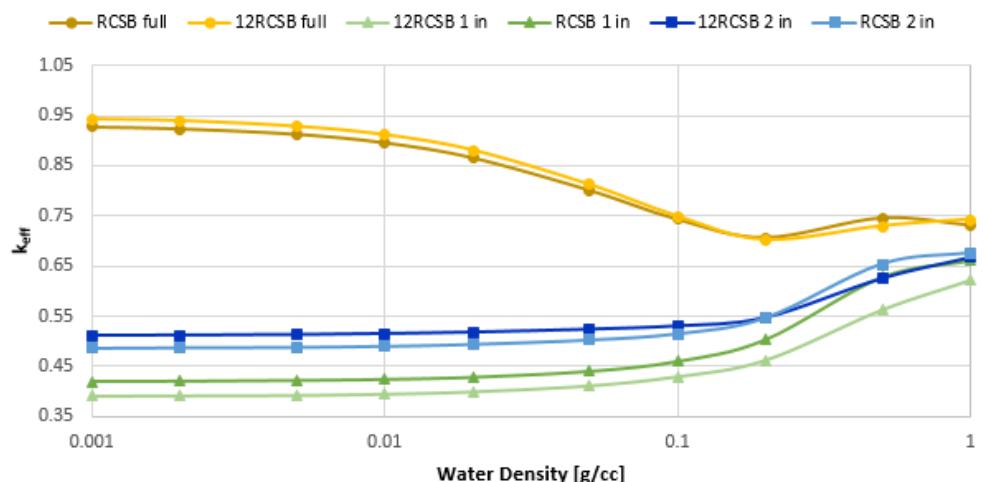


## Results – Dehydrated BoroBond<sup>TM</sup>

Sphere Loadings



Shell Loadings



- Anticipated behavior: 12-place RCSB produce lower  $k_{eff}$ , interaction effects obvious at low water densities, converge at full density water
- Only cases exceeding USL (0.96) are full dehydration

- Interaction effects dominate immediately due to increased surface area (shell) and limited BoroBond<sup>TM</sup>, RCSB lower  $k_{eff}$
- Little difference between container types

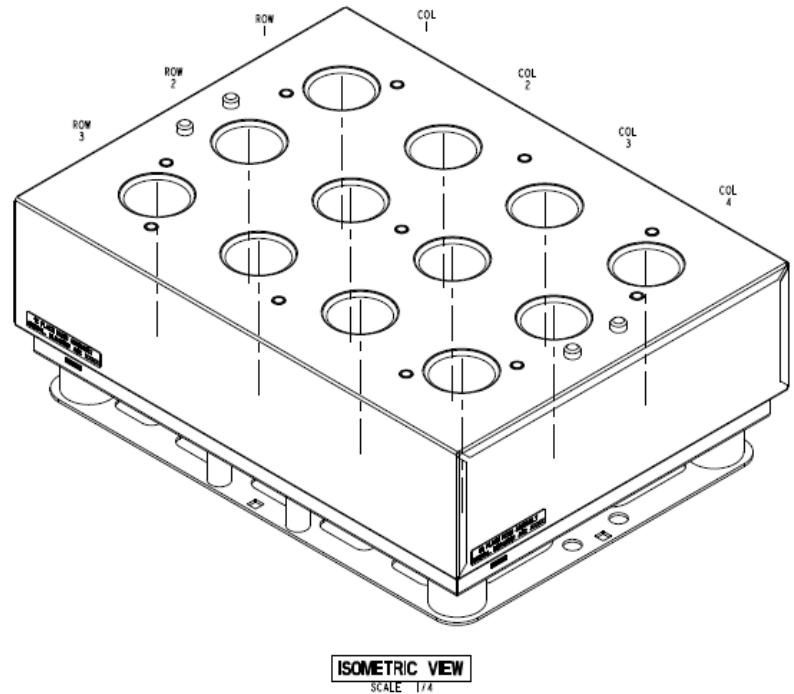
# Conclusions and Future Work

## 12-Place RCSB conclusions

- Lower or similar k-eff values produced in most cases – safer or similar level of safety as existing boxes
- Less mass within individual cavities → increases fissile material surface area in close proximity of poison, aids in absorption ability
- Although cavities are closer together, increased neutron interaction effects are not observable until substantial dehydration occurs

## Future Work

- Over mass loadings – largest credible over mass
- Homogenous U-water mixture loadings
- Results of packaging thermal and drop tests (DOE 420.1c) will inform CSE and additional calculations



# Questions?

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