CRITICALITY PACKAGE DESIGN CONSIDERATIONS

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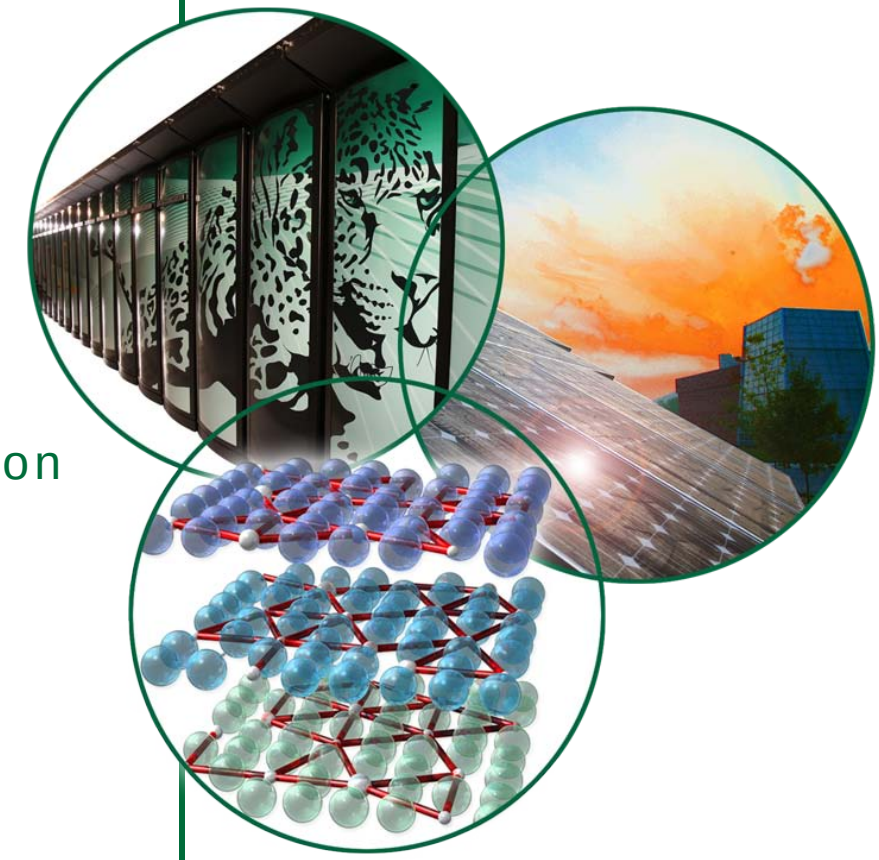

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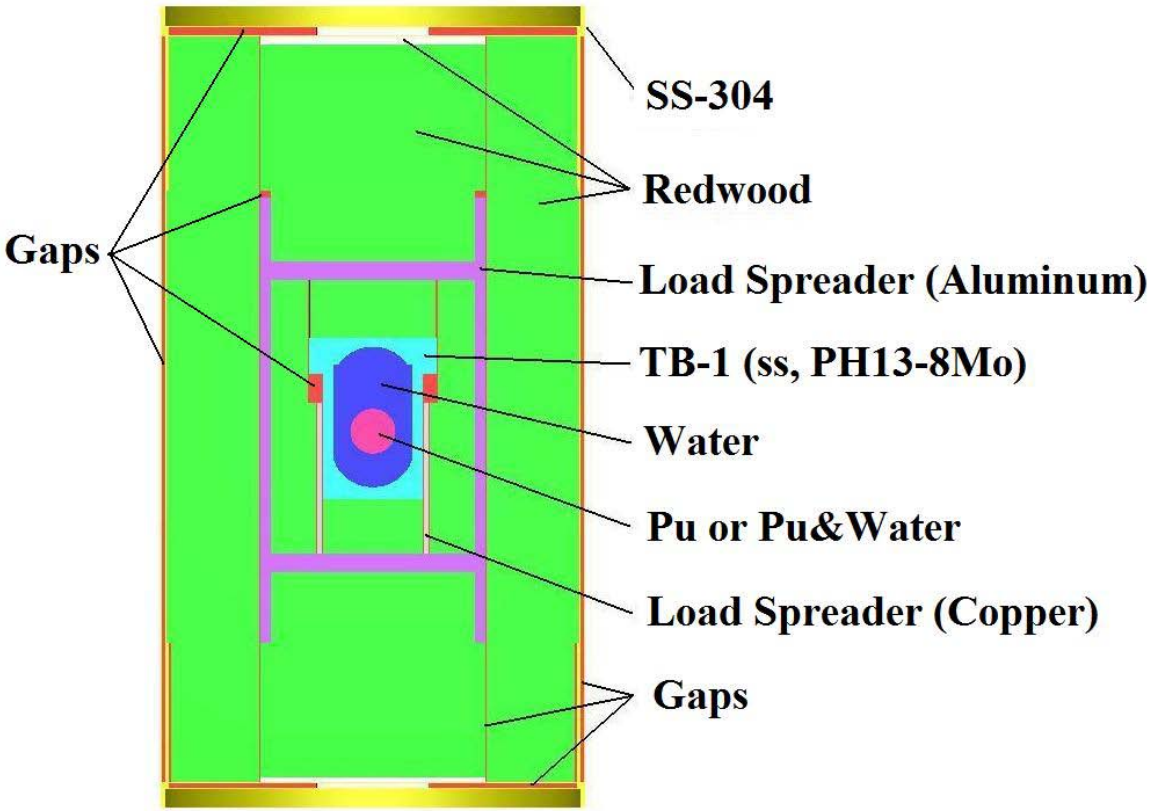
Introduction

- Design features associated with criticality could be categorized as one or more of the following:
  - Contents protection
  - Contents containment
  - Package spacing
  - Neutron absorption

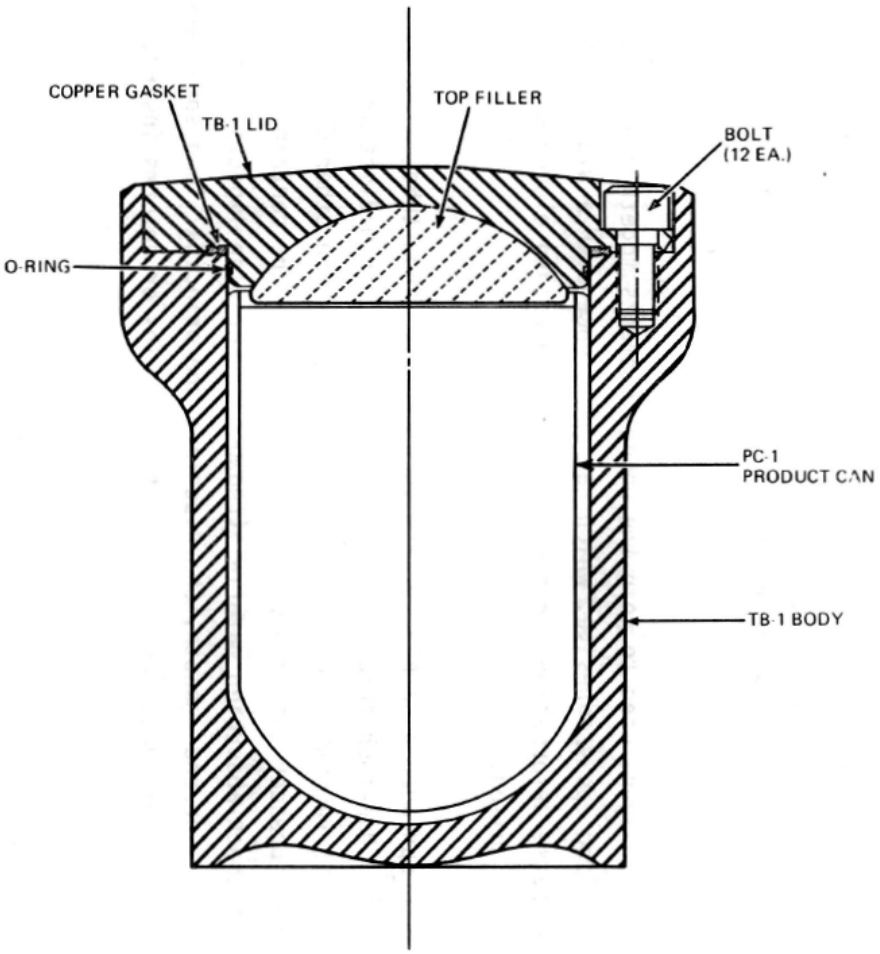


Contents Protection

- Features that protect the contents, thus limiting the parameter space that must be defended in the analysis
  - Features that protect the package, such as impact limiters
  - Structural design that protects the contents from external impacts and high-velocity impacts, such as shock absorbers and crush-zones
  - Structural design that ensures separation of multiple content elements within a package
  - Structural design that maintains contents geometry, such as spacers or holders
- Performance of these design features during normal and accident conditions does affect criticality safety

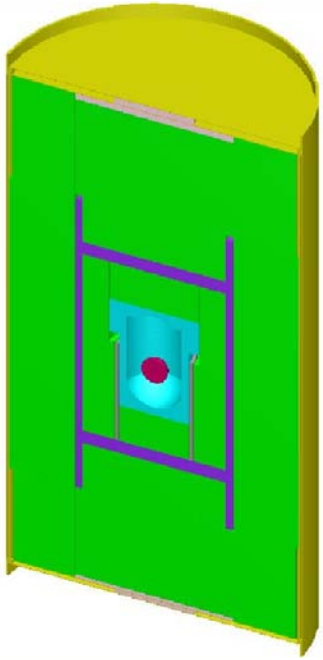
Contents containment

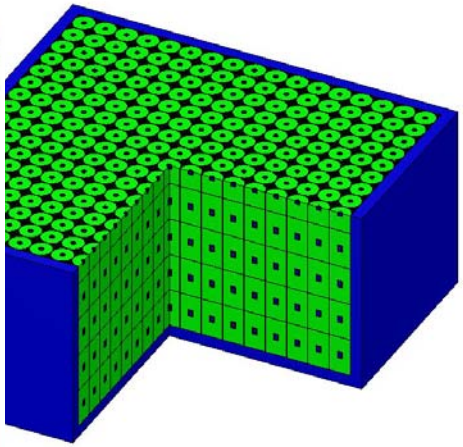
- Some design features ensure the contents remain within the package
- If the contents can credibly leak from or fall out of or be ejected from the package, criticality analysis should address the potential for accumulation of contents from multiple packages
- Design features may include strong primary containment vessels, additional containment layers, and strong outer packaging layer(s) design to survive the tests prescribed by the appropriate CFR

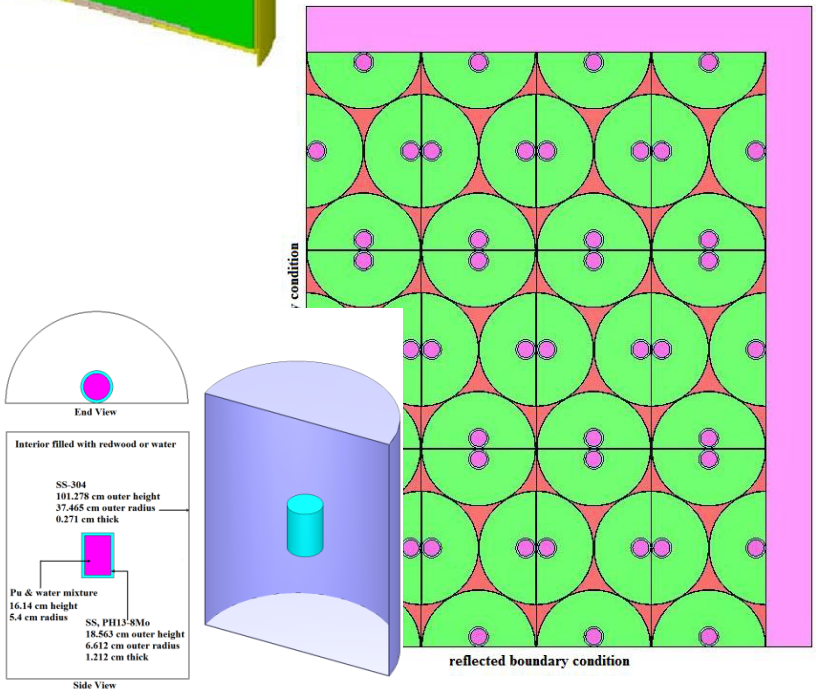


Package spacing

- The criticality transportation index (TI) limits the number of packages that may be in one shipment
- The package design enforces spacing between contents in separate packages and fissile content density of the array, thereby affecting the TI under both normal and accident conditions
- Design features may include strong primary containment vessels, additional containment layers, and strong outer packaging layer(s) design to survive the tests prescribed by the appropriate CFR







Neutron absorption

- Neutron absorbers are sometimes added to packages and casks to permit higher density storage of fissile material
- Neutron absorbing plates, sleeves, coated structural components
- Design considerations are:
  - Minimum absorber loading
  - Continued effectiveness during normal and accident conditions
  - Flux trap dimensions & flooding

Neutron absorption

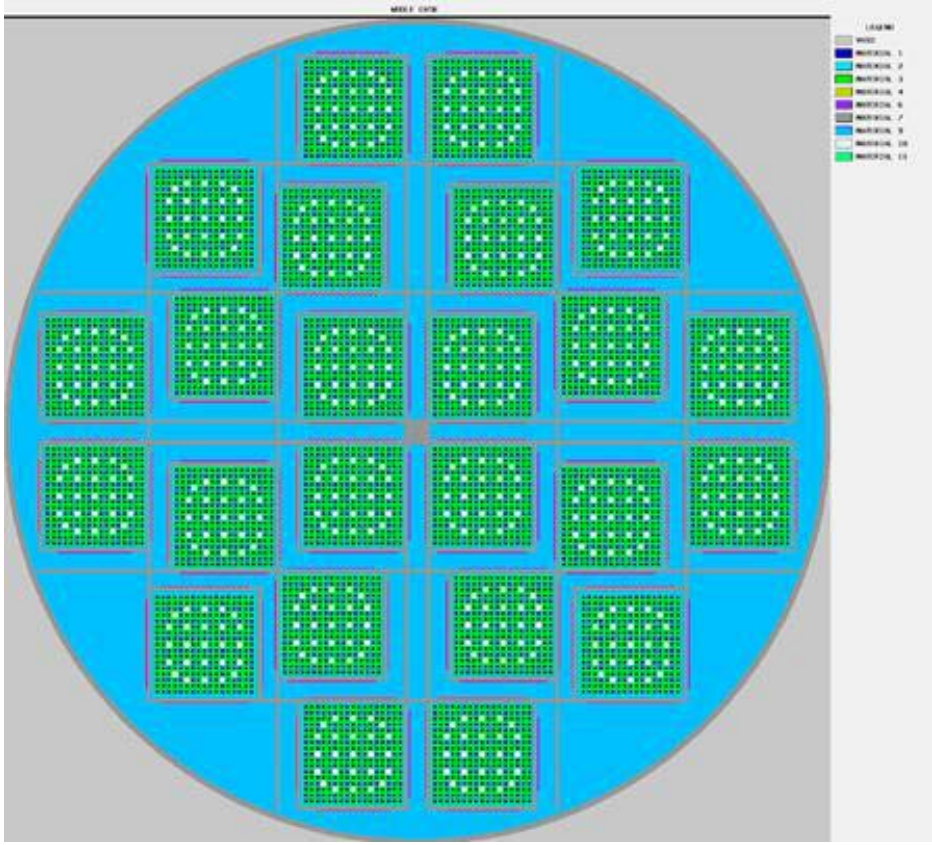
- Minimum absorber loading
  - Credit in criticality analyses typically limited to minimum certified absorber loading
  - In the U.S., credit further reduced to 75% of minimum unless appropriate measurements are performed to assure minimum absorber loading
  - Consider potential for neutron streaming between B_4C crystals through absorber panels (fine versus coarse crystals)

Neutron absorption

- Continued effectiveness during HACs
  - When neutron absorbers are credited, consideration should be given to their continued effectiveness during hypothetical accident conditions
  - Neutron absorbers may be affected by accidents involving fire
  - Neutron absorbers could be physically displaced or mechanically damaged during accidents
  - Contents may be physically displaced relative to the neutron absorbers

Neutron absorption

- Flux trap dimensions and flooding
  - Some packages include parallel poison panels with a gap between the panels
  - Gap flooding increases neutron thermalization and absorption in poison panels
  - Reactivity reduction may be sensitive to the gap size
  - Flux trap design should ensure
    - Gap geometry is maintained and
    - Volume between poison panels will flood as quickly as the rest of the package



Questions & discussion

- Thank you for your attention!

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