

Cask Size and Weight Reductions Through the Use of DUO_2 -Steel Cermet Materials

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What Will it Take to Become Competitive in the Spent Nuclear Fuel Cask Industry?

- **Existing materials and designs are suitable**
- **We need:**
 - A unique product, e.g., a special material that only we have
 - Enhance cask features, characteristics
 - Lower costs than competitors
 - Good business sense, strategy
- **We have unique shielding material: DUCRETE and Cermet**

Do more, with less, better!

Size and Weight Reductions

- **This presentation discusses the smaller dimensions and less weight of DUO₂-steel cermet casks**
- **This data was provided several years ago for DUCRETE casks by Sierra Nuclear Corp.**

A “Comparative” Study was Performed

- **Holtec’s HI-STAR 100 steel storage and transport cask system was used as a reference**
- **Radiation source calculations are based on Holtec’s Multi-Purpose Canister-24 [for 24 pressurized water reactor (PWR) fuel assemblies]**
- **Oak Ridge’s ORIGEN-ARP program was used to calculate the radiation source term**
- **Oak Ridge’s SCALE 4.4a package was used for (one dimension) shielding and dose calculations**
- **With the radiation surface dose for cermet and HI-STAR 100 casks the same, the radius and weight were compared**

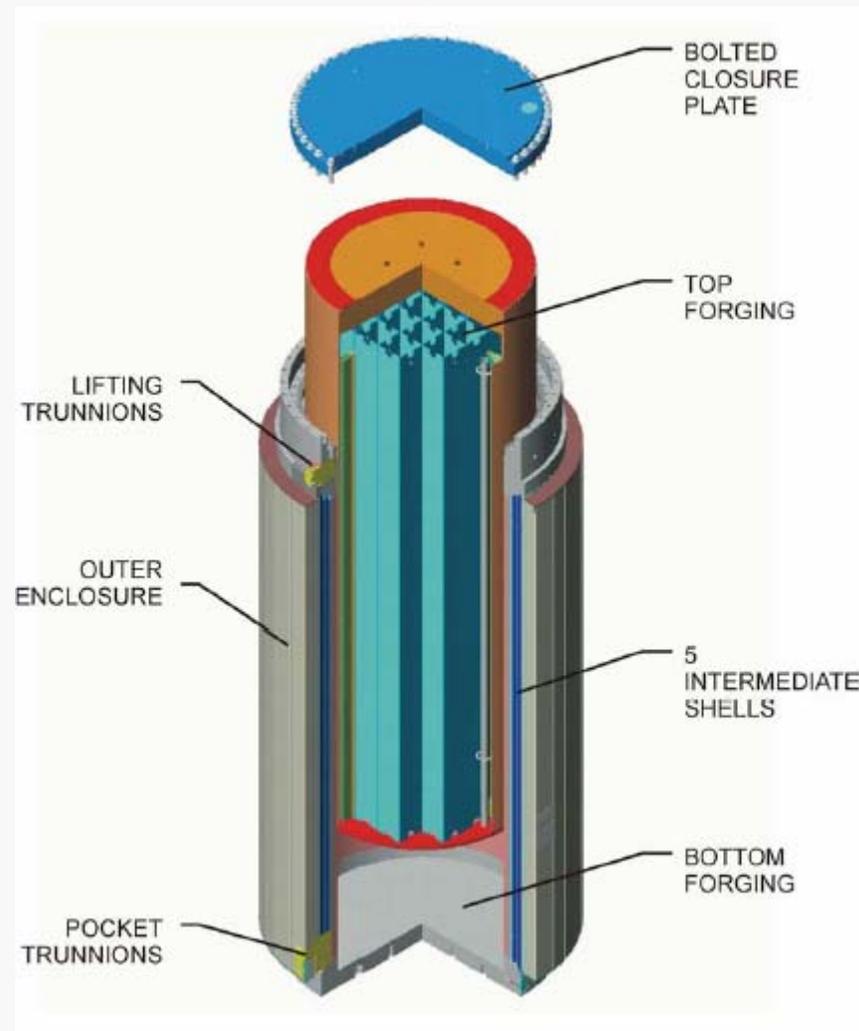
Calculations Are Based on Holtec International's HI-STAR 100 Steel Cask

The HI-STAR 100 is **H**oltec **I**nternational's **S**torage, **T**ransport **A**nd **R**epository cask system. The HI-STAR 100 uses six layers of conventional steel for gamma shielding. The conceptual cermet cask will replace the layers of conventional steel with a layer of DUO₂-steel cermet material.



*Figure of a HI-STORM cask
(courtesy of Holtec International)*

Basic Layout of Holtec's HI-STAR Rail Transport and Storage Cask

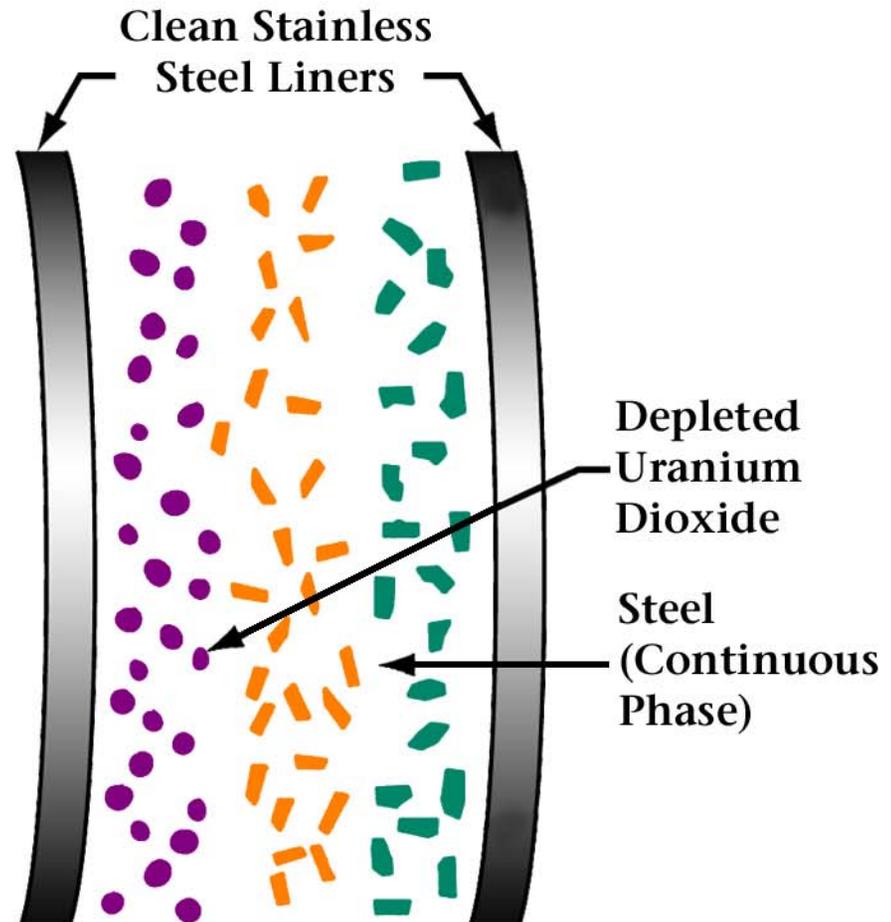


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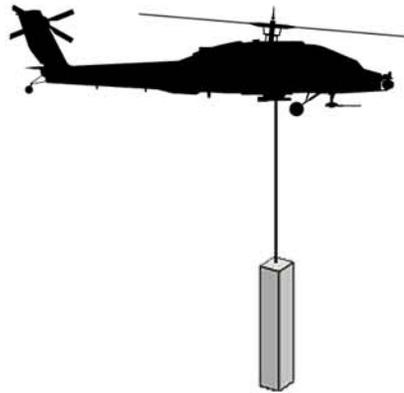

UT-BATTELLE

Cermets

A cermet is a compound composed of ceramic particles embedded in a metal matrix. The cermet used in our cask has depleted uranium dioxide mixed in a continuous phase of iron. The depleted uranium dioxide provides improved shielding capabilities while the iron improves heat transfer through the material.



Requirements for Next Generation Spent Nuclear Fuel Cask



1. Enhance Non-Proliferation Features
2. Improved passive cooling and decay heat removal

3. Dry Storage
4. Physical Protection Against Terrorist Assault
5. Reduced Size and Weight



Calculations Used SCALE4.4a Code

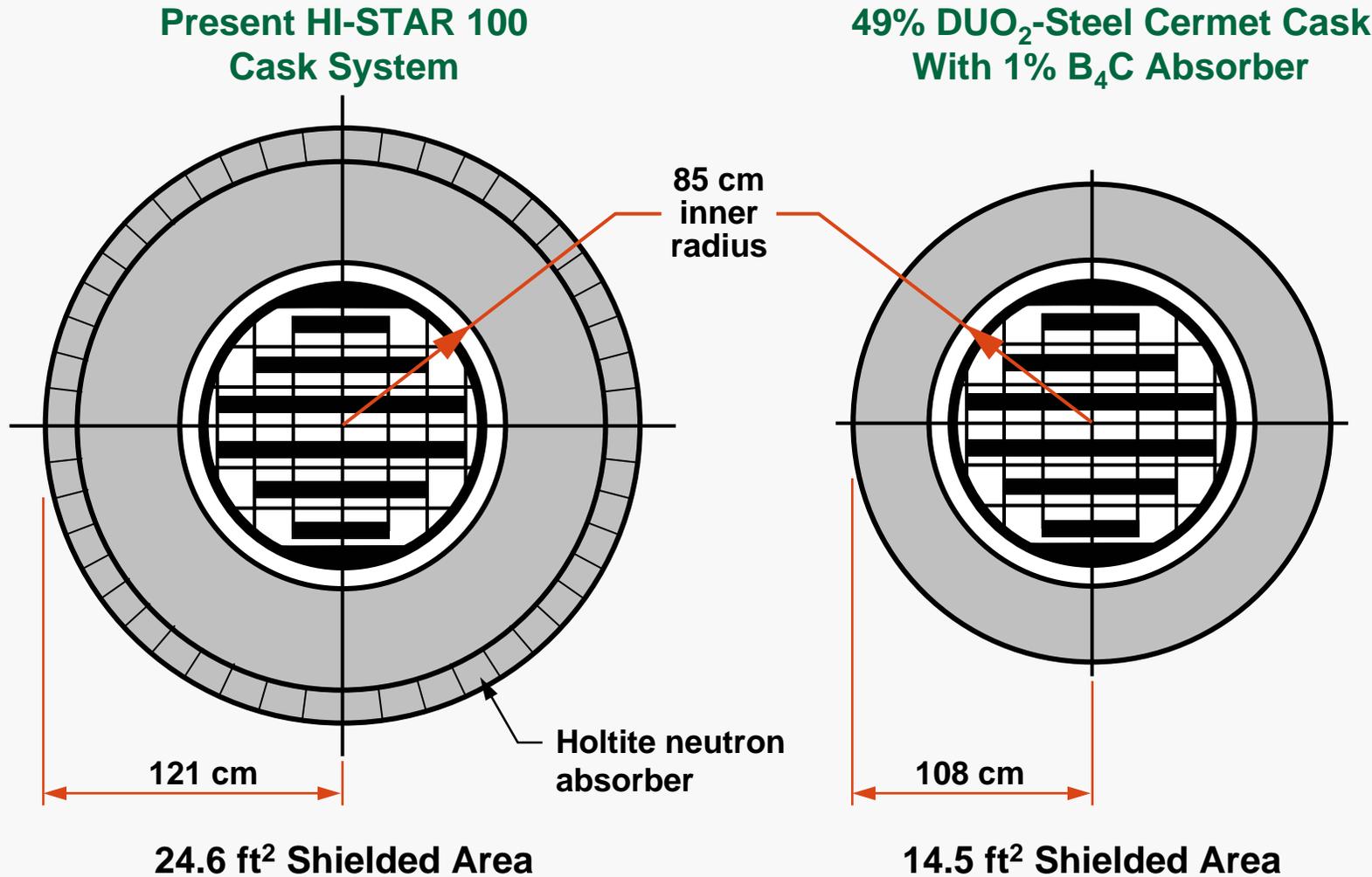
- The SCALE code was obtained from the Radiation Safety Information Computational Center at Oak Ridge National Laboratory
- Origen-ARP Express from the SCALE code was used to generate the radiation source terms for the spent nuclear fuel
- The SAS1 module in the SCALE code was used for one dimensional shielding analysis of the conceptual cermet cask compared to the HI-STAR 100



Study Parameters

- **Calculations were performed with volume percents of DUO_2 in the cermet material of 30, 50, and 70%, with 50% being the nominal case and 70% being best case conditions**
- **The thickness of the steel liners surrounding the cermet material was varied between 1.27 and 3.81 cm**
- **A study was performed to test the feasibility of adding B_4C to the cermet material to eliminate the need for a separate neutron shield**

There is a 41% Reduction in Shielded Cross-Sectional Area With DUO₂-Steel Cermet Casks



Cermet Casks Weigh Less



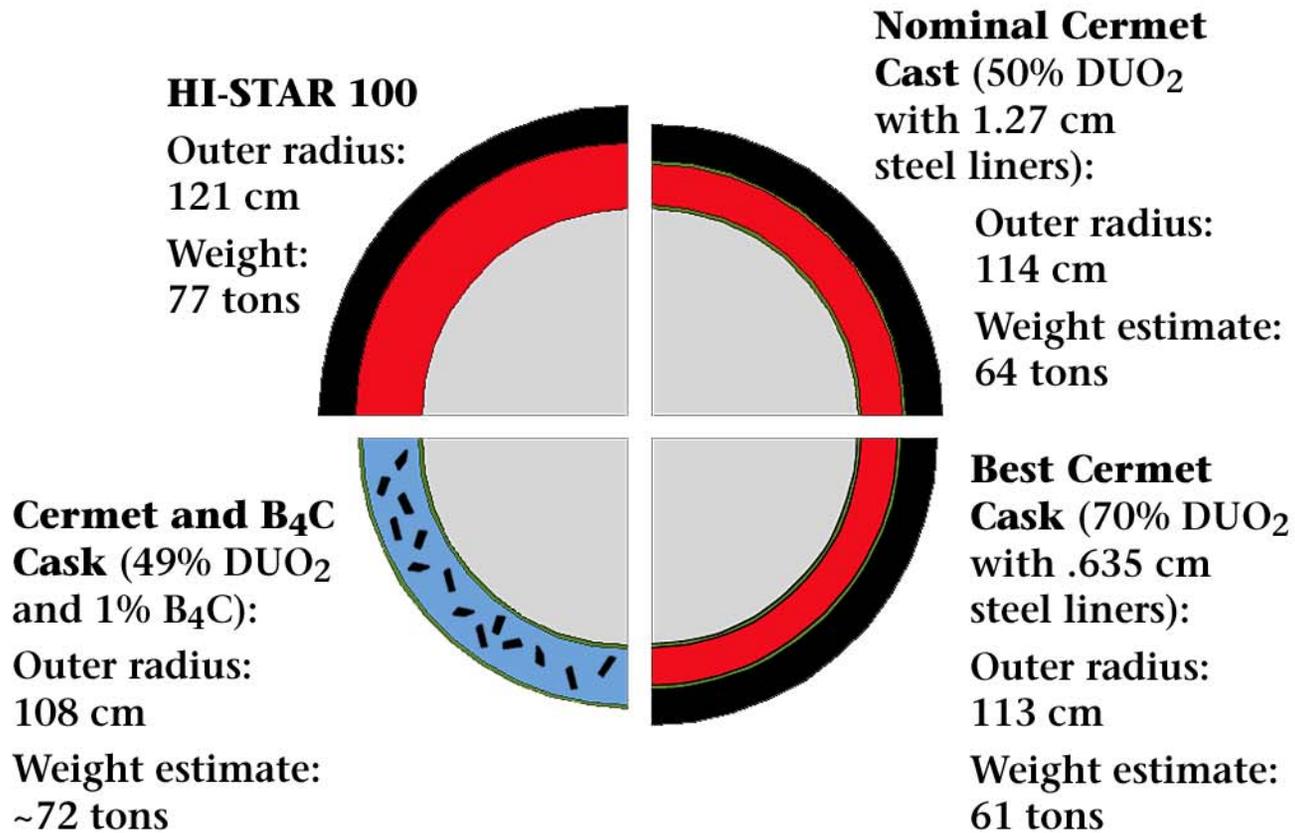
HI-STAR 100

Weight = 77 tons

Cermet Cask

Best Case* Weight = 61 tons

*Best case weight including neutron absorber = 72 tons



Conclusions

- **At nominal conditions:**
 - Cask diameter decreased 5.8%
 - Cask weight decreased 16.5%
- **At best conditions:**
 - Cask diameter decreased 7.2%
 - Cask weight decreased 20%
- **At best conditions plus neutron absorber (a 0.3% ^{235}U content is assumed in the DU)**
 - Cask diameter decreased ~11%
 - Cask weight decreased ~6.5%
- **In the SNF cask design world, these are large beneficial changes**