

AREVA NP next generation fresh UO₂ fuel assembly shipping cask: SCALE - CRISTAL comparisons lead to safety criticality confidence

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AREVA NP as a worldwide PWR fuel provider has to have a fleet of fresh UO₂ shipping casks being agreed within a number of countries including the USA, France, Germany, Belgium, Sweden, China, South Africa... and to accommodate foreseen EPR Nuclear Power Plants fuel buildings. To reach this target the AREVA NP Fuel Sector decided to develop an up to date shipping cask gathering experience feedback of the today fleet and an improved safety allowing the design to comply with international regulations (NRC and IAEA) and local Safety Authorities.

Based on pre design features a safety case was set up to highlight safety margins. Criticality hypothetical accidental assumptions were defined:

- Preferential flooding
- Fuel rod lattice pitch expansion for full length of fuel assemblies
- Neutron absorber penalty
- ...

Well known computer codes, American SCALE package and French CRISTAL package, were used to check configurations reactivity and to ensure that both codes lead to coherent results. Basic spectral calculations are based on similar algorithms with specific microscopic cross sections ENDF/BVI for SCALE and JEF2.2 for CRISTAL. The main differences between the two packages is on one hand SCALE's three dimensional fuel assembly geometry is described by a pin by pin model while an homogenized fuel assembly description is used by CRISTAL and on the other hand SCALE is working with either 44 or 238 neutron energy groups while CRISTAL is with a 172 neutron energy groups. Those two computer packages rely on a wide validation process helping defining uncertainties as required by regulations in force.

The shipping cask with two fuel assemblies is designed to maximize fuel isolation inside a cask and with neighboring ones even for large array configuration cases.

Proven industrial products are used:

- Boral™ as neutron absorber
- High density polyethylene (HDPE) or Nylon as neutron moderator
- Foam as thermal and mechanical protection

The cask is designed to handle the complete AREVA fuel assembly types from the 14x14 to the 18x18 design with a ²³⁵U enrichment up to 5.0% enriched natural uranium (ENU) and enriched reprocessed uranium (ERU).

After a brief presentation of the computer codes and the description of the shipping cask, calculation results and comparisons between SCALE and CRISTAL will be discussed.