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Net Weight Issue LLNL DOE-STD-3013 Containers

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LLNL DOE-STD-3013 Containers

#L000072 and #L000076

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The following position paper will describe DOE-STD-3013 container sets #L000072 and #L000076, and how they are compliant with DOE-STD-3013-2004.

All masses of accountable nuclear materials are measured on LLNL certified balances maintained under an MC&A Program approved by DOE/NNSA LSO. All accountability balances are recalibrated annually and checked to be within calibration on each day that the balance is used for accountability purposes. A statistical analysis of the historical calibration checks from the last seven years indicates that the full-range Limit of Error (LoE, 95% confidence level) for the balance used to measure the mass of the contents of the above indicated 3013 containers is 0.185 g. If this error envelope, at the 95% confidence level, were to be used to generate an upper-limit to the measured weight of the containers #L000072 and #L000076, the error-envelope would extend beyond the 5.0 kg 3013-standard limit on the package contents by less than 0.3 g. However, this is still well within the intended safety bounds of DOE-STD-3013-2004.

The fissile material loaded into containers #L000072 and #L000076 have the following measured masses:

Container	Net	Total Fissile Material
#L000072	4.9999 kg	3.3 kg
#L000076	4.9998 kg	4.2 kg

These containers pose no criticality concern. Both are below the DOE-STD-3013-2004 mandated limit of 4.4 kg of fissile material. Applying the same conservative method described above by adding the respective measurement LoE's (95% confidence level) to the total mass of the fissile material, the sum is still below 4.4 kg.

The DOE-STD-3013-2004 indicates the 5.0 kg limit on the package contents was included for two reasons: criticality safety and drop-testing. The first constraint, criticality, is called out in section A.6.3.2 of the standard. It is based on k_{eff} criticality safety margin of 0.05 as applied to a fully water-reflected, metal sphere of plutonium. The mass of plutonium metal that would be allowed within this margin would be 4.4 kg, based on an assumption of a 4.53 kg fully water-reflected, spherical critical mass. SRS Criticality Safety Analysts have assumed in their calculations 5.4 kg plutonium in the storage configuration as an additional safety buffer. The DOE 3013 standard states that 4.4 kg would correspond to 5.0 kg of oxide, which is based on the fact that plutonium oxide is about 88% plutonium by mass. However, this linear extrapolation from the metal

to the oxide is very conservative because plutonium oxide has a critical mass much greater than plutonium metal. A sphere of plutonium oxide in an optimum configuration with full water-reflection has a critical mass of approximately 12 kg, as opposed to 4.53 kg as mentioned in DOE-STD-3013-2004. A 5.0003 kg sphere of plutonium oxide is well inside a k_{eff} criticality safety margin of 0.05, which is the intent of the 3013 standard.

The second reason that the DOE-STD-3013-2004 constrains the mass to 5.0 kg, is that it ensures a drop-test safety envelope through container certification. This is also called out in section A.6.3.2 of DOE-STD-3013-2004. The variation between containers far exceeds 0.3 g and thus the perturbation of the drop-test safety envelope by 0.3 g is negligible.

LLNL containers #L000072 and #L000076 are compliant with DOE-STD-3013-2004.