Authorized Fissile Packaging- Determining the CSI

Primarily, we think of NRC- and DOE- approved packaging that have been certified for fissile contents and have a certificate of compliance issued by the respective entity. The certificate details the authorized contents for the package and controls, such as an assigned criticality safety index (CSI).

Frequently, the USA DOT 7A Type A packaging is overlooked as an option for small quantities of fissile materials under section 49 CFR 173.417(a). Mass restrictions of fissile materials in the DOT 7A packages are determined in 10 CFR 71.22 and must be met. These restrictions also limit the amount of beryllium, graphite, and hydrogenous material enriched with deuterium. The following equation in 10 CFR 71.22(e)(1) is used to calculate the CSI for the package:

$$CSI = 10[\frac{grams\ U-235}{X} + \frac{grams\ U-233}{Y} + \frac{grams\ Pu}{Z}]$$

The calculated CSI must have a value less than or equal to 10. There are two Tables identified in 10 CFR 71.22. If you have mixed radionuclides, have an enrichment greater than 24% or unknown enrichment, the values of x, y, and z are defined in Table 71-1. Mixed radioisotopes would include U-233 and/or plutonium greater than 1% of the mass of U-235. You must also take into account substances mixed with the fissile materials having a moderating effectiveness such as hydrocarbon oils or plastics. Polyethylene used for packing or wrapping may be present and does not have to be considered.

> For example, determine the CSI for a package containing the following mixture:
>
>> U-235, 50 grams, 93% enrichment
>> U-233, 3 grams
>> Pu-241, 2 grams
>> No substances having moderating effectiveness are present
>> Plastic wrapping used for packing is present
>
> $$CSI = 10[\frac{50\ g\ U-235}{60\ g} + \frac{3\ g\ U-233}{43\ g} + \frac{2\ g\ Pu}{37\ g}] = 9.57$$
> *Note: The values of x, y, and z are found in Table 71-1.*
>
> 10 CFR 71.22(e)(2) requires us to round up to the first decimal place, so the final answer is 9.6.

Table 71-2 is used to calculate the CSI if there are no mixed isotopes and the U-235 enrichment is less than or equal to 24%.

> For example, determine the CSI for a package containing the following:
>
>> 75 g U-235, 6.1% enrichment

No substances having moderating effectiveness are present
Plastic wrapping used for packing is present

Table 71-2 provides mass limits for Uranium enrichments in weight percent of U-235 less than or equal to 24%. We have an enrichment of 6.1%, so choose the next higher value of 6.5% since the table does not state the value for 6.1%. Alternatively, you may extrapolate the real value corresponding to 6.1% from a plotted curve. The value of U-235(x) corresponding to 6.5% is 93.

$$CSI = 10[\frac{75\ g\ U-235}{93\ g}] = 8.06$$

When rounded up to the first decimal place, the CSI = 8.1.

In summary, determining the CSI depends on the packaging used. For fissile material packaging approved by NRC or DOE, the CSI is documented in the packaging certificate. Use the instructions in 10 CFR 71.22 when determining the CSI for DOT 7A packaging.

In addition to all other requirements for DOT 7A packaging, an additional drop test is required under 49 CFR 173.465(c)(2) when using to transport fissile contents. These packagings are common, but make sure the appropriate test documentation accompanies procurements and is maintained on file.