

**Safety Evaluation Report for the
Application for Contents Amendment for Shipping
Training Source Contents in 9977 Packaging**

Paul Mann (NNSA) Memorandum to James Shuler DOE PCP

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Background

The Department of Energy (DOE) Packaging Certification Program (PCP) received a memorandum (Ref. 1) describing a proposed modification to the “Training Sources” contents for the Model 9977-96 radioactive material transportation package. This DOE PCP Safety Evaluation Report is a technical review of the proposed changes to the “Training Sources” contents to determine if the proposed changes are within the established safety basis for the packaging. The currently authorized “Training Sources” contents are described in Justification for Training Sources Contents Safety Analysis Report for Packaging Model 9977-96 Addendum 5, S-SARA-G-00009, Revision 2 May 2010 (Ref. 2), and were authorized with the Department of Energy (DOE) Certificate of Compliance USA/9977/B(M)F-96(DOE), Revision 6 (Ref. 3).

The Pacific Northwest National Laboratory uses plutonium and uranium sources for the training of domestic and international customs agents in the identification and detection of radioactive materials. The current authorized “Training Sources” contents in the Model 9977-96 are described in Table A.1.1 Training Sources in the Safety Analysis Report for Packaging (SARP), Addendum 5. The current “Training Sources” contents are composed of ^{238}Pu (3.5 g), ^{239}Pu (190 g), ^{240}Pu (25 g), ^{241}Pu (7 g), ^{242}Pu (10 g), ^{237}Np (10 g), ^{243}Am (6.63 g), ^{234}U (1 g), ^{235}U (500 g), ^{236}U (1 g), ^{238}U (2,000 g) and ^{232}Th (10,000 g). A few other elements like Be, Al, Mg, Na, F, Ca, Fe and Cr are present in trace quantities. The total amount of Training Sources is limited to 12.75 kg of radioisotopes, out of which 12 kg are non-fissile isotopes of ^{232}Th and ^{238}U . The amount of fissile isotopes is less than 750 g.

The proposed change is to increase the ^{234}U content from 1 g to 10 g, keeping the total amount of radioactive material (RAM) unchanged at 12.75 kg..

Review Results

Structural

Since the overall “Training Sources” contents mass is unchanged at 12.75 kg, no structural evaluation or structural-related conditions of approval are necessary

Thermal

The DOE PCP Staff examined the thermal load from increasing the ^{234}U content from 1 g to 10 g in the “Training Sources” contents, and concluded that this increase will involve a negligible increase in the contents decay heat. No additional thermal-related conditions are required to be compliant with the limits set forth in 10 CFR Part 71.

Containment

Since the containment vessel has a “leak tight” criterion, no additional containment analysis or conditions of approval are necessary to be compliant with the external containment limits set forth in 10 CFR Part 71.

Shielding

The DOE PCP Staff examined the application to increase the amount of ^{234}U by 9 g for “Training Sources” in the Model 9977 Package, and concluded that this addition will involve a negligible (i.e., less than 0.05%) increase in the external radiation levels as presented in the S-SARA-G-00009, Revision 2 (May 2010). No additional conditions are required to be compliant with the external radiation limits set forth in 10 CFR Part 71.

Criticality

In previous analyses, the single package analysis was shown to be subcritical by using the ANSI/ANS 8.1(Ref. 4) single-parameter subcritical limits of ^{239}Pu and ^{235}U . For Normal Conditions of Transport (NCT) and Hypothetical Accident Conditions (HAC) analysis, it was shown that the “Training Sources” content is bounded by the content envelope C.2 in the 9978 packaging assuming a fissile mass of 4.4 kg of ^{239}Pu .

The original criticality evaluation for “Training Sources” contents was very conservative and based on fissile materials in solution form. However, the training sources shall be in solid form (metal or oxide) and there shall be no free liquids as specified. A large quantity fissionable material like ^{238}U , ^{232}Th , or ^{234}U will act like a poison in the solution system and will act like a diluent when mixed with fissile solid material (Ref. 5). The critical mass will be reduced when U or Th are used as a reflector. However, the “Training Sources” content mass is an order of magnitude lower than the critical reflected mass of U or Pu in the solid form.

An increase of ^{234}U mass from 1 g to 10 g, keeping the total RAM unchanged, will not have a significant impact on the radioactivity of the system. Based on the fact that there is a considerable reactivity margin available for the “Training Sources” contents based on its significantly lower fissile mass, it is concluded that the Training Sources contents shall remain subcritical in the single package or the NCT and HAC array scenarios of 9977.

The Criticality Safety Index (CSI) for content envelope C.2 is 1.0 in the 9978 SARP. Since the bounding calculations (using 6 inch containment vessel model) for content envelope C.2 in the 9978 SARP were used for the justification of subcriticality of the “Training Sources” contents for 9977, the same CSI value of 1.0 can be used for 9977 with the “Training Sources” contents.

The DOE PCP concluded that the “Training Sources” contents for 9977 shipping container remain subcritical under the Single package, NCT and HAC scenarios with a CSI of 1.0, and that no criticality-related conditions of approval are required to be compliant with the criticality limits set forth in 10 CFR Part 71

Acceptance Tests and Maintenance, Operations, Quality Assurance

The proposed change to the “Training Sources” contents does not necessitate any additional analysis or conditions of approval in the areas of Acceptance Tests and Maintenance, Operations, or Quality Assurance.

Conclusion

DOE PCP concludes that the changes to the "Training Sources" contents (Ref. 1), as described in Justification for Training Sources Contents Safety Analysis Report for Packaging Model 9977-96 Addendum 5, S-SARA-G-00009, Revision 2 (May 2010) (Ref. 2), are within the established safety basis and therefore approves the proposed changes to the Model 9977-96 contents.

References

1. Memorandum from P. Mann to J. Shuler, "ACTION: Review of Application for Contents Amendment for Shipping Training Source Contents in 9977 Packaging," November 22, 2010.
2. *Justification for Training Sources Contents Safety Analysis Report for Packaging Model 9977-96 Addendum 5*, S-SARA-G-00009, Revision 2 (May 2010).
3. Department of Energy (DOE) Certificate of Compliance USA/9977/B(M)F-96(DOE), Revision 6.
4. ANSI/ANS-8.1-1998, "Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors."
5. LA-10860-MS, "Critical Dimensions of Systems containing ^{235}U , ^{239}Pu , and ^{233}U ," 1986 Revision, Los Alamos National Laboratory, New Mexico.