

SAFETY EVALUATION REPORT

DEPARTMENT OF ENERGY

MOUND 1KW PACKAGE

DOCKET 91-10-9516

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SUMMARY

EG&G Mound Technologies in support of the United States Department of Energy (DOE) Dayton Area Office has requested a DOE Certificate of Compliance for the Mound 1KW package. The requested content was PuO₂ powdered heat source material. Fissile Class I¹ and exclusive use shipment were requested. Land and sea transport in an 8x8x20 ft cargo container⁴ and land transport in a Safe and Secure Trailer were requested.

Based on the statements and representations in the documentation submitted by EG&G Mound Technologies^{1,2,4} and the conditions listed below, the staff of DOE's Transportation and Packaging Safety Division (EH-33.2) has concluded that the Mound 1kW package design satisfies the requirements of DOE Order 5480.3, 10 CFR Part 71, 49 CFR Part 173 and IAEA Safety Series 6 1973 Revised Edition (As Amended)¹⁰.

DRAWINGS

The cask and personnel barrier of the Mound 1KW package are constructed in accordance with PAI drawing MD-9516 sheets 1 through 14b. The two containment vessels are constructed in accordance with Mound drawings AYD901017, AYD901018 and ADY901019.

Two shipping configurations are identified: Savannah River Site (SRS)¹ and Russian². In the SRS configuration, the PuO₂ powder heat source material is to be retained within eight threaded stainless steel product cans (SRS-PC) 2.0 inches in diameter, each of which holds a single threaded stainless steel powder can. In the Russian configuration, the PuO₂ powder heat source material is to be retained within eight welded stainless steel product cans (Russian-PC) 1.5 inches in diameter, each of which holds a single threaded

stainless steel ampule inside a welded stainless steel capsule. In both shipping configurations, four PCs are positioned within a graphite support block and contained within each of two completely welded cylindrical stainless steel primary containment vessels (PCVs). The two PCVs are stacked on top of each other, with a graphite filler block in between, and contained within a completely welded cylindrical stainless steel secondary containment vessel (SCV). The SCV, with two PCVs, is confined by the stainless steel cask, which is surrounded by a stainless steel cage and wire mesh personnel shield.

DISCUSSION

The following detail the general findings and conclusions from the technical evaluation of the Mound 1KW package.

General Information

The general information section of the SARP^{1,2} was reviewed to determine that the packaging and its contents were described in sufficient detail to identify the package accurately and provide a sufficient basis for evaluation of the package. The scope of the review covered the use of the packaging, the packaging description, the operational features, the contents of the packaging, the packaging evaluation, the quality assurance program, and supportive information or documentation.

Basis for acceptance in the review was conformance with established guidelines and criteria. The review of the SARP^{1,2} describing the Mound 1kW package indicates that the SARP^{1,2} contains all information required to demonstrate compliance with DOE Order 1540.2⁵, 10 CFR Part 71⁶ and IAEA Safety Series 6¹⁰. Where alternative methods have been proposed to demonstrate compliance, sufficient information has been provided to perform orderly review. The SARP provides sufficient information and does in fact assure compliance with the requirements relating to general standards for all packages. The SARP also contains a quality assurance program that conforms to DOE Order 5700.6C⁷ and 10 CFR Part 71⁶.

The staff concludes that the general information provided in the Mound 1KW package SARP conforms to applicable regulations, regulatory guides, and industry standards, and is acceptable.

Structural Evaluation

The structural section of the SARP¹ was reviewed to determine that the Mound 1KW package was designed in a manner that will assure compliance with the applicable performance requirements of 10 CFR Part 71⁶ and IAEA Safety Series 6¹⁰ for shipment under normal conditions of transport and hypothetical accident conditions and the applicable design requirements of the American Society of Mechanical Engineers' (ASME) Boiler and Pressure Vessel Code⁸ (B&PVC), Section III. The scope of the review covered the structural design, the weights and centers of gravity, the mechanical properties of the materials, the general standards for all packages, the lifting and tie-down standards for all packages, the structural evaluation for normal conditions of transport, the structural evaluation for hypothetical accident conditions, and supportive information or documentation. For normal conditions of transport, PCV and SCV wall temperatures were limited to 426.7°C (800°F). The maximum weight of the SCV and its contents was established at 32.6 kg (72 lb).

Basis for acceptance in the review was conformance with established guidelines and criteria. The review of the Mound 1kW package structural design indicates that, under normal conditions of transport and hypothetical accident conditions, a package loaded with eight product cans containing PuO₂ powder fuel at a weight equivalent to 500 watts total heat is in compliance with the applicable performance requirements of 10 CFR Part 71⁶ and the applicable design requirements of the ASME B&PVC⁸, Section III. Furthermore, there are no adverse structural effects on the containment, shielding, and criticality functions of the package.

The staff concludes that the protective features provided in the design of the Mound 1KW package conform to applicable regulations, regulatory guides, and industry standards, and are acceptable.

Thermal Evaluation

The thermal section of the SARP^{1,2,3,4} was reviewed to determine that the Mound 1KW package was designed in a manner that will assure compliance with the applicable performance requirements of 10 CFR Part 71⁶ and IAEA Safety Series 6¹⁰ for shipment under normal conditions of transport and hypothetical accident conditions; and 49 CFR Part 173⁹, paragraph 173.403 (ff) and IAEA Safety Series No. 6¹⁰, paragraph 805(g) for stowage conditions during transport. The scope of the review covered the thermal properties of the materials, the thermal specifications on packaging components and parts, the thermal evaluation for normal conditions of transport, the thermal evaluation for hypothetical accident conditions, and supportive information or documentation. Two shipping configurations were reviewed: SRS¹ and Russian². Thermal limits for each configuration are shown in the following table:

	<u>²³⁸Pu Limit in watts</u>	
	<u>SRS-PC</u>	<u>Russian-PC</u>
SCV	464	500
PCV	232	255
PC	58	70
Difference between PCVs in SCV	50*	50*
Diff. circumferentially adjoining PCs	20	20
Maximum diff. between all PCs in a PCV	30	30
Single PC in SCV (7 empty positions)	50**	50**

* The PCV with the higher content of the two PCVs in an SCV shall be stacked in the top position in the SCV.

** The 7 unused positions need not be filled with dummy PCs. The PCV containing the single heat generating PC may be in either position in the SCV.

Stowage conditions to include land and sea transport in an 8x8x20 ft cargo container⁴ have been reviewed.

Basis for acceptance in the review was conformance with established guidelines

and criteria. The review of the Mound 1KW package thermal design indicates that, under normal conditions of transport and hypothetical accident conditions, a package loaded with product cans containing PuO_2 powder fuel at the thermal limits specified above is in compliance with the applicable performance requirements of 10 CFR Part 71⁶ and Safety Series 6¹⁰.

Furthermore, there are no adverse thermal effects on the containment, shielding, and criticality functions of the package. For the package to meet the stowage requirements of 49 CFR Part 173⁹, paragraph 173.403 (ff) and IAEA Safety Series No. 6¹⁰, paragraph 805(g), the following conditions must be met.

1. A package may not be shipped in an enclosed space that impedes natural convection heat transfer with the atmosphere. The exception is shipment of up to three packages containing up to 500 W each in an 8x8x20 foot cargo container, provided the cargo container does not have a double wall, is made of metal (except for the flooring), is not insulated, and has at least 3.8 cm (1.5 in) thick flooring. In land transport, all surfaces of the cargo container except its bottom shall be exposed to the ambient air. In sea transport, the cargo container shall be in the top layer of the on-deck stacks with at least 60 cm (2 ft) clearance on both long sides from other cargo boxes and ship structures.
2. The package may not be covered with a tarpaulin or other material that impedes natural convection heat transfer with the atmosphere.

The staff concludes that the protective features provided in the design of the Mound 1KW package conform to applicable regulations, regulatory guides, and industry standards, and are acceptable.

Containment Evaluation

The containment section of the SARP¹ was reviewed to determine that package containment was designed in a manner that will assure compliance with the applicable performance requirements of 10 CFR Part 71⁶ and Safety Series 6¹⁰ under normal conditions of transport and hypothetical accident conditions.

The scope of the review covered the containment boundaries, the requirements

for normal conditions of transport, the requirements for hypothetical accident conditions, the special requirements for plutonium shipments, and supportive information or documentation.

Basis for acceptance in the review was conformance with established guidelines and criteria. The review of the Mound 1KW package containment design indicates that, under normal conditions of transport and hypothetical accident conditions, the use of all-welded primary containment vessels and secondary containment vessels is in compliance with the applicable performance requirements of 10 CFR Part 71⁶ and Safety Series 6¹⁰.

The staff concludes that the protective features provided in the design of the Mound 1KW package conform to applicable regulations, regulatory guides, and industry standards, and are acceptable.

Shielding Evaluation

The shielding section of the SARP^{1,2,3} was reviewed to determine that the Mound 1KW package shielding was designed in a manner that will assure compliance with the performance requirements of 10 CFR Part 71⁶, 49 CFR Part 173⁹, and IAEA Safety Series 6¹⁰ for an exclusive use shipment under normal conditions of transport and for hypothetical accident conditions. The scope of the review covered the shielding design features of the package, the source and model specifications, the shielding evaluation, and supportive information or documentation. Two shipping configurations were reviewed: SRS¹ and Russian². Source terms consistent with the SRS-PC and Russian_PC thermal limits were evaluated independently^{1,2,3}. The effect of fluorine and other low atomic number element contaminants on the quantity of PuO₂ powder fuel that may be shipped was considered. Land and sea transport in an 8x8x20 ft cargo container and land transport by truck have been considered.

Basis for acceptance in the review was conformance with established guidelines and criteria. The review of the Mound 1KW package shielding design indicates that the total dose equivalent rates are such that exclusive use shipment must be employed and that under normal conditions of transport and hypothetical

accident conditions exclusive use truck shipments of one and six Mound 1KW packages loaded with eight product cans containing PuO_2 powder fuel with total source strengths equivalent to the thermal limits established above are in compliance with the performance requirements for exclusive use of 10 CFR Part 71⁶ and 49 CFR Part 173⁹ at all locations except the normally occupied position in the truck tractor. To assure compliance, any persons occupying this position must be provided with special health supervision, personnel radiation exposure monitoring devices, and training in accordance with 10 CFR Part 19¹¹, paragraph 19.12. To ensure that the total dose equivalent rates are in compliance with 10 CFR Part 71⁶, paragraph 71.47 and 49 CFR Part 173⁹, paragraph 173.441 for exclusive use cargo container shipment by sea, the external surface of the cargo container must be 2.44 m (8 ft) or more from any normally occupied position.

The staff concludes that the protective features provided in the design of the Mound 1KW package conform to applicable regulations, regulatory guides, and industry standards, and are acceptable.

Criticality Evaluation

The criticality section of the SARP^{1,2,3} was reviewed to determine that the Mound 1KW package was designed in a manner that will assure compliance with the applicable performance requirements of 10 CFR Part 71⁶ and Safety Series 6¹⁰ under normal conditions of transport and hypothetical accident conditions. The scope of the review covered the package fuel loading, the model specification, the criticality calculation, the critical benchmark experiments, and supportive information or documentation. Two shipping configurations were reviewed: SRS¹ and Russian². Total source material consistent with the SRS and Russian configuration thermal limits were evaluated independently^{1,2,3}.

Basis for acceptance in the review was conformance with established guidelines and criteria. The review of the Mound 1KW package criticality indicates that, under normal conditions of transport and hypothetical accident conditions, an unlimited number of packages loaded with eight product cans containing a total

of 2,470 grams of PuO_2 powder fuel at 80 wt% ^{238}Pu will remain subcritical in compliance with the applicable performance requirements of 10 CFR Part 71⁶ and IAEA Safety Series 6¹⁰. The loading limit of 500 watts ^{238}Pu per Mound 1KW package corresponds to 1,251 grams of PuO_2 at 80 wt% ^{238}Pu .

The staff concludes that the protective features provided in the design of the Mound 1kW package conform to applicable regulations, regulatory guides, and industry standards, and are acceptable.

Operating Procedures Evaluation

The operating procedures section of the SARP¹ was reviewed to determine that operating procedures for the Mound 1KW package are designed in a manner that will assure compliance with the applicable performance requirements of 10 CFR Part 71⁶ and IAEA Safety Series 6¹⁰. The scope of the review covered the general requirements, the summary of operating requirements and restrictions, the package loading, the shipment preparation, the package receipt, the package unloading, and supportive information or documentation.

Basis for acceptance in the review was conformance with established guidelines and criteria. The review of the Mound 1KW package operating procedures indicates that the operating procedures are in compliance with the applicable performance requirements of 10 CFR Part 71⁶ and IAEA Safety Series 6¹⁰.

The staff concludes that the protective features provided in the design of the Mound 1KW package conform to applicable regulations, regulatory guides, and industry standards, and are acceptable.

Acceptance Test and Maintenance Program Evaluation

The acceptance tests and maintenance program section of the SARP¹ was reviewed to determine that the Mound 1KW package acceptance tests and maintenance program are designed in a manner that will assure compliance with the applicable performance requirements of 10 CFR Part 71⁶ and IAEA Safety Series 6¹⁰. The scope of the review covered the acceptance tests, the maintenance

program, and supportive information or documentation.

Basis for acceptance in the review was conformance with established guidelines and criteria. The review of the Mound 1KW package acceptance tests and maintenance program indicates that the acceptance tests and maintenance program are in compliance with the applicable performance requirements of 10 CFR Part 71⁶ and IAEA Safety Series 6¹⁰ with addition of the following conditions.

1. If any SCV or PCV welded at a participant site fails the periodic overpressure test specified in the SARP¹, the DOE Certifying Official shall be notified immediately. SCVs and PCVs welded by that site since its last successful periodic test must be removed from transportation service.
2. SCV and PCV closure welds must be examined by radiography (RT) in accordance with the ASME B&PVC⁸, Section III, Subsection NB, paragraphs NB-5220 and NB-5320. The acceptance criteria for elongated indications, other than cracks or zones of incomplete fusion or penetration which are not allowed at any size, shall be 0.10 cm (0.040 in) or less. For use of the double-wall exposure RT technique, at least six (6) x-ray exposures taken at 60° increments are required. In lieu of the requirement in NB-5220 for either a liquid penetrant or magnetic particle inspection, each PCV and SCV shall be visually inspected per the ASME B&PVC⁸, Section V, Article 9 and shall be helium leak tested as specified in the SARP¹. This condition applies to weld qualification vessels and to periodic overpressure test vessels as well as all production vessels. The number of x-ray exposures may be reduced by demonstrating to the satisfaction of the DOE Certifying Official that all cracks, all zones of incomplete fusion, and all unacceptable elongated indications are detectable with the proposed number of x-ray views.

For all other SCV and PCV welds, a single-wall exposure technique shall be used for radiography whenever practical with at least 4 x-ray

exposures at 90° increments. When it is not practical to use the single-wall technique, the double wall technique may be used in conjunction with visual examination of the inside and outside weld beads and heat affected zones per the requirements of the ASME B&PVC⁸, Section V, Article 9. Acceptance criteria shall be the same as for the closure welds.

3. If the welding apparatus is diverted to other uses other than welding Mound 1KW containment vessels or welding operations are halted for more than 90 days, welding procedure qualification records shall be reviewed and one PCV and one SCV shall be welded by a qualified welder using the qualified welding procedure specification (WPS) parameters. If these trial welds are not acceptable per the required inspections cited above, then the WPS shall be requalified per the requirements of the ASME B&PVC⁸, Section IX and the overpressure tests shall be redone. This requirement is dictated by 10 CFR Part 71⁶, paragraphs 71.105 and 71.119 as interpreted by NRC Regulatory Guide 7.10¹². The visual inspection and helium leak test procedures shall apply to the overpressure test vessels and the weld qualification vessels.

The staff concludes that the protective features provided in the design of the Mound 1KW package conform to applicable regulations, regulatory guides, and industry standards, and are acceptable.

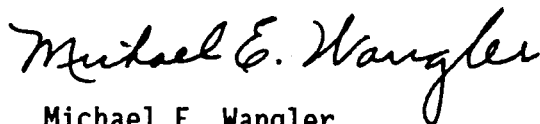
Quality Assurance Evaluation

The quality assurance section of the SARP¹ was reviewed to determine that the Mound 1KW package quality assurance program was designed in a manner that will assure compliance with the applicable performance requirements of DOE Orders 1540.2⁵, 5480.3¹³, and 5700.6C⁷; 10 CFR Part 71⁶; 49 CFR Parts 171¹³ and 173⁹; and IAEA Safety Series No. 6¹⁵, paragraph 209. The scope of the review covered the quality assurance requirements important to safety which apply to packaging design, purchase, fabrication, handling, shipment, storage, cleaning, assembly, inspection, test, operation, maintenance, repair, and component modification, and supportive information or documentation.

Basis for acceptance in the review was conformance with established guidelines and criteria. The review of the Mound 1KW package quality assurance program indicates that, for use of the packaging within the United States boundaries, the quality assurance program is in compliance with the applicable performance requirements of DOE Orders 1540.2⁵, 5480.3¹³, and 5700.6C⁷; 10 CFR Part 71⁶, 49 CFR Part 173⁹ and IAEA Safety Series No. 6¹⁵, paragraph 209. For international use of the Mound 1KW package, the requirements of 49 CFR Part 171¹⁴, paragraph 171.12(e) must be satisfied and the shipment must be prepared in accordance with IAEA Safety Series No. 6¹⁵, paragraph 209.

The staff concludes that the protective features provided in the design of the Mound 1KW package conform to applicable regulations, regulatory guides, and industry standards, and are acceptable. For a package loaded with product cans containing Russian PuO₂ powder fuel, additional requirements are necessary pertaining to the QA oversight of the Russian production facilities.

Approved by



Michael E. Wangler

Director

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