UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

AUG 3 1978

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MEMORANDUM FOR: Clifford V. Smith, Jr., Director
Office of Nuclear Material Safety
and Safeguards

FROM: Saul Levine, Director
Office of Nuclear Regulatory Research

SUBJECT: RESEARCH INFORMATION LETTER NO. #33 - PLUTONIUM ACCIDENT CONTAINER PROGRAM - RESEARCH, DESIGN AND DEVELOPMENT

INTRODUCTION

This memorandum transmits the documented results from the completed research program which designed, developed and tested the PAT-1 plutonium package that meets the NRC qualification criteria published in NUREG-0360, "Qualification Criteria to Certify a Package for Air Transport of Plutonium." The program was conducted by Sandia Laboratories, Albuquerque, New Mexico, for the Office of Nuclear Regulatory Research (RES) in response to your research request, NMSS 77-10.

The purpose of the program was to establish that a package could be developed that meets the acceptance standards defined in NUREG-0360. The success of this effort is documented in Enclosure 1, NUREG/CR-0030, "PARC (Plutonium Accident Resistant Container Program) - Research, Design, and Development." Much of the information contained in this report has already been utilized by your staff in the publication of NUREG-0361, "Plutonium Air Transportable Package, Model PAT-1, Safety Analysis Report."

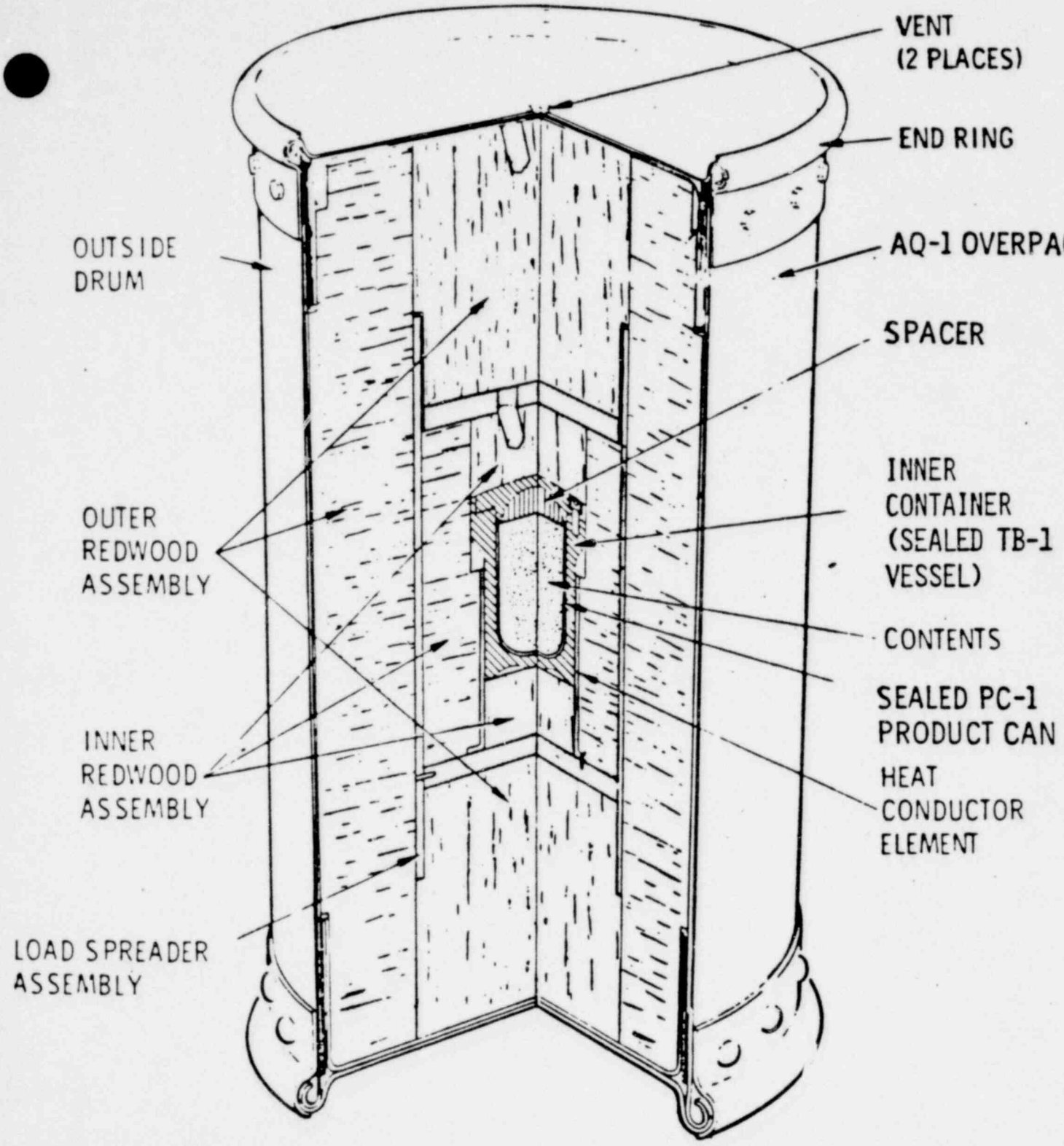
DISCUSSION

Development and design of the PAT-1 package began under a technical assistance effort by your Office in mid-1976 and continued from late 1976 through mid-1977 as a program funded by this Office. The program progressed (in parallel with your Office's efforts to finalize test and acceptance criteria) through several development design and test facility failures until the successful design was finalized in mid-1977. Testing of this design, Model PAT-1, was initiated in mid-1977 and was completed in December 1977.

Externally, the PAT-1 package (Figure 1) resembles a 65-gallon commercial stainless steel process vessel. The package is comprised, however, of a multi-layered stainless steel outer drum containing a redwood overpack (designated AQ-1), a containment vessel (TB-1) and a product can (PC-1). A summary report (SAND78-0724) outlining the design features of this package, the qualification requirements, and test results is provided in Enclosure 2.

RESULTS

Tables 1 through 4 of this memorandum summarize the package qualification requirements and the analyses of the package response to these requirements. Table 1 illustrates that during the qualification test program, five PAT-1 packages were subjected to the required series of performance tests - impact orientation being the only variable. The capability of these packages to meet post-test containment acceptance standards was demonstrated by measurements indicating: (1) no loss of surrogate contents (to a sensitivity level of 10^{-8} grams), and (2) very small air leakage rates across the containment vessel seals. These air leakage values were used by members of your staff to obtain bounding estimates on the potential for PuO_2 loss. Table 1 also indicates that the required hydrostatic test and the high and low temperature tests were conducted with successful results. Table 2 summarizes the calculations which demonstrate PAT-1 compliance with the shielding and criticality requirements of the Qualification Criteria. These calculations indicate that, in its intended use, potential maximum external radiation levels are well below acceptable limits and that the potential for a criticality incident is essentially non-existent. Table 3 summarizes the tests which demonstrate compliance with the requirements of 10 CFR 71. In these tests, the capability of a product can (internal to the containment vessel) to meet the requirements of 10 CFR 71.42 was demonstrated. Finally, Table 4 presents analyses indicating margins of safety for containment vessel integrity under maximum credible internal and external pressure environments.



PAT-1 PLUTONIUM AIR TRANSPORTABLE PACKAGE

FIGURE 1

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TABLE 1

Summary of Qualification Tests, PAT-1 Package

Impact Orientation	Impact Vel. ⊥ to Unyielding Target (fps)	Crush 70,000 (lb)	Puncture 5000 (ft-lb)	Slash 15,000 (ft-lb)	Fire 2200°F 60 Minutes	Immersion	Uranium Detection $\geq 10^{-8}$ g	Post-Test Air Leakage (cm^3/s)
Top 0°	442	√	√	√	√	√	none	$< 4.6 \times 10^{-6}$
Top Corner 30°	451	√	√	√	√	√	none	$< 4.5 \times 10^{-5}$ probably $\sim 1.7 \times 10^{-7}$
Side 90°	445	√	√	√	√	√	none	1.4×10^{-6}
Bottom Corner 150°	443	√	√	√	√	√	none	5.5×10^{-6}
End 180°	486	√	√	√	√	√	none	1.8×10^{-6}

Individual Test: 600 psig hydrostatic; 8 hours - No detectable water leakage: $< 10^{-10}$ cm^3/s

Other Requirements: Impact at -40°F -- 2.4×10^{-8} cm^3/s
Impact at 200°F -- 7×10^{-8} cm^3/s

TABLE 2

Shielding and Criticality

Shielding

Normal Transport -- PAT-1 Package Provides Sufficient Shielding (49 CFR 173)

Required -- < 10 mrem/hr 3 ft from surface

Calculated -- 2 mrem/hr 3 ft from AQ-1*

Required -- < 200 mrem/hr at surface

Calculated -- 33 mrem/hr at surface of AQ-1*

Postaccident -- Containment Vessel (TB-1) Provides Sufficient Shielding (10 CFR 71) -- This permits AQ-1 overpack to be discounted

Required -- < 1000 mrem/hr 3 ft from surface

Calculated -- 4 mrem/hr 3 ft from surface of TB-1*

Criticality

Normal Transport -- Undamaged Infinite Array $K_{eff} \sim 0.3$

Postaccident -- Damaged Infinite Array $K_{eff} \sim 0.4$

Single Water-Flooded and Reflected TB-1 $K_{eff} \sim 0.6$

(K_{eff} = effective neutron multiplication factor)

*Using 13.5 year-old Hanford-type plutonium as a conservative source model.

TABLE 3

Results of 10 CFR 71 Qualification Tests, PAT-1 Package

Normal Conditions of Transport: Heat, cold, internal pressure, vibration, water spray, drop (4 ft), penetration, compression

-- No Effect on Shielding
-- No Effect on Criticality
-- No Release: Leaktight (leakrate < 10^{-10} cm^3/s) Containment Vessel
No Release (<10^{-8} g) of UO_2 Surrogate from Product Can
-- Double Containment (product can and containment vessel both meet requirements)

Accident Conditions of Transport: Drop (30 ft), puncture, fire, immersion

-- No Effect on Shielding
-- No Effect on Criticality
-- No Release: Leaktight (leakrate < 10^{-10} cm^3/s) Containment Vessel
No Release (< 10^{-8} g) of UO_2 Surrogate from Product Can
-- Double Containment (product can and containment vessel both meet requirements)

TABLE 4

Containment Vessel Integrity

Internal Pressure

-- Maximum Credible Accident Environment -- 1080°F, 1253 psi (Bounding Assessment)

Tested to: 1000°F, 3330 psi, 18 hrs

Many tests at ~1080°F, ~1253 psi

Analysis 18,300 psi stress

93,000 psi strength

At 1080°F and 1253 psi, Margin of Safety $\simeq 4$

-- Maximum Normal Operating Pressure -- 215°F, 34.3 psi

Analysis 455 psi stress

140,000 psi strength

At 215°F and 34.3 psi, Margin of Safety $\simeq 306$

External Pressure

-- Hydrostatic Requirement -- 600 psi

Tested to: 5,000 psi: No leak

Analysis 5,000 psi load produces -43,000 psi stress

150,000 psi strength gives Margin of Safety $\simeq 2.5$

Margin of Safety $\simeq 20$ at 600 psi

RECOMMENDATIONS

The above results and enclosed documentation are offered for your use to support the NRC efforts to certify that a plutonium package has been developed to meet the requirements of Public Law 94-79. Any questions on the presented information, or on unpublished but documented results of development tests, should be referred to W. R. Lahs of the Systems Performance Branch of the Division of Safeguards, Fuel Cycle and Environmental Research.

Saul Levine, Director
Office of Nuclear Regulatory Research

Enclosures:
1. NUREG/CR-0030
2. SAND78-0724