71-0361

Sandia Laboratories
Albuquerque, New Mexico 87115

February 20, 1980

Mr. Charles E. MacDonald, Chief
Transportation Branch
Division of Fuel Cycle and Material Safety
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. MacDonald,

The International Atomic Energy Agency (IAEA) has an urgent requirement to air transport plutonium-bearing safeguards samples, and has requested U. S. assistance (Ref. 1). The United States also has strong commitments in support of safeguards and non-proliferation (Ref. 2). With some minor additions to the Certificate of Compliance, the PAT-1 package could be utilized for the air transport of safeguards samples (Refs. 3 and 4). As you know, additional background on this problem has been presented to you by the DOE Office of Safeguards and Security in various meetings.

During meetings in Vienna between October 29, 1979, and November 1, 1979, the IAEA requested Sandia Laboratories' assistance with a revision to the PAT-1 Certificate of Compliance (Enclosure 1, Action Item 9, page 7). This letter is in response to that request.

The Certificate of Compliance for the PAT-1 Package, Certificate Number 0361, Package Identification No. USA/0361/B( )F, signed by you on September 5, 1978, is oriented to the packaging of a single mass of UO_2 or Pu_2O_2 (solid form only), double bagged and canned. In order for the Certificate to be clearly and directly applicable to a group of individually packaged safeguards samples, it is proposed that the following condition be added to the Certificate.

> With a maximum of 200 grams material per 5.(b)(1) and a maximum decay heat load not to exceed 25 watts, additional permissible contents are limited to any combination of 1 gram maximum of water, 35 grams maximum of polyethylene, 400 grams maximum of metal canning material, 100 grams of aluminum foil and/or aluminum honeycomb, and 175 grams of quartz (silica glass).

15645

A Safety Analysis for this proposed addition to the PAT-1 Certificate of Compliance is attached as Attachment I.

Please advise us if further information is required.

Very truly yours,

M. R. Madsen, Div. 1721
Nuclear Security Systems

R. B. Pope, Div. 4552
Transportation Systems Technology

JAAndersen:1721:lc

Attachment I: Safety Analysis
Enclosure I: Uncl. letter, W. C. Myre, 1700 to A. H. E. VonBaeckmann, IAEA Dec. 21, 1979

Distribution:
Mr. George Weisz, Director, OSS/DOE
Mr. Leon Green, Head, ISPO/BNL
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ATTACHMENT I

Safety Analysis for Air Shipment of Plutonium Safeguards Samples in the PAT-1 Package

General

All conditions specified in the PAT-1 Safety Analysis Report, NUREG-0361, Ref. 5, other than the changes herein described, are to be complied with; the requested addition to the definition of permissible contents does not cause any presently certificated TB-1 containment vessel condition to be exceeded. These conditions include:

Total mass of all contents: a reduction would occur.
Maximum quantity of nuclear material: a reduction would occur.
Type and form of material: no change.
Maximum credible accident pressure in the TB-1 containment vessel: no increase.

The proposed change involves an increase in the amount of polyethylene (PE) packaging material (bags), and an increase in the amount of inert (metal and glass) packaging material. The increased partial pressure that could be generated by thermal decomposition of the additional PE under the conditions of NUREG-0360 will be offset by a reduction in the partial pressure that could be generated by the decreased allowable mass of water. The reduction in water content will be commensurate with the reduction in the allowable mass of plutonium oxide and/or uranium oxide.

Presently Certificated Status

Ref: NUREG-0361, Safety Analysis Report, Plutonium Air Transportable Package Model PAT-1, June, 1978, Ref. 5.
Paragraph 4.4.2, page 4-7, "Pressurization of Containment Vessel."

Peak internal pressure within TB-1: < 1110 psi

Original free volume:	1460 cm^3	
Pressure comprised of:	772 psi	superheated steam @ 1080°F
	49 psi	heated air @ 1080°F
	285 psi	ethylene gas - decomposition of 2 polyethylene bags
	1106 psi;	< 1110 psi

Proposed Addition to Certificated Status

Limit contents to any combination within the following maximum limits:

1) 200 grams UO_2 and/or PuO_2, any isotopic composition; and 25 watts maximum decay heat
2) 1 gram water content (1/2 weight percent of the maximum sample mass)
3) 400 grams of metal canning material (e.g., approx. 50 cm^3 of stainless steel; this allows approx. 200 grams or 25 cm^3 for the PC-1 product can and additional allowance for additional smaller cans or canisters within the PC-1)
4) 100 grams of aluminum (approx. 36 cm^3) in the form of aluminum foil or aluminum honeycomb, for packaging
5) 175 grams of quartz (SiO_2) (80 cm^3) or other silica glass (this would be used, in some cases, in the drying of liquid samples and the vial is shipped with the sample)
6) 35 grams of polyethylene (used to double-bag the samples)

Volume containing gases generated by the 1080°F environment:

Original free volume:	1460 cm^3
less 1), sample volume	25 cm^3 (200g @ 8g/cm^3)
less 3), metal canning	50 cm^3
less 4), aluminum packaging	36 cm^3
less 5), glassware	80 cm^3
Net Volume:	1269 cm^3

Pressure of the superheated steam:

$$Vg = \frac{1269\ cm^3\ ft^3\ 454\ g}{2.8317 \times 10^4\ cm^3\ lb\ 1\ g} = 20.34\ ft^3/lb$$

From the Steam Tables (English Units), Keenan, Keyes, Hill and Moore, John Wiley & Sons, 1969:

		44 psi		46 psi
At 1000°F	Vg	19.724	Vg	18.865
Interpolating for 1080°F	Vg	20.8	Vg	19.9
At 1100°F	Vg	21.08	Vg	20.17

Interpolating for Vg = 20.34 at 1080°F,

Pressure = 45.02 psi

Pressure of the heated air:

$$m = \frac{(1269\ cm^3)(1.29 \times 10^{-3}\ gm)\ lb}{454\ gm\ \ cm^3} = 3.606 \times 10^{-3}\ lbs$$

$$R_{air} = 53.342\ \frac{ft\text{-}lb}{lb\text{-}R}\quad \text{(standard value for air)}$$

$$T = T_R = 1080^\circ F + 460 = 1540^\circ R$$

$$V = 1269\ cm^3 = 77.44\ in^3$$

$$P = \frac{mRT}{V} = \frac{(3.606 \times 10^{-3}\ lbs)(53.342\ ft\text{-}lb)(1540^\circ R)(12\ in.)}{(77.44\ in^3)\qquad lb\text{-}R\qquad\qquad ft}$$

$$= 45.90\ psi$$

Pressure of the decomposed polyethylene:

Conservative assumption is that entire mass transforms to C_2H_4 ethylene gas.

$m = 35 \text{ grams} = 7.7 \times 10^{-2} \text{ lbs}$

$$R_{PE} = \frac{\text{Universal Gas Constant}}{\text{Molecular Wt., } C_2H_4} = \frac{1545}{28} = 55.18 \ \frac{\text{ft-lb}}{\text{lb-R}}$$

$T = 1080^{\circ}F + 460 = 1540^{\circ}R$

$V = 1269 \text{ cm}^3 = 77.44 \text{ in}^3$

$$P = \frac{mRT}{V} = \frac{(7.7 \times 10^{-2} \text{ lbs})(55.18 \text{ ft-lb})(1540^{\circ}R)(12 \text{ in.})}{(77.44 \text{ in}^3)(\text{lb-R})(\text{ft})}$$

$= \underline{1013.93}$ psi

$P_{Total} = 45.02 + 45.90 + 1013.93 = 1104.85$ or $\underline{1105}$ psi

1105 psi < 1106 psi

Therefore additional permissible contents per the proposed addition to the Certificate of Compliance for PAT-1 result in conditions that are within the presently certified conditions.

References

1. Priority cable from U.S. Mission to the IAEA, Vienna, Austria, to U.S. Secretary of State, copies to U.S. DOE, April 26, 1979, subject: Rapid Shipment of Small Plutonium Samples for IAEA Safeguards.

2. Letter from U.S. Senator John Glenn, Subcommittee on Energy, Nuclear Proliferation, and Federal Services, to Hon. James R. Schlesinger, Sec., DOE, May 29, 1979, subject: Rapid shipment of IAEA plutonium safeguards samples.

3. Letter from George Weisz, Director, Office of Safeguards and Security, U.S. DOE, to Prof. J. J. Gruem, Deputy Director for Safeguards, IAEA, June 4, 1979, citing communications with the US NRC regarding use of PAT-1 containers.

4. Letter from George Weisz, Director, OSS/DOE, to Mike Lawrence, ET-97/DOE, Aug. 2, 1979, citing "...Regulatory approvals, as necessary for early shipments in the PAT-1 container by cargo aircraft, require early DOT/NRC action."

5. NUREG-0361, Plutonium Air Transportable Package Model PAT-1, Safety Analysis Report, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, June, 1978.

ENCLOSURE I

W. C. Myre, Director
Nuclear Security Systems

Sandia Laboratories
Albuquerque, New Mexico 87115

DEC 21 1979

Dr. A. H. E. von Baeckmann
Director, Division of Development
Department of Safeguards and Inspection
International Atomic Energy Agency
P. O. Box 100
Vienna A-1400
Austria

Dear Dr. von Baeckmann:

Enclosed is a summary of the LAARC (Lightweight Air-transportable Accident Resistant Container) program presentations and meetings which occurred at the Vienna International Center and the Seibersdorf Analytical Laboratory, between you and members of your staff and John Andersen of Sandia Laboratories during the period of October 29 through November 1, 1979.

Following that summary is an account of the conclusions and action items that were discussed. Your comments and observations are invited.

Sincerely,

W. C. Myre

JAA:1721:1c

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LAARC/IAEA Meetings
Oct. 29--Nov. 1, 1979
Vienna, Austria

Summary:

The LAARC (Lightweight Air-transportable Accident Resistant Container) has been requested of the United States by the IAEA in order to support the Non-Proliferation Treaty (NPT) for timely shipment of plutonium-bearing safeguards samples from plutonium-processing plants world-wide to the IAEA analytical laboratory near Vienna, Austria.

In the period of October 29 to November 1, 1979, program objectives and package design were presented to the IAEA safeguards, safety, and laboratory staffs. Topics included: regulations (NUREG-0360, 10 CFR 71, 49 CFR); a summary of the PAT-1 and its problems of rules, regulations, and multinational licensing for sample shipments; LAARC package design considerations (energy absorption, fire retardation, stress, thermal, criticality, shielding, release fraction, and containment integrity analyses); testing; acceptance criteria; and the LAARC optimized/iterated design as presently defined. Also, air carrier restrictions and capabilities, and an outlook toward regulatory and procedural matters were covered in the briefing. This presentation conveyed the impression that substantive changes to LAARC are not really feasible if all the bounding parameters are to be observed. Understanding and cooperation were established regarding the limiting design conditions placed on LAARC, including the iterative design process required to satisfy new and old U.S. regulations and to provide a minimal but usable payload (plutonium sample) capacity, while still achieving a practical limit on size and weight for one-man operations and for practical air transport.

Implementation of the LAARC by the IAEA will involve modifications to presently-used laboratory procedures in a number of countries, including the SAL (Seibersdorf Analytical Laboratory).

Tentative design goals and agreements, none of which change the LAARC, were established. These agreements involve new laboratory processing labware, for safeguards analytical samples, which will be double-bagged and encapsulated within the LAARC package.

Planning for international acceptance and licensing (certification) of LAARC was initiated with both the IAEA and the U.S. Mission. The next key point in this plan is a multi-national meeting in Albuquerque, to be announced by the IAEA (following formal notification to the IAEA by the U.S. Mission). This meeting, especially oriented to the U.S. NRC and the Competent Authorities of the States involved with plutonium safeguards sample shipments, will demonstrate LAARC project progress through in-progress scheduled tests and presentations and discussions. It is planned that this will be a step in the expedited acceptance and licensing of the LAARC by all necessary agencies and nations.

Conclusions and Action Items Concerning LAARC Package Development:

1. Only solid-form samples (no liquids) may be accommodated in LAARC, due both to U. S. regulations and to the technical problem of containment of very high pressure at elevated temperature in a sealed pressure vessel.
2. Five types of samples and their packaging for the LAARC were defined:
   a) Sintered fuel pellets: Double bag ("welded" plastic bags) and place two or more pellets in a LAARC capsule (note: an additional canister for the pellets may be needed to protect the bags.)
   b) PuO_2 powders: Samples will be packaged in a crimp-sealed metal tube or a canister; sample size, in order to contain at least 0.5 gram actual Pu content, would range from two to

seven grams for FBR and five grams for recycle fuel. Up to six canisters, each single-bagged, would be double-bagged as a group and then inserted into the LAARC capsule.

c) Mixed oxide [(U, Pu) O_2] powders: Similar to b) above, but canister will be larger and perhaps only two will fit in the LAARC capsule.

d) Pu $(NO_3)_4$ solutions: A hydrofluoric acid-resistant vessel must be developed and provided for sample evaporative drying (before shipment in LAARC) and sample dissolution (after receipt of sample at SAL). This could be a stainless steel or teflon (TFE) vessel.

e) Spent fuel samples: These are extracted as liquids, such as Pu $(NO_3)_4$, and will be dried and handled the same as d) above.

3. The Agency (in particular, the Seibersdorf Lab) will provide to Sandia Labs some double-bagged mockups or models of the above five types of samples, in about one week. (Note: This has been done and was received at Sandia on or about November 22, 1979.)

4. For the above-defined packagings, 2a) through 2e), Sandia (Andersen) will calculate the allowable mass of hydrocarbon (plastic) packaging materials that can be permitted in the LAARC capsule and containment sphere and will provide this information to the IAEA as soon as possible so as to properly interact with the proposed sample packagings. (Note: This was done, preliminarily, by an Andersen to Krivanek letter dated December 4, 1979.)

5. It was agreed on 11/1/79 that any request by the IAEA for changes to the LAARC as presented in Vienna and Seibersdorf (drawings and an actual capsule with tools were provided to the Agency by Sandia Labs) should be

received at Sandia prior to Friday, December 21, 1979 (the last day of scheduled work in 1979). There can be no assurance that some change unspecified at this time can be accommodated. However, after the above date, any serious change that can be made will possibly affect project end dates (LAARC availability).

6. The Agency (IAEA) and Sandia Labs are to complete a detailed design description of all LAARC safeguards sample loadings by March 28, 1980, so that proper payloads can be included in Sandia's Phase 3B testing (LAARC PERT chart "LAARC/RAMAT ND T65616" was provided to the IAEA). This description must include mass, elements, compounds, and isotopic form; maximum water content; thermal activity; radioactivity; all organic material present, especially including plastic packaging materials of any sort whatsoever. It is very important that the description be precise because Phase 3B testing may suffice for U.S. NRC licensing consideration, and the test results will not be valid if the contents are not correctly modeled. Maximum-threat sample models must be utilized in LAARC testing for licensing. This involves heaviest weight (for mechanical rupture threat), largest possible fraction of organics (water, plastics, any hydrocarbon or any material that has a vapor state up to 1850°F) for pressurization of the containment, maximum radioactivity (for shielding calculations), maximum fissile content (for critical calculations), and maximum thermal activity (for heating and pressurization calculations and tests).

7. Regarding any new-design packaging, items required to accommodate samples in accordance with point 2. above, such as special-shape plastic bags, teflon or metallic canisters, etc., it remains to be decided if these are

to be developed by Sandia Labs as a part of the LAARC packaging system or if they are to be developed by the Seibersdorf Analytical Lab or the Agency's Development Division as a part of their safeguards analytical support.

Conclusions and Action Items Concerning Regulations, Procedure, and Jurisdictional Matters:

1. Since LAARC is perhaps two years away from licensing and international implementation, the immediate problem of timely shipment of safeguards samples could be solved in these ways:
   a) Exempt quantity shipments (microcurie resin bead technique) in Type A or Type B packages.
   b) Normal sample shipments per current IAEA Safety Series No. 6 methods (e.g., using DOT Spec. 6-M package).
   c) Implementation of the PAT-1. Additional PAT-1 licensing actions will be needed. Necessary supportive documentation includes the PAT-1 Certificate of Compliance, NUREG-0360 (the new criteria), NUREG-0361 (the SAR), and the National Academy of Engineering's Report of the ad hoc Committee on the Air Transport of Plutonium, all to be provided by the NRC, and Sandia's SAND76-0587 (PARC R&D Report).
2. The planned change to U. S. regulation 49 CFR, deleting aircrew access requirements to RAM shipments, is vital to any practical use of the PAT-1. This will be checked by Mr. Labowitz, with Rick Rawl, the U. S. Competent Authority.
3. Sandia's current study of co-cargo crush threat, along with the existing crush test in NUREG-0360 for

belly cargo, may permit NRC to agree to a less restrictive location for LAARC within aircraft.

4. Contacts are to commence with the Japanese regarding their use of Type A packages or the DOT Spec. 6M, now, or the PAT-1, soon, for air shipment of safeguards samples. (This was accomplished, in part, by a Sandia/ISPO/DOE-OSS meeting with the Japanese Scientific Attache in Washington on 11/19/79; the IAEA is to approach the Japanese Competent Authority through normal channels.)
5. Contact is to be made by the IAEA with India on their continued use of the 6M.
6. The appropriate authority (IAEA Competent Authority) from Austria (or the IAEA), Belgium, Canada, France, Federal Republic of Germany, India, Italy, Japan, Pakistan and the United Kingdom are to be briefed on LAARC, especially as pertains to national certifications for air transport of safeguards plutonium samples. Mr. Labowitz will coordinate a draft message with Dr. von Baeckmann and Mr. Haycock for consideration by the U. S. Mission to the IAEA, for the Mission to officially transmit to the IAEA, formally informing the Agency of the LAARC, the regulatory and procedural status, and of a proposed meeting in Albuquerque. The IAEA will then inform those States who are to be invited to the special demonstrations and presentations at Sandia Labs, Albuquerque, possibly in July, 1980. A sponsoring organization other than Sandia is to be determined.
7. PATRAM 80 in Berlin, November 1980, was cited as another important international forum for LAARC.
8. The RTSG (RAM Transport Study Group) meeting in Warsaw in November 1980 was cited as an important non-IAEA informational contact for LAARC.

9. The PAT-1 Certificate of Compliance has a specific limitation (the contents may include two plastic bags) which technically obstructs its use for multiple small safeguards samples in numerous plastic bags. Mr. Sonnier suggested that Sandia request the NRC to consider some proposed rewording on content description that would enable a suitable U.S. certificate to be in existence. Mr. Andersen is to prepare a rationale for other PAT-1 loadings that would present no greater threat to containment than the currently licensed payload (decreased plutonium and water content but increased plastics content, not to exceed those pressures certified by the Safety Analysis Report, SAND76-0587). This will then be discussed with the U.S. NRC staff, by Sandia.

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