DOE/EA--0336

DE93 005744

ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED NEW AGREEMENT FOR PEACEFUL NUCLEAR COOPERATION BETWEEN THE UNITED STATES AND JAPAN AND AN ASSOCIATED SUBSEQUENT ARRANGEMENT FOR THE RETURN OF RECOVERED PLUTONIUM FROM EURATOM TO JAPAN

DEPARTMENT OF ENERGY
ASSISTANT SECRETARY FOR INTERNATIONAL
AFFAIRS AND ENERGY EMERGENCIES

SEPTEMBER 11, 1987

ENVIRONMENTAL ASSESSMENT OF THE PROPOSED NEW AGREEMENT FOR PEACEFUL NUCLEAR COOPERATION BETWEEN THE UNITED STATES AND JAPAN AND AN ASSOCIATED SUBSEQUENT ARRANGEMENT FOR THE RETURN OF RECOVERED PLUTONIUM FROM EURATOM TO JAPAN

1.0 BACKGROUND AND NEED FOR ACTION

1.1 Introduction and Description of the Proposed Action

The proposed action is a new Agreement for Cooperation with Japan concerning the peaceful uses of nuclear energy pursuant to Section 123 of the Atomic Energy Act, as amended (AEA)1/, and an associated "subsequent arrangement" pursuant to Section 131 of the AEA. Together these actions will provide the framework for the return from EURATOM to Japan of plutonium recovered from spent fuel reprocessed for Japan in France or the United Kingdom. The proposed new Agreement for Cooperation would replace the existing Agreement for Cooperation with Japan which was signed in 1968. 2/ This new agreement has been negotiated

1/ Following a recommendation by the Secretaries of State and Energy to approve entry into an Agreement for Cooperation concerning the civil uses of atomic energy, the President must give his authorization to enter into the Agreement pursuant to Section 123b of the AEA, determining in writing that performance of the proposed agreement will promote, and will not constitute an unreasonable risk to, the common defense and security. The agreement must then be submitted to Congress for an aggregate period of ninety continuous session days of review (Sections 123b and 123d, AEA). Unless a joint resolution of disapproval (Section 123d AEA) is enacted, the agreement, as well as the subsequent arrangement, may then enter into force.

2/ Agreement for Cooperation between the Government of the United States and the Government of Japan Concerning Civil Uses of Atomic Energy, signed on February 26, 1968, 19 UST 5214; 23 UST 275; 24 UST 2323.

in accordance with the mandate of Section 404(a) of the Nuclear Non-Proliferation Act of 1978 (NNPA). The proposed "subsequent arrangement" within the meaning of Section 131 of the AEA, would be concluded under an existing agreement for peaceful nuclear cooperation with the European Atomic Energy Community (EURATOM)3/ to implement a provision of the proposed agreement with Japan in which the U.S. undertook to give its approval, subject to specified conditions, to the transfer of separated plutonium from EURATOM to Japan.

As a general rule, neither environmental assessments (EAs) nor environmental impact statements (EISs) are required prior to conclusion of agreements for cooperation or entry into of subsequent arrangements. Agreements for cooperation usually only establish a legal framework for peaceful nuclear cooperation without committing either party to engage in any precise form of cooperation and it has never been judged necessary to prepare an "environmental assessment" (EA) in processing such an agreement. Moreover, past environmental statements have been deemed to adequately address the kinds of activities that can occur pursuant to an agreement for cooperation. A Generic Environmental Impact Statement has been prepared concerning the U.S. Program of civil Nuclear

3/ Additional Agreement for Cooperation Between the United States of America and the European Atomic Energy Community (EURATOM) Concerning Peaceful Uses of Atomic Energy, (as amended) signed June 11, 1960. 11 UST 2589; 13 UST 1439; 14 UST 1459; 24 UST 472.

International Cooperation entitled "United States Nuclear Power Export Activities - Final Environmental Statement ERDA-1542." The impacts on the global commons resulting from normal nuclear power plant operations and various waste disposal options have been considered in past specific or generic environmental impact statements.4/ Further, a program analysis of the environmental impacts on the United States and the global commons of R&D export activities was completed in August 1979 and it concluded that the environmental impacts of on-going and prospective R&D export activities on the global commons or on the United States are not such that further environmental review pursuant to the National Environmental Policy Act is required.5/ Also, agreements for cooperation are excluded from Executive Order 12114 under Section 2-5 since such agreements themselves do not "provide" the facilities referred to in the exemption. This exclusion is reflected by the exemption of actions taken pursuant to Section 123 of the Atomic Energy Act or 404(a) of the Nuclear Non-Proliferation Act from the Unified Procedures that implement that Executive Order.

4/ Final Environmental Statement relating to the Manufacture of Floating Nuclear Power Plants by Offshore Power Systems NUREG0502, (December 1978), the Liquid Pathway Generic Study NUREG-0440 (February 1978), and the Final Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in Light Water Reactors, NUREG-0002 (August 1976).

5/ Department of Energy, generic EIS entitled "Storage of Foreign Spent Power Reactor Fuel" (1979).

Similarly, "subsequent arrangements" under the AEA[6] normally do not impact U.S. territory, but rather involve activities abroad for which an agreement for cooperation gives the U.S. a consent right. In general, the kinds of activities that are covered by subsequent arrangements either have been covered in past specific or generic environmental impact statements or they have involved the kinds of activities where it has been generally concluded that they would not significantly affect the quality of the human environment.

However, the proposed new agreement for peaceful nuclear cooperation with Japan and an associated subsequent arrangement with EURATOM differ from past practice in one respect which has become a matter of public interest. Article 11 of the Agreement for Cooperation requires the parties to make separate arrangements, consistent with non-proliferation and national security interests, to facilitate certain aspects of the Japanese nuclear program. The separate arrangements are set forth in an Implementing Agreement and constitue an integral part

6/ Under the terms of the Atomic Energy Act "subsequent arrangements" are defined to include various transactions that occur under agreements for cooperation including retransfers of special nuclear material from the territory or control of a cooperating party that only can occur under an Agreement for Cooperation with prior U.S. approval. In this case, the subsequent arrangement would involve the granting of a U.S. approval, pursuant to Article XI of the U.S.-EURATOM Agreement for Cooperation signed on November 8, 1958, as amended to transfer and return to Japan separated plutonium to be employed in the Japanese civil nuclear program.

of the Agreement for Cooperation under the Atomic Energy Act. In Article 1(1)(a)(iii) of the Implementing Agreement, the parties agree to the transfer of spent reactor fuel from Japan to facilities in France and the United Kingdom for reprocessing (i.e. the removal of the plutonium and residual uranium). In Article 1(3)(a)(ii) of the Implementing Agreement, the U.S. is required to give its consent to EURATOM under the U.S.-EURATOM Agreement for Cooperation for the return of the recovered material to Japan. However, one of the conditions for this approval, as set forth in both Annex 5 of the Implementing Agreement and the proposed subsequent arrangement, is that the recovered plutonium must be shipped by air pursuant to various measures designed to assure its security and safety. This would include shipments via a "polar route or another route selected to avoid areas of natural disaster or civil disorder." Since a polar route from Europe to Japan could transit parts of the U.S., including a potential stopover in Alaska for refueling, a question has been raised as to whether the arrangements for these transfers might involve a greater likelihood of environmental effects on U.S. territory than traditional Agreements for Cooperation or "subsequent arrangements" entered into pursuant to such Agreements.

In view of this concern and the requirement under the Council on Environmental Quality (CEQ) regulations implementing the National Environmental Policy Act (NEPA) to "integrate the NEPA process with other planning at the earliest possible time" (40 CFR 1501.2), this Environmental Assessment has been prepared to assess the potential environmental impacts of air shipments of plutonium over U.S. territory, with or without a refueling stop in U.S. territory under the proposed new agreement with Japan and associated subsequent arrangement with EURATOM. Where applicable, it also considers, indirectly, the the likely environmental effects of such shipments on the global commons. This assessment includes a discussion, prepared by the Department of State, of the political and policy setting in which the new U.S.-Japanese Agreement for Cooperation has been negotiated, the quantities of plutonium that could be shipped, the likely number of shipments that would be involved in a given period, the nature of the conditions that will have to be met before any such air shipments will be approved by the United States and the alternatives to authorizing air shipments of the subject plutonium from EURATOM back to Japan including their environmental implications.

1.2 Involvement of Other Agencies

This environmental assessment was prepared by the Department of Energy based in part upon information provided by interested offices in the Departments of State and Transportation, and in the Nuclear Regulatory Commission.

1.3 Need for the Proposed Action

1.3.1 Need for the Agreement for Cooperation

Under the U.S. Atomic Energy Act, an agreement for cooperation in peaceful uses of nuclear energy which sets forth specified terms and conditions for such cooperation is required for significant types of U.S. nuclear trade and cooperation with other nations. This includes the export of nuclear reactors, major reactor components, and special nuclear materials, such as enriched uranium. The existing Agreement for Cooperation between the U.S. and Japan was entered into in 1968. However, the U.S. Nuclear Non-Proliferation Act (NNPA), which became law in 1978, has established new, more stringent non-proliferation conditions for inclusion in new agreements for cooperation. Section 404(a) also requires the President to initiate a program to seek to update all existing Agreements for Cooperation to include the stricter NNPA standards. In the judgments of the Departments of State and Energy, the proposed new Agreement for Cooperation with Japan satisfies all U.S. statutory requirements for new agreements, including all requirements of the NNPA. It thus responds in a positive fashion to the NNPA's mandate aimed at the renegotiation of existing agreements to include updated U.S. non-proliferation conditions.

The NNPA also states that it is U.S. policy to take such actions as are required to confirm the reliability of the U.S. as a nuclear supplier to nations that adhere to effective non-proliferation policies. President Reagan has likewise declared his intention to seek to restore the reputation of the U.S. as a credible nuclear trading partner with countries whose non-proliferation credentials are unquestioned and Japan is one such country. The proposed new U.S.-Japan agreement has been negotiated with this goal in mind, and its implementation is necessary if the United States is to reestablish itself as a dependable nuclear supplier to Japan.

Among the provisions of the existing United States-Japan Agreement is the U.S. consent right over reprocessing of U.S. origin nuclear fuel in Japan. In the past, the U.S. has provided such consent only for short periods of time and for limited quantities of material. This has created considerable uncertainty for Japan, where reprocessing and use of the derived plutonium for peaceful energy production play an important role in current and future energy plans. The proposed new Agreement for Cooperation, and its associated Implementing Agreement provides advance, long-term U.S. consent to Japan for the reprocessing, alteration, and storage of nuclear material subject to the Agreement where the reprocessing and subsequent use of the recovered plutonium occur in facilities and within a program that meet and continue to meet the criteria set out in the U.S. law, including criteria relating to adequate international safeguards and physical protection. Since Japan also avails itself of the use of reprocessing services within the European Community (in France and the United Kingdom), the proposed Implementing Agreement with Japan also provides for the granting of certain long-term approvals under the U.S.-EURATOM

Agreement pertaining to the use of such reprocessing services. Under the arrangements proposed, Japan would receive long-term U.S. approvals to ship spent fuel to EURATOM for reprocessing and if some important criteria are met, EURATOM would receive long-term approvals to return the separated plutonium to Japan where it would again become subject to the terms of the U.S.-Japanese Agreement for Cooperation.

The proposed new Agreement for Cooperation thus affirms the U.S. intention to be a predictable nuclear trading partner. It also satisfies the intention of President Reagan as expressed in the joint communique of May 8, 1981 with then Prime Minister Suzuki of Japan, to work out a permanent solution to the issue of reprocessing in Japan.

The following points highlight the benefits of the new Agreement for Cooperation to the United States.

- It contains all consent rights and guarantees required by U.S. law, thus substantially upgrading U.S. controls over items subject to the agreement;

- It will strengthen the international non-proliferation regime, a fundamental U.S. national security and foreign policy objective, by obtaining agreement by a major U.S. nuclear trading partner to new rigorous non-proliferation conditions and controls in agreements for peaceful nuclear coope[illegible]

- It provides the basis for the U.S. to work closely with Japan in ensuring application of state-of-the-art safeguards concepts and physical protection measures.

- It establishes a detailed tracking system for U.S. origin nuclear material (particularly plutonium) while in transit.

- By affirming the U.S. intention to be a reliable nuclear trading partner, the new agreement helps to ensure the continuation and growth of U.S. nuclear exports to Japan. The exports include enrichment services with an average annual value of approximately $250 million and component exports whose value is also substantial. The international market in enrichment services has become intensely competitive, and the U.S. share of that market has been declining. Japan is the best foreign customer of the United States for enrichment services, but is likely to remain so only if the U.S. can be relied upon to cooperate on a firm and predictable basis. The proposed new agreement provides such a basis.

- The new Agreement for Cooperation should help to ensure a continuation of strong support from Japan on non-prolifera-tion issues generally, including support for the Nuclear Non-Proliferation Treaty, (NPT) and controls on nuclear-related exports to countries of proliferation concern.

- The new agreement will demonstrate to other major U.S. nuclear trading partners the willingness and determination of the United States to be a predictable partner, thereby enhancing the prospect that such countries will wish to continue to deal with the U.S. and accept nonproliferation conditions.

The specific arrangements incorporated in the Agreement for Cooperation related to the transfer of spent fuel from Japan to EURATOM and return of recovered nuclear material to Japan are responsive to the present reliance of the Japanese nuclear program on foreign as well as domestic reprocessing. A separate document entitled "Analysis of Consents and Approvals Agreed Upon in Conjunction with the Proposed new Agreement for Cooperation Between the Government of the United States and the Government of Japan Concerning Peaceful Uses of Nuclear Energy" provides an overview of Japan's energy resources, nuclear program, and the rationale for the U.S. long-term consents in the Implementing Agreement. That analysis describes Japan's extraordinary reliance upon imported energy sources (over 80 percent of total consumption) as well as Japan's national commitment to reduce the vulnerability of its energy supply by expanding the role of nuclear power, including the development of the breeder reactors as well as the recycling of nuclear fuel to maximize the energy value of such material. Japan has been shipping spent fuel abroad for reprocessing since the late 1960's. This has included U.S. origin material as well as nuclear material from EURATOM which has been used to fuel a British built, "Calder Hall" type reactor station in Japan. Until Japan's commercial size reprocessing plant* is constructed, this pattern will continue. The U.S. has approved, on a case-by-case basis, numerous transfers of U.S. origin spent fuel from Japan to EURATOM for reprocessing as well as the return in 1984 of some separated plutonium from EURATOM to Japan for use in the Japanese breeder development program (in the so-called "JOYO" fast breeder reactor experiment).

1.3.2. <u>The need for the "subsequent arrangement" with EURATOM and the associated arrangements to assure the safe, secure and timely return of separated plutonium to Japan</u>

The particular provisions of the proposed arrangements that are the focus of this Environmental Assessment are designed to facilitate the timely return to Japan from EURATOM of the plutonium that will be reprocessed and separated in French and British reprocessing plants located in the European Community. At the present time such returns have to be considered and approved on a case-by-case basis but there have been no mutually agreed long-term understandings as to the mode of transfer, or the safety and physical security protective measures that will apply to such transfers. Under the proposed new procedures the U.S. would grant EURATOM a long-term authorization to permit such transfers to occur so long as they go by aircraft in accordance

*To follow its current pilot reprocessing plant at Tokai Mura.

with rigorous protective measures. Of special concern to the U.S. in negotiating these provisions was the need to develop agreeable physical security protection measures and other precautions to ensure that the plutonium involved would be transferred to Japan in an environmentally safe, secure, and reliable manner. The new understandings that have been developed with Japan and EURATOM therefore provide for stringent criteria relating to the safe packaging of the plutonium as well as precautions against theft, seizure, or hijacking of the material, including the application of criteria to assure appropriate routing, provisions for effective communication, and continuous monitoring of shipments as well as provision for the application of effective emergency response measures if circumstances so required.

Three features of these arrangements bear special emphasis in this regard for purposes of this Environmental Assessment:

- All return shipments of separated plutonium from EURATOM to Japan must be in dedicated cargo aircraft. This was a requirement established by the United States and agreed to by Japan. Air shipment significantly reduces the time during which the plutonium is in transit over long distances and helps minimize access to the material by individuals not associated with the shipment.

- The air route taken must be a polar route or other route designed to avoid areas of natural disaster or civil disturbance. The arrangements (and this point must be emphasized) do not designate a particular route, nor do they obligate any country to permit the shipments to transit its territory. Rather, they specify criteria to ensure that the route chosen will minimize access to the material and provide the best basis for associated physical protection measures, for example by facilitating control over the situation in which the aircraft might be on the ground.

- The plutonium itself must be encased in a manner to ensure it will not be accessible to the environment, human or natural, even in the event of a crash. Annex 5 to the Implementing Agreement which is part of the new Agreement for Cooperation provides a fundamental condition of the shipments that:

> "Shipment casks will be designed and certified to maintain their integrity even in a crash of the aircraft, and these casks will be stowed in locked or sealed containers which impede access to the nuclear material by unauthorized persons. Individual transport containers will be equipped with transponders or transmitters to facilitate location in the event of a crash."

Shipments will be made in casks that are either certified by the U.S. NRC in accordance with the criteria in NUREG-0360* (a condition that will apply when U.S. territory is involved) or

*"Qualification Criteria to Certify a Package for Air Transport of plutonium," NUREG-0360, January 1978.

that are certified by Japan on a basis consistent with the U.S. criteria. The Japanese side letter to the Agreement states:

> "It was confirmed during the negotiations that any shipments transiting or overflying United States territorial jurisdiction must utilize shipment casks certified by the United States Nuclear Regulatory Commission as meeting the safety and environmental standards codified in United States law and regulations. Moreover, it was confirmed that, in all cases, the safety of the shipment casks is also to be certified by the appropriate authorities of the Government of Japan. I can confirm that although Japan regulations have not yet been finalized, it is expected they will provide a level of safety and environmental protection comparable to that provided for in the current regulations of the United States Nuclea Regulatory Commission, while fulfilling the requirements of sub-paragraph (d) of paragraph 2 Annex 5 and the applicable provisions of the International Standards and Recommended Practices for the Safe Transport of Dangerous Goods by Air found in Annex 18 to the Convention on International Civil Aviation."

The foregoing three conditions relating to plutonium shipments are reflected not only in the new U.S.-Japan Agreement for Cooperation but they also will govern the subsequent arrangement approving such retransfers that the U.S. would propose to grant to EURATOM pursuant to the terms of the U.S.-EURATOM Agreement for Cooperation.

Although the U.S. will be exercising its consent for the shipment of the plutonium in the manner just described, this consent will only pertain to U.S. legal controls in the applicable agreements for cooperation. Neither the proposed agreement for cooperation with Japan, the existing agreement with EURATOM nor the proposed subsequent arrangement under that agreement will detract from any other provisions of the U.S. law pertaining to the shipment of nuclear material through U.S. territory. Accordingly, for a shipment to depart EURATOM it must comply with the provisions of the international agreements, but for it to enter U.S. territory it must also comply with applicable U.S. laws and regulations, including those for the protection of the environment and human health and safety. In this regard, in a recent communication to Governor Cowper of Alaska on May 15, 1987, who is concerned about the environmental implications of such possible shipments, the Chairman of the U.S. Nuclear Regulatory Regulatory Commission, Lando Zech, addressed this very issue, and the Chairman made the following statement:

> "Any plutonium air shipments under the proposed agreement which land in, or pass over the United States territory will have to meet the Commission's standards for plutonium transportation, including standards for plutonium cask design. These standards and requirements are based, in part, on Public Law 94-79 and are implemented in NRC regulation 10 CFR 71.88 on air transport of plutonium. These safety standards are stringent and are intended to provide a high degree of assurance that plutonium packages can withstand virtually all aircraft accidents. I am enclosing for your information a copy of NUREG-0360, Qualification Criteria to Certify a Package for Air Transport of Plutonium and 10 CFR Part 71, Packaging and Transportation of Radioactive Material."

The U.S. long-term consent provided for these shipments also is not irrevocable. Pursuant to Article 3 of the proposed Implementing Agreement with Japan, the U.S. reserves the right to suspend its consent for these shipments, in whole or in part, if they pose a substantial risk to the U.S. national security or non-proliferation interests. This right of suspension is not to be exercised lightly. However, each party may suspend the arrangements if their fundamental interests are jeopardized. (A serious and not readily corrected threat to the physical security of plutonium shipments might be one valid ground for suspending the U.S. approval to transfer separated plutonium from EURATOM to Japan.)

With these elements, the negotiators of the proposed arrangements determined that a workable framework had been established for the return of recovered plutonium from EURATOM to Japan on long term basis. Without this agreed framework, the U.S. and Japan would be required, in consultation with EURATOM, to establish arrangements for each plutonium shipment individually.

Under the terms of the proposed subsequent arrangement with EURATOM, it is anticipated that the first air shipment will occur around 1990 assuming the requisite approvals or cask certifications are granted in time. It also is anticipated that there will be a gradual increase in the frequency of air shipments from two per year to a possible three per month, and that the quantity of plutonium, which is expected to be in the form of plutonium oxide, will initially be approximately 50 kilograms per flight. The maximum amount of plutonium to be shipped would be 150 kg. This quantity per flight will probably increase as larger casks are developed that meet the regulatory requirements and subsequently increase the payload of the aircraft. Over the course of the new

Agreement for Cooperation which will last for a thirty year period, the maximum quantity of plutonium that will be transferred will be approximately 25 metric tonnes.

It must be reiterated again, that under the foregoing criteria that have been agreed to by the U.S. and Japan, no air shipments are to occur unless they will occur in casks designed and certified to maintain their integrity in the event of a crash of the aircraft. More will be said about the environmental implications of air shipment later in this assessment.

It is conceivable that under the modalities that have been agreed to, the Government of Japan, in appropriate consultation, with the Government of the United States, may elect an air route that neither overflies the United States nor lands on U.S. territory. In this case, both parties still have a common interest in assuring that the shipment will have no adverse effect on the global commons. Japan also has a strong self interest in assuring that the most rigorous safety and environmental standards are applied to air shipments of plutonium flown into its own territory. Accordingly, the Japanese side-letter on Physical Protection states that the Japanese regulations will provide a level of safety and environmental protection comparable to that provided for in the current regulations of the U.S. NRC.

2.0 U.S. REGULATORY FRAMEWORK

Before addressing the environmental effects of the use of air transport for such plutonium shipments (as well as the alternate modes of transport that may be available), the U.S. legal and regulatory framework that will apply to any air shipments of the separated plutonium that will overfly U.S. territory or that may land within the United States for refueling purposes will be summarized. These include the applicable regulations of the Department of Transportation, mainly with the Federal Aviation Administration, and the criteria and tests that are employed by the USNRC in reviewing and certifying casks for air shipment of plutonium. Mention also will be made of the relevant Transportation Guidelines that have been adopted by the International Atomic Energy Agency and how they compare to the U.S. standards and criteria.

2.1 Role of the Federal Aviation Administration

Entry of aircraft engaged in commerce into the United States is regulated by the Federal Aviation Administration. Under Part 129 of the Federal Aviation Regulations (14 CFR Part 129), the FAA issues operations specifications for any foreign air carrier which has economic authority from the Department of Transportation to serve the U.S. prior to the commencement of such services. The operations specifications, among other matters, list the airports to be used and routes to be flown. However, an airport used solely for technical stops for refueling, minor maintenance or due to an emergency is not required to be listed in the operations specifications. Neither is a carrier which does not have operations specifications required to obtain them if enroute stops are only for non-commercial, technical purposes. By "non-commercial" one means, for example, a stop for refueling or maintenance purposes that does not involve acceptance or removal of cargo or passengers. The nature of the cargo carried on an aircraft making technical stops is not relevant to whether operations specifications are required. The FAA has concluded that authorization of stops for these purposes does not require separate environmental review because such stops do not create any significant impacts on the environment. While the FAA is responsible for establishing Federal airways and jet routes throughout the U.S., no new Federal airways or jet routes would be required for the transit of U.S. airspace, as covered by the proposed new Agreement for Cooperation with Japan, and therefore there would be no requirement for the FAA to prepare environmental assessments. Even if there were a requirement to establish a new airway or jet route, such actions are categorically excluded from the requirement to prepare environmental assessments on the basis that they are operational rules which normally have been found to have no significant impact on the quality of human health or welfare.

Annex 5 to the proposed Implementing Agreement calls for submission of a transportation plan, which will permit appropriate U.S. authorities to review, for each case, operational issues, aircraft crew suitability and training, travel and rest schedules.

2.2 Role of the Department of Transportation In Regulating Shipments of Radioactive Materials

The regulations of the Department of Transportation (49 CFR Parts 171, 172, 173 and 175) establish regulatory requirements for radioactive materials packages to be transported by aircraft. These regulations also establish the limits of exposure, criticality control, design requirements, storage restrictions, and inspections applicable to all types of radioactive material being transported. Thus, a plutonium shipment which complied with all applicable safety regulations would expose the crew and escorts to no greater risk than would be posed by any other shipment of radioactive materials.

The Department of Transportation also acts as "competent authority" for the United States under the Chicago Convention on International Civil Aviation. The radioactive material is to be packaged, marked, labelled, classified, described and otherwise be in a condition for shipment as required by the "Technical Instructions for the Safe Transport of Dangerous Goods by Air" issued by ICAO, and the applicable sections of 49 CFR Parts 172 and 173. The "Technical Instructions" issued by the International Civil Aviation Organization,(ICAO) have been accepted by the United States (49 CFR 171.11). These instructions set international standards for package certification pursuant to the Chicago Convention. They are to be followed for use in air transportation and any related ground transportation in the United States. The Instructions are designed to provide consistency and limit adverse effects to the aircrew, ground workers, end the general public for international shipments of hazardous materials.

"Competent Authority" under the Chicago Convention means a national agency responsible under its national law for the control or regulation of the transportation of hazardous materials. The Materials Transportation Bureau (MTB) of the U.S. Department of Transportation is the United States Competent Authority. [49 CFR 107.3 and 173.471(e)] The Competent Authority is responsible for administering the requirements of Section 8 of the IAEA "Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6" as amended. To this end, the U.S. Competent Authority issues Certificates for packagings of Type B, B(U), B(M) or fissile material packages as required by the IAEA Safety Series 6 for export of radioactive materials and revalidates foreign packagings for import to the U.S. Shippers must register with the U.S. Competent Authority as a user of the appropriate U.S. Competent Authority Certificate and the shipment must be made in accordance with the certificate. Certificates issued by a foreign competent authority must be revalidated by the U.S. Competent Authority prior to the first shipment of such a package into or from the U.S.

The DOT regulations specify that each Type B(U) or B(M) must be designed and constructed to meet the applicable requirements in 10 CFR Part 71. For domestic transport, authorized Type B packagings for fissile radioactive materials must therefore meet the regulations of the U.S. NRC. Those packagings meeting the regulations of the IAEA Safety Series 6 and for which the foreign competent authority certificate has been revalidated by the U.S. Competent Authority are authorized only for export and import shipments [49 CFR 173.417, 173.471, 173.472, and 173.473]. Foreign-made packagings may apply for an NRC Certificate of Compliance; in which case, the process for certification would follow all applicable NRC regulations as contained in 10 CFR Part 71. The NRC has, for example, certified the European-made Transnucleaire cask for use by a U.S. domestic utility for transshipment of spent nuclear fuel in the U.S.

General transportation requirements that govern the labeling, determination of the "Transport Index," and the allowable number of packages are discussed below.

The Transport Index (TI) is a dimensionless number placed on the label of a package to designate the degree of control to be exercised by the carrier during transportation. It is determined as follows:

1. The "TI" is equivalent to the number expressing the maximum radiation level in millirem per hour at one meter

from the external surface of the package (rounded up to the first decimal place).

2. For Fissile Class II or Fissile Class III, the TI is the number expressing the maximum radiation level at one meter from the external surface of the package, or the number obtained by dividing 50 by the allowable number of packages which may be transported together, whichever is larger. [49 CFR 173.403]

The labeling requirements to be applied to radioactive materials packages are found at 49 CFR 172.403. The Categories of Labels are White-I, Yellow-II and Yellow-III and are a function of the "TI," the radiation level at package surface and the fissile class. The following Table is taken from the applicable section in the DOT regulations.

Additional requirements of the DOT for carriage by aircraft are found in 49 CFR Part 175. Since this Environmental Assessment is addressing the "Subsequent Arrangement" that stipulates the plutonium will be shipped only by dedicated cargo aircraft, the requirements of the DOT governing cargo aircraft are relevant here [49 CFR 175.702 (b) (2) (iv)]. This section states:

> The total transport index for all packages containing fissile radioactive materials does not exceed 50.0

This limitation will restrict the number of packages and, therefore, the quantity of plutonium that may be air transported.

Radiation level limitations for air transport are as follows:

1. the radiation level may not exceed 200 millirem per hour at any point on the external surface of the package,

2. the transport index of the package may not exceed 10, and

3. the radiation level may not exceed 2 millirem per hour in any normally occupied position of the transport vehicle.

2.3 The role of the U.S. Nuclear Regulatory Commission

In 1975, Congress mandated that protection against the potential hazards of an air accident involving plutonium warranted restriction of such shipments until a container for transporting plutonium had been developed and tested that would withstand a severe aircraft accident. In the "Scheuer Amendment" to the Energy Reorganization Act of 1974, P.L. 94-97, 89 Stat. 413 (Aug. 9, 1975), 42 USC 5841 noted, Congress provided:

> "The Nuclear Regulatory Commission shall not license any shipments by air transport of plutonium in any form, whether exports, imports or domestic shipments: Provided, however, that any plutonium in

> any form contained in a medical device designed for individual human application is not subject to this restriction. This restriction shall be in force until the Nuclear Regulatory Commission has certified to the Joint Committee on Atomic Energy of the Congress that a safe container has been developed and tested which will not rupture under crash and blast-testing equivalent to the crash and explosion of a high-flying aircraft."

This provision is currently enforced through NRC regulations at 10 CFR 71.88, which provide that:

> "Notwithstanding the provisions of any general licenses...the licensee shall assure that plutonium in any form, whether for import, export, or domestic shipment, is not transported by air or delivered to a carrier for air transport unless...(4) The plutonium is shipped in a package specifically authorized for the shipment of plutonium by air in the Certificate of Compliance for that package issued by the Commission."

On June 2, 1975, the NRC initiated a process for establishing the criteria for issuing certificate for plutonium air shipment packaging. In 1978 these criteria were published as "Qualification Criteria to Certify a Package for Air Transport of Plutonium" NUREG-0360 (January 1978).

The NRC criteria for certification of plutonium transport packages assure "near certain" package survival in aircraft accidents occurring during take-off, landing or ground operations and a "high degree" of protection against accidents of extreme severity such as mid-air collisions and high speed crashes. Certification requirements include a series of sequential tests such that the total damage produced is an accumulation of the effects produced by each test. The physical tests are intended to simulate the accident environments that could be produced in severe aircraft accidents. The qualification criteria and acceptance standards represent a minimum level of required package performance and are evaluated after the accident-simulation tests.

Sequential Tests

Six tests are to be performed sequentially in the order indicated to determine their cumulative effect. These tests are briefly described below:

1. SURFACE/CRASH TEST: Impact at a velocity of not less than 422 ft/sec at a right angle onto a flat, essentially unyielding surface, in the orientation expected to result in maximum damage at the conclusion of the test sequence.

2. CRUSH TEST: A static compressive load of 70,000 pounds applied in the orientation expected to result in maximum damage at the conclusion of the test sequence...

3. PUNCTURE TEST: ....For packages weighing 500 pounds or more, the base of a solid probe of mild steel to be placed on a flat, essentially unyielding surface and the package dropped from a height of 10 feet onto the probe, striking in the position expected to result in maximum damage at the conclusion of the test sequence.

4. RIPPING/TEARING TEST: The package to be firmly restrained and supported such that its longitudinal axis is inclined approximately 45° to the horizontal. The package to be struck at approximately the center of its vertical projection by the end of a structural steel angle section falling from a height of at least 150 feet. The package to be rotated approximately 90° about its longitudinal axis and struck by a steel angle section falling as before.

5. THERMAL TEST: The package to be exposed to luminous flames from a pool fire of JP-4 or JP-5 aviation fuel for a period of at least 60 minutes. ... At the conclusion of the thermal test, the package shall be allowed to cool naturally or shall be cooled by water sprinkling, whichever is expected to result in maximum damage at the conclusion of the test sequence.

6. IMMERSION TEST: Immersion under at least three feet of water for at least eight hours.

Individual Tests:

In addition to the sequential tests described above, the following are required:

1. FREE-FALL IMPACT: Impact at a velocity not less than the calculated terminal free-fall velocity at mean sea level at

a right angle onto a flat essentially unyielding surface, in the orientation expected to result in maximum damage. (NOTE: the test is not required if the calculated terminal velocity of the package is less than the 422 ft/sec used in the SURFACE/CRASH test described in No. 1. above, or if its terminal velocity, exceeding 422 ft/sec, is used in the SURFACE/CRASH test.)

II. DEEP SUBMERSION: The package to be submerged and subjected to an external water pressure of at least 600 psi for not less than eight hours.

Acceptance Standards

Three standards are required to be met following the Sequential Tests and Individual Test I; they are:

1. CONTAINMENT: The containment vessel must not be ruptured in its post-tested condition and the package must provide a sufficient degree of containment to restrict accumulated loss of plutonium contents to not more than an A_2 quantity in a period of one week.*

*A2 quantity of plutonium is defined in Table VII of the IAEA "Regulations for the Safe Transport of Radioactive Materials (IAEA Safety Series 6) or in 10 CFR Part 71, Appendix A, Table A-1.

2. SHIELDING: Demonstration that the external radiation level would not exceed one rem per hour at a distance of three feet from the surface of the package in its post-tested condition in air.

3. SUB-CRITICALITY: A single package and an array of packages shall be demonstrated to be sub-critical in accordance with 10 CFR Part 71, following damage sustained in the tests proscribed by NUREG-0360.

The acceptance standard for the Individual Test II, the deep submersion test, is that there be no detectable leakage of water into the containment vessel of the package.

Other Requirements and Operational Controls

The other requirements specified in NUREG-0360 are related to assurances of testing requirements and demonstration that the package will meet the acceptance standards. The operational controls are related to the proper stowage and tiedown of plutonium packages and the exclusion of other hazardous materials from the cargo.

The NRC qualification criteria were reviewed by a special panel of the National Research Council for the National Academy of Sciences, NUREG/CR-0429, and by the NRC's Advisory Committee on Reactor Safeguards, which concurred in their adequacy. The

National Research Council's ad hoc committee on the Transportation of Plutonium by air drew the following conclusions in this regard:

> "The committee concluded therefore that a package designed, constructed, and tested to meet the requirements of Section II of the commission's Qualification Criteria could withstand the crash and explosion of a high flying aircraft, with the inner container remaining intact. Each engineering test prescribed in the qualification criteria was found to be at or near the extreme limit for the particular type of abuse to the package that it simulates. Considering the severity of testing in sequence, the committee found the criteria to be prudent and conservative. It is highly improbable that all of the test conditions would be encountered in any actual airplane crash."

NRC's requirements for packaging and transport of licensed material package, design features, test results, and requirements for package fabrication, inspection, and operation are published at 10 CFR Part 71. Air transport of plutonium is addressed specifically at 10 CFR 71.88.

The NRC has certified two packages for transporting plutonium by air under these criteria: PAT-1 (August 4, 1978; suitable for up to 2.0 kg of plutonium oxide in any solid form); and PAT-2 (September 14, 1983, revised October 13, 1983, suitable for gram quantities of plutonium shipped by DOE, especially for international safeguards activities). Each certification was supported by a safety analysis report for packaging (SARP) detailing how the packaging was determined to meet the applicable criteria of NUREG-0360, and 10 CFR Part 71. A copy of the certification for PAT-1 is enclosed as Annex A to this assessment.

Any air shipments of plutonium that transit the United States, whether pursuant to the proposed new Agreement for Cooperation with Japan or not, will have to take place in the above or similarly certified packaging so long as the Scheuer amendment and the NRC's implementing regulations remain in place. No modification or liberalization of the conditions in the Scheuer amendment are under consideration or are contemplated. Should another package other than the PAT-1 package be used, that package will have to meet the criteria previously described. In this regard Japan, in collaboration with the Sandia National

Laboratory, is in the process of developing and testing a larger cask than PAT-1 (known as PAT-3) that would be designed to hold six to seven kilograms of plutonium oxide (about 13 to 15 pounds). The testing program for this cask is still in progress. If a larger cask is not certified by the U.S. NRC under the conditions outlined above for any reason, or if delays in such certification occur, it is assumed in this analysis that the air shipments that will occur through U.S. territory will employ the use of the smaller PAT-1 container. It also is assumed, as already noted, that if no air transit of U.S. territory is involved, Japanese rules, regulations and practices on their own will mandate the application of standards similar to those applicable in the United States.

2.4 Transportation Guidelines of the International Atomic Energy Agency

The International Atomic Energy Agency (IAEA) established, as a part of its safety standards series, the "Regulations for the Safe Transport of Radioactive Materials, Safety Series 6" in 1961. These safety standards or regulations have been adopted by many IAEA Member States for multimodal transport and world-wide application and have resulted in an excellent safety record for the international transport of radioactive and fissile materials. The regulations are under constant review by the Standing Advisory Group on the Safe Transport of Radioactive Materials (SAGSTRAM) and numerous Amendments to Safety Series 6 have been approved and published, the most current Amendment being the 1985 Edition. Safety Series 6 is supported by other IAEA documents, specifically Safety Series Nos. 7, 37, and 80. The revision process calls for proposals to the Amendments and identification of problems by the member states. These are referred to SAGSTRAM for action.

Under current IAEA regulations, plutonium may be air transported in Type B(U) packages. The criteria specified in NUREG-0360 to ensure sufficient protection in the case of an accident in air transport is considerably more stringent than the Type B(U) requirements. During the most recent review of the IAEA Safety Series 6, Switzerland proposed amending the regulations to provide that plutonium transported by air be contained in packages capable of "ensuring containment to the contents in the case of accident" (IAEA Log No.SS6/PA/87-010). This issue was also addressed by the U.K. in an Identification of Problem paper (IAEA Log. No. SS6/IP/87-012). The U.K. paper states:

> "Guidance is required on the validity of the requirements of Safety Series No 6, 1985 Edition, in respect of air transport, taking into account the more stringent measures which are being applied by some transport authorities and the inconsistency and lack of harmony which result. The views of the IAEA and other Member States on this problem are invited."

Justification for identification of the problem and proposed revision by the U.K. are:

> "To ensure that IAEA Regulations afford a consistent level of protection by all modes of transport; to respond to public

concerns on this question; and to provide a basis for regulatory harmony in international transport by air."

At the SAGSTRAM meeting in June 1987, these items were among many reviewed. Although no action to change the IAEA regulations in regard to plutonium air shipments was taken, the IAEA will sponsor a study on the consequences of serious air accidents. Whether this will lead to more stringent certification requirements by the IAEA more in line with the present U.S. position is uncertain at this time. It is significant, however, in terms of global environmental concerns and the options considered in this document, that adoption by the IAEA of more stringent packaging requirements for air transport of plutonium are being considered.

3.0 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION

In this section of this assessment, additional information is provided pertinent to evaluating the likely environmental effects of the proposed new agreement for cooperation and especially the terms in Article 5 of the Implementing Agreement that would govern the U.S. approval to EURATOM to retransfer plutonium oxide by air transport to Japan. These evaluations are limited to potential radiological impacts. The non-radiological environmental impacts associated with air transport of this material (e.g., degradation of air quality due to use of aviation fuel, increased noise levels, etc.) will be negligibly small given the few air shipments required to implement this agreement and the temporal nature of these impacts.

This section includes general descriptive data pertaining to the use of air transport from Europe to Japan, analysis of radiological effects under normal operations and from potential accidents, and other implications.

3.1 General Observations

The following background information is pertinent to evaluating the implications of the possible shipment of the subject plutonium by air.

As required by the agreed understandings in Annex 5 all shipments will be in dedicated cargo aircraft. A likely candidate aircraft is the 747 which has a range of payload capability suitable for the shipment requirements. For example, _Jane's All the World's Aircraft_ states that the 747F has a maximum cargo capacity of 254,900 pounds and carries a typical fuel load of 300,000 pounds. This aircraft is used routinely for long distance international flights.

As already noted, the Annex 5 guidelines call for a route "from an airport in the United Kingdom or France to an airport in Japan via the polar route or another route selected to avoid areas of natural disaster or civil disorder". Thus any route is a possible route, provided that it is selected only to avoid natural disaster or civil disorder. The agreement does not obligate Japan to choose a route crossing U.S. territory, nor does it expressly authorize a transit of U.S. territory. Any proposal to choose a route crossing U.S. territory or using the U.S. as a refueling point must be set forth in the transportation plan.

Within this context, there are three apparent routes of flight between France and the U.K. and Japan that merit comment: (a) a route that overflies or refuels in the U.S.; (b) one that goes the shortest distance; or (c) a route that avoids both the U.S. and USSR.

The most direct route from major airports in France and the U.K. to Japan that would accommodate either overflight or landing in the U.S. for refueling is a great circle[1] polar route. This route passes over the extreme northern parts of Greenland and Canada's Ellesmere Island, parallels the coasts of Canada's Queen Elizabeth Island, crosses Alaska from Northeast to Southwest, and then overflies the Pacific Ocean paralleling the Kamchatka Peninsula to Japan. This is the route that appears to be receiving greatest current attention.

The second option would be to choose a route going the shortest distance. This would be a great circle route over the polar regions that crosses much of the eastern part of the Soviet Union and avoids the U.S. altogether. It is the assumption in this analysis that this option is unlikely to be acceptable on political or national security grounds to either the U.S. or Japan or both countries.

The third option would be to select some other routing that avoids either the U.S. or the USSR so long (in accordance with the agreed criteria) as it avoids areas of civil disorder or natural disaster. The determination of a precise and suitable route of flight that totally avoids the U.S. and the USSR cannot be made at this time due to the many variables involved. This route would not be a great circle and would be therefore much longer and could cross any number of international boundaries.

1/ A great circle is the shortest distance between two points on a sphere. It is formed by the intersection of the surface of a sphere with a plane passing through the center of the sphere.

Looking at the first option, the typical air distances and flying time, based on a ground speed of 450 knots, are shown below.

	Nautical Miles 2/	Time
France to Alaska	4066	9.03 hrs.
Alaska to Japan	2990	6.66 hrs.
Total	7056	15.69 hrs.

For comparative purposes, a non-stop overflight of the USSR is approximately 5700 nautical miles and would take approximately 12 and one-half hours.

2/ A nautical mile is the international standard unit of distance for air and sea navigation and represents one minute of arc of a great circle, i.e. one minute of latitude anywhere on the globe is one nautical mile. A knot represents a speed of one nautical mile per hour. Multiply by 1.151 to obtain statute miles or by 1.852 to obtain kilometers.

FIGURE 1

NON-SCHEDULED AIR CARRIER ACCIDENT & FATAL ACCIDENT RATES FOR 1976 – 1986

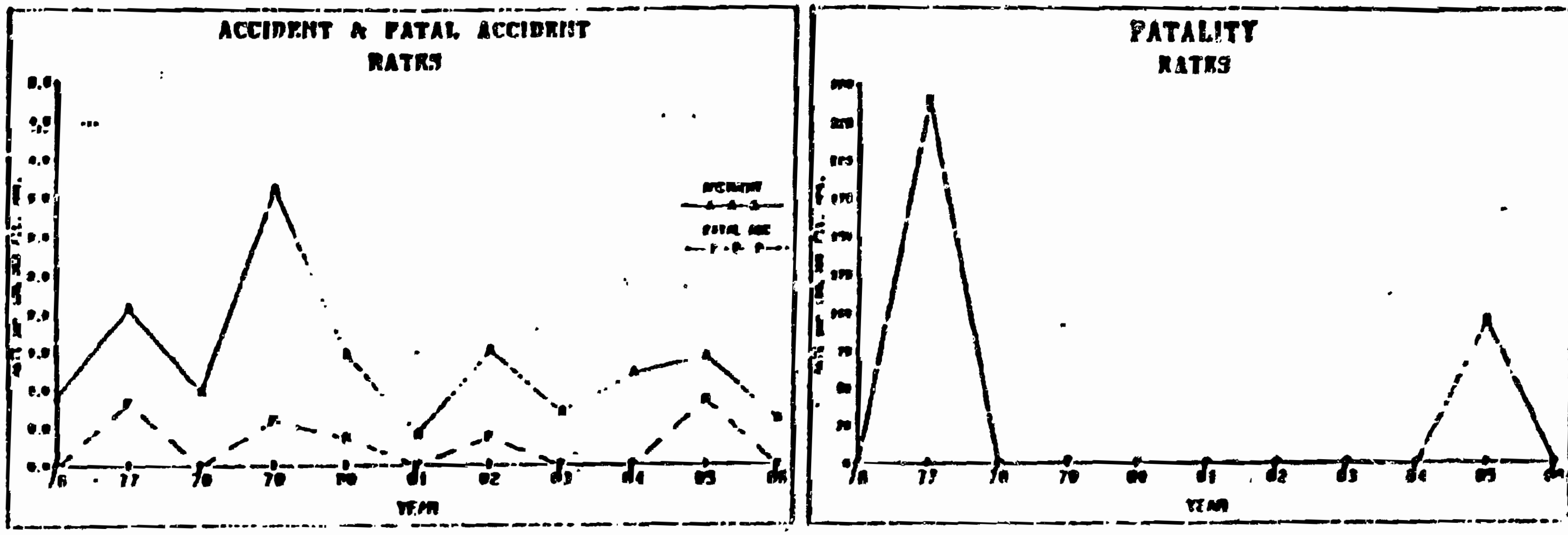


TABLE 5

YEAR	TOTAL FLT. HOURS	TOTAL ACCIDENTS	TOTAL ACCIDENTS per 100,000 hrs.	TOTAL FATAL ACCIDENTS	FATAL ACCIDENTS per 100,000 hrs.	TOTAL FATALITIES	FATALITY PER 100,000
1976	218,953	2	0.91	0	0.00	0	0.00
1977	240,834	5	2.08	2	0.83	577	239.58
1978	202,083	2	0.99	0	0.00	0	0.00
1979	165,817	6	3.62	1	0.60	3	1.81
1980	269,890	4	1.48	1	0.37	1	0.37
1981	238,967	1	0.42	0	0.00	0	0.00
1982	262,000	4	1.53	1	0.38	1	0.38
1983	281,555	2	0.71	0	0.00	0	0.00
1984	325,060	4	1.23	0	0.00	0	0.00
1985	344,[illegible]17	5	1.45	3	0.87	329	95.57
1986	321,000	2	0.62	0	0.00	0	0.00

Source: NTSB Safety Information Release SB 87-2 1/12/87 P = Preliminary

FIGURE 2

SCHEDULED AIR CARRIER ACCIDENT & FATAL ACCIDENT RATES 1976 – 1986

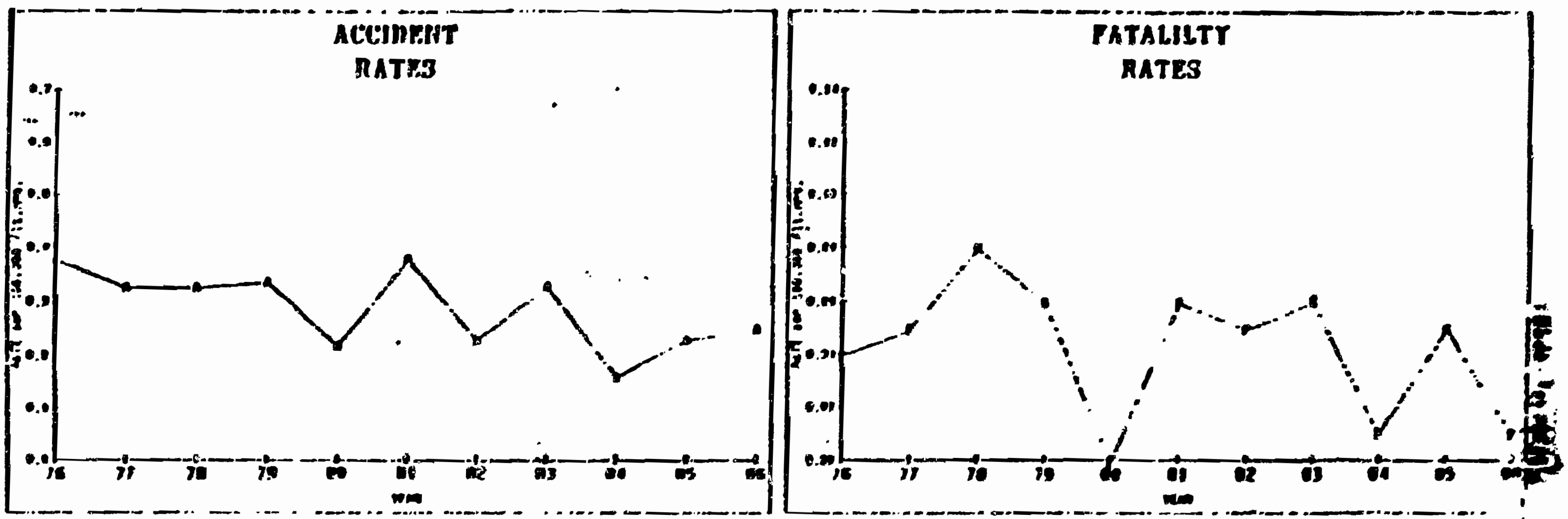


TABLE 3

YEAR	TOTAL FLT. HOURS	TOTAL ACCIDENTS	TOTAL ACCIDENTS per 100,000 hrs.	TOTAL FATAL ACCIDENTS	FATAL ACCIDENTS per 100,000 hrs.
1976	5,507,776	21	0.38	2	0.04
1977	5,798,873	19	0.33	3	0.05
1978	6,031,743	20	0.33	5	0.08
1979	6,713,094	23	0.34	4	0.06
1980	6,797,578	15	0.22	0	0.00
1981	6,571,280	25	0.38	4	0.06
1982	6,440,163	15	0.23	3	0.05
1983	6,649,009	22	0.33	4	0.06
1984	7,438,497	12	0.16	1	0.01
1985	7,934,135	18	0.23	4	0.05
1986P	8,941,000	22	0.25	1	0.01

Source: NTSB Safety Information Release SB 87-2 1/12/87

P = Preliminary

Although much of the 7056 mile route with overflight or stopover in Alaska is over water, 45% of the flight is over land as indicated below:

United States (Alaska)		1575 Nautical miles
Canada (Ellesmere Island)		500 " "
Denmark (Greenland)		800 " "
Japan		200 " "
France		150 " "
	Total	3225 Nautical miles

While no precise route has been selected nor is any mandated by the Agreement, it is common knowledge that Japan is considering, along with other options, a route that would include a refueling stop in Alaska. There are several apparent reasons why this option is being studied. It would traverse a remote area of the globe and would have the plane touch down in a protected setting. A refueling stop would enhance, over time, the cargo carrying capacity of the craft. Also, a route that traverses a remote area like Alaska offers certain marginal environmental advantages since the chances of an accident involving mid-air collisions are likely to be reduced owing to the smaller volume of air traffic than other possible locations.

In this regard, it may be useful to note some general statistics relevant to assessing the likely probability that a dedicated cargo carrier might encounter an accident. Figure 1 shows the declining accident rates[3] for Non-scheduled Air Carriers for the years 1976 through 1986. The averaged rates for the eleven years is 1.29 accidents per 100,000 flight hours (37 accidents divided by 2,873,294 hours). For purposes of analysis, this figure is conservative when compared with statistics for similar aircraft under the category of Scheduled Air Carriers. Figure 2 shows the declining accident rates [3/] for Scheduled Air Carriers, which is somewhat less than that for Non-scheduled carriers flying the same types of aircraft. The Scheduled Air Carrier accident rate for the eleven years between 1976 and 1986 is 0.28 per 100,000 flight hours (212 accidents divided by 74,903,156 hours). The combined weighted accident rates over the eleven year period for both Non-Scheduled and Scheduled Air Carriers is 1.57 accidents per 100,000 flight hours. This analytical method has been chosen because although the shipments of plutonium will not be on "scheduled" flights, the safety reviews and other relevant aspects of the flight will be on dedicated aircraft whose attributes are the same or similar to scheduled aircraft flights.

Expressed in terms of accidents per million miles flown[4], the accident rates for Scheduled and Non-scheduled Air Carriers was 0.0049 for 1984, 0.0082 for 1983, and 0.0068 for 1982. For comparison, NUREG-0170, published in 1977, gives an

3/ NTSB: Safety Information Release SB 87-2 1/12/87.

4/ National Transportation Safety Board, Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations, Calendar Year 1984, NTSB/ARC-87/02, April 1987.

overall aircraft accident rate of 1.44 x 10^{-8} vehicle-kilometer which, when expressed in the same units, is 0.0089 accidents per million miles, showing consistency between current aircraft statistics and NUREG-0170 statistics.

As already stressed, in the event the first route noted above were selected (namely an overflight or landing in the U.S.), all shipments would have to be made in accordance with the applicable U.S. federal regulations that have been described in this assessment. The package would have to be certified by the U.S. NRC to meet their qualification criteria for air transport of plutonium. The aircraft also would have to be loaded in accordance with U.S. Department of Transportation regulations. Also, should the aircraft land in Alaska for a short refueling stop, U.S. regulations (14 CFR 121.507) would require a crew change prior to departure on the next segment of the flight.

Payload should not be a problem. As noted, the only currently certified U.S. cask that could be used to transport plutonium is the PAT-1 container. Although designed to carry 2 kg of plutonium, the PAT-1 container is limited, as a condition of certification, to a 25 watt maximum heat load, which is the load produced by to 1.648 kg of plutonium oxide. In addition, DOT regulations 49 CFR 175.702(b)(1) limit the total Transport Index per shipment for Fissile Class II material to 50. As the transport index for each PAT-1 package containing 1.648 kg of plutonium oxide is 1.6, the total maximum number of PAT-1 packages per shipment is 31. At 500 pounds per package, this gives a total shipment weight of 15,500 pounds to transport 51.088 kilograms of plutonium oxide. This plus any containerization and overpacks would be well within the maximum payload of 245,000 pounds for the 747 (or equivalent) aircraft. Should a larger package such as the PAT-III now being tested be certified, up to 150 kilograms of plutonium oxide could be shipped provided the package plus containerization and overpacks did not exceed the aircraft maximum capacity for weight and volume and provided that the total Transport Index per shipment does not exceed 50.

In the paragraphs that follow the radiological effects that can be expected from a possible shipment of the subject plutonium with a refueling stop in the U.S. under normal flight conditions and under accident conditions are analyzed.

3.2 Radiological Impacts Under Normal Conditions

The radiological effects of nuclear material in air transport have been previously reviewed in NUREG-0170, "Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes" prepared by the NRC. This study concluded that because the radiological effects of nuclear material decrease rapidly with distance, there was no measurable effect to those on the ground while the aircraft is airborne. Since the plutonium will be packaged and unpackaged, loaded and unloaded, and otherwise handled exclusively in foreign jurisdictions, the potential exposure within the U.S. during normal shipments will be limited to that experienced by the air crew, any escort force on board, and those on the ground during refueling operations. Annex 5 of the Implementing Agreement requires use of a dedicated cargo aircraft so that there will be no passenger exposure. Annex 5 also requires, as an integral element of the transportation plan that:

> "At all airports isolation of the aircraft will be ensured to the maximum extent feasible by controlling the access to the aircraft, with the cooperation of relevant authorities including police or by use of other armed personnel to protect against theft or sabotage."

Although this provision is directed to physical protection requirements, it will have the secondary effect of limiting exposure to personnel on the ground.

As just noted, the Department of Transportation regulations for Cargo Aircraft transport, 49 CFR 175.702, limit the total TI allowed per shipment to 50. This same regulation requires that a distance of 30 feet (9 meters) be established between the cargo (plutonium oxide carrying container) and the flight crew. With these constraints, each air shipment would be limited to a maximum number of 31 containers per shipment, with a total load of 51 kilograms of plutonium oxide assuming a PAT-1 container is employed. This loading could be increased if a larger, PAT-III container is successfully developed and certified by NRC as meeting the rigorous U.S. tests already described.

The radiation exposure of normal transport by means of an exclusive use cargo aircraft to the crew and on flight escort force, as well as the incidental radiation exposure to bystanders during any flight stopover, can be calculated based on various parameters. Those used in this evaluation are set forth in Figure 3.

The inflight radiation exposure to the flight crew can be estimated by treating the shipment of 31 containers as a point source with a total radiation level of 50 mrem/hr at one meter (corresponding to a total TI of 50). The rate of crew exposure is then 0.6 mrem/hr. It is also assumed that 2 armed guards are on board at a distance of 9 meters from the cargo. (This calculation is conservative in that it ignores the fact that the loading of containers in an array and the associated overpacks and tiedowns all provide some shielding which reduces the radiation level.)

FIGURE 3

PARAMETERS FOR DETERMINATION OF DOSES
PER FLIGHT FROM NORMAL AIR TRANSPORT

Flight Crew and Guards	5 people
Distance Between Cargo and Crew	9 meters
Total Transport Index per Flight	50 (TI)
Refueling Stopover Time	8 hrs.
Ground Crew and Bystanders	10 people
Average Exposure Distance During Stopover	50 meters
Cargo Size (weight of PuO_2 powder)	51 kg*

*Assumes PAT-1 container. Annual cargo is anticipated to range from 600 to 1,800 kg.

The radiation exposure to each crew member:

Direct Flight (16 hrs)	9.6 mrem per flight
Flight with refueling stop	
1st leg (9.6 hrs)	5.7 mrem per flight
Stopover (8 hrs)	0
2nd leg (7 hrs)	4.2 mrem per flight

The radiation exposure to the ground crew and bystanders at the airport during a refueling stopover of 8 hours is estimated by using the methodology of NUREG-0170. Assuming annual shipments ranging from 600 to 1,800 kg[1/] the number of flights would range from 12 to 36 per year[2/], and the annual radiation exposures would be as presented below. Since the flight crew will be rotated between these and other non-radiation flights, the crew exposures are presented as person-rem.

1/ To provide annual dose estimates which are comparable between the air and sea transport cases, transport quantities ranging from 600 to 1800 kg were used in both cases.

2/ It is assumed that the total number of flights will not exceed twelve per year. At this frequency, 1800 kg could only be transported in a one year period if the maximum allowed per flight is raised to 150 kg. This may be possible if a larger container such as the PAT-III is certified and provides sufficient shielding to lower the transport index and/or if an exception is made to the 50 TI limit per flight. (Presumably this is a principal reason why efforts are being made to certify a larger container.) Since at the present time the maximum allowed per flight is 51 kg, it is assumed in this assessment, for dose estimation purposes, that up to 36 shipments would be made per year (i.e., up to 1800 kg), even though it is not anticipated that the annual number of flights would exceed twelve.

Based on these various assumptions, the annual exposure resulting from normal air transport would be:

All Direct Flights	0.59 to 1.77 person-rem to crew
All Flights with Refueling Stop (8 hr):	
1st leg	0.33 to 0.99 person-rem to crew
8 hr Stopover	0.14 to 0.42 person-rem to ground crew
2nd leg	0.26 to 0.78 person-rem to crew

The annual radiation exposure from normal transport would be highest for flights which stopped over for refueling, with an annual exposure of from 0.73 to 2.19 person-rem. This annual exposure is small when compared to the annual exposures calculated for cargo and passenger aircraft in the domestic U.S. by the NRC in NUREG-0170, December 1977. NUREG-0170 estimated a total 1985 exposure of 43 person-rem to flight and ground crews for all cargo aircraft in the U.S. (Table 4-17 of NUREG-0170). If there was no refueling stop involved, the annual exposure could be reduced from the amounts just described.

3.3 Radiological Impacts from Potential Accident

Theoretically, the risk from accidents involving the shipment of plutonium by air will be a function of the probability of an accident, the probability of the loss of shielding efficiency or containment during an accident, and the radiological effects of such loss of protective covering. This latter factor depends on such variables as the form of nuclear material, its quantity, location, weather patterns and mitigating measures taken for recovering the material.

As we have already emphasized earlier in this analysis, because of the concern raised in the 1970s that the protection against the possible effects of an aircraft accident involving plutonium warranted extraordinary measures independent of routine risk analysis, Congress enacted into law (Public Law 94-79) on August 9, 1975 the so-called Scheuer Amendment:

> "The Nuclear Regulatory Commission shall not license any shipments by air transport of plutonium in any form, whether exports, imports or domestic shipments; provided, however, that any plutonium in any form contained in a medical device designed for human application is not subject to this restriction. This restriction shall be in force until the Nuclear Regulatory Commission has certified to the Joint Committee on Atomic Energy of the Congress that a safe container has been developed and tested which will not rupture under crash and blast-testing equivalent to the crash and explosion of high-flying aircraft."

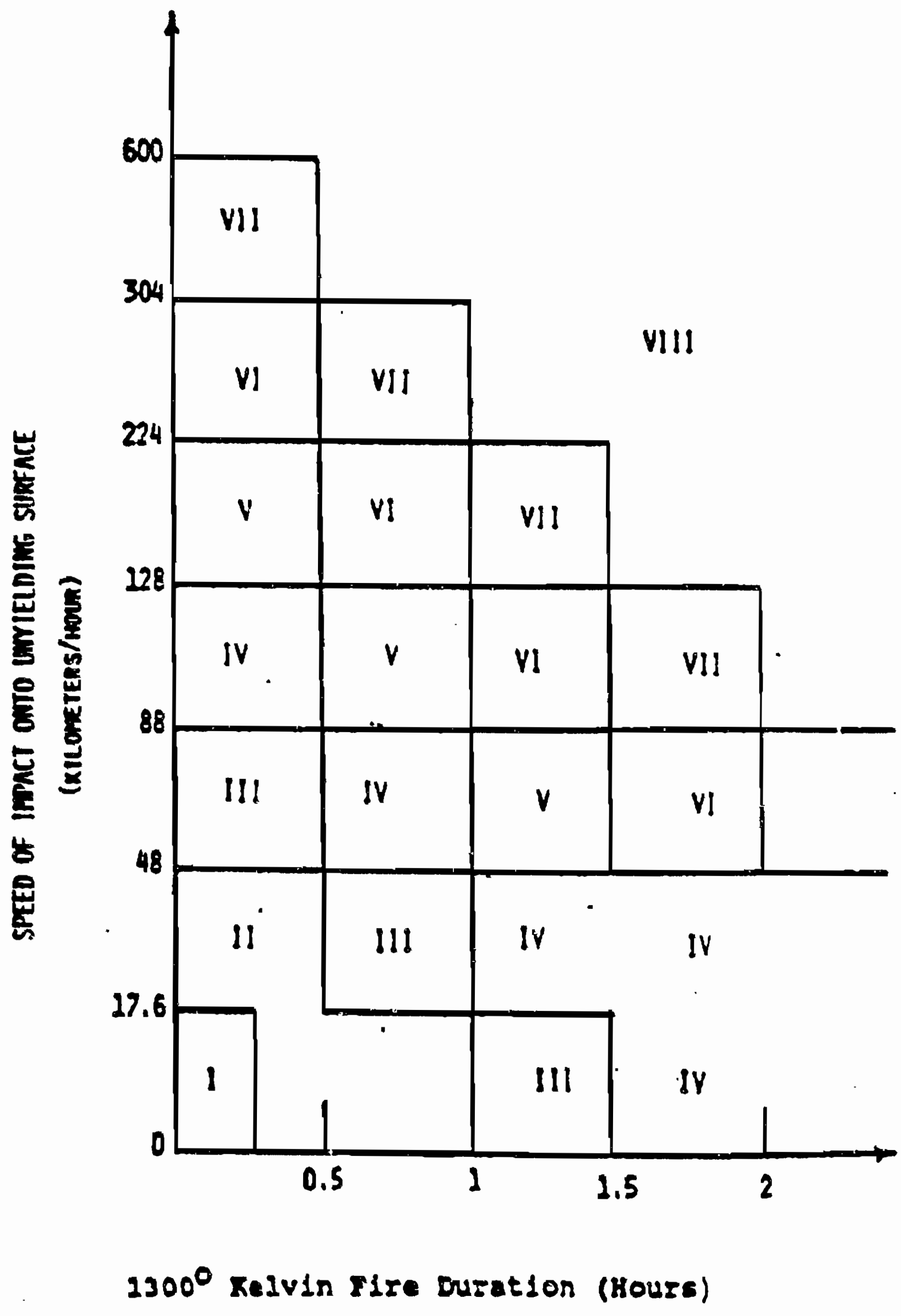
As a result of Public Law 94-79, the NRC established a certification program consisting of: (1) evaluation of the conditions which could be produced in severe aircraft accidents; (2) development of an acceptance standards for packages used to transport plutonium by air; and (3) a series of physical tests and engineering studies of plutonium packages to demonstrate their ability to meet the qualifications criteria. All of these measures were described at length earlier in this analysis. We noted that the PAT-1 cask has been certified by the NRC to meet the requirement of NUREG-0360 and is capable therefore of withstanding severe aircraft accidents, and also if a larger cask is successfully developed to overfly or refuel in the U.S., it would have to meet these same standards to certify its acceptability for use in air transport of plutonium.

In this section of the assessment an estimate of the likely radiological effects that could be attributable to accidents involving the PAT-1 container are analyzed. The annual radiological risk from accidents is estimated by considering the probability of occurrence of an accident of a given severity level and the consequences associated with a particular severity level accident.

NUREG-0170 presents a range of accident severity levels which are classified from level I to level VIII (See Figure 5.2 from NUREG- 0170 which follows). These severity levels classify a range of speed of impact and duration of high temperature fire conditions for aircraft accidents.

Examination of Figure 5.2 from NUREG-0170 indicates that a certified container for air transport, like the PAT-1 container, is designed and has been demonstrated by test to withstand <u>all</u> severity categories up to and including severity level VII with <u>no release</u> of material from the container. In order to compute the probability of an accident with a severity level VIII, it is first necessary to use the overall accident rate for air transport by cargo aircraft.

From the National Traffic Safety Board Safety Information release SB87-2, dated January 12, 1987, an overall accident rate



(Figure 5-2 from NUREG-0170. ACCIDENT SAFETY CATEGORY CLASSIFICATION SCHEME-AIRCR is obtained for Non-Scheduled Air Carriers. This overall rate is an average for the years 1976-1986 and is expressed as 1.3×10^{-5} total accidents per hour. Table 5-2 of NUREG-0170 presents the fractional occurrences of aircraft accidents by accident severity category. Since, with a PAT-1 type container, there are no releases for accident severity level Categories I-VII, the 99.97% of all accidents can be ignored in this accident analysis. The remaining 0.03% occurrence for severity level VIII is considered to occur randomly along the flight path.

With an assumption that each flight will have a duration of 16 hours, and that the total number of flights per year will range from 12 to 36 (in order to transport 600 to 1800 kg per year), the chance of severity level VIII accident annually ranges from about 0.79×10^{-6} to 2.37×10^{-6}. With only 19% of the flight time over U.S. land, the chance of a severity level VIII accident annually over U.S. land is 1.5×10^{-7} to 4.5×10^{-7}.

For a severity level VIII accident condition, the regulatory specification is that the PAT-1 container shall be assumed to release an "A_2 quantity" of material in a week following the accident. As a result of detailed testing of these containers, it has been demonstrated that actual releases, following severity level VIII tests, are less than the regulatory specification. As indicated in NUREG-0360, the "A_2 quantity" per container for the plutonium recycle mixture is 46 mCi of activity.

For dose assessment purposes, this assessment, assumes that an airplane crashes on land (including after a mid-air collision) and that all of the 31 containers leak the specified A_2 quantity in one day rather than over a week. Further, it is assumed, without postulating any specific mechanism for such, that all of the "A_2 quantity" for containers is available to be dispersed in the air.

Using a plutonium fire model developed by Lawrence Livermore Laboratory called "HOT SPOT"[1/], a release height of 10 meters and a wind speed of one meter per second, the 50 yr. committed effective dose equivalent to a person 500 meters downwind will be 0.7 rem. This dose is conservative since it assumes that all of the radioactivity that is released from the breached containers becomes airborne and is available for inhalation, and that all of the released particles are 1 micron in diameter, whereas the particle size distribution is likely to include only a fraction of particles this diameter or smaller and in the respirable size range. Because of the routing it is assumed that the accident would occur in a remote area and it is assumed conservatively that 10 persons would be similarly exposed. The total committed effective dose equivalent would then be 7 person-rem. Considering the annualized probability of an aircraft accident over U.S. land of 1.5×10^{-7} to 4.5×10^{-7}, the annual radiation risk is 1.1×10^{-6} to 3.2×10^{-6} person-rem. Using a health effect risk coefficient of 165 health effects (primarily

1/"HOT SPOT," Health Physics Codes, Lawrence Livermore National Laboratory, April 1985 (M-161).

increased risk of death from cancer) per million person-rem[2/], the estimated number of adverse health effects from severe aircraft accidents leading to plutonium inhalation exposures is 2×10^{-10} to 6×10^{-10} per year, a value extremely small compared to the normal incidence of cancer in the general population or the risk of accidental death due to transportation.

Since it is difficult to predict the population density near the crash site, for demonstration purposes we can postulate an extremely conservative case where the population exposed within a 50 miles radius to the above effective dose equivalent is 100,000. Then, the number of adverse health effects per year in this total population would be 2×10^{-6} to 6×10^{-6}. Accordingly, even under the above (extremely conservative) case, the number of adverse health effects per year is a very low figure, well below one (1).

Figure 4 which follows tabulates some relevant information pertinent to the accident scenario.

2/ International Commission on Radiological Protection, 1977. Recommendations of the International Commission on Radiological Protection (Adopted January 17, 1977). ICRP Publ. 26, Annals of the ICRP 1(3).

3.4 Effects on the Global Commons

An additional word is warranted about the implications of an air accident on the global commons. This has two features - namely what is likely to occur if a U.S. NRC certified cask, like PAT-1, is involved, and secondly, what is likely to be the situation if there is no overflight or refueling stop in the U.S., hence no formal need for a U.S. NRC certification of the cask, and if a cask essentially only meeting Japanese certification standards is employed.

It is the judgment of this analysis that if a PAT-1 cask or a larger cask meeting U.S. NRC standards is employed, the likely risks and effects of an accident will be the same or similar to those just described. We also assume that a similar situation will apply if U.S. territory is not involved and if no formal U.S. NRC certification is required. We base this on the conclusion that the certification standards, processes, and conditions adopted and applied by Japan will be comparable in conservatism to those applied within the United States. This is confirmed in the Japanese side-letter on Physical Protection cited earlier.

FIGURE 4

Table of Parameters used for Air Accidents Assessment

Accident Severity Levels	I-VIII (1)
Total Accident Rate for Non-Scheduled Air Transport	1.3×10^{-5} per hr (2)
Fractional Occurrence of Severity Level VIII Accidents	3×10^{-4} (1)
Plutonium Available for Accident Fire	A_2 (2.6 mg per pkg)
Risk Coefficient	$\frac{165 \text{ adverse health effects}}{10^6 \text{ person-rem}}$ (3)

(1) NUREG-0170, Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes, December 1977.

(2) NTSB Data

(3) ICRP Report No. 26.

4.0 ALTERNATIVES TO THE PROPOSED ACTION

This section of the assessment discusses the implications of the major alternatives to the proposed course of action described in Section 1. These include the alternatives of:

- taking no action on the proposed Agreement for Cooperation and associated "subsequent arrangement" with EURATOM;

- concluding an Agreement for Cooperation, not involving advance long-term U.S. consent to the return of U.S.-origin plutonium from Europe to Japan (such shipments will continue to be approved case-by-case);

- the use of transportation modes or transportation criteria other than those contemplated in the new Agreement and the associated "subsequent arrangement."

4.1 Alternative 1 - Take No Action

Under this alternative, the U.S. would not enter into the proposed new Agreement for Cooperation with Japan. Neither would it conclude any alternate new Agreement for Cooperation with Japan at this time. In this event, the expected benefits for the U.S. described under the Need for Action section prepared by the Department of State would not materialize and the President would not carry out the mandate of NNPA. There will most likely be a serious loss of confidence by Japan and other countries in the U.S. as a civil nuclear cooperating partner with a consequent reduction in U.S. influence over the course of the Japanese program and the program of other cooperating countries. Also, most likely there would be a serious deterioration in the overall quality of the U.S.-Japanese bilateral nuclear relationship, a reduction in U.S. nuclear exports, including the provision of enrichment services to Japan, and a reduction of the ability of the U.S. to work cooperatively with Japan in the improvement of the international non-proliferation regime including physical security measures applicable to international transfers of separated plutonium.

A U.S. refusal to conclude a new agreement for cooperation with Japan on the basis described above would not necessarily preclude the return of separated plutonium from EURATOM to Japan or the need for the U.S. to address this issue and how such shipments can be managed in the safest and most secure manner. Japan and EURATOM undoubtedly will still come to the U.S. with requests for approvals of retransfers and returns of separated plutonium from EURATOM to Japan. Accordingly, unless it wishes to block such returns altogether, the U.S. will be confronted with either insisting on transportation guidelines and conditions similar to those already negotiated between the two governments or on some alternative arrangements. However, under this option, since the U.S. will not be granting Japan a long-term approval (via EURATOM) of such returns, it could have less influence than under the proposed new agreement for cooperation on the protective measures that will apply over the longer-term to such shipments.

Also, if the U.S. refused to approve any returns of plutonium to Japan whatsoever, this would not necessarily preclude separated plutonium going back from EURATOM to Japan nor would it prevent international transfers of separated plutonium between other nations. Japan has access to plutonium in Europe that has been produced in the Japanese "Calder Hall" type reactor. Moreover, there are other transfers of plutonium occurring between other countries over which the U.S. has no control. However, by being cooperative with Japan, as proposed in the new U.S.-Japanese Agreement for Cooperation, it can be argued that the U.S. is in an improved position to induce Japan to agree to rigorous safety and physical security measures governing such transfers over long-distances that could become a model for application in other nations as well.

Under this alternative, transportation impacts would be expected to be similar to those that would occur under the proposed action. However, these impacts would not occur on U.S. territories.

4.2 -Alternative 2: Conclude a new Agreement for Cooperation with Japan that does not entail an advance, long-term U.S. approval of the return of U.S.-origin plutonium from Europe to Japan. Instead, continue to subject such shipments to case-by-case U.S. approval.

The U.S. proposal to negotiate a new agreement incorporating all of the non-proliferation requirements of the Non-Proliferation Act of 1978 (NNPA) was made in the context of a U.S. willingness (previously approved at the Presidential level) to extend to Japan various long-term approvals. As noted, these included long-term approvals of reprocessing operations in Japan, of the shipment of spent fuel to EURATOM for reprocessing purposes and of the return of the separated plutonium returned to Japan from EURATOM for specified projects. The Government of Japan (in agreeing after several years of arduous exploratory discussions to negotiate a new agreement) expressed the strong view that a U.S. advance consent arrangement should form part of the package. Given the uncertainty that Japan had encountered during the late 1970's in obtaining necessary U.S. consents to such operations, the Japanese Government felt it would have to establish a more stable understanding with the U.S. as to how the U.S. would exercise its consent rights as part of any new agreement for cooperation incorporating the new NNPA conditions. Had the U.S. not been prepared to extend Japan such long-term approvals, it appears certain that it would not have been feasible to negotiate and conclude a new agreement for cooperation incorporating the new conditions in the NNPA.

Moreover, even if one assumes that it might have been feasible to conclude the kind of agreement for cooperation with Japan described under this second alternative, this would not necessarily alter the environmental implications and effects described in this Environmental Assessment. That is to say, if the U.S. preserved for itself the ability to approve returns of separated plutonium to Japan on a case-by-case basis, at the present time it most likely would still favor or insist on air shipment as the preferred mode of transportation. Moreover, it might insist that such transfers take place under all of the same safety related and security related conditions as have been included in Annex 5 to the proposed new Agreement for Cooperation. The environmental impacts of this alternative would be expected to be similar with those anticipated under the proposed new Agreement for Cooperation.

4.3 Alternative 3 - Conclude a new Agreement but alter the principal conditions of transport Enter into a new Agreement for Cooperation with Japan calling for long-term U.S. approvals of plutonium returns from EURATOM to Japan. However, modify the modes of transport and the physical security requirements to apply to such transfers so that they differ from those set forth in Annex 5 in the Agreement Package (i.e., the proposed course of action).

Under this option the U.S. would still grant long-term approvals of plutonium returns from EURATOM to Japan but the modalities of shipment would differ from those that have been negotiated. The major sub-alternatives could include the following:

a. shipping the material by methods other than air transport, namely through the use of sea transport or a combination of air and sea transport;

b. shipping the material by air but in much smaller quantities than currently anticipated;

c. shipping the material by air but by a route other than "the polar route" or another route deliberately selected to avoid areas of natural disaster or civil disorder.

These sub-options are discussed in further detail below.

a. Shipping by sea or a combination of air transport and sea transport

There are two alternative modes of transport to the use of air shipment that are theoretically available for moving plutonium from Europe to Japan: shipping the material by sea for the entire route or flying it part way, transferring the material to a vessel and shipping it the remainder of the distance by sea.

Sea Shipment

There is precedent for sea transport by common carrier for the entire route. In particular, on July 20, 1984 the Secretary of Energy, pursuant to Section 131 of the Atomic Energy Act, approved a shipment of 189 kilograms of fissile plutonium (287 kgs total PuO_2) from France to Japan aboard a dedicated Japanese cargo vessel. The plutonium was encased in 16 French and 4 British casks* and the shipment was subjected to very rigorous physical protection and surveillance measures throughout the voyage.

*French model FS-47 cask and the British model 1356 cask otherwise known as the "PUB" cask in Japan.

These included:

- modifications of the vessel to preclude removal of containers at sea (disabling of hatch cover motors and on-board cranes);

- the assignment of suitable individuals experienced in plutonium handling, maritime safety, and physical protection - including the use of armed guards;

- the establishment of a central control station in Japan manned 24 hours a day with real time communications with the vessel as well as governmental authorities responsible for emergency response;

- the establishment of special communication systems permitting the escorts to communicate on a real time basis

with the Japanese central control station, as well as satellite tracking of the ship's position and status of container seals with automated communication to the central control station;

- the prior investigation of all members of crew and the escort force to determine their trustworthiness; and

- the establishment of contingency plans for the crew, response force, central control station personnel, as well as appropriate authorities in participating governments;

Finally, and significantly, the vessel was placed under surveillance by military vessels, or maritime safety vessels, including U.S. vessels, throughout the voyage. Also, the ship was provided with additional fuel tanks, and did not make any stops for bunkering.

While every effort was made to secure, protect and monitor the 1984 sea shipment in as rigorous a manner as possible, there was substantial concern at the time within the Executive Branch and the Congress* that the transit time for such a shipment was too long to become a desirable precedent for the future - if one considers the risk of theft or attack by hostile forces and the fact that a commercial carrier was being employed. Also there was a perception that the need for escort surveillance by U.S. military forces to help ensure the physical protection of the system was extremely expensive and could detract from the normal defense missions of U.S. armed forces. Accordingly, the U.S. expressed the view that future shipments of this kind should be by air, and the interested agencies in Japan have been working

*On August 31, 1984, 15 members of the Congress wrote to President Reagan urging, among other things, that he not permit any further shipments of this material to take place by sea but rather insist upon air transport as being the only mode of transport that the U.S. would approve.

to make this an achievable objective. Pursuant to the new Agreement package with Japan, only air transfers would be eligible to receive long-term U.S. approvals. The use of any other modes of transfer would have to be reviewed and approved by the U.S. on a case-by-case basis.

There could of course, be significant environmental effects should the material fall into the hands of terrorists.

Within this context, the option of transferring plutonium by sea would have distinguishing characteristics along the following lines:

- The use of the sea option presumably could involve a substantially greater quantity of plutonium per shipment than by air - if one assumes an aircraft is unlikely to carry more than about 150-200 kilograms per flight. Also, a vessel could carry fabricated or partially fabricated fuel elements in a suitable cask whereas no air cask now in existence or contemplated would be large enough to carry fabricated or partially fabricated elements;

- The nominal transit time of vessel from Europe to Japan (assuming no stop-overs) would be several weeks if one postulates going through the Panama Canal, whereas shipment by air could take place in about 16 hours. The duration of the sea shipment from Le Havre to Tokyo in 1984 was about 45 days, without any stops.

- An air shipment is very difficult to intercept and essentially requires a military aircraft to do the job, whereas a ship is easier to find and approach (though this is by no means a simple matter). Also, the difficulty of interception and hostile boarding on the high seas will depend on the specific physical protection measures implemented.

- If a vessel sank or encountered an accident enroute, the environmental effects would depend somewhat on the circumstances, location, weather conditions, etc. If a breach of a cask occurred at deep ocean depths the enormous dilution characteristics of the ocean would preclude adverse effects to the environment.

Certain general observations also can be made about the radiological consequences of sea transport of plutonium oxide powder from France to Japan under both routine and accident conditions. These observations may be compared with similar radiological assessments of transport by air, provided in Section 3.0.

With respect to routine exposure at sea, under DOT regulation 49 CFR 176.740 (a), the sum of the transport indexes for all radioactive packages on board a vessel must not exceed 200. As discussed below, a single container carrying less than 1.648 kg of plutonium oxide powder has a transport index of about 1.6. Therefore, shipments would have to be made at least three times per year to accommodate the forecasted cargo sizes. However, for purposes of determining the annual radiation dose, we may assume for simplification a single shipment of the entire annual load, based on an expected linear relationship between size of shipment and radiation dose.

The PAT-1 container has been certified by the NRC for air transport of plutonium, and its specifications for this purpose have been discussed previously. Although PAT-1 containers or similar designs would not be necessary for sea transport (because high velocity impacts would not be expected) and would not likely be used, sufficient data are available for the PAT-1 container and it is useful to apply such data to the calculation of dose estimates for sea transport. Dose estimates are expected to be about the same regardless of the type of container used, because the PAT-1 and other container do not provide extensive shielding.*

*Calculations should be made for exposure from actual containers which might be used for sea transport of plutonium oxide, such as the British 1356 and the French FS47 which were used for a shipment of plutonium oxide from France to Japan in 1984. Transport index and A_2 quantity data were not available for these casks at the time of preparation of this document. However, dose estimates are anticipated to be similar to those using the PAT-1.

The PAT-1 can carry up to 1.648 kg of plutonium oxide, limited to this amount due to a maximum heat rate of 25 watts per container. This quantity of plutonium oxide in this container would have a transport index of 1.6. For annual cargoes ranging from 600 to 1,800 kgs, the total transport index would range from 583 to 1,748.

The following data are used from Appendix F of the RADTRAN User's Guide:

Distance from crew to radioactive source:	61 m
Size of crew and escort force:	30
Ship speed:	6.7 meters per second

Furthermore, the distance by sea from France to Japan is approximately 25,000 km, travelling via the Panama Canal. Therefore, at the speed indicated above, the total estimated travel time is 1040 hours (about 43 days).

By the inverse square law, the dose rate at a distance of 61 m for the range of transport indices stated above would range from approximately .15 to .47 mrem/hr. This range of dose rates over the duration of the trip would cause total individual doses of from 163 to 489 mrem. Finally, for a crew of thirty, including guards, the collective dose ranges from 4.9 to 14.7 person-rem. This range is about 7 times as large as the annual routine dose due to air transport given in Section 3.2, but is small in comparison with annual exposures which have been calculated by the NRC in NUREG-0170 for cargo and passenger aircraft in the U.S.

These figures represent the total dose to crew members resulting from sea transport of an annual quantity of 600 to 1,800 kg of plutonium oxide. The dose estimates are valid approximations regardless of how many separate shipments the annual load is divided into.

Using the analysis developed in DOE/EH-0321, accidents on the open seas (global commons) that result in the release of plutonium oxide are unlikely to have significant consequences in any nearby port or city. This could come about because the volume of open ocean water is much larger than the volume of particulates that could potentially escape a damaged certified package, the amount of dilution would be large; and mixing and dispersion would occur because of ocean currents. Thus for, the sea transport scenario, the greatest risk of accidental release of plutonium oxide would would result from a port accident involving a fire or explosion which causes severe damage to cargo.

DOE's Environmental Assessment on Shipment of Taiwanese Research Reactor Spent Nuclear Fuel (DOE/EA-0321, December 11, 1986) provides data which may be used to determine the probability of a port accident that would cause a release of plutonium oxide. Tables C.1A and C.1B of this document (page 44) indicate that 33 fires or explosions are expected to occur for every 78,000 transits in inland waters. According to Table C.1C (page 45), 2.8% of these fires or explosions would cause severe damage to cargo. The result is a risk of 12 accidents causing severe cargo damage per 1 million transits into seaports.

To determine the consequences of such an occurrcnce, we estimate a maximum release of 46 mCi per container, the "A2 Quantity" of plutonium oxide powder identified in NUREG-0360. With a limit of 25 watts heat load per container, only 1.648 kg of plutonium oxide may be loaded into a single container. Therefore, total annual cargoes of from 600 to 1,800 kg would be carried in 364 to 1092 containers, and the total released quantity would range from 16.7 to 50.2 Ci. Furthermore, it is assumed that 1% of this released quantity becomes airborne as a result of this accident and subsequent fire and is available for inhalation.

Using the same plutonium fire model as was used in Section 3.3., the 50 year committed effective dose equivalent to a person 100 meters downwind ranges from 0.036 to 0.11 rem from this accidental release. Using a health effect risk coeffecient of 165 health effects per million person-rem, a crew and escort size of 30, and the probability determined above of 12 accidents per 1 million transits, the estimated number of adverse health effects from such an accident is estimated to range from 2×10^{-9} to 6×10^{-9} per year.

The most distinguishing feature of the option of sea transport appears to be the relatively long transit time in remote regions. Under normal circumstances a sea transfer should have no adverse environmental effect on the global commons. However, from a physical security standpoint (and especially if one assumed that a civilian carrier rather than a military vessel if employed to carry the plutonium), shipment by sea appears to offer a lesser degree of protection of the human environment against the risks associated with seizure of plutonium than would be provided by shipment of the material by air.

Air and Sea Shipment

Under a second alternate mode of transport (which was one of the options studied by Japan prior to the 1984 shipment by sea), the separated plutonium would be flown by air for a part of the route, and transferred to a vessel for shipment over the remainder of the distance. It is postulated that for the first leg the cargo would be flown to a West Coast port in the U.S. or an island in the Pacific, and that the cargo would be off-loaded and transferred in bond to a vessel for the remainder of the voyage. In theory, this option might commend itself for consideration in a situation in which there still would be a strong incentive, for physical security and national security reasons, to reduce the transit time that would otherwise be involved if sea shipment alone were employed.

Under this sub-option, if U.S. territory were transited or if the air cargo were off-loaded at a West Coast U.S. port or a Pacific Island under U.S. jurisdiction, the air cask would have to be approved and certified by the U.S. NRC in accordance with the criteria which have already been described. If it were legally and politically feasible to fly the material into some other jurisdiction and transfer it under bond to a vessel, it is assumed from the standpoint of this analysis that, in order to receive U.S. approval of the shipment from EURATOM, the air cask would have to meet criteria that are comparable to those adhered to by the U.S. NRC and that are designed to withstand accidents in any and all environments.

This particular alternative obviously would entail a transit time shorter than sea shipment alone, but still significantly longer than the use of shipment by air. The environmental effects obviously would represent a combination of those described elsewhere in this report for air and sea shipment. In addition, there would be some additive environmental effects greater than the sum of the air and sea legs of the journey. These would be those associated with off-loading casks from an aircraft, moving them by a vehicle to a seaport and loading them and securing them on a vessel. It is assumed that under this option the airport and seaport that might be employed would be in a reasonable promixity to each other.

Unless one knows the quantities of materials that would be involved, the routes, the containers that would be employed, how much the voyage would be by air and how much by sea, etc., it would be difficult to quantify the environmental effects of this option. However, since there have been many instances where plutonium has been shipped safely and without incident by land, it is unlikely that the transshipment of the material from the airport to the seaport would have any significant effect on the human environment. On balance, however, it must be noted that this alternative, like the alternative of using sea transport in its entirety, would not be consistent with the expressed U.S. policy goal that future transfers of separated plutonium from Europe to Japan should be by air.

b. Transporting of plutonium in limited quantities per shipment

Under this alternative, the amount of plutonium that would be transported per air shipment would be cut back to some arbitrary quantity that would be substantially below the nominal 150 kilograms (or greater per shipment that Japan ultimately would like to achieve). It is assumed that this quantity would have to be greater than 2 kilograms since the Implementing Agreement with Japan - which is part of the Agreement package - states that the plutonium would be shipped in quantities of 2 kilograms or more. This is related to the fact that the figure of 2 kilograms per shipment triggers the most stringent physical protection measures required under both U.S. and Japanese policy and regulations, as well as the international guidelines to which both governments have subscribed. It was agreed during the negotiations that the long-term approvals of plutonium shipments should be based on these heightened physical protection standards. The Japanese Government was not interested in developing mutually agreed standards with the U.S. for smaller shipments probably because such smaller shipments would not be economically and logistically attractive.

The presumed rationale for this alternative would be that by reducing the quantities of plutonium that would be involved per shipment, the consequences of any particular adverse event, per shipment, whether it be an accident or seizure of the material, also could be reduced.

On the other hand, a significant reduction in the amount of material that would be authorized per shipment could also add significantly to the number of air shipments that would be required to deliver to Japan the same amount of material. A reduction by half of the allowed cargo per shipment would presumably double the number of needed flights. It can be argued that such an increase in the number of air shipments basically should have no significant additive impact on the human environment within U.S. territory as well as in the global commons because as the number of shipments is increased, the quantity transported per shipment would decrease accordingly. Also, adequate physical security protective measures presumably will apply to such transfers. However, the more credible position would appear to be that the risks go up with increases in frequencies of such transfers. As the number of shipments increases, the prospects of an accident or other untoward event also tends to increase.

c. <u>Air transport by a route other than that meeting one criteria set forth in Annex 5 of the Implementing Agreement</u>

The Annex 5 guidelines which were quoted above call for a route "from an airport in the United Kingdom or France to an airport in Japan via the polar route or another route selected to avoid areas of civil disorder." Thus any route is a possible route, provided that it is selected only to avoid natural disaster or civil disorder. The Agreement does not obligate Japan to choose a route crossing U.S. territory, nor does it authorize a transit of U.S. territory. Also, any route that is chosen will be subject to a transportation plan on which there will be advance consultations between the U.S. and Japanese Governments and any overflight or landing in the U.S. for refueling will be subject to the applicable U.S. laws and regulations.

In contrast to the approach just described, one can visualize two alternate approaches as to how the route for air shipment might be selected. Under the first approach, the parties could have simply stipulated the use of air transport as the agreed mode of transport without specifying any criteria to be employed in selecting the route to be chosen. That is to say they could have avoided reference to the use of the polar route or to the need to avoid natural disasters or civil disorders. This approach would have accorded Japan the maximum flexibility to choose whatever air route appeared most appropriate at a given time.

The criteria of using a polar route or another route selected to avoid areas of "natural disaster or civil disorder" obviously was selected to appropriately recognize the importance of applying the most prudent transport measures to the international transfers of plutonium over long distances. Its elimination or removal as a test could conceivably add to the risk to the global commons by removing the admonition that dangerous areas should be avoided. On the other hand, it is difficult to conceive that Japan would knowingly fly a cargo of plutonium to areas that would significantly add to the risk of the integrity of the shipment. Nevertheless, all things being equal, it would appear to be preferable to have air shipments governed by an explicit criterion of this nature than to leave any ambiguity on the point.

Under the second approach, which would be at the opposite extreme, a precise and definitive route would be chosen at this stage with no chance of deviation in the absence of modifying the Implementing Agreement in the Agreement package. In theory, it might be feasible at this time to fix on one specific route to be employed for all air shipments to be employed or returning separated plutonium subject to U.S. consent rights from EURATOM to Japan. The election of this option has not been judged to be prudent or desirable at this time because it has been deemed available to leave flexibility on the route to be selected in light of the additional steps that will be necessary before a shipment can take place. The cooperation of national authorities in the countries along the route chosen may be a function of the size of the cargo and the aircraft that is selected and its capacity. Also, since the threats of a physical security nature, and of national disturbances may shift geographically over a period of time it would appear prudent to leave the flight planners flexibility to alter route selections as evolving circumstances warrant. This would be especially true since the proposed new Agreement for Cooperation is of long-term nature. While the fixing on a specific route might enable one to estimate the potential environmental effects of air transfer with a greater degree of specificity than is now the case, it is not evident that this approach would have either a better or less advantageous effect on the human environment than having the parties to choose alternate routes depending on evolving needs and circumstances.

TABLE

Transport index (T.I.)	Radiation level at package surface (RL)	Fissile criteria	Label category.[1]
N/A	RL<0.5 millirem per hour (mrem/h).	Fissile class I only, no fissile class II or III.	White-I.
T.I.<1.0	0.5 mrem/h<RL<50 mrem/h.	Fissile class I, fissile class II, with T.I.<1.0, no fissile class III.	Yellow-II.
1.0<T.I.	50 mrem/h<RL	Fissile class II with 1.0<T.I., [illegible] fissile class III.	Yellow-III.

[1] Any package containing a "highway route controlled quantity" (§ 173.403 of this subchapter) must be labeled as Radioactive Yellow-III.

NRC FORM 618
(6-83)
10 CFR 71

U.S. NUCLEAR REGULATORY COMMISSION

CERTIFICATE OF COMPLIANCE
FOR RADIOACTIVE MATERIALS PACKAGES

1. a CERTIFICATE NUMBER	b REVISION NUMBER	c PACKAGE IDENTIFICATION NUMBER	d PAGE NUMBER	e TOTAL NUMBER PAGES
0361	2	USA/0361/B(U)F	1	4

2. PREAMBLE

a. This certificate is issued to certify that the packaging and contents described in Item 5 below meets the applicable safety standards set forth in Title 10, Code of Federal Regulations, Part 71, "Packaging of Radioactive Materials for Transport and Transportation of Radioactive Material Under Certain Conditions."

b. This certificate does not relieve the consignor from compliance with any requirement of the regulations of the U.S. Department of Transportation or other applicable regulatory agencies, including the government of any country through or into which the package will be transported.

3. THIS CERTIFICATE IS ISSUED ON THE BASIS OF A SAFETY ANALYSIS REPORT OF THE PACKAGE DESIGN OR APPLICATION

a. PREPARED BY (Name and Address)

U.S. Nuclear Regulatory Commission
Washington, DC 20555

b. TITLE AND IDENTIFICATION OF REPORT OR APPLICATION

NUREG-0361; Safety Analysis Report for the Plutonium Air Transportable Package Model No. PAT-1

c. DOCKET NUMBER 71-0361

4. CONDITIONS

This certificate is conditional upon fulfilling the requirements of 10 CFR Part 71, as applicable, and the conditions specified below.

5.

(a) Packaging

(1) Model No.: PAT-1

(2) Description

A stainless steel containment vessel (designated TB-1) surrounded by a stainless steel and redwood overpack (designated AQ-1). The contents are sealed within a stainless steel product can (designated PC-1) inside the containment vessel.

The AQ-1 overpack is a right circular cylinder, approximately 42-1/2 inches long by 24-1/2 inches outside diameter. The walls of the overpack consist of approximately 9 inches of grain oriented redwood encased within double stainless steel drums. The ends of the drums are doubly closed. A copper heat conducting element and an aluminum load distributer are encased within the redwood.

The TB-1 containment vessel is approximately 8-1/2 inches outside length by 6-3/4 inches outside diameter. The minimum wall thickness of the vessel is approximately 1/2 inch. The interior cavity of the vessel is a right circular cylinder, 4-1/4 inches diameter, with hemispherical ends. The vessel is closed by 12, 1/2-inch diameter bolts and doubly sealed with a copper gasket and knife edges and an elastomer O-ring.

5. (a) Packaging (continued)

(2) Description (continued)

The weight of the package is approximately 500 pounds. The weight of the TB-1 containment vessel, when loaded with 4.4 pounds of contents is approximately 41.7 pounds.

(3) Drawings and Specifications

The Model No. PAT-1 packaging is fabricated in accordance with the drawings and specifications in Section 9.0 of the Safety Analysis Report, NUREG-0361.

(b) Contents

(1) Type and form of material

Plutonium oxide and its daughter products, in any solid form. The plutonium oxide may be mixed with uranium oxide and its daughter products, in any solid form.

(2) Maximum quantity of material per package and additional permissible contents

(i) Maximum 2.0 kg total radioactive material, plus: maximum 16 grams of water and 10 grams of polyethylene or polyvinylchloride bagging material. The maximum decay heat load of the contents may not exceed 25 watts.

(ii) Maximum 200 grams total radioactive material, plus: maximum one gram of water, maximum 200 grams of metal canning material (in addition to the PC-1 product can, Drawing No. 1024), maximum 64 grams of aluminum foil or honeycomb (in addition to the top spacer, Drawing No. 1015), maximum 175 grams of glass and maximum 35 grams polyethylene or polyvinylchloride bagging material. The maximum decay heat load of the contents may not exceed 25 watts.

(c) Fissile Class: I

6. The PC-1 product can (Drawing No. 1024) and the top spacer (Drawing No. 1015) need not be used when the contents include 20 curies or less of plutonium.

7. Prior to first use, each packaging shall meet the acceptance tests and standards specified in Subsection 8.1 and Section 9.0 of the Safety Analysis Report.

8. Prior to each shipment, the package shall meet the tests and criteria specified in Subsection 8.2 of the Safety Analysis Report.

9. The package shall be prepared for shipment and operated in accordance with the procedures specified in Section 7.0 of the Safety Analysis Report.

10. The systems and components of each packaging shall meet the periodic tests and criteria specified in Subsection 8.3 of the Safety Analysis Report.

11. Repair and maintenance of the packaging shall be in accordance with Sections 8.0 and 9.0 of the Safety Analysis Report.

12. The packaging shall be designed, procured, fabricated, accepted, operated, maintained, and repaired in accordance with a quality assurance plan approved by the Nuclear Regulatory Commission for this purpose.

13. Through special arrangement with the carrier, the shipper shall ensure observance of the following operational controls for each shipment of plutonium by air:

    (a) The package(s) must be stowed aboard aircraft on the main deck in the aft-most location that is possible for cargo of its size and weight. No other type cargo may be stowed aft of the package(s).

    (b) The package(s) must be securely cradled and tied-down to the main deck of the aircraft. The tie-down system must be capable of providing package restraint against the following inertia forces acting separately relative to the deck of the aircraft: Upward, 2g; Forward, 9g; Sideward, 1.5g; Downward, 4.5g.

    (c) Cargo which bears one of the following hazardous material labels may not be transported aboard an aircraft carrying a package(s):

Explosive A	Non-Flammable Gas
Explosive B	Flammable Liquid
Explosive C	Flammable Solid
Spontaneously Combustible	Flammable Gas
Dangerous When Wet	Oxidizer
Organic Peroxide	Corrosive

    This restriction does not apply to hazardous material cargo labeled solely as:

Radioactive I	Poison
Radioactive II	Poison Gas
Radioactive III	Irritant
Megnetized Mateirals	Etiologic Agent

14. The package authorized by this certificate is hereby approved for use under the general license provisions of 10 CFR §71.12.

15. The package authorized by this certificate is hereby approved for transportation of plutonium by air.

16. Expiration date: August 31, 1988.

Page 4 - Certificate No. 0361 - Revision No. 2 - Docket No. 71-0361

REFERENCES

Safety Analysis Report for the Plutonium Air Transportable Package Model Number PAT-1, NUREG-0361, June 1978.

Sandia Laboratories application dated February 20, 1980.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

Charles E. MacDonald, Chief
Transportation Certification Branch
Division of Fuel Cycle and
Material Safety, NMSS

Date: SEP 06 1983