An Analysis of the Background and Development of Regulations for the Air Transport of Plutonium in the USA*

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INTRODUCTION

On August 9, 1975, the U.S. Congress passed Public Law 94-79 which imposed a prohibition on the air transport of plutonium until the U.S. Nuclear Regulatory Commission (NRC) developed and tested a packaging that would not rupture under the crash and blast testing equivalent to the crash and explosion of a high-flying aircraft. The exact text of the amendment to Public Law 94-79, the NRC funding authorization bill, is as follows:

"The Nuclear Regulatory Commission shall not license any shipments by air transport of plutonium in any form, whether exports, 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 amendment was offered in the House of Representatives on June 20, 1975 (Congressional Record).

A similar legislative restriction was placed on the Energy Research and Development Administration through Public Law 94-187 on December 31, 1975.

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The Energy Reorganization Act of 1974, Public Law 93-438, reorganized the Atomic Energy Commission into two separate agencies, the Energy Research and Development Administration (ERDA) and the NRC. Research and development matters concerning nuclear energy were concentrated in ERDA and regulatory programs related to nuclear energy, reactor safety, and the certification of packagings for the transportation of radioactive materials were the responsibility of the NRC. On June 2, 1975, the NRC announced its intentions to reevaluate the rules concerning the transportation of radioactive materials by air and other modes. On June 20, 1975 Congressman Scheuer of New York offered an amendment in the House of Representatives to restrict the transport of plutonium by air. Mr. Scheuer cited two specific accidents involving plutonium contamination, (1), the Thule, Greenland accident involving the air crash of a U.S. bomber carrying nuclear weapons and (2), a similar occurrence in Palomares, Spain. Congressman Scheuer's District included John F. Kennedy International Airport and he expressed particular concern over the possibility of an aircraft crash which might involve a package containing plutonium. Such an accident, it was contended, would give rise to the possibility of a large number of potential health effects, large scale decontamination costs, and perhaps a large scale population evacuation. Mr. Scheuer's amendment was offered in his remarks to the House. The two accidents mentioned above (both of which involved military aircraft) allegedly had a combined cost of the clean-up and recovery which totaled approximately half a billion dollars. Mr. Scheuer received support for his efforts from Louis Lefkowitz, then Attorney General for the State of New York. Lefkowitz stated in a July 10, 1975 letter to Mr. Scheuer that the Attorney General's Office in New York would continue its legal fight in the federal courts to seek an injunction enjoining the air transport of plutonium until a thorough assessment of the issues, including the adequacy of plutonium containers, was made in an environmental assessment (Congressional Record, July 24, 1975).

Congressman Scheuer assumed office in January 1975. Whatever furnished the impetus for the introduction of his amendment in June 1975, there were clearly some earlier concerns about this matter on the state (New York) level before he assumed his congressional seat. There appears to have been considerable concern in the metropolitan area of greater New York and surrounding areas for a period of time with respect to the potential for a large release of radioactive material into the environment. (Congressional Record, July 24, 1975, copy of Lefkowitz to Scheuer letter).

One of the documented references which supported Mr. Scheuer's concerns about air transport of plutonium was the fact that he had access to information indicating that in a six-month sampling period, ERDA had made about 2100 shipments of special nuclear materials. Approximately 400 of these shipments were by air and about 90 percent of the 400 were related to defense programs (Congressional Record, July 24, 1975, copy of Scheuer to Seamons letter).

On June 24, 1975, a letter was sent from Marcus Rowden, Acting Chairman of the NRC, to Mr. George F. Murphy Jr., Executive Director of the Joint Committee on Atomic Energy (JCAE). This letter stated NRC's objections to the amendment offered by Congressman Scheuer which prohibited air transport of plutonium (an amendment to H.R. 7001, the NRC appropriations bill). NRC

objected to this amendment for two reasons. First, the NRC was actively considering the matter of the air transportation of radioactive material by air in a rule-making proceeding and, second, NRC felt that the amendment required an absolute guarantee of safety, which was undesirable from both a practical and a social standpoint.

Congressman Scheuer contacted Dr. Robert Seamons, Administrator of ERDA in a July 11,1975 letter outlining his concerns about air transport of plutonium. On the same day Dr. Seamons wrote to Senator John Pastore, Chairman of the JCAE, stating that plutonium isotopes were transported by air because of their short half-lives and programmatic urgency. He assured the JCAE that the shipments were being made in containers that could withstand serious accidents in all transport modes. Further, Dr. Seamons introduced the information that aircraft flight recorders were designed to standards developed by the FAA, based on the same conditions required for plutonium shipping containers. Dr. Seamons concluded by stating that the key to public safety was through adequate control rather than prohibition and that the proper avenue for this control was through a public rulemaking and enforcement procedure through the agencies to whom Congress had assigned such responsibilities, the NRC and the DOT.

At the time of Dr. Seamons' response to the JCAE, Sandia Laboratories was conducting a series of tests (under an NRC contract) of three small packaging designs, the LLD-1, 6M, and the FL-10. These tests were to be equivalent to the severity of the FAA flight recorder standards. In each of the tests the packagings were severely damaged but did not leak any of their simulated radioactive contents (McWhirter).

On July 24, 1975, Congressman Scheuer made additional remarks on the floor of the House and responded to the letters to the JCAE by Acting Chairman Rowden on behalf of the NRC, and Dr. Seamons on behalf of ERDA. Mr. Scheuer considered that the NRC was insensitive to the risks associated with the air transport of plutonium and also considered that Dr. Seamons had replied similarly.

There were a number of events related to this issue all of which could be summarized in some detail, but the passage of the amendments cited above resulted, essentially, in a prohibition of the air transport of plutonium. As a result of the passage of Public Law 94-79, the NRC established a package development and certification program consisting of: (1) evaluation of the conditions which could be produced in severe aircraft accidents; (2) development of qualification criteria prescribing appropriate performance requirements and 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 qualification criteria. This program led to the engineering development of PAT-1, the acronym PAT standing for plutonium, air transportable.

THE DEVELOPMENT OF U.S. AIR PU AIR TRANSPORT REGULATIONS AND PAT-1

Sandia National Laboratories (SNL) had been active in the performance of regulatory and extra-regulatory tests on packaging designs for a long period of time. One of the main components of this work was the availability of large scale testing facilities at SNL which have been used in weapons development work for the AEC, ERDA (and the DOE). In fact, the AEC requested, in 1973, that Sandia evaluate the adequacy of the tests in the regulatory hypothetical accident conditions used to certify the accident resistant containers for transporting radioactive materials. Sandia's response to this request was that before it could assess how adequate the regulatory tests were, the severity of real transportation accidents would have to be described in engineering terms. Following such a study, an assessment of the adequacy of the regulatory tests could be performed. In 1973, Sandia embarked on a two year effort to gather accident severity data which was ultimately published in two reports, one for small packages (smaller than 1000 lbs.) (Clarke), and a companion report for the severity of accidents involving large packagings (Dennis).

From 1974 to 1977 Sandia Laboratories also acted as NRC's contractor on the development of the risk assessment techniques and analysis of the environmental effects of transporting radioactive material by air and other modes which was reported in (NRC 1977). From that study NRC concluded that no additional change to the regulations involving RAM shipments was required based on radiological risk to the public.

Because of the separation of the AEC into ERDA and NRC, an awareness existed in NRC of the need for reevaluating the existing packaging regulations. This reevaluation was implemented by the NRC on June 2, 1975 with announcement that the NRC intended to initiate a public rulemaking procedure to address this packaging issue.

During 1975, NRC requested that Sandia examine the possibility of retrofitting an existing accident resistant package, the 6M. This program was informally called the 6M-MOD program. At the same time, Sandia was studying, under a NRC sponsored program, the extra-regulatory capabilities of packages such as the LLD-1 and the 6M (Bonzon). Sandia was also assessing the ability of packages such as the LLD-1 and the 6M to survive tests equivalent to the severity of FAA flight recorder standards (McWhirter). NRC had the opinion that adequate package designs for air transport were in existence. Furthermore, NRC had already announced its intention to reexamine this issue. Any modification of the 6M would necessarily be a very time dependent program because NRC was trying to respond to the requirements of the Scheuer amendment as quickly as possible. Bonzon's work demonstrated that the impact failure threshold for 6M packagings was on the order of 100 m/s (331 fps) onto an unyielding target with traces of contents loss at impact velocities as low as 75 m/s (245 fps). These technical observations contributed to the eventual decision to abandon any attempt to modify an existing packaging design.

In his remarks to the House, Mr. Scheuer contended that the regulatory test of a 30 foot drop was in no way an adequate test to simulate the severity of an aircraft

crash. This view is perhaps understandable if one compares only the impact velocity of the regulatory tests with velocities that can be attained in actual accidents and impact target hardness is not included. The arguments presented in the House of Representatives did not contain much of the data that could be obtained from technical experts in the public comment phase of a regulatory rulemaking procedure.

Passage of the Scheuer amendment occurred on Aug. 9, 1975. As mentioned above, it was decided that it was not effective to develop a modification to an existing package. This led to the full-scale effort to develop a packaging to survive an aircraft crash. All efforts by the NRC were focused on the development of test criteria representative of a severe aircraft accident and development of a package which could survive this accident qualification criteria. Sandia Laboratories acted as NRC's development contractor for this package. During development of the package Sandia used the nomenclature PARC (Plutonium Accident Resistant Container) but the package ultimately became known as PAT-1, the acronym PAT standing for plutonium, air transportable. The official starting date for the development of PAT-1 is listed in correspondence between Sandia and the NRC as mid-May 1976.

The NRC was operating in an area without precedent with respect to certifying that it had indeed developed a package which could withstand an environment equivalent to the crash and explosion of a high flying aircraft. The NRC requested that the National Research Council of the National Academy of Sciences and the National Academy of Engineering conduct an independent assessment of the NRC program to develop such a package. A ten member committee (the Ad Hoc Committee on the Transportation of Plutonium by Air) was formed and met for the first time in Washington, DC in March 1977. The committee took no position on the question of whether plutonium should or should not be transported by air. The committee's work paralleled the work of the NRC and consisted of essentially two phases: (1) an evaluation of the proposed NRC qualification criteria; and (2) an evaluation of the results of tests of a package designed and constructed to qualify under the criteria. The committee met five times, two of which were at Sandia and three meetings were in Washington, DC. The results and recommendations of the committee were given in its final report, Review of Criteria for Packaging Plutonium for Transport by Air (National Academy of Science). The development of the criteria and the PAT-1 were essentially in parallel with some lead time required in the definition of the qualification criteria so that the package could be sized and test facilities readied for the certification tests. The NRC package certification criteria was very severe (NRC 1978). The severity of the qualification criteria was based on analyses of accidents and accident data and incorporated many of the features of traditional packaging certification tests but to greater severity levels. That is, the accident testing sequence included impacts onto an unyielding target, puncture and fire testing, and the addition of a crush test and a more severe immersion test. As severe as the proposed NRC criteria was, it was the judgement of the Ad Hoc committee that the sequential tests did not impose on the candidate packaging design the ripping and tearing damage that they believed was often observed at aircraft accident crash sites. For this reason, the Ad Hoc committee recommended that a ripping/tearing test be added

to the sequence of tests. The ripping/tearing test consisted of a 100 lb. structural steel angle being dropped onto the package from an elevation of 100 feet.

The development of PAT-1 proceeded at a vigorous pace and culminated with the publication of the qualification criteria (NRC 1978) in January 1978. The development report for PARC (Andersen 1978) was published in July 1978. The Certificate of Compliance for PAT-1 was issued on September 30, 1978.

PAT-1 is a circular cylinder in its basic design with a 24.5 inch outside diameter and a height of 42.5 in. PAT-1 has a weight of 500 lbs. The weight of PAT-1 makes it somewhat difficult to handle by an individual. This feature of the PAT-1 ultimately led to the development of a smaller, light-weight packaging for the air transport of small samples of plutonium in support of non-proliferation treaty verification. This new packaging is the PAT-2 and weighs 70 to 74 lbs (Andersen 1981). PAT-2 was also certified to the qualification criteria of NUREG-0360, (NRC 1978).

THE PRESENT SITUATION

The existence of special rules for the air transport of plutonium in the U.S. packaging regulations represents a significant departure from earlier and existing rules of the IAEA in Safety Series 6. In 1987, Switzerland and the United Kingdom introduced the idea that the requirements of NUREG-0360 should be incorporated into IAEA Safety Series 6 and discussion of this possibility is in its early phases. This would be a significant departure from the perceived historical pattern of having transport mode independence in the IAEA regulations for all radionuclides.

It is interesting to contrast how the U.S. requirements for a plutonium packaging were incorporated into the U.S. regulations compared to the "normal process" for making changes to the regulations. The NUREG-0360 qualification requirements are certainly stringent. The concerns of the U.S. Congress were such in 1975 that the initiative to "do something" about the possibility of an aircraft crash in a densely populated area was taken from the NRC and its normal rulemaking procedures and transformed into a legislative action with the passing of Public Law 94-79 in August 1975. Normally the NRC rulemaking process includes the possibility of broad technical and institutional discussions of pertinent safety issues which come from the public inquiry component of the rulemaking protocol. The 1975 Sandia tests conducted on existing packagings to the FAA flight recorder standards provided evidence that small radioactive packagings were able to sustain and survive severe aircraft accidents. NRC complied with the provisions of the Scheuer amendment since it was attached to NRC's funding authorization for Fiscal 1976. As mentioned above, similar restrictions on ERDA were attached to ERDA's funding bill. It is important to point out that it was the legislative action of the Scheuer amendment, rather than any significant development of safety information in the normal regulatory process, which served as the causal event in the development of U.S. regulations for the air transport of plutonium.

In December 1987, Sen. Murkowski of Alaska introduced an amendment to H.R. 2700 which requires that the U.S. NRC conduct actual crash tests of packages

before they are certified as being safe for the air transport of plutonium (Congressional Record, Dec.21. 1987). The tests consist of (1) an actual drop test from maximum cruising altitude of a full-scale container loaded with test materials and (2) an actual crash test of a cargo aircraft loaded with full-scale samples of the container loaded with test materials. Test (2) is not required if an independent assessment reveals that stresses on the container produced by other tests used in developing the container exceed the stresses which would occur during a worst case plutonium air transport accident.

In summary, the following aspects of special packaging of plutonium for air transport should be recognized.

1. The accident cases cited by Congressman Scheuer were incidents of local plutonium contamination in military aircraft accidents that had nuclear weapons on board. There is no disputing the occurrence of these military accidents but military weapon shipments were exempted from the provisions of the Scheuer amendment (Congressional Record, June 20, 1975). There have been no recorded civilian aircraft crashes involving plutonium dispersal although there have been civilian aircraft crashes that were severe. Shortly after the introduction of the amendment by Mr. Scheuer on June 20, 1975, there was a serious aircraft crash at JFK International. In his remarks to the House on July 24, 1975 Mr. Scheuer called attention to this event.

2. The NRC originally opposed the provisions of the Scheuer amendment but with the passing of the amendment NRC complied with its provisions. This led to the development of the plutonium air transport package PAT-1 in the U.S..

3. The introduction of special rules for the air transport of plutonium into the U.S. packaging regulations has made them more severe than the provisions of the international regulations, IAEA Safety Series 6. The IAEA is now discussing proposed regulations related to the air transport of plutonium.

4. An additional legislative action was introduced the U.S. in December 1987 which would require actual crash tests of packages intended for the air transport of plutonium, the Murkowski amendment.

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