AIR TRANSPORTATION OF RADIOACTIVE MATERIALS AND PASSENGER PROTECTION UNDER INTERNATIONAL LAW

On April 5th, 1974, Delta Airlines Flight 311 from Washington, D.C., to Baton Rouge, Louisiana, contained an improperly packaged and labeled shipment of radioactive Iridium 92 which leaked in flight. The leakage was not discovered until two days later by monitoring equipment at the receiver's warehouse. A cargo handler at the Baton Rouge Airport received a heavy dose of radiation, and the 157 passengers and seven crew members received substantial contamination.[1] This incident illustrates the fact that if one is contemplating air travel in the immediate future, it would be wise to consider the possibility that one might be exposed to potentially harmful radiation while aboard the plane. Such radiation could seriously affect not only one's health and life expectancy, but that of one's descendants as well.

From its infancy in the days after the Second World War, the global market for atomic energy technology has grown at a steady rate. The development of a myriad of new products and techniques has created demands where none previously existed.[2] This burgeoning industry now has worldwide suppliers as well as customers.[3] As a result, there has been an increase in the international transportation of some of the more hazardous materials used in the atomic energy related industries. Because no exact data are available on the volume of international shipments,[4] this

1. *See Hearings Before Subcomm. of House Comm. on Interstate and Foreign Commerce on Aircraft Radiation Incident, April 1974,* and *Aircraft Contamination Incident, December 1971-January 1972*; 93rd Cong., 2d Sess., (1974) [hereinafter cited as AIRCRAFT RADIATION HEARINGS].

2. One area which has attracted companies in Europe and the United States is the nuclear powered pacemaker for heart patients. Although some forty test implants have been made in Europe, the United States is just getting into this area. Moline Herald, September 8, 1972, § 1, at 3, col. 1.

3. International dealers in radioactive pharmaceuticals include: Curtis Nuclear Corp., Los Angeles, California; Amersham/Searle, the Netherlands; Pharmacia Laboratories, Upsalon, Sweden; and McGraw Laboratories, Australia. AEC, THE NUCLEAR INDUSTRY 1974, at 76 (1974).

4. Exhaustive research by the author has failed to reveal any national or international source of data on the volume of international shipments of radioactive materials.

comment will rely primarily on a detailed analysis of the United States experience in this area as illustrative of the problems to be faced on a multinational scale.

In the United States last year, there were an estimated one million shipments of radioactive materials by all types of carriers. Approximately seventy-five to ninety percent of these were radioactive pharmaceuticals,[5] the majority of which were shipped by air aboard passenger carrying aircraft.[6] The heavy dependence on air shipment of the radiopharmaceutical industry both here and abroad is dictated by the rapid deterioration rate (the short half-life) of the substances shipped primarily for use in hospitals.[7] More then 2,500 hospitals in this country have nuclear medicine departments, and more than 5,000 American doctors and medical laboratories are using radioisotopes in diagnosis and treatment.[8] The remaining ten to twenty-five percent of air shipments, the non-radiopharmaceuticals, include special nuclear materials,[9] and the whole range of radioactive substances currently in use in American industry.[10] By their very nature, these latter substances have relatively longer half-lives and are capable of being forwarded via surface transportation without substantial loss through deterioration.

The total number of domestic shipments of radioactive materials is projected to surpass one million in 1975 and to continue to show an increase every year thereafter. Passenger aircraft will probably remain the predominant mode of transportation.[11] Thus, one's chances of flying with radioactive cargo are presently rated

5. Radioactive pharmaceuticals, also referred to as "radiopharmaceuticals", are radioactive substances used in the diagnosis and treatment of certain diseases. *See generally* 49 C.F.R. § 173.390 (1968).

6. NATIONAL TRANSPORTATION SAFETY BOARD, SPECIAL STUDY OF THE CARRIAGE OF RADIOACTIVE MATERIALS BY AIR, at 4, (1972). [hereinafter cited as NTSB REPORT].

7. According to the Society For Nuclear Medicine, approximately one patient out of every four admitted to hospitals today is directly benefitted from the use of medical isotopes, particularly the short lived Technitium 99M, which has a six hour half-life. SPECIAL PANEL TO STUDY TRANSPORTATION OF NUCLEAR MATERIALS, JOINT COMMITTEE ON ATOMIC ENERGY, TRANSPORTATION OF RADIOACTIVE MATERIAL BY PASSENGER AIRCRAFT, 93rd Cong., 2d Sess., (1974). [hereinafter cited as NUCLEAR MATERIALS REPORT].

8. *Id.*

9. *See generally* 49 C.F.R. § 173.490 (1973).

10. *See generally* 10 C.F.R. § 71.64, app. C (1968).

11. NUCLEAR MATERIALS REPORT, *supra* note 7, at 2.

at one in ten by the Airline Pilots Association.[12] However accurate this estimate, the steady increase in air carriage of radioactive materials both here and abroad can only increase your chances of flying with such substances in the future.

In light of the dearth of information available on international transportation of these materials, an evaluation of the efficiency of international regulation is best obtained through an examination of the existing regulatory scheme and its performance record in the United States. This comment will discuss current international and domestic regulations, and then proceed to analyze these regulations as they function on a domestic basis, as well as the impact of that performance on international regulation. It will conclude with a proposal for needed changes in existing law.

I. INTERNATIONAL REGULATION

Radioactive materials are defined as those which spontaneously emit ionizing radiation.[13] The main component of this radiation, gamma rays, is capable of penetrating any substance except thick lead.[14] Gamma radiation is imperceptible to the human senses; hence, a person could receive an excessive dose of which he is not aware.[15] Such a dose, unnoticed and thus untreated, might result in injury both to an individual and to his descendants by inducing a wide variety of harmful effects.[16]

12. Butler, *Coffee, Tea or Nitric Acid?*, San Francisco Guardian, August 30, 1974, at 7, col. 1.

13. Nuclear radiation may be considered as the emission of either particulate matter (alpha or beta radiation) from the nucleus of the atom, or of high energy electromagnetic radiation called gamma rays. Gamma radiation is identical in characteristics to the more familiar x-rays. Radiation affects a person by ionizing the atoms of the body. It is the phenomenon of ionization or the orbital displacement of one or more electrons around the atoms nucleus which distinguishes gamma radiation from other radiation such as light rays. NTSB REPORT, *supra* note 6, at 1.

14. DEPARTMENT OF TRANSPORTATION, A REVIEW OF THE DEPARTMENT OF TRANSPORTATION REGULATIONS FOR TRANSPORTATION OF RADIOACTIVE MATERIALS, December 1972, at 35 [hereinafter cited as TRANSPORTATION REGULATIONS REVIEW].

15. NTSB REPORT, *supra* note 6, at 6. The NTSB in this report indicates that the public as a whole is permitted an average yearly exposure of 0.17 Rems (170 millirem, or m/rem) per person. One rem is the measure of the effect of radiation from all sources on the human body. Because of the relatively small numbers involved, these units are frequently expressed as millirem (one millirem equals one thousandth of a rem). Thus, an "excessive" dose would be any exposure which, if repeated, (as in frequent flights by an individual where exposure results) would surpass the maximum permissible yearly dose.

16. Late somatic injuries include leukemia and other malignant diseases, impaired fertility, cataracts, and shortening of life. Genetic injuries

In order to continue to meet the world's need for radioisotopic products while protecting airline passengers and crews, two international organizations have promulgated regulations for the safe transport of these materials.[17] The most significant agency with responsibility for the issuance of worldwide regulations is the International Atomic Energy Agency (IAEA). The statute of the IAEA was approved on October 23, 1956 by the Conference on the Statute of the International Atomic Energy Agency at United Nations headquarters in New York.[18] The United States Senate ratified the statute on June 18, 1957. There are, at present, 102 member states in the organization.

The agency's regulations for the transport of radioactive materials were first published in 1961. Subsequent revisions have related mainly to the packaging and transport of highly radioactive sources.[19] By 1969, the Agency's regulations had not only been adopted by almost every international organization involved with air transport, but many of the member states had incorporated these regulations in their municipal law as well.

To be accepted for air transport, radioactive materials must be delivered to the shipper in IAEA approved shipping containers specially designed to prevent leakage.[20] Because it is thought impossible to totally shield radiation emission from shipping packages without using lead shielding too bulky for use in aircraft, efforts have been made to limit radiation emission to within limits thought safe for passenger exposure during flight. Transport index (TI) is the unit of measure used in connection therewith. TI is the expression used for the radiation level in millirem per hour

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manifest themselves in the offspring of irradiated individuals and may not be apparent for many generations. Their detrimental effect may spread throughout a population by mating of exposed individuals with other members of the population.

Keyes & Howarth, *Approaches to Liability for Remote Causes: The Low Level Radiation Example*, 56 IOWA L. REV. 531, 539 n.18.

17. *See* REGULATIONS RELATING TO THE CARRIAGE OF RESTRICTED ARTICLES BY AIR, INTERNATIONAL AIR TRANSPORT ASSOCIATION (Montreal 1970); REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIALS (rev. ed. 1973). This comment will focus primarily on the regulations of the IAEA because that organization has a larger and more representative membership and its standards bind the governments of its member states where I.A.T.A. only directs corporate air carriers.

18. Statute of the International Atomic Energy Agency, [1957] 2 U.S.T. 1095, T.I.A.S. No. 3873 (1956).

19. INTERNATIONAL ATOMIC ENERGY AGENCY, REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIALS (rev. ed. 1973).

20. *Id.* §§ 201-08.

at one meter from the external surface of the package involved.[21] Further, minimum separation distances in feet from package surfaces to personnel and photographic film are specified.[22] Measurement of radiation emission is made at a distance of three feet, which is significant because passengers' feet and legs are frequently that close to packages stored in the cargo hold immediately below the passenger deck.

In order to insure international uniformity, the IAEA requires that, to the greatest extent possible, member states keep their domestic regulations in conformity with the agency's recommended standards.[23] To this end, the agency recognizes in each state a "national competent authority" which represents that country to the agency.[24] The regulations of the United States "national competent authority," the Department of Transportation, are, with minor variations, almost exactly the same as the IAEA standards.[25]

In light of the predominance of the United States in nuclear medicine research and development, and reactor technology, the experience accumulated by this country in regulating the air transportation of radioactive materials is vital to the world community. It is not illogical to assume that, when other IAEA member states achieve a level of technology and volume of traffic equivalent to present levels in the United States, they will face problems parallel to those being faced by the United States today. In order for them to better understand how to deal with such problems when they arise, an analysis of the present American domestic regulatory scheme may be helpful.

II. DOMESTIC REGULATION

Responsibility for radioactive materials transportation regulation in the United States is divided between the Atomic Energy Commission (AEC) and the Department of Transportation

21. 10 TI equals 200 millirem per hour at the surface of the package or 10 millirem per hour at one meter. *Id.* § 137.

22. *Id.* § 520.

23. INTERNATIONAL ATOMIC ENERGY AGENCY, ADVISORY MATERIAL FOR THE APPLICATION OF THE IAEA TRANSPORT REGULATIONS, § 115 (1973).

24. INTERNATIONAL ATOMIC ENERGY AGENCY, REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIALS § 112 (rev. ed. 1973).

25. "The DOT regulations were almost completely revised as of January 1, 1969 to achieve a substantial conformity with the IAEA standards". TRANSPORTATION REGULATIONS REVIEW, *supra* note 14, at 7.

(DOT).[26] To avoid unnecessary overlapping of function and authority, these two agencies issued a Joint Memorandum of Understanding in 1973.[27] Pursuant to this agreement, the DOT is charged with the development of standards for the packaging, classification and shipment of small quantities of radioactive materials per shipment, while the AEC bears this responsibility for large amounts per shipment as well as those containing fissile class materials.[28] The DOT requires notification of incidents involving radioactive packages in transit, including suspected leakage and other accidents which occur. Conversely, the AEC requires notification of accidents only if they occur either before or after transit.[29] While the AEC takes the lead in accident investigation involving radioactive materials, the DOT is the "national competent authority" with respect to the requirements of the IAEA.[30] Finally, each of the two agencies is required by the Memorandum to exchange information with the other prior to the issuance of new regulations for those engaged in the manufacture, sale, and transportation of radioactive materials.[31]

Unfortunately, this division of authority has not worked as planned, and the two agencies are working at cross purposes without the communication which the Memorandum requires. The situation is succinctly characterized by the Director of the Kansas State Radiation Control Program:

> There is apparently not only a lack of good working relationships among the various Federal agencies but an out and out avoidance of contacting each other on matters of mutual

26. Late in the course of the preparation of this article the Atomic Energy Commission was dissolved and its functions transferred to the Nuclear Regulatory Commission. However, since the regulatory history detailed herein remains largely the same, references to specific reform proposals will remain in the name of the agency which proposed them.

27. MEMORANDUM OF UNDERSTANDING BETWEEN THE U.S. DEPARTMENT OF TRANSPORTATION AND THE U.S. ATOMIC ENERGY COMMISSION FOR REGULATION OF SAFETY IN THE TRANSPORTATION OF RADIOACTIVE MATERIALS IN THE JURISDICTION OF THE DEPARTMENT OF TRANSPORTATION AND ATOMIC ENERGY COMMISSION, May 22, 1973. [hereinafter cited as MEMORANDUM OF UNDERSTANDING] [copy on file at CALIF. W. INT'L L.J.].

28. *Id.* at 2. "Fissile materials" are Plutonium 238, 239, and 241, Uranium 233, 235, or any material containing any of the foregoing. *See generally* 49 C.F.R. § 173.389(a), 173.396(a) (1973).

29. MEMORANDUM OF UNDERSTANDING, *supra* note 27, at 5.

30. INTERNATIONAL ATOMIC ENERGY AGENCY, REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIALS, § 112 (rev. ed. 1973).

31. MEMORANDUM OF UNDERSTANDING, *supra* note 27, at 6.

interest. Each seems to be jealously guarding its own fragmented radiation control program.[32]

In recent years, the increasing number of reported accidents demonstrates that shippers and carriers either do not understand the various regulations, or do not choose to follow them.[33] This tendency has gone unchecked because of a lack of proper investigation and enforcement by both agencies. In his 1973 Report to the Congress, the Comptroller General of the United States characterized the DOT inspection effort as "small and unsystematic".[34] The report on radioactive materials accidents of the National Transportation Safety Board also indicates that the AEC control over packaging for radioactive materials "suggest[s] the possible existence of deficiencies in the performance criteria specified for such packaging."[35]

The Comptroller General's report further pointed out that the discrepancies in the present regulatory scheme were encouraged because the agencies involved hesitated to prosecute violators of the regulations due to the difficulty of processing claims, and the knowledge on the part of inspectors that cases were frequently closed with only minimal penalties.[36] Indeed, violations of the regulations would seem to be wholesale, leading the Senate Commerce Committee, after a thorough analysis, to conclude that "noncompliance is the rule rather than the exception in this dangerous business."[37]

This state of confusion has not gone unnoticed in the aviation industry. In response to the recent increase in incidents involving

32. Report by Comptroller General to the Joint Committee on Atomic Energy, *Opportunity for Improving AEC's Administration of Agreements with States Regulating Users of Radioactive Materials*, 15 ATOM. EN. L.J. 63, 123 (1973).

33. The Secretary of Transportation indicated that in 1973 there were 6,014 "incidents" of unintentional release of hazardous substances in the course of transportation. While only a portion of these accidents involved radioactive materials, exact data are difficult to gather. As William Burns, Director of the Office of Hazardous Materials testified before the Senate Commerce Committee, there is evidence to suggest that few of the carriers actually report the hazardous materials incidents they are supposed to report. SENATE COMMERCE COMMITTEE, REPORT ON S. 4057, S. REP. NO. 93-1192, 93rd Cong., 2d Sess., at 8 (Sept. 30, 1974) [hereinafter cited as REPORT ON S. 4057].

34. COMPTROLLER GENERAL OF THE UNITED STATES, REPORT TO THE CONGRESS ON THE NEED FOR IMPROVED INSPECTION AND ENFORCEMENT IN REGULATING TRANSPORTATION OF HAZARDOUS MATERIALS, S. REP. NO. B-164497, 93rd Cong., 2d Sess., (1973). [hereinafter cited as COMPTROLLER GENERAL'S REPORT].

35. NTSB REPORT, *supra* note 6, at 19.

36. COMPTROLLER GENERAL'S REPORT, *supra* note 34, at 28.

37. REPORT ON S. 4057, *supra* note 33, at 2.

hazardous cargo, concerned employee and citizen action groups, such as the Airline Pilots Association (ALPA) and the Aviation Consumer Action Project, have begun to question the efficacy of the federal regulatory action in this area. Partly as a result of testimony by members of ALPA's subcommittee on hazardous materials before two congressional committees,[38] some reform proposals have appeared. The Federal Aviation Administration (FAA) has proposed that both packages containing radioactive materials and appropriate sections of aircraft used in their transport be scanned with proper monitoring equipment prior to flight.[39] The AEC has responded that "measures other than the monitoring of radiation levels to provide control are necessary,"[40] and urged that radioactive materials with a half-life of greater than thirty days be banned from passenger aircraft.[41]

Despite these and similar attempts at modification of the rules, the situation in the air travel industry remains relatively unchanged. As a result, ALPA has called for an embargo on all hazardous materials shipments in passenger aircraft.[42] This reaction, coupled with the poor U.S. accident rate, indicates that some part of the regulatory scheme is amiss.

A major source of difficulty and controversy in this area centers around use of the TI number. The present DOT regulations governing the TI system's use in aircraft originated in shipping regulations adopted on August 24, 1947, by the Interstate Commerce Commission for use in radiation related industries.[43] Since then, the figures have been lowered significantly, but, although the AEC has proposed a guide of 5 millirem per hour as the low TI limit for civilian employees at nuclear power plants, no such

38. HEARINGS ON TRANSPORTATION OF HAZARDOUS MATERIALS BEFORE SUBCOMM. OF HOUSE GOVERNMENT OPERATIONS COMM., 93rd Cong., 1st Sess., at 55, (1973); NUCLEAR MATERIALS REPORT, note 7, *supra.*

39. Loading and Carrying Dangerous Articles: Inspection Requirements, 39 Fed. Reg. 81 (1974).

40. UNITED STATES ATOMIC ENERGY COMMISSION, RECOMMENDATIONS FOR REVISING REGULATIONS GOVERNING THE TRANSPORTATION OF RADIOACTIVE MATERIAL IN PASSENGER AIRCRAFT, SUBMITTED TO THE FAA BY THE AEC (July 1974). [copy on file at CALIF. W. INT'L L.J.] [hereinafter cited as RECOMMENDATIONS FOR REVISIONS].

41. *Id.* at 9.

42. ALPA called on all member pilots to refuse, as of February 1, 1975, to transport hazardous materials on passenger aircraft, including radioactive materials, except radio pharmaceuticals used in hospitals. L.A. Times, Jan. 31, 1975, § 1, at 5, col. 1.

43. NUCLEAR MATERIALS REPORT, *supra* note 7, at 2.

guide has been formulated for common carrier shipments of radioactive materials.[44] The Joint Committee on Atomic Energy has concluded that the present limits of 200 millirem per hour are too high:

> It was obvious to the panel that with increasing numbers of radioactive materials shipments, 200 millirem per hour at the package surface is too high and should be set at a lower limit to protect the cargo handlers who unload the shipments. Similarly, the panel concluded that 10 TI—10 millirem at 3 feet—is not as low as practible and should be lowered for the better protection of passengers and crew. It was equally obvious that what may be as low as practicable for civilian nuclear plants—5 millirem per year—is not practicable for shipping radioactive material and the same guide limit may not be appropriate in the transportation industry.[45]

However, in February 1972, the FAA issued a more lenient interpretation of the recommended package separation distances.[46] The FAA believes that a large number of packages may be stored in the cargo hold so long as the TI for each group does not exceed 50, and a certain minimum separation distance is maintained between each group. This relaxation of standards is questionable because it virtually trebles the potential exposure rate to passengers.[47] Such exposure may continue for up to eleven hours on transoceanic flights, and it is thought that the risk of developing

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44. *Id.* at 4.

45. *Id.* at 4.

46. Application Of The Radioactive Materials Distance Table in F.A.R. 103.23(a), General Notice 8430 I 95, 38 Fed. Reg. 6690 (1973).

47. It has been said,

> The new FAA interpretation of the table of distances allows much larger radioactive loads per aircraft than were allowed before, and thus has the effect of raising the maximum dose rate to passengers and crew. For example, if in a given aircraft, the distance between the floor of the passenger cabin and the floor of the cargo bin below is 57 inches, then previously only *one* 10-TI package, 21 inches on the side, could be carried. Under such circumstances, the maximum nominal dose rate at seat level, 16 inches above the cabin floor, is 5.5 millirem per hour. However, under the new FAA interpretation, four additional, similar 10-TI packages, adding to a total of 50-TI, can be stowed in the cargo compartment provided that the distance between the package surfaces and the cabin floor is not less than 36 inches. The resulting maximum dose rate obtained with five 10-TI packages can be as high as 18 millirem per hour. In effect then, the FAA interpretation raises the maximum permissible dose rate to passengers and crew by more than a factor of three. Also, under this new proposed FAA rule many passenger carrying aircraft could carry up to five 10-TI packages, whereas none of the aircraft now in service can do this legally. . . .

Klarmann and Luszczynski, *Radioactivity in Aircraft*, ENVIRONMENTS, at 39 (June 1973).

radiation-induced malignancies increases somewhat linearly with the dosage.[48]

The AEC revision[49] would limit per package TI to three, while the recommendation of the Joint Committee on Atomic Energy would lower the limit to one.[50] While these recommendations would appear logical, they would be of no effect if shippers continue to mislabel the TI number on packages as they have in the past.[51]

It is submitted that the unique nature of hazards induced by the accidental release of radiation during air transport demands strict standards of preventive procedure, together with even stricter compliance with, and enforcement of, such procedures. This cannot be effected by two agencies with overlapping jurisdiction, inadequate inter-communication, and questionable inspection and enforcement techniques, as evidenced by the many examples of negligent conduct in connection with the regulation of transportation of radioactive materials. It is obvious that regulatory modifications in connection with the transport of these materials are presently needed.

A. Revision of Domestic Regulation

Thus far, reform in radioactive materials regulation in the U.S. has been sporadic at best. Congressional hearings and accident investigations have been conducted, but little if any action has resulted. Under the direction of Senator Warren Magnuson of Washington, and Congressman Thomas Kuykendall of Tennessee, Congress has enacted the Transportation Safety Act of

48. According to the International Air Transport Association Minimum Distance Separation Tables, a person could receive a maximum dose rate of 14 millirem per hour, or up to 70 millirem on a five hour flight. It is easy to see how the NTSB-recommended national limit for the general public of 170 millirem per year, *supra* note 15, might be surpassed by most travelling businessmen, to say nothing of stewardesses and flight crews, in less than a year. Morgan, *Radiation Aloft*, ENVIRONMENTS, at 29 (Dec. 1972).

49. RECOMMENDATIONS FOR REVISIONS, *supra* note 40, at 7.

50. NUCLEAR MATERIALS REPORT, *supra* note 7, at 9.

51. *See* note 33, *supra*, and accompanying text. The NTSB found that the lack or incorrect designation of TI number to be one of the most frequent examples of shipper error. NTSB REPORT, *supra* note 6, at 21. There was no TI number on the package involved in the Delta Airlines incident last April. AIRCRAFT RADIATION HEARINGS, *supra* note 1. In all fairness to the manufacturers involved in radioactive materials transport, it must be noted that it is more often the maze of confusing and often conflicting sets of rules of the several agencies involved rather than any intent to deceive, that accounts for the incorrect labeling involved.

1974.[52] The provisions of the bill pertinent to the air transport of radioactive materials will: (1) increase the regulatory authority and enforcement powers of the Secretary of Transportation to include jurisdiction over manufacturers of radioactive materials packaging;[53] (2) require the Secretary to designate certain radioactive shipments as "hazardous" or "ultrahazardous", and to register handlers in the latter category every two years;[54] (3) compel the Secretary to ban from passenger flights all but radioactive substances used in diagnosis and treatment of patients;[55] and (4) authorize the Secretary to subject violators of the Act's provisions to civil penalties of up to $10,000, and criminal penalties of up to $25,000 or five years imprisonment.[56]

By this broad mandate, the Transportation Safety Act attempts to centralize federal regulation in the Secretary of Transportation and better ensure its enforcement. The most innovative provision is the penalty clause which introduces stern measures into this field of legislation for the first time. It also goes a step further than any other governmental act by banning all but radiopharmaceuticals from passenger flights, a move the government has heretofore resisted.[57]

However thorough it is, the Act fails to adopt two important procedures which have been advocated by ALPA: active monitoring of all radioactive materials packages, and a certification program for proper training in radioactive materials handling procedures for shippers and carriers.[58] While the former proposal has been agreed to in principle by the DOT through the FAA,[59] neither it nor the latter have been adopted. The chief objection to both is the cost involved in such projects. But an existing system may present a solution to both problems.

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52. 49 U.S.C. § 1801 (1974).

53. *Id.* § 105(a).

54. *Id.* §§ 104, 196.

55. *Id.* § 108.

56. *Id.* § 110.

57. The Civil Aeronautics Board rejected a tariff proposal by Delta Airlines which would have banned from passenger flights all radioactive substances other than those intended for diagnostic or therapeutic purposes. CAB, NON-ACCEPTANCE OF CERTAIN RADIOACTIVE MATERIALS PROPOSED BY DELTA AIRLINES, ORDER OF REJECTION No. 74-9-14 (Sept. 5, 1974).

58. Resolution of the 20th Executive Board Meeting of the Air Line Pilots Association, May 29-30, 1974.

59. Loading and Carrying Dangerous Articles: Inspection Requirements, 39 Fed. Reg. 81 (1974).

B. Feasibility of National Monitoring

A practical and relatively inexpensive monitoring program is feasible by merely designating certain areas at airports in the mainstream of radioactive materials traffic as sites for control centers for such materials. Such a program is currently in operation at the Metropolitan Airport in Minneapolis.[60] The Director of Noise Abatement and Environmental Control at the Minneapolis airport divides the total cost of the monitoring system between local shippers and carriers and receives a standard, per package fee to recover the total cost of the system.[61] The system has successfully withstood an attack based on grounds of Federal preemption of the field of radioactive materials control,[62] but has been criticized elsewhere as a hindrance to interstate commerce, and a function better left to the Federal Government.[63]

As provided in the Transportation Safety Act, the Secretary has the power to effect numerous improvements in this area on a national scale.[64] In addition to these measures, the Secretary should adopt the AEC proposal to lower the per package TI limit from 10 to 3.[65] A national monitoring system at major airports would achieve the dual purpose of assuring conformity with the

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60. In view of the federal unwillingness to provide adequate monitoring of radioactive shipments, the MAC (Metropolitan Airport Commission), primarily through the efforts of St. Paul mayor Lawrence D. Cohen, enacted its own monitoring system to provide a higher degreee of safety to freight workers, flight crews, and the air traveling public.

Letter to the author from Mr. Steven Collins, Administrative Aid, Environmental Affairs, Metropolitan Airport Commission, Oct. 21, 1974 [copy on file at CALIF. W. INT'L L.J.].

61. *Id.*

62. Braniff Airways v. Minneapolis-St. Paul Metropolitan Airport Commission, Civil No. 3-74; (D. Minn., filed July 14, 1974).

63. While the panel considers the action taken by Delta and MAC to be proper and timely, the panel has concern that if each local government or airline were to set up a monitoring system, the multiplicity of rules and regulations and standards, which might eventually develop in different sections of the United States, would cause confusion and unnecessarily hinder the interstate transportation of radioactive material. What is needed is an effective and standardized Federal program of enforceable regulations.

NUCLEAR MATERIALS REPORT, *supra* note 7, at 12.

64. The Act provides:

Within 90 days after the enactment of this section, the Secretary shall issue regulations, in accordance with this section and pursuant to Section 105 of this Act, with respect to the transportation of radioactive materials on any passenger carrying aircraft in air commerce, as defined in Section 101(4) of the Federal Aviation Act of 1958.

TRANSPORTATION SAFETY ACT OF 1974, H.R. DOC. NO. 15223, 93rd Cong., 2d Sess., at 23 (1974).

65. RECOMMENDATIONS FOR REVISIONS, *supra* note 40.

more stringent TI limits and preventing leaking packages from ever reaching aircraft. In addition, the expense of such facilities could easily be user-funded by distributing its costs among the shippers and carriers of radioactive materials. Such centralization of function would also make monitoring by DOT officials much easier.[66]

Despite stringent pre-flight control, it is possible that circumstances encountered in flight might cause packages to begin to leak once on board. In such a case, an on-board monitoring system would be necessary. This could be implemented by the use of personal dosimeters by airline personnel or a network of film badges mounted aboard the aircraft.[67] Upon detection, responsible safety personnel at the point of destination could be alerted, and aircraft, passengers and crew temporarily quarantined until decontaminated.[68]

With the implementation of the Act and these additional measures, the United States would not only eliminate the present confusion and duplication of effort, but would also provide the necessary added protection to human life at little expense to the aviation and nuclear material industries. It is submitted that, to the extent that experience has proven United States standards for the air carriage of radioactive materials to be inefficient and in need of revision, so too are the identical IAEA international regulations. Absent modification of these rules, similar accidents in air transport are bound to happen. A recent radiation related accident in Europe[69] furnished unfortunate proof of this, and, if the American safety record is exemplary, other international incidents will sadly follow. The need for changes in the international regulatory scheme is clearly demonstrated by these experiences. But, with or without such revision, in light of the probability of additional

66. *Id.* § 106(b).

67. Ionization chambers, or dosimeters, are susceptible to certain error in measurement of radiation levels. But, used in conjunction with film badges, the two are a good indication of actual dose received. The use and reliability of film badges and dosimeter records as evidence is well treated in Hutton, *Evidentiary Problems in Proving Radiation Injury*, 46 GEORGETOWN L.J. 52 (1957).

68. This avoids the situation where a contaminated aircraft inadvertently might spread its contaminating radiation to airport equipment and personnel. *See* note 96, *infra*, and accompanying text.

69. The Association Press reported that a capsule containing radioactive material aboard a British aircraft burst on landing at Dusseldorf, Germany, and that the plane required "emergency decontamination". San Diego Evening Tribune, Oct. 22, 1974, at 5, col. 1.

mishaps, an examination of the legal consequences involved in such an accident is necessary.

III. RELIEF FOR HARMFUL EXPOSURE TO RADIATION

Since no exact data are available regarding the volume of international shipments of radioactive materials, it is difficult to estimate the number of shippers, carriers, and passengers involved.[70] However, as the level of sophistication of nuclear industrial technology rises throughout the world, an increase in international air traffic in radioactive materials comparable to that currently being experienced in the United States can be expected. Regardless of the total volume of this traffic, even a single incident of radiation leakage resulting in passenger exposure could generate suits for damages by the passengers so exposed and, perhaps, by their descendants as well. It will be recalled[71] that many of the harmful (and thus compensable) effects of radiation exposure may not be immediately apparent. The question remains as to whether a person who has been exposed to potentially harmful radiation has a compensable injury. While the answer to this question has varied considerably in the American courts,[72] certain independent factors must be considered where international aviation is concerned.

A. The Warsaw Convention and the Guatemala Protocol

Under the terms of the Warsaw Convention,[73] there are created both a presumption of liability on the part of the carrier for death or bodily injury arising out of international transportation, and a concomitant limitation of liability for such injury to 125,000

70. T.I.A.S. Cumulative Index Volume 4, lists 49 countries with one or more treaties on cooperation for use of atomic energy, in addition to 21 agreements between the U.S. and other countries for application of the IAEA safeguards on transport of materials. Also of note is the U.S. agreement with EURATOM for trade in nuclear materials, [1958] U.S.T. 1116, T.I.A.S. No. 4091 (1958). *See also,* CAMERON, COHEN, ERIKSSON, OLSON, PAYNE, SELIGMAN & VETRER, RADIOACTIVE NUCLIDES AND THEIR APPLICATION AS AN IMPORTANT TOOL FOR THE BENEFIT OF LESS DEVELOPED AREAS (IAEA, Vienna 1973).

71. *See* note 16, *supra*, and accompanying text.

72. *See generally* Hutton, *Evidentiary Problems in Proving Radiation Injury*, 46 GEORGETOWN L.J. 52 (1957); Keyes & Howarth, *Approaches to Liability for Remote Causes: The Low Level Radiation Example*, 56 IOWA L. REV. 531 (1971); Stason, *Tort Liability for Radiation Injuries*, 12 VAND. L. REV. 145 (1959); *See also* 21 A.L.R.3d 1356 (1968).

73. Convention For The Unification of Certain Rules Relating To International Carriage By Air, 49 Stat. 3000. T.S. No. 876 (1929) [hereinafter cited as the WARSAW CONVENTION].

francs, ($8,300) per passenger.[74] The presumption may be rebutted by a showing that the carrier used due care to avoid the damage, or that the damage itself was unavoidable regardless of the precautions taken.[75]

On November 15, 1965, the United States deposited its formal denunciation of the convention with the Polish government.[76] The day before the denunciation was to become effective, the United States formally withdrew it and announced an interim agreement which provided that the majority of airlines would agree to include in their tariffs an agreement by which the carrier would waive its defense of due care under article 20,[77] as well as its limitation on liability under the convention up to $75,000.[78] Together, the agreement and tariffs filed under it constitute the Montreal Agreement.[79] This agreement does not change the Warsaw Convention in form, but imposes a contractual notion of liability on all international commerce involving the United States.[80] Therefore, on flights not originating, crossing over, or ending in the United States, the rule of the Warsaw Convention regarding the defense of due care[81] is still in effect.

Recognition of the ability of the airlines to provide indemnification for injuries caused to passengers led to the drafting of the Guatemala Protocol in 1971.[82] The two main features of the Protocol are the establishment of absolute liability for all carriers in international aviation in any part of the world, thus abolishing the defense of due care under the Warsaw Convention,[83] and the es-

74. 1 L. KRIENDLER, AVIATION ACCIDENT LAW, chs. 11, 12 (1963).

75. "The carrier shall not be liable if he proves that he and his agents have taken all necessary measures to avoid the damage or that it was impossible for him to take such measures". WARSAW CONVENTION, *supra* note 73, art. 20(1).

76. Dept. of State Press Release No. 268, 50 DEPT. STATE BULL. 923, (1965).

77. *See* note 75, *supra.*

78. Liability limitations of Warsaw convention and Hague protocol, order approving agreement, 31 Fed. Reg. 7302 (1966).

79. Montreal Agreement, C.A.B. order No. 18900, 39 Fed. Reg. 7302 (1966).

80. KRIENDLER, *supra* note 74, ch. 12.

81. *See* note 75, *supra.*

82. Protocol to Amend The Convention For The Unification Of Certain Rules Relating To International Carriage By Air, Signed at Warsaw on 12 October 1929, as amended by the Protocol Done at The Hague on 28 September 1955, *open for signature* March 8, 1971, International Civil Aviation Organization Doc. No. 8932, [reproduced in 64 DEPT. STATE BULL. 555, (1971)] [hereinafter cited as the GUATEMALA PROTOCOL].

83. *Id.*, art. IV:

tablishment of a higher limit on liability of $100,000.[84] The Protocol is not yet in effect because it has not been ratified by the requisite number of states.[85]

B. "Injury" Under Warsaw-Guatemala

Quite apart from issues of liability limitations and degree of care owed is the question of bodily injury under the Warsaw Convention.[86] In a number of cases arising from the hijacking and subsequent destruction of a Pan American World Airways Boeing 747 by the Popular Front for the Liberation of Palestine,[87] American courts were faced with the question of whether or not the emotional distress of passengers forced to sit on the plane for two days in searing desert heat, under continual harassment by the hijackers, was compensable "injury" within the meaning of the Warsaw Convention.[88]

Having already decided that a hijacking was an "accident" under the terms of the Warsaw Convention,[89] the courts had to decide whether it was the intent of the framers of the convention

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> The carrier is liable for damage sustained in case of death or personal injury of a passenger upon condition only that the event which caused the death or injury took place on board the aircraft or in the course of any of the operations of embarking or disembarking. However, the carrier is not liable if the death or injury resulted solely from the state of health of the passenger.

84. *Id.*, art. VIII.

85. The terms of the Protocol provide that it shall enter into force on the 19th day after the deposit of the 13th ratification, provided that, of the scheduled passenger-kilometers for that year, the schedules of five of the ratifying states constitute 40% of the total passenger-kilometers for that year. *Id.*, art. 10. Upon ratification, the protocol will become the comprehensive law governing airline liability, fully replacing the Warsaw Convention, Hague Protocol, and the Montreal Agreement. *See* KRIENDLER, *supra* note 74, ch. 12.

> 86. The carrier shall be liable for damage sustained in the event of death or wounding of a passenger or any other *bodily injury* suffered by a passenger, if the accident which caused the damage so sustained took place on board the aircraft or in the course of any of the operations of embarking or disembarking.

WARSAW CONVENTION, *supra* note 82, art. 17 (emphasis added). There is no indication that the "personal injury" provision of Article IV of the Protocol differs in any way from the "bodily injury" language of article 17 of the Warsaw Convention. Hereafter, then, references to "injury" will be to the Warsaw Convention meaning.

87. *See* Herman v. Trans World Airways, 34 N.Y.2d 385, 314 N.E.2d 848, 358 N.Y.S.2d 97 (1974).

88. Kriendler, *An Appraisal From a Plaintiff's Viewpoint of Tort Liability Arising From Aircraft Hijacking*, 1 SYR. J. INT'L L. & COM. 327 (1974).

89. Husserl v. Swiss Air Transp. Co., 351 F. Supp. 702 (S.D.N.Y. 1972), *aff'd* 485 F.2d 1240 (2d Cir. 1973).

to compensate emotional distress as well as actual physical injury. In reversing summary judgment for plaintiffs in the lower court, the appellate division ruled that, although the hijacking was an accident within the convention's meaning, the precise meaning of "bodily injury" (*lesion corporelle*), while never discussed at Montreal,[90] did not include mental injury unless it was a direct result of physical injury. The court went on to state:

> The inclusion of the term "bodily" to modify "injury" cannot be ignored, and in its ordinary usage, the term "bodily" suggests opposition to "mental" . . . . In our view, therefore, the ordinary, natural meaning of "bodily injury" as used in article 17 connotes palpable, conspicuous physical injury, and excludes mental injury with no observable "bodily", as distinguished from "behavorial," manifestations.[91]

Thus a plaintiff exposed to radiation on an international flight could not be compensated for the anguish resulting from the exposure, unless he could link this anguish to discernible physical injury.

C. *The Statute of Limitations*

As has been seen,[92] the physical effects of harmful irradiation may not be readily apparent. The difficulty of proving damages in the hijacking cases (the lack of palpable injuries), would also arise in a suit for wrongful exposure to harmful radiation. In the latter situation, the statute of limitations might run before plaintiff developed detectable, and thus compensable, injuries. As stated by one expert in the field of radiation injury litigation, "the statute of limitations is still a formidable problem . . . insofar as tort actions based on radiation injury are concerned."[93]

In the majority of foreign courts, the time allowed for the running of the statute is more liberal than in this country.[94] None-

90. Lowenfeld, *Hijacking, Warsaw, and the Problem of Psychic Trauma*, 1 SYR. J. INT'L L. & COM. 345, 347 (1974).

91. Herman v. Trans World Airways, 34 N.Y.2d 385, 402, 314 N.E.2d 848, 855, 358 N.Y.S.2d 97, 107 (1974).

92. *See* Keyes & Howarth, *supra* note 15.

93. Hutton, *Statute of Limitations and Radiation Injury*, 23 TENN. L. REV. 278, 286 (1954).

94. As Hutton states:

> It is of interest to note that many foreign countries have enacted statutes of limitation which are considerably more liberal than those generally prevailing in this country. The limitation period for torts in England, New Zealand, and Alberta, for example, is six years. Other countries appear to have shorter periods than six years, but in reality are even

theless, the physical symptoms of radiation-induced injuries often take much longer to appear than the time allowed by even the most liberal of these statutes of limitations.[95]

Therefore, even if a plaintiff filed suit and stopped the running of the statute involved, he would still be faced with the task of proving palpable "bodily injury" where *none then existed.* The combination of these two procedural limitations would deprive a person of relief should his type of radiation injury be one which did not manifest itself for a considerably long time. While there is no case on point involving radiation injury under the Warsaw Convention, there is a suit, arising from the aforementioned Delta Airlines incident awaiting trial in the United States. This case might well provide some guidelines as to liability for radiation injury in international aviation. An examination of the facts involved in the case will be helpful.

D. Aircraft Radiation Incident

As a result of the radiation leakage in the Delta incident in April, 1974, a cargo handler received a heavy dose of radiation.[96]

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more liberal from plaintiff's viewpoint than the British statutes. Illustrative of this is the statute of limitations in Switzerland. In that country tort actions are barred after the expiration of one year which, however, does not begin running until (1) the injured person learns of his damage, and (2) the injured person has learned the identity of the party responsible for his injury. Action is finally barred if suit is not instituted within ten years after the date of the injury even though a plaintiff has not learned of his injury and the person responsible therefore.

Id. at 285-286.

The IAEA has dealt with the question of the statute of limitations before. In dealing with rights to compensation from accidents involving nuclear reactor installations, an agency convention suggested ten years as the maximum time for recovery. However, this convention specifically exempts radiopharmaceuticals and any other finished products from its coverage. INTERNATIONAL CONFERENCE, VIENNA, 29 APRIL-19 MAY 1963, CIVIL LIABILITY FOR NUCLEAR DAMAGE, art. 1 (1963).

95. According to one scholar:

> The latent period between the initial tissue injury and the manifestation of serious symptoms may be many years. Malignant tumors following radiation therapy have shown a relatively long latent period of twenty years or more. The latent period for cancer of the bone resulting from ingesting luminous paint was more than 15 years in some cases although death occurred in other instances within 3 or 4 years following substantive ingestion of such radioactive materials. Lung cancer in the case of miners of radium-bearing ores has occurred on an average of 17 years after occupational exposure. The latent period of skin cancer may be as long as 50 years; and cases of thyroid cancer are reported as following x-ray treatment in 7 to 10 years.

Hutton, *Evidentiary Problems in Proving Radiation Injury*, 46 GEORGETOWN L.J. 52, 55 (1957).

96. Freight handler Willie Evans received a dose estimated at 350 Rems

While the exposure to passengers was less,[97] it was nonetheless far beyond the recommended annual exposure.[98] Shortly thereafter, three passengers and another cargo handler filed suit[99] against Delta Airlines and the shipper based on negligence and strict liability, of which a key damages element was the mental trauma allegedly resulting from the exposure.[100] The Court denied a motion for a class action suit and, as of this writing, no date had been set for trial.

In order to preserve plaintiff's right to recover for injuries sustained but not yet apparent, the plaintiff asked for the rather novel equitable remedy of:

> [A] medical monitoring system in order to keep track of each member of the class so as to determine whether any health problems develop and . . . to ascertain whether there is any [relation] between such problem[s] and the exposure to radiation.[101]

It is submitted that this type of relief, admittedly without precedent, is appropriate in a radiation injury suit for two reasons. First, it mitigates the potentially harsh effects of the statute of limitations on plaintiffs exposed to radiation but lacking present palpable symptoms; second, it protects the defendant by leaving on the plaintiff the burden of proving that the exposure to radiation was the legal cause of the injury (a burden which has proved difficult to sustain).[102] The granting of such relief to a plaintiff

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from this exposure. It is extimated that such a dose would kill one quarter of those exposed and induce serious injury in 90% of the remaining cases. Since the incident, Evans has had vomiting spells. Lyons & Lyons, *The Hidden Passengers*, WNEW AM/FM News, May 6-12, 1974.

97. Calculations from inspection of the aircraft involved indicate that estimated exposure for the Boeing 727 (Flight 311) to be 7.1 Rems for males and 10.6 Rems for females. AIRCRAFT RADIATION HEARINGS, *supra* note 1, at 20.

98. 170 millirem, or 0.17 Rems. *See* note 15, *supra.*

99. Penna v. Value Engineering & Delta Air Lines, Civil No. 74-407 (D.D.C., filed May 9, 1974).

100. Letter to author from Mr. Phillip Silverman, attorney for plaintiff [copy on file at CALIF. W. INT'L L.J.].

101. *Id.*

102. The confusion over proximate cause should not absolve the plaintiff from the duty to demonstrate that radiation was, in fact, a definite causative factor of his injuries. On the issue of causation, the plaintiff, in general, must bear the burden of proof, he must offer evidence sufficient to support a conclusion that defendant's conduct, more likely than not, was a substantial factor in bringing about the result. A mere possibility of such causation is insufficient. When the evidence offered leaves the matter as one of pure speculation or conjecture or the probabilities are at best an even balance the court should award a directed verdict for the defendant.

seeking compensation for radiation injuries not presently apparent in a case coming under the Warsaw Convention would be especially fitting. This remedy would afford the victim an opportunity for compensation otherwise denied him by combination of the statute of limitations and the wording of the Warsaw Convention.

IV. CONCLUSION

The methods of international regulation of the air transport of radioactive materials are clearly in need of significant revision. The experience of the United States, the largest and most technologically sophisticated of the IAEA member states, clearly demonstrates a need for such revision. Immediate steps should be taken to insure that the dismal safety record of the United States is not repeated on an international scale.

Utilizing his powers under the Transportation Safety Act of 1974, the Secretary of Transportation should move to supplement the Act with a national system of monitoring radioactive materials shipments at major airports. Contemporaneously with the adoption of these measures in our own national law, the United States should call for a convening of the IAEA Panel of Experts and urge that the following measures be adopted by that body: (1) the banning of all radioactive materials, except necessary radiopharmaceuticals, from passenger carrying aircraft; (2) the establishment of radiation detection facilities at those major airports which handle the majority of radioactive materials; (3) the establishment of a mandatory system of film badges and personal dosimeters to be used on aircraft carrying radioactive materials; and (4) the reduction of the TI limit for any one package from 10 to 3.

It is recognized, however, that even in the face of such revisions, accidents will likely continue to occur in international aviation.[103] At present, the combined effect of the various statutes of limitations, and the bodily injury limitation of the Warsaw Convention deprives wrongfully exposed passengers of any remedy should the symptoms of their injury take a long time to appear.

The courts, as well as various modern writers[104] agree that the aim of the Warsaw Convention is to provide uniformity in the

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Keyes & Howarth, *Approaches to Liability for Remote Causes: The Low Level Radiation Example*, 56 IOWA L. REV. 531, 549 (1971).

103. *See* note 69, *supra*.

104. *See, e.g.*, KRIENDLER, *supra* note 88, at 106. *See also Conference Inter-*

rules of liability in international air transportation. This purpose can best be served in the unique situation of time-delayed radiation injury by the application of judicial ingenuity to the solution of the problem. Should another incident occur such as the Delta Airlines case,[105] the remedy sought in that case should be considered by courts in cases arising under the jurisdiction of the Warsaw Convention as a practical remedy where one is not now available. Until such time as this hazard can be better controlled, the purpose of the Warsaw Convention commands this, and injured passengers deserve no less.

Dennis B. Atchley

national De Droit Prive Aerien, Varsovie 17 (1930); Lowenfeld & Mendelsohn, *The United States And the Warsaw Convention*, 80 HARV. L. REV. 497 (1967).

105. Penna v. Value Engineering & Delta Airlines, Civil No. 74-407, (D.D.C., filed May 9, 1974).