SPECIAL STUDY OF THE CARRIAGE OF RADIOACTIVE MATERIALS BY AIR

Adopted: April 26, 1972

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15. Supplementary Notes

16 Abstract

The National Transportation Safety Board initiated this study in order to investigate a radioactive contamination incident involving a U.S. air carrier and to investigate all aspects of the air shipment of radioactive materials. The Safety Board's study led it to the conclusion that, at the present time, the radioactive materials carried by air do not normally constitute any unusual risk of life to the public. Nevertheless, as the government relinquishes more of its activities to private industry and as the nuclear industry continues its phenomenal growth, the proliferation of the system presents new demands for vigilance if the current minimal risk to the public is not to rise. Accordingly, the Board's primary concern is not the risks engendered by present operations, but rather, it is the risk potential created by the rapid expansion of the nuclear industry.

The Board's study did reveal numerous deficiencies in the operation of the system, as well as in the pertinent regulations. Consequently, the Board has made a number of recommendations for improvement in the general areas of regulations and enforcement, handling, packaging and labeling, and investigating.

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INTRODUCTION

This study was initiated by the National Transportation Safety Board in order to:

• Determine all the facts surrounding a radioactive contamination incident involving a U. S. air carrier;

• Investigate all aspects of the air shipment of radioactive materials.

In addition to presenting the significant findings of the incident investigation (Appendix A), this report is intended to provide an overview of the general problems associated with the air transportation of radioactive materials. The scope of the investigation was limited to discussions with, or spot checks of various segments of the industry, and to a review of the findings of others who have undertaken studies of the system.

Nevertheless, it is the Board's intention that this study will provide sufficient background knowledge of the subject, and a perspective from which to view it, to enable the reader to assess the nature of the problem confronting the shippers and air carriers of radioactive materials, and to evaluate the changes proposed herein to increase the safety of this operation.

As has been noted, this study was confined primarily to the air aspects of transportation. Any effects created by the interaction with surface transportation before and after each air shipment were considered generally beyond the scope of the study.

NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20591 SPECIAL STUDY

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SPECIAL STUDY OF THE CARRIAGE OF RADIOACTIVE MATERIALS BY AIR

I. SYNOPSIS

The National Transportation Safety Board initiated this study in order to investigate a radioactive contamination incident involving a U. S. air carrier and to investigate all aspects of the air transportation of radioactive materials. The Safety Board concludes that, at this time, the radioactive materials carried by air do not normally constitute unusual risk of injury to the public. Nevertheless, as the government relinquishes more of its activities to private industry and as the nuclear industry continues its rapid growth, increased vigilance will be necessary if the current minimal risk to the public is not to rise. Accordingly, the Board's primary concern is not the risks engendered by current operations, but rather, it is the risk potential created by the rapid expansion of the nuclear industry.

This study reveals numerous deficiencies in the operation of the system, as well as in the pertinent regulations. Consequently, the Board recommends improvements in the general areas of regulations and enforcement, handling, packaging and labeling.

II. BACKGROUND AND DISCUSSION

A. Background Data

1. Radiation

In order to discuss the effects of radiation, it is first necessary to review briefly the nature of radiation. Nuclear radiation may be considered as the emission of either particulate matter (alpha or beta radiation) from the nucleus of an atom, or of high energy electromagnetic radiations called gamma rays. Gamma radiation is

identical in characteristics to the more familiar X-rays. Radiation affects us by ionizing the atoms of which our body is composed. It is the phenomenon of ionization, or orbital displacement of one or more electrons around an atom nucleus, which distinguishes gamma radiation from other radiation such as light rays.

However, in contrast to light rays, the presence of gamma, and other radiation, is not readily perceptible to the human senses. Thus, an individual may be receiving radiation exposure at an excessive rate and be totally unaware of the fact.

The amount of radiation received by the body is basically a function of three factors:

- (a) Intensity or the strength of the radiation at the surface of the body.
- (b) Duration or the length of time an exposure exists.
- (c) Frequency or how often the body exposures occur.

A reduction of any of these factors will reduce the total body exposure. For example, shielding or distance separation reduces the intensity of the exposure. Shielding takes place because radiation is absorbed by matter. The amount of absorption is a function of the density of the matter, making materials such as lead ideal as a shield. The dose received also decreases rapidly as the distance from the source is increased. Various means may be employed to reduce duration of exposure. For example, the use of faster (more sensitive) X-ray film can reduce the exposure time required for radiography. Employee rotation can be used to reduce the frequency of individual exposures.

The effect on the body of the various types of radiation varies with the material from which the radiation is emitted as well as with the specific type of radiation. The radiation composed of alpha or beta particles is relatively easy to protect against. Alpha particles have very little penetrating power - a sheet of paper will absorb most of them, and they travel very short distances in air. This radiation is, therefore, nearly harmless until the material is ingested. Beta particles are more penetrating and they travel farther in air than alpha particles, making these particles more hazardous outside the body. However, they are still relatively easily shielded. Gamma rays can be very penetrating, and they travel great distances in air. For example, even 5 inches of lead will not absorb all the gamma radiation emitted from certain isotopes.

Several units of measurement are commonly used in connection with radiation. The quantity of radioactivity - or the decay rate - taking place in a material is expressed in curies (Ci). Terms used to describe energy actually absorbed by matter per unit of time - the dose rate - include the Roentgen (R), the rem and the rad. The Roentgen is the measurement of the amount of radiation energy absorbed per mass of air, or a measurement of the radiation environment. This is the unit in which instruments used to measure the strength of X - or gamma radiation are calibrated. The rad is a unit which expresses the amount of radiation energy absorbed per unit of matter, i.e., 1 rad equals 100 ergs/gram. This unit applies to any kind of ionizing radiation energy and to any kind of matter. The rem is the measure of the effect of radiation, from all sources, on the human body. For gamma radiation, 1 R equals 1 rem. Because of the relatively small numbers involved, these units of measurement are frequently expressed as millirem (1 mrem equals 1/1000 rem).

2. Hazards Associated with Radiation

Radiation is a natural process which has always existed. However, it is only in the last 70

to 80 years that man has been aware of the presence of radiation, and only since World War II that the public has been somewhat acquainted with the topic. It is, perhaps, a reaction to the wartime use of nuclear energy which has caused a general public apprehension concerning the effects of radiation.

This does not imply that radiation presents no problem to the public. All radiation can prove damaging to the body if received in sufficient quantity. However, within certain limits, the body can repair this damage with no noticeable effects. It is the intent of all radiation protection criteria to maintain radiation dosages within these limitations.

The effects of radiation may be classified either as somatic - the effect (long-term or short-term) on the individual himself - or as genetic - the effect on future generations. Radiation criteria for individual members of society are generally based upon somatic effects, whereas those related to the general public are governed by possible genetic effects. Certain of the radiation criteria are empirical since adequate scientific data are not always available, especially at the lower limits of the exposure range. Therefore, it has become an accepted fact that radiation protection criteria depend not only upon purely biomedical and physical considerations, but also upon value judgments based upon the concept that there may be some degree of risk at any level of exposure. Thus, the possible hazards associated with the exposure either of individuals or our entire population to varying amounts of radiation must be weighed against the benefits that society accrues from the use of nuclear energy.

Much of this assessment is accomplished by the National Council on Radiation Protection and Measurements (NCRP). The Board noted in its review of this matter that the NCRP recommendations, which are frequently adopted by governmental agencies as regulatory standards, are considered to be on the conservative side. These limits are constantly subjected to review in the light of our increased knowledge of the effects of radiation exposure on man. This knowledge is being rapidly expanded as more and more radiation workers are completing full working careers in that field.

The radiation limits to which persons may be exposed vary from one individual to another. It is generally accepted that a short-time dose of 450R will prove fatal to 50 percent of the persons so exposed. Personnel involved in emergency life-saving operations are permitted a short-time exposure of 100 rem once in their lifetime. The minimum exposure threshold which produces noticeable effects on the body is about 25 rem, and that value is accepted as the maximum permissible limit for a "less urgent" emergency condition. The lower threshold below which no genetic effects will be produced is not known; its existence is even denied by some.

The allowable exposure for individuals under normal conditions depends, in part, upon the amount of the body or specific organs which are exposed, the age, and even upon the occupation of the individual. For example, occupational workers are permitted whole body doses of 5.0 rems per year for their entire working careers; individual members of the general public are permitted yearly doses of 0.50 rems; and the public as a whole is permitted an average yearly dose of only 0.17 rems (170 mrem) per person. That limit is in addition to the exposure from natural sources and from medical exposures. Sources of natural radiation include cosmic radiation, gamma radiation from materials normally present in the ground, and radionuclides in our food, water and air. Natural radiation exposures vary throughout the U.S. from about 100 to 400 mrem, with an average annual value of 125 mrem. Radiation used in medical practice contributes another 65 mrem to that received from natural sources. Thus, these two sources contribute close to 200 mrem to the public, or just slightly more than the 170 mrem allowed from all other sources.

In order to relate these regulatory exposure limits to real-life conditions, the dose which an individual could receive from exposure to a sealed package containing radioactive materials, is of interest. Radiation emitted from a package is expressed in terms of its Transport Index (TI). The TI is a unit expressing the highest radiation dose rate in mrem per hour 3 feet from the external surface of any package. The maximum TI permitted by regulation for a single package is 10 - the dose rate 3 feet from such a package is therefore 10 mrem per hour. Thus, if a person could be oriented with his entire body 3 feet from the surface of this package, he would receive, in 17 hours, the maximum dose permitted the general public. To receive the yearly dose permitted individual members of the public would require 50 hours exposure time, and to receive a dose equal to that permitted an occupational worker would require an exposure of 500 hours (excluding half-life considerations which, in case of some isotopes, would prohibit the accumulation of such dosage).

The variation in exposure limits is justified partially upon the acceptance of some small degree of risk by the relatively few occupational workers, and these workers are made aware of this risk. Conversely, the general public may be unaware that it is subjected to such exposures; it may be unaware of the possible risk associated with such exposure levels; and, furthermore, it may be unwilling to accept such risk.

To place the matter of radiation hazards in further perspective, it might be noted that in its first 21 years of operation, the Atomic Energy Commission (AEC) (and its predecessor, the Manhattan Engineer District) attained an accident rate below that of the overall industrial experience. During this time, the AEC had 243 fatal accidents, only three of which were attributed to radiation exposure. By the way of comparison, approximately one-third of the 243 accidents were attributed, in one way or another, to the effects of gravity (e.g. falls, etc.).

It is also noteworthy that the transportation industry has recorded no known injuries or significant radiation overexposures to transportation workers or to the public. This record does not, of course, reflect any possible long-term effects such as shortened life span or increased incidence of cancer.

√ 3. Amount of Air Shipment

In order to assess the magnitude of the problems associated with the air transportation of radioactive materials, the Board attempted to determine the types of materials shipped and the annual number of these shipments.

Radioisotopes comprise most of the air shipments of radioactive materials. Many isotopes must, of necessity, be transported by air because their rapid rate of decay, expressed in terms of "half-life," makes their useful life relatively short. This is especially true of the radiopharmaceuticals - the isotopes used for medical purposes. It has been estimated that 8 million individual diagnostic or therapeutic treatments were administered in 1971 to 3- to 4-million patients. Other isotopes are used in industrial applications such as radiography, measuring devices, self-illuminating devices, and isotopic power devices.

Figures for the number of shipments of radioactive materials vary according to the source quoted. However, it is estimated that there are between 500,000 to 800,000 total shipments per year on all modes of transportation. Approximately 80 to 90 percent of these shipments comprise radiopharmaceuticals, and 75 percent of the radiopharmaceuticals are shipped by air, generally in relatively small quantities. Thus, according to these estimates, between 300,000 and 540,000 air shipments are made each year. The majority of these shipments is believed to travel on regularly-scheduled passenger - carrying aircraft.

The Board was unable to determine all of the types of radioactive materials which are shipped

by air, or to determine the total number of shipments of materials other than isotopes. However, special nuclear materials are another class of materials frequently shipped by air because of their monetary value. In fiscal year 1970, 464 air shipments of special nuclear material were made. Many of these consisted of enriched uranium reactor fuel, which is shipped in large quantities in solid form. Although 15 air carriers handled one or more of these shipments, it was noted that three carriers transported nearly 90 percent of the total number.

The nuclear industry is undergoing rapid expansion which is expected to continue. The overall growth rate is currently about 15 percent per annum. The radiopharmaceutical field is expanding approximately 25 percent per year. The organizations shipping significant amounts of radioactive materials by air currently number in the low hundreds. This number is expected to increase considerably during the 1970's.

B. Regulatory Aspects

1. Evolution of Standards

International Atomic Energy Agency (IAEA)

The IAEA was established on October 26, 1956, at United Nations Headquarters in New York. IAEA headquarters are in Vienna, Austria. In 1961, the IAEA published safety regulations which could be applied to the national and international transportation of radioactive materials by all modes of transportation. The regulations have been revised several times. The latest edition is dated 1967, and those regulations are currently under review by the Member States of IAEA for reissuance in updated form in the near future. The IAEA Regulations for the Safe Transport of Radioactive Materials have been accepted and adopted either wholly or in part by most nations of the world. U.S. regulations for the safe transport of radioactive materials are in general conformity with the IAEA Regulations.

✓ 2. Responsible Authorities

a. Department of Transportation (DOT)

The DOT has the regulatory responsibility for the safe transportation in interstate and foreign commerce of all hazardous materials, including radioactive materials, by all modes of transport (air, highway, rail or water), and by all means (truck, bus, auto, airplane, ocean vessel, river barge, rail car, etc.) except postal shipments, which are under the jurisdiction of the U. S. Postal Service. The operating administrations of the DOT, i.e., Federal Aviation Administration (FAA), Federal Highway Administration (FHWA), Federal Railroad Administration (FRA), and the U. S. Coast Guard (USCG), retain direct regulatory authority for each respective mode of transport.

b. Office of Hazardous Materials (OHM)

The operating administrations have few personnel technically qualified in radiation matters. Accordingly, most of the technical staff work is performed by the DOT's OHM, which is in the Office of the Secretary (Assistant Secretary for Safety and Consumer Affairs). The OHM acts as coordinator and technical focal point in all matters concerning the transport of radioactive materials.

The OHM also acts as the U. S. representative to the IAEA and is the U. S. "competent authority" as defined in the regulations of the IAEA. The IAEA defines the "competent authority" of a country as: "...any national or international authority designated or otherwise recognized as such by that country for any purpose in connection with these regulations."

c. Hazardous Materials Regulations Board (HMRB)

In order to assure that the regulations for each mode of transport are consistent, the promulgation of hazardous materials regulations is accomplished through the HMRB. The HMRB consists of representatives of each of the operating administrations of the DOT and the OHM. Signatory authority for amendment of regulations applicable to a given mode rests with that mode's representative on the HMRB.

d. Atomic Energy Commission (AEC)

The AEC, under the Atomic Energy Act of 1954, as amended, has responsibility for safety in the possession and use, including transport, of by product, source and special nuclear materials. Except for certain small quantities and specific products for which the possession and use are exempted, a license is required from the AEC for possession and use of such materials. The AEC has established requirements which must be met for licensees to deliver licensed materials for transport if fissile material or large radioactive sources are involved. The AEC also assists and advises the DOT in establishment of national safety standards and in review and evaluation of packaging designs.

Under Section 274 of the Atomic Energy Act, States may assume, from the AEC, certain regulatory authority over byproduct, source and small quantities of special nuclear materials. This is known as the Agreement State Program. By November 1971, there were 23 states operating under agreements with the AEC. These Agreement States have adopted uniform regulations pertaining to intrastate transportation of radioactive materials which require the shipper to conform to the packaging, labeling and marking requirements of the DOT to the same extent as if intrastate transportation were subject to the rules and regulations of that agency.

3. Other Pertinent Organizations

a. International Air Transport Association (IATA)

IATA is a voluntary association of airline companies whose membership is comprised of 103 scheduled airlines flying the flags of 84 countries. Any company is eligible to join IATA if it operates scheduled air service between two or more countries for the transport of passengers, mail, or cargo under the flag of a state eligible for membership in the International Civil Aviation Organization. IATA has issued its Restricted Articles Regulations which are accepted and utilized by many countries. However, those regulations do not play a direct part in the U.S. domestic regulatory system. The IATA Regulations are similar to the U.S. Regulations, since they are also based on the standards of IAEA.

b. Air Transport Association of America (ATA)

ATA is an association of domestic trunk, local service, international, territorial, intra-Hawaii and intra-Alaska airlines engaged in the transport of persons, goods and mail by aircraft between fixed terminals on regular schedules. The ATA, as the carriers' agent, files with the Civil Aeronautics Board, a tariff known as Tariff 6-D (Official Air Transport Restricted Articles Tariff 6-D Governing the Transportation of Restricted Articles by Air Including the Restrictions Applicable to the Acceptance of such Articles by the Individual Participating Carriers Between Points Throughout the World). This compilation of pertinent regulations and listing of restricted articles is under the supervision of the ATA Restricted Articles Policy Advisory Board.

c. Interstate Commerce Commission (ICC) and Civil Aeronautics Board (CAB)

The ICC formerly had jurisdiction over both the safety and the economic aspects of the transport of radioactive materials by land. The jurisdiction over safety was transferred to the DOT in 1967. The ICC (for land shipments) and the CAB (for air shipments) continue to exercise jurisdiction over the economic aspects of radioactive materials transport by means of the issuance of operating authority to carriers, as well as regulation of freight rates.

d. Bureau of Explosives, Association of American Railroads

This Bureau was for many years the principal technical advisor to the ICC and, prior to withdrawal by the ICC of its delegation of authority over these packaging controls, issued Bureau of Explosives special permits for radioactive materials transport. The Bureau no longer has delegated authority over the development or the administration of the U.S. radioactive materials safety regulatory program. However, the Bureau does publish as the carriers' agent, R. M. Graziano's (formerly T. C. George's) Tariff 23, Hazardous Materials Regulations of the Department of Transportation, Including Specifications for Shipping Containers. Tariff 23 also includes Regulations for Transportation of Explosives and Other Dangerous Articles in Rail Express and Rail Baggage and Restrictions Covering the Acceptance and Transportation of Explosives and Other Dangerous Articles by Carriers Parties to the Tariff.

e. American Trucking Association

The Motor Carriers' Explosives and Dangerous Articles Tariff, Dangerous Articles Tariff No. 14, is published by this association.

f. The National Council on Radiation Protection and Measurements (NCRP)

The NCRP is a nonprofit organization chartered by the Congress to collect and disseminate information regarding radiation protection and measurement, and to assist in coordinating the efforts of other concerned organizations. The NCRP issues recommendations concerning limits of radiation exposure.

g. Other advisory groups utilized by the DOT and the AEC include the National Academy of Sciences, the Atomic Industrial Forum and the American National Standards Institute.

4. Regulations and Associated Material

The regulations pertinent to the transport of hazardous material (including radioactive material) by air are contained in the Code of Federal Regulations (CFR) in Title 14, Part 103. (FAR 103). However, most of the regulations related particularly to the air transport of radioactive materials are in fact accomplished by reference to appropriate sections of 49 CFR, i.e., Parts 170-178, dealing with the transport of hazardous material by highway and rail. The standards for packaging of large sources and fissile materials are contained in the AEC regulations, 10 CFR 71, and pertinent postal regulations are in 39 CFR 124-125.

a. Proposed Changes in Federal Aviation Regulations (FAR)

Discussions in January with the Special Assistant (Regulatory) to the Chief, Operations Division of FAA's Flight Standards Service indicated that some changes to FAR 103 were being contemplated. These changes included, but were not necessarily limited to, minor changes in the paragraphs dealing with Deviation Authority and inclusion of a commodity list. Difficulties in air carrier interpretation of the distance tables in Section 103.23 were mentioned. Apparently, FAA was not aware of any problems with the table and was not considering any changes. Changes to Part 121 were also being considered. (Part 121 deals with

Certification and Operations: Domestic, Flag, and Supplemental Air Carriers and Commercial Operators of Large Aircraft). Thought is being given to requiring the appropriate carriers to include information in their Operations Manuals pertinent to radioactive materials. In addition, there may be a requirement for the carriers to develop and initiate approved training programs regarding the handling and carriage of radioactive materials. FAA was not currently considering changes in Part 135 concerning Air Taxi operators.

b. Other Actions (Regulatory and Non-regulatory)

At a February 1, 1972, meeting of FAA, DOT and AEC representatives with members of industry, the following actions were proposed and agreed to:

- "(1) Obtain and distribute, as necessary, the General Counsel's (FAA) interpretation of the provisions of FAR Section 103.23 as it pertains to distance limitations between packages of radioactive materials and personnel aboard aircraft.
- (2) Representatives from OHM, AEC, FAA and ATA will begin immediately a reevaluation of the transport index limitations now contained in Section 103.23(a) and make appropriate recommendations.
- (3) FAR Part 103 will be updated by FAA to reflect the above-mentioned legal interpretation and recommendations that may result from the reevaluation of the transport index limitation.
- (4) ATA will prepare a letter to all members stressing the importance of initial and recurrent training in the care and handling of hazardous materials.

- (5) OHM, in conjunction with AEC, will publish an alert bulletin on the handling of radioactive materials, for distribution to manufacturers, shippers and carriers.
- (6) Consolidation of all regulations pertaining to shippers from the various modal regulations into 49 CFR.
- (7) OHM, in conjunction with the modal agencies, will develop a training package on hazardous materials to be distributed to shippers, freight forwarders and carriers as guidance material in training their personnel."

c. Airport Certification

At the time of this investigation the FAA was in the process of issuing new rules which will be applicable to those airports used regularly by scheduled air carriers which operate aircraft of 12,500 pounds and above and are certificated by the CAB. These new rules will appear in 14 CFR 139. (FAR 139). The airport certification requirement date will be effective by May 1973.

FAR 139 lists provisions under sections 139.51 and 139.55 which relate specifically to handling and storing hazardous articles and materials, and requirements for an emergency plan.

Once the airport has been certificated as required by FAR 139, the FAA will monitor these facilities to assure that they are properly and adequately equipped and maintained to conduct safe operations.

5. Packaging Requirements

There are applicable standard requirements for all hazardous materials packages and in addition there are general requirements for radioactive materials packages. The list of such requirements is rather lengthy, but there follows a brief summary of several of the more significant ones:

Security Seals and Closure Devices

The outside of each package must incorporate a seal, which is not readily breakable, and which, while intact, will be evidence that the package has not been opened illicitly. There is also a requirement that inner shield closures must be positively closed to prevent loss of contents.

Surface Temperature Limitations

The regulations prescribe that the temperature of the accessible external surface of any fully loaded radioactive materials package may not exceed 122°F, assuming still air at ambient temperature, unless the package is transported in a sole use vehicle, in which case the maximum surface temperature of any package may be 180°F.

Liquid Radioactive Materials

The regulations specify that liquid radioactive materials must be packaged within a leak-resistant and corrosion-resistant inner container which must either be adequate to prevent the loss or dispersal of the liquid contents if the package is subjected to a 30-foot-drop test, or enough absorbent material must be provided to absorb at least twice the volume of the liquid contents.

a. Types of Packaging

Prior to a discussion of types of packaging, it is first necessary to discuss the type, quantity, and the form of the radioactive material to be packaged. The type of material must be determined (list in 49 CFR), the quantity to be shipped (in terms of curies, millicuries or microcuries) must be determined and the form of the

material, i.e., normal form or special form. Special form materials are those which if released might present a hazard because of direct. external radiation, but which, because of their high physical integrity, would present very little hazard because of radiotoxicity as a result of the spread of contamination. Normal form radioactive materials are any materials which do not meet the criteria for special form and they are classified into one of seven Transport Groups in order to determine the appropriate packaging limits. This grouping is utilized to account for the greater risks presented by various isotopes such as those with long half-lives. Varying quantities of special form and normal form radioactive materials are specified for Type A packaging, larger quantities for Type packaging and in excess of Type B quantities for "Large Quantities." Type A packaging standards are basically to withstand normal conditions of transport. Type B packaging standards are basically to withstand hypothetical accident conditions without loss of contents and with minimal loss of shielding. There are separate standards for the packaging of "Large Quantities" and for Fissile Materials. Fissile Materials require special consideration because of the potential for accidental criticality (an unplanned nuclear chain reaction). Prior to delivering radioactive material to a carrier for transport, the shipper either must determine that the packaging meets the requirements of a Specification Container listed in the DOT regulations, or he must obtain approval of the packaging design from the DOT, by means of a Special Permit. If Fissile Material or a Large Quantity is to be shipped, approval of the packaging design by the AEC is also required.

Information from the OHM indicates that as of early 1972, there were 899 Special Permits in effect, of which approximately 250 deal with radioactive materials. Except for a limited number of specification Type B packages described in the regulations, all Type B packages require prior approval of the DOT under a

Special Permit. It is the expressed objective of the DOT to "convert a major percentage of the existing Special Permit Program into permanent regulations."

SPECIAL PERMIT 5800

The shipment involved in the contamination incident (Appendix A) moved under the terms of Special Permit 5800 issued by the HMRB on January 3, 1969, on behalf of the four operating administrations of the DOT. Thus, this shipment entered transportation under authority provided by the terms of a special permit, the development of which occurred outside public rule-making channels. The circumstances associated with the inception, development, and expansion of this special permit are of interest.

A change in the regulations which prompted the need for development of the permit occurred in 1968, at which time the DOT adopted in large measure the IAEA's international approach to safety regulations for radioactive materials. This approach is strongly performance oriented, and is illustrative of the performance standards which are stated goals for hazardous materials regulations for other classes of dangerous commodities.¹

These amendments resulted in, among other things, the obsolescence of numerous containers then being utilized for radioactive hazardous materials.

The AEC and the DOT, in joint consultation, and based on prior packaging studies and diverse permits, developed the generalized specification for the "over pack" approach to permit the continued use of the otherwise obsolete

¹ Statement of Benjamin O. Davis, Jr., Assistant Secretary for Safety and Consumer Affairs, U.S. Department of Transportation, before the Subcommittee on Government Activities of the House Committee on Government Operations, regarding the transportation of hazardous materials, Wednesday, November 17, 1971.

containers. Other old permits were retired from the transport service. Shipments in this new specification package were first authorized under the terms of Special Permit No. 5800. The issuance of this Special Permit (See Appendix A Attachment 4) constituted the introduction of additional DOT radioactive materials container specification, in paragraph 3. A component of this new packaging specification was the "interim DOT specification 20WC wooden protected jacket" with certain inner containment vessels. This permit provided for the shipment of Type B quantities of nonfissile radioactive materials, considered more of a potential danger than Type A materials, under the amended regulations.

Under amended regulations, Type B packaging must be approved by a "certificate of compliance" covering each design (except for Specification 6M and Specification 55 containers under certain circumstances). This requirement is currently accomodated by Special Permits. Thus, Special Permit 5800 served the dual purpose of certifying the design for the container involved in the air carrier contamination incident described in Appendix A, and establishing new regulatory container requirements without delaying their development in a public rulemaking proceeding. Since its issuance, at least 21 shippers have registered with the HMRB and presumably make shipments in the containers authorized under the conditions prescribed by Special Permit 5800.

b. Proposed Changes

The Board notes that in the Federal Register on November 20, 1971, there were published Notices of Proposed Rulemaking (NPRM) No. 71-30 (Ref. 49 CFR 173, 174, 175, 177) and 71-39 (Ref. 14 CFR 103) dealing with Design Approvals for Radioactive Materials Packages. Under the regulations proposed, petitioners for Type B, Fissile and Large Quantity packages would apply directly to the AEC for package

review, evaluation, and approval. In a separate document in the same issue of the Federal Register, the AEC published an NPRM to add procedures for review and approval of Type B packages to 10 CFR 71. The preamble notes that the proposal is to transfer the administrative requirements for the approvals of certain radioactive materials packages (Type B) from the DOT to the AEC, and further that it would be in the public interest and would not adversely affect safety in transportation to eliminate the present duplicative ministerial procedure of the issuance of special permits for packages which have been reviewed and approved by the AEC. Other changes proposed in the NPRM concern required warning statements on fissile class III packages, limitations of the carriage of "Large Quantities" of radioactive material by passengercarrying aircraft, and special requirements for the carriage of fissile class III radioactive materials by air. Comments on the aforementioned NPRM's were due in Washington by February 29, 1972, in order to be considered prior to final action being taken by the HMRB.

6. Transportation Requirements (Air)²

a. Shipper

After selecting the proper packaging for the specific radioactive material, the shipper is required to check for compliance in the following areas: radiation dose rate, surface contamination, labels and other package markings, shipping papers and shipper's certification.

(1) Radiation Dose Rate

The maximum radiation dose rate at the surface of the package may not exceed 200 mrem/hr. and at 3 feet (TI) may not exceed 10 mrem/hr. For foreign shipments, the TI is

²There are small specified quantities of radioactive materials which are exempt from specification packaging, marking, and labeling.

determined by measuring the mrem/hr. one meter from the center of the package. The TI is the number which determines which radioactive material labeling is to be applied to the package (See paragraph 3).

(2) Surface Contamination

Loose radioactive contamination on the outside of the package may not be "significant." "Significant" removable contamination is defined as that which, as measured by wipe test, does not exceed certain limits specified in the regulations.

(3) Labels

Each package of radioactive materials is required to be labeled on two opposite sides, with a distinctive warning label. There are three warning label formats bearing the standard trefoil radiation symbol. (See Attachment 1.)

As indicated previously, the TI is the number which determines which label will be applied to the package of radioactive material. The following table illustrates the labeling criteria which are required to be applied.

Label Criteria

Dose Rate Limits

Label	At any point on Accessible Surface of package	At 3 ft. from External Surface of Package (TI)	
RADIOACTIVE WHITE-I	≤0.5 mrem/hr.	0.0	
RADIOACTIVE YELLOW-II	≤10 mrem/hr.	≤0.5 mrem/hr.	
RADIOACTIVE YELLOW-III*	<200 mrem/hr.	<10 mrem/hr.	

^{*}Requires vehicle placarding (rail or highway). Label mandatory for any Fissile Class III or Large Quantity package, regardless of dose rate levels.

(4) Other Package Markings

The outside of the package is required to be marked with the appropriate specification number or Special Permit number, if applicable, and it must also be marked with the proper shipping name as shown in the commodity list appearing in the regulations.

(5) Shipping Papers

The regulations require certain essential elements of information to be included in the

shipping paper description of the package of radioactive material (and the driver of a truck carrying such a package is required to have a copy of the shipping paper in his possession). The shipping paper must include:

- (a) The transport group or groups of the radionuclides in the radioactive material, if the material is in normal form;
- (b) The name of the radionuclides in the radioactive material, and a description of its physical and chemical form if the material is in normal form;

- (c) The activity of the radioactive material in curies;
- (d) The type of label applied to the package, i.e., Radioactive White-I, Radioactive Yellow-III;
- (e) For fissile radioactive materials, the fissile class of the package and the weight in grams or kilograms of the fissile isotope; and
- (f) For export shipments, a copy of any special permit issued by the DOT for the package.

(6) Shipper's Certification

The shipping papers must include a certificate signed by the shipper, which reads as follows: "This is to certify that the above-named articles are properly classified, described, packaged, marked, and labeled, and are in proper condition for transportation, according to the applicable regulations of the Department of Transportation." For shipments on passenger-carrying aircraft, the shipper must also add the words: "This shipment is within the limitations prescribed for passenger-carrying aircraft."

b. Air Carrier

(1) Acceptance of Shipper's Certificate

The regulations specify that no shipper may offer and no aircraft operator may knowingly accept for shipment any dangerous article (including radioactive materials) for shipment in an aircraft unless there is a clear and visible statement that the shipment complies with the regulatory requirements. The aircraft operator may rely on the shipper's statement as prima facie evidence that the packaging is in compliance with the regulatory requirements. One signed copy of the shipper's certificate must accompany the shipment and the originating air carrier retains the other signed copy.

(2) Transport Index Control

The regulations require each air carrier, or aircraft operator, to observe a storage control on accumulations of packages bearing either the Radioactive Yellow-II or Radioactive Yellow-III label. This control is based on the TI value which has been assigned to each package. The total TI determined by adding the TI number shown on the label of each package, may not exceed 50 in any location on any single aircraft.

The total TI is also utilized to control the distances between packages bearing the yellow labels and areas continuously occupied by persons or animals, or to packages which contain undeveloped film. Reproduced below from 14 CFR 103.23(a) is a table indicating the minimum separation distances based on the variables of total TI and transit time.

In order to comply properly with this regulation, the aircraft operator must take into consideration the particular physical arrangement of the baggage or cargo compartment of the specific aircraft, as it concerns the positioning of the yellow label packages relative to the nearest passengers (or crew, animals or undeveloped film).

The TI system has also been adapted for use in limiting aggregations of packages containing fissile materials in order to avoid assembling in one location an amount of fissile material which, under credible conditions, would support a chain reaction. As for radiation levels, the shipper determines, in accordance with specific criteria laid down in the regulations, a TI figure which is to be assigned to the fissile material package. For shipping, the shipper assigns to each package of fissile material, the nuclear safety TI, as calculated, or the radiation level TI, whichever is higher. As in the case for radiation levels, the TI's are added and by complying with the limitations on the number of TI's (the rule of 50), the amount of fissile material in all types of packages is limited to safe amounts.

Total transport index	Minimum separation distances in feet to nearest undeveloped film for various times of transit					Minimum distance in feet
	Up to 2 hours	2-4 hours	4-8 hours	8-12 hours	Over 12 hours	to area of persons, or minimum distance in feet from dividing partition of cargo compartments
None	0	0	0	0	0	0
0.1 to 1.0	1	2	3	4	5	1
1.1 to 5.0	3	4	6	8	11	2
5.1 to 10.0	4	6	9	11	15	3
10.1 to 20.0	5	8	12	16	22	4
20.1 to 30.0	7	10	15	20	29	5
30.1 to 40.0	8	11	17	22	33	6
40.1 to 50.0	9	12	19	24	36	7

Whenever radioactive materials are carried in an aircraft, the operator is required to inform the pilot-in-command of the name, type of label, quantity and location of that material. The person marking the cargo load manifest is required to mark it conspicuously to indicate the materials.

C. System Operation

1. General

In order to assess the functioning of the transportation system with regard to radioactive shipments, the Board canvassed a cross section of the industry, interviewing representatives from various segments including: shippers; freight forwarders; airport operators; trade associations; and all government agencies with responsibility in this area. Board investigators also conducted a spot check to further their knowledge of the system. For this check, the investigators inspected the facility of a shipper,

observed the packaging of a consignment, and followed this shipment through the system to the facility of the consignee.

The consensus of the parties canvassed was that the regulations were adequate (if somewhat confusing because of differences between modal requirements and between modal and AEC requirements) and that implementation was generally adequate. However, one aspect was frequently cited as inadequate, even by representatives of some of the regulatory agencies. This aspect was the enforcement of the regulations.

For convenience, discussion of the operation of the system has been divided into five general areas: shippers; packaging; air carriers; regulatory authorities; and a resumé of the Board's spot check of a shipment.

2. Shippers

One observation made by several of those interviewed was that the transportation of radioactive materials probably represents less risk to the public than does the transportation of some

of the other commodities on the restricted articles lists. This is reputed to be true because radioactive materials shippers are generally more regulated and more knowledgeable concerning the potential hazards associated with their products than are shippers of other restricted materials. This, in turn, is attributed to the Federal licensing requirements and the stringent packaging requirements.

3. Packaging

Representatives of a number of those organizations, other than regulatory agencies, which were canvassed noted that packaging requirements were adequate or were quite stringent. However, the Board found few statistics relating to the adequacy of packaging. Although the DOT has in effect a system for reporting the unintentional release of hazardous material, this reporting system records only the packaging failures, and not the more frequent instances in which a package was exposed to more than the usual rigors of transportation and survived it without release of contents.

Discussion with many personnel from the industry revealed that the packaging is indeed quite crashworthy. It was noted that Type B packaging, which is designed to withstand hypothetical survivable-type accident conditions, has done so many times. Numerous cases were cited in which packages survived not only high impact loadings, but also intense post-crash fires. One representative of a regulatory agency observed that Type A packages have also frequently survived accidents without loss of their contents - even in nonsurvivable aircraft accidents. A representative of a state health department noted that his organization is frequently called upon to inspect damaged Type A packages, and he could not remember their discovering any leaking packages. A representative from the AEC said that, because the quantity of radioactivity which can be carried in Type A containers is so limited, spillage from these packages is not generally considered a hazard to health. Such spillage, he noted, is generally more of a nuisance than a hazard.

The requirements for containers which are reused was explored during the investigation of the contamination incident. Although the DOT regulations specify that reuseable containers must comply with the prescribed requirements, most persons with whom the matter was discussed were unfamiliar with the standards for the reuse.

4. Air Carriers/Airport Operators/Flight Personnel

The Board found little standardization in the procedures employed by air carriers in handling and storing restricted articles, and in training personnel to work with this material. However, all but one of the carriers visited had some written procedures; the one exception generally prohibited the carriage of restricted articles.

Of the carriers questioned, few have separate storage areas in their facilities for restricted articles; most store this material with the other freight scheduled for a given flight. Based upon limited observation, few airports now have any requirements for handling and storing restricted articles. One exception was the Port of New York Authority. That authority has a blanket provision in its rules which, among other things, prohibits the use and storage of various materials, including radioactive materials, in a dangerous manner. That authority also requires advance notification of the movement of large quantities of radioactive materials.

As has been noted, all but one of the carriers visited had written procedures for handling restricted materials. Most of them had reprinted the distance table from 14 CFR 103.23(a) in their cargo manuals, and some had additional written procedures for implementing the loading requirements. One carrier has detailed loading instructions which specify the maximum TI which can be carried in the various baggage

compartments of all its aircraft. All these carriers had provisions for notifying the authorities in the event of a mishap.

The carriers which normally carry radioactive materials had procedures for the acceptance of consignments. These generally included a check for the proper certification, for labeling, and for damaged packages. However, representatives of a pilots' organization and of a freight forwarder said that carriers do not always check to assure that the maximum TI limit is not exceeded. Also, it was noted that freight consolidators occasionally package radioactive material consignments in large containers which do not always state properly the types of material and the aggregate TI enclosed.

The degree to which carrier personnel handling radioactive material are trained also varies considerably from carrier to carrier. Although some of the parties questioned had different opinions, most believed that the carrier cargo personnel were reasonably well informed - at least at the supervisory level. Most carriers included procedures for handling restricted articles in their general training programs, and most seemed to rely on on-the-job-training for recurrent training in the matter. None of the carriers offered their pilots comprehensive training or written guidance regarding the matter.

Although this report is presented in a manner intended to preserve the anonymity of the parties visited, the Board does wish to commend Pan American World Airways for its handling procedures and personnel training program.

One aspect of the air transportation of radioactive materials which was considered generally beyond the scope of this project was the extent of the involvement of the third-level air carriers (air taxi and commuter operators) operating under FAR Part 135. The Board is currently conducting an in-depth study of that segment of the industry. The extent of the third-level carrier activity in transporting radioactive materials will be included in that study.

5. Enforcement

Enforcement of the regulations concerning the packaging and transportation of radioactive materials was regarded by most of those interviewed as a weak link in the system. The problem cited most frequently was the limited specialist manpower which most governmental authorities have devoted to enforcement.

Most of the enforcement action which is taken is "after the fact," as a followup on incident/accident investigations. This is especially true of action taken against shippers of Type A quantities. As one official described the situation, "Isotope shippers should be inspected. OHM hasn't the manpower, and the modes are primarily carrier-oriented and don't want to become involved with the shippers."

In addition to the interfaces between shippers and modes, the interfaces between the modes were also cited as deficient in enforcement. To quote one AEC source, "The total system ought to be watched."

6. Followup of a Shipment

In order to observe the functioning of the system, Board investigators followed a radioactive shipment (Americium 241, solid form with a half-life of 458 years) from the manufacturer/shipper at Oak Ridge, Tennessee, to the consignee in Dayton, Ohio. The complete report is presented in Appendix B. The shipment consisted of four Type B containers with an overall packaged weight of 60 lbs. per container (DOT 6M packaging specifications). The TI was determined to be 0.75 per container, for a total of 3.0 TI. The movement of this shipment was via truck van to the originating airport (Knoxville, Tennessee) and from there via air to the destination airport (Dayton, Ohio). Final transportation was via truck from the airport freight dock to the consignee. The Board investigators

made the following observations regarding this shipment:

- 1. In accordance with regulations, the individual TI's of 0.75 should have been rounded to the next highest tenth before they were entered on the package labels. Thus, the TI of each package should have been 0.8, and the total for the four packages should have been 3.2 TI.
- 2. The shipment was placed in common storage areas at the respective air freight docks pending further movement.
- 3. The crew of one flight received flight papers (restricted article notice) that showed a total of 0.75 TI units in lieu of 3.0 units which was the total of the amounts marked on the labels. The same form depicted the total number of curies as 0.75 instead of the proper total of 689 curies.
- 4. The TI was observed to be the one common denominator recognized by the various personnel concerned with this shipment. It was also the basis for decisions concerning storage and loading of radioactive materials shipments. However, the TI units on the labels were often barely legible. This was the case because the three red bars which denote the category of the package partially obscured the markings, and also, because those marking the labels often did not utilize the entire space provided on the label.
- 5. The truck used for final transportation to the consignee was without required exterior placarding showing that Radioactive Yellow—III material was aboard.
- 6. The consignee advised that a test for contamination was not always immediately conducted upon receipt of shipment. However, to demonstrate the procedure to the Board's investigators, a wipe test was conducted with negative contamination findings.

The consignee of this shipment advised the Board's investigators that they were licensed by AEC with routine surveillance and inspection by that agency.

III. CONCLUSIONS

A. General Conclusions

The Board concludes that, at this time, the radioactive materials carried by aircraft do not normally constitute any unusual risk of injury to the public. Transportation by any mode involves the possibility that incidents or accidents may occur. The presence of radioactive materials in such events may, in turn, increase the risk level for individuals or large numbers of the public likely to be exposed to high radiation levels. Although the risk to life created by such increased exposure is probably less than the risks associated with accidents/incidents involving other hazardous commodities, the unknown or uncertain genetic effects of even small exposures make any such increase undesirable.

As indicated previously, the Board concludes that the transportation of radioactive materials by air may generate less risk to the public than does the transportation of other hazardous materials. The nuclear industry as a whole is highly regulated, and the shippers of all sizeable amounts of material must meet stringent licensing and inspection requirements.

This attention to safety is probably an outgrowth of tragedies which occurred during the formative years of the nuclear industry. Accordingly, the need for protective standards was readily apparent. Regulatory action then followed the growth of the industry, and the industry now appears to the Board to be generally well regulated and knowledgeable.

However, as the Government (AEC) relinquishes more and more of its activities to private industry, and as the industry continues its rapid growth, the proliferation of the system presents

new demands for vigilance if the current minimal risk to the public is not to rise. The special treatment once accorded the movement of radioactive materials can no longer be provided, and those handling the increased number of shipments are no longer limited to experts in the field. For example, although most air carriers believed that they have adequate procedures and training, the practices used in the field and the extent and quality of the training of their handlers are not always of the highest quality.

Thus, the Board's primary concern is not the risk engendered by present operations, but rather, it is the risk potential created by the rapid expansion and by the change in the nature of the nuclear industry.

B. Specific Conclusions

Regulatory

• The Safety Board's investigation of the facts and circumstances surrounding the radioactive materials spill in the previously mentioned contamination incident has disclosed that losses from the transportation of radioactive materials by air have been negligible to date. Because of the expected growth of this activity, however, losses in air transport of these materials can be expected to increase with the increase in the number of shippers and employees involved, and the growing quantities and varieties of materials involved.

Some of the difficulties associated with radioactive materials noted during this investigation are also associated with the transportation of other hazardous materials by air. Their identification during this investigation suggests a need to examine air transport of hazardous materials in general. An examination of the practices followed, the capabilities required, and the dangers associated with transportation of hazardous

materials by air would be likely to identify additional hazards and resultant controls required to reduce the risk associated with the transportation of these materials. Such an examination should be conducted by parties knowledgeable in modal transportation operations, aware of the manner in which hazardous materials can cause injury, capable in contemporary and advanced safety analysis techniques, and without direct interest in compliance with or promulgation of regulations. Among the areas which should be reviewed are the practices associated with the identification of hazardous shipments; the reliance which should be placed in shipment markings and labels; the basis for certain carriers' reluctance to transport such shipments; the comparative degree to which certain classes of materials pose greater risks than other materials; the scope of the difficulty which the format of the regulations poses for operating personnel; and the principal hazard control measures which are exercised or need to be exercised. Other aspects which might be reviewed are the need for timely discovery of leakage of other materials which might affect inflight safety or produce lingering or delayed damages; safeguards which may be required for emergency response personnel as the quantity of such materials in air transport grows; and safety of personnel and facilities during the times such materials are awaiting airborne movement. Finally, an examination of the differences between international and domestic approaches to regulation of these materials, to identify the specific differences. and to determine how these differences affect the risk level of the transportation of such materials by air appears to be warranted.

The Safety Board's brief review of these practices has indicated that there may be problem areas, but it has not specifically established the fact of their existence in a conclusive manner. However, the review did disclose sufficient

information to warrant concern and further inquiry in these areas.

• The Board's study has revealed that the profusion of regulations and tariffs pertinent to the various modes concerning the handling and carriage of hazardous materials has given rise to considerable confusion and some misunderstanding by manufacturers, shippers, and carriers. At least one authoritative source estimated that no more than about 20 people in the entire nation were truly knowledgeable in the area of regulations and tariffs. The Board is aware that its findings relative to problems arising from the profusion of regulations actually confirm the findings of others and the Board is cognizant of the fact that action is being taken to ease these problems. In November 1971, the DOT indicated that for Fiscal Year 1972 the main objectives of its Office of Hazardous Materials included, in part, the following:

A revision and standardization of format for all hazardous materials regulations of the Department.

A regulatory system based on technically standardized criteria encompassing all modes.

The Safety Board endorses these objectives. • As has been discussed previously, the total TI of any aggregate number of packages in any single transport vehicle (other than a "sole-use vehicle," except aircraft), or in a storage area, may not exceed 50. Even though the the regulations provide graded tables of stowage distance versus time for stowage in vehicles in accordance with the cumulative TI, they do not provide guidance in regard to the separation, in storage, of aggregates of packages when the total TI of more than one group of packages exceeds 50. The Board notes that the Official Air Transport Restricted Articles Tariff No. 6-D, does contain guidance on separation of such aggregates in storage areas, but the Tariff is not regulatory and compliance is therefore voluntary. The

6-D Tariff guidance is based on the international regulations (IAEA) for storage which are, in part, reproduced or paraphrased below:

The number of Category II and III Yellow packages stored in any one place, such as a terminal building or store room, shall be limited so that sum of the TI's on their labels does not exceed 50, unless those packages are in groups, none of which contains TI's the sum of which is in excess of 50 and each group is handled and stored not closer to any other than 6 meters (approximately 20 feet). The above limitations shall not apply to packages of low specific activity materials when such materials are maintained in a compact stack.

The Board is of the opinion that the U.S. regulations should be revised along the lines provided by the regulations of IAEA.

As a result of its investigation, the Board believes that there is inadequate enforcement of the Federal regulations pertinent to the carriage of radioactive materials by air. It is understood that most of the enforcement actions which have been taken in the past year were initiated as followup actions on the investigation of incidents or accidents rather than as a result of inspection and monitoring. The FAA proposes to perform more inspections, including the inspections of air carrier storage areas, and the Board endorses those efforts.

Handling

• Since contamination from radioactive materials may not be readily apparent, a need exists to assure the timely discovery of any such contamination in order to protect the public, traveling or otherwise, from exposure to the hazards.

The need for timely discovery was made very apparent by the incident described in Appendix A. A total of 917 passengers had traveled aboard the aircraft involved in that incident before the contamination was discovered and the aircraft was taken out of service. The radiation level at one seat was such that passengers could possibly have been exposed to radiation doses in excess of those permitted the general public.

Since a shipment is most likely to be damaged or spilled during movement, it would seem that shipments should be monitored for contamination immediately after receipt at the final freight terminal or at the facility of the consignee.

Most air carriers have neither the equipment nor the trained staff to perform adequately this operation. On the other hand, the consignee, in addition to possible licensing requirements, and in order to conduct a safe business operation, must be staffed with knowledgeable personnel who are familiar with the precautions required for safe handling of radioactive materials and must now possess accurate radioactivity measuring devices. Many consignees may routinely perform such monitoring; however, it appears that this should be a requirement for all shipments of Type B or larger amounts which are transported in a form which may be dispersed if the packaging leaks or if its integrity is destroyed by mishaps in transit. Given these considerations, it is not unreasonable to expect the consignee to perform this assignment.

• Regarding the matter of personnel training, the Board is not unmindful of the OHM and FAA efforts in this regard. We endorse such efforts, especially in regard to the possibility of requiring carriers to develop and initiate approved training programs concerning hazardous materials.

The Board also noted that FAA was considering changes to Part 121 (Air Carriers and Commercial Operators of Large Aircraft) to require inclusion of material pertinent to radioactive materials in the carrier's Opera-

tions Manuals. We consider this a desirable requirement and we believe that consideration should also be given to a similar requirement for those Part 135 (Air Taxi) operators who regularly transport radioactive materials.

Packaging and Labeling

• The events which culminated in the issuance of Special Permit 5800 occurred during a transition period in the regulations. Recognizing that difficulties occur in such transition periods, certain aspects of the development of this special permit warrant comment. These aspects relate to the validity of the current performance standards approach, the use of the special permit processes for design certification of containers under performance standards, and the use of the special permit process as an interim rule-making procedure.

Problems associated with the performance standards approach in the regulations have previously been cited by the Safety Board.3 The requirement for the AEC to retain control over the Type B packaging designs through the certificate of compliance approach4 suggests the possible existence of deficiencies in the performance criteria specified for such packaging. Alternatively, the retention of the certification approach might be construed to imply that the execution of the designs under the performance standards provided is thus far unreliable. In either event, reexamination of the difficulties in the current performance standards approach in the radioactive materials packaging regulations is suggested.

³ Special study entitled "Risk Concepts in Dangerous Goods Transportation Regulations," National Transportation Safety Board, Report No.: NTSB No. STS-71-1, page 14.

⁴Hazardous Materials Regulations Board Docket HM-73; Notice 71-1 (36 F.R. 292), et al.

It is noteworthy that in the contamination incident, a duly certified Type B container leaked in normal transportation. The use of the special permit for purposes of certifying compliance with performance standards in the regulations constitutes a difficulty with the special permit process not previously discussed by the Safety Board. The Board's investigators were told that over 25 percent of the outstanding permits issued by the HMRB involved radioactive materials, and most of these involved certification of compliance for Type B packages. Thus, the certification process under the performance standards approach may not relieve the regulatory workload on the DOT if it is still required to maintain surveillance to assure safe package designs in all hazardous materials transporta-

The use of the special permit process as a substitute for a public rulemaking proceeding, in this instance, permitted the introduction of a new approach to the safe transportation of radioactive materials (the "over pack") without the exposure to public scrutiny or comment which would have been possible in a public rulemaking proceeding conducted in accordance with the Administrative Procedures Act. The use of the special permit process for such "private rulemaking" has delayed disclosure of the rulemaking to the public for 3 years already, and no date for publication of a notice of proposed rulemaking is scheduled. In view of the horizontal expansion of this special permit, evidenced by the large number of currently registered shippers, the escalation of investment in special permits, addressed by the Safety Board Recommendation I-71-2 (Attachment 2) on August 17, 1971, is again illustrated. Thus, the safeguards contemplated by public rulemaking proceedings become inoperative and economic considerations increase in weight when the ultimate changeover from a permit to an amendment to the regulations is considered.⁵

• The investigation of the contamination incident (Appendix A) also revealed a possible need for a review of the philosophy of the regulations concerned with performance tests. The current performance tests may cover adequately the design of packaging for crashworthiness, but they do not allow fully for all operational aspects such as faulty packaging and human handling.

For example, the containment of the liquid isotope which leaked in that incident should have been assured by the requirements for the inner plastic bottle and for the gasketed closure of the lead-lined stainless steel secondary container (pig). However, in this case, it was determined that the mechanical manipulator used to install the top on the plastic bottle did not secure the top tightly enough to prevent leakage, and a section of the gasket under the plug top of the pig was missing. Thus, packaging designed to prevent release of its contents in accident conditions was not capable of preventing such release under conditions of normal transport.

In order to protect against errors in packaging and handling, it seems that revision may be required of those regulations which now attempt to prevent the inadvertent release of materials by requiring the use of containers which will either survive a drop test or which will meet certain absorbancy requirements. The events which resulted in this incident suggest that, for transport of radioactive materials in liquid or powder form, both the drop test and the absorbancy requirements should be met, or that redundancy of containment should be provided by

⁵ The HMRB is considering possible controls, but no rulemaking to amend 49 CFR 170 is in process or presently contemplated by the HMRB. Its December 9, 1971, reply to the Safety Board's recommendation discusses horizontal expansion of Special Permits, but indicates no resolution of this problem.

means such as the addition of a sealed plastic bag over the inner container.

• This investigation revealed two areas of concern regarding package labeling. The investigation of field operations made it evident that the TI serves as the key identifier in handling radioactive material, and as the common denominator which is recognized by most individuals working with those materials. This index is the basic decision datum required for acceptance of consignments, for storage of shipments, and for load planning. It appears that the prominence of the TI marking on the package label should reflect the significance of the index. However, Board investigators noted that, on the packages they observed, this was not always the case. One reason was simply that the individuals who marked the labels did not always utilize the entire space available for that purpose. Another reason was that the conspicuity of this marking was reduced by the semitransparent red bars superimposed on the background of the label to denote the category of the package.

The Board notes that the proposed label revision in the Third Revised Draft of the IAEA Regulations for the Safe Transport of Radioactive Materials is better in this respect. The separation of the box provided for the TI on the proposed label from the red bars should provide a significant increase in

conspicuity.

• The observations of the air transportation of radioactive materials and the discussions concerning the general subject knowledge of the carrier personnel handling this material have demonstrated a need for carriers to designate, if they have not already established the practice, responsible trained personnel to accept all hazardous materials received for shipment. For example, the reported problems concerning acceptance of oversized and improperly labeled consignments demonstrate the need for a means of affixing the respon-

sibility for such acceptance to one knowledgeable person, as well as the need for personnel who are more adequately trained in this regard.

Investigation

• The special Safety Board investigation of a radioactive contamination incident involving a scheduled air carrier (see Appendix A) revealed that there is no one organization required to investigate an occurrence that qualifies as a "dangerous article incident" (14 CFR 103.28). Additionally, there is neither a central repository for the safety information developed during such an investigation, nor is there a means for disseminating the information derived therefrom. The Board contrasts this situation with the investigation of an occurrence classified as an aircraft accident (14 CFR 430.2) which is investigated by the Board or its designee. For example, in a Safety Board aircraft accident investigation, the authorities and groups concerned would be designated as parties to the investigation and serve as members on the team under the direction of the Board. The parties work as one team, exchange information, and can their own organization factual information on the suspect areas as soon as these areas are identified. Subsequently, the public is informed by means of a formal report published and disseminated by the Board, which also acts as repository for all of the information related to the particular case.

In addition to the special Board investigation, the incident described in Appendix A was wholly or partially investigated by at least three other Federal agencies, two state agencies, and three private organizations. It is recognized that there were some cooperative efforts involved. With the exception of the Board's report, there has been no report on the incident released to the public nor has any information gleaned from those investigations been disseminated to or among all the interested parties despite the high degree of interest in the occurrence. The Board concludes, therefore, that there is a need for one agency to be designated to investigate the occurrence of "dangerous articles incidents" (with other involved agencies and organizations participating as interested parties), to write and publish the report of the investigation, to determine cause, to make recommendations which in its opinion will tend to prevent such incidents, and to act as the repository for all the pertinent related information.

• Because of the additional hazards created when restricted commodities are subjected to accident conditions, emergency personnel who must be at the scene may be unknowingly placed in jeopardy. For this reason the Board sees a need for implementation of a threat notification system which would insure that the proper local authorities (police, fire, rescue personnel) are promptly notified of any additional hazard potential in the event of en route accidents involving aircraft transporting hazardous materials.

It should be noted that air carrier operators are currently required to report the existence of explosives, radioactive materials, or other dangerous articles carried, in their initial notification of accident/incident and overdue aircraft in accordance with Part 430 of the NTSB regulations. Upon receipt of this information, the Board will make every effort to notify the local authorities of any potential hazards.

IV. RECOMMENDATIONS

On the basis of the findings discussed in the previous section of this report, the National Transportation Safety Board submits the following recommendations:

That the AEC or Agreement States, as appropriate:

1. Require the consignees of all shipments of Type B or larger amounts of radio-active materials to assure that these shipments are promptly picked up from the carrier's facility, and are delivered to and monitored without delay at the facility of the consignee.

That the Secretary of the Department of Transportation:

- 2. Establish an Advisory Working Group, composed of representatives of shippers, carrier management and labor, governmental modal and safety organizations, and the public, to inquire into the need for additional private or regulatory safety controls in the air transportation of hazardous materials, and to advise him of any changes found to be necessary.
- 3. Continue to pursue vigorously the stated objectives of the Hazardous Materials Regulations Board to develop a revised and standardized format for all hazardous materials regulations of the Department, and a regulatory system based on technically standardized criteria encompassing all modes.
- 4. Adopt the label revision proposed in the Third Revised Draft of the IAEA Regulations for the Safe Transport of radioactive materials. In addition to adopting this proposed label, which should provide a more conspicuous area in which to mark the Transport Index, it is recommended that the Department of Transportation stress the need for making this index as conspicuous and legible as possible.
- 5. Initiate action to amend appropriate regulations to provide guidance in regard to the separation, in storage, of aggregates of packages of radioactive materials, when the total transport index of more than one group of packages exceeds 50. The new regulations should

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- be developed along the lines provided by the regulations of the International Atomic Energy Agency.
- 6. Consider a revision to the regulations which permit either a drop test or inclusion of an absorbent material requirement for Type B or larger shipments, to include both requirements in the case of liquid radioactive materials, to include a requirement for redundancy of containment such as the enclosure of the inner container in a sealed plastic bag. Standards for containment of liquid and powder form radioactive materials should be reviewed with consideration given problems associated with manufacturing imperfections, maintenance problems, and human error aspects, for both new and reused Type B and larger shipping containers.

That the Federal Aviation Administration:

- 7. Accelerate its efforts to inspect and monitor air carriers in order to insure compliance with regulations concerning the handling and carriage of radioactive materials.
- 8. Accelerate its consideration to require all Part 121 air carriers to develop and initiate approved training programs concerning hazardous materials, and to require inclusion of pertinent material in the carrier's Operations Manuals. It is also recommended that consideration should be given to establishing a similar manual requirement for those Part 135 operators who regularly transport these materials.
- 9. Require that air carriers have available one responsible, well-trained individual who is designated to accept all hazardous materials received for shipment.

That all interstate air commerce operators:

10. Take cognizance of Part 430.6 of the National Transportation Safety Board's regulations (14 CFR 430.6) and insure that the Board is advised without delay any time that explosives, radioactive materials, or other dangerous articles were carried aboard an aircraft involved in an aircraft accident or incident in order that the Board may promptly notify emergency personnel at the scene of any possible additional hazard potential created by these materials.

The Safety Board also wishes to reiterate and reemphasize the following recommendation made in Safety Recommendation I-71-2, issued August 17, 1971 that:

11. "The Hazardous Materials Regulations Board and Department of Transportation Administrations act to amend 49 CFR 170.15(b) to establish appropriate limitations on the time duration, number of shipments, or amount of equipment which will henceforth be authorized under the terms of each Special Permit."

Finally, the Safety Board's study reveals the need for one federal agency to assume the responsibility for the investigation of transportation incidents involving radioactive materials. This study disclosed that one incident was investigated, wholly or in part, by three federal agencies, two State agencies and three private organizations, only one of which is publishing a report of its findings. A similar problem appears to exist as to incidents involving the transportation of other "dangerous articles," particularly in intermodal transportation incidents. The Board, therefore, intends to undertake discussions with the appropriate Administrations within the Department of Transportation and other interested federal agencies, to arrive at an understanding which will clarify the overall responsibility for the investigation of incidents involving the transportation of radioactive materials and other "dangerous articles."

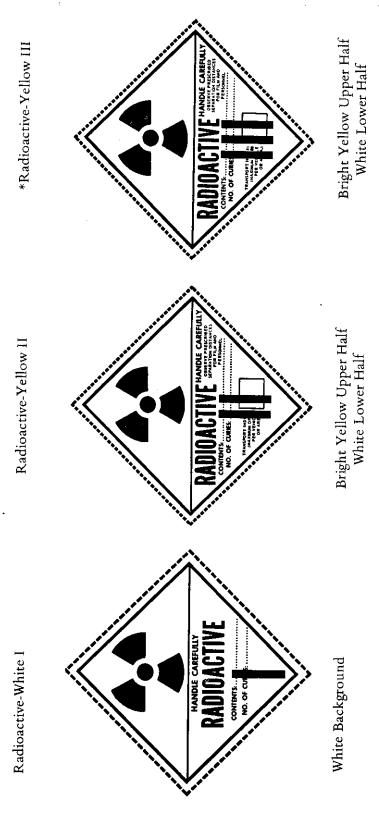
It is the Board's expectation that, through such discussions and coordination, an effective program can be undertaken which will provide for interagency notification procedures, conduct of investigations and publication of findings within the provisions of existing statutes. If this cannot be accomplished, consideration will then be given to the question of whether legislation should be sought to clarify this matter.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD:

/s/	JOHN H. REED	_
	Chairman	
	OGGAD M. I ALIDEI	
/s/	OSCAR M. LAUREL	
	Member	
/s/	LOUIS M. THAYER	
	Member	-
/s/	ISABEL A. BURGESS	
1 31	Member Member	-
	Member	

Francis H. McAdams, was absent, not voting.

April 26, 1972.



For All Labels

Vertical bars overprinted in lower half of each label are red. Each label is diamond shaped four inches on each side. Printing must be in black inside a black border measuring at least 3-1/2 inches on each side.

*Vehicle placarding (rail or highway) requirement is keyed to the use of this label.

UNITED STATES OF AMERICA NATIONAL TRANSPORTATION SAFETY BOARD WASHINGTON, D.C.

ISSUED: August 17, 1971

Adopted by the NATIONAL TRANSPORTATION SAFETY BOARD at its office in Washington, D. C. on the 29th day of July, 1971.

FORWARDED TO:
Chairman
Hazardous Materials Regulations
Board
Department of Transportation
Washington, D. C. 20590

SAFETY RECOMMENDATION I-71-2

The National Transportation Safety Board notes that current practices under which Special Permits authorizing transportation of hazardous materials are issued (49 CFR 170.13-15), allow economic considerations to escalate during the period the Permits are in effect, creating conditions which might adversely influence safety decisions. A recent Hazardous Materials Regulations Board Docket (HM-63) illustrates how this escalation can occur. In this proceeding, it was proposed, for safety reasons, to cease issuance and renewal of Special Permits which modify certain regulatory requirements for tank cars. The proposal was later withdrawn.

The record indicates that if the Special Permits had been withdrawn as proposed, approximately 7,000 tank cars with an estimated value of \$160,000,000, representing almost one-half of the total fleet of LPG tank cars in the larger size category, would have had to be removed from LPG transportation service. The scope of the economic hardships such action would precipitate is readily apparent. Circumstances which encourage economic considerations of this magnitude to develop, on a Special Permit basis, appear contrary to the best interest of safety.

The practice of issuing Special Permits, which do not limit the number of cars that could be built or updated thereunder, and which are renewed almost automatically, is conducive to the development of such circumstances. For example, one respondent to the Notice indicated it was his belief that it was just a matter of time before the terms of one of the Permits would be incorporated into the regulations. Another asserted that because of the prior

governmental sanctions of the use of cars with a welded joint efficiency of E = 1.0, he had entered into long*term commitments. Regardless of the merits of the proposal to withdraw these Special Permits, it is evident that the large fleet of cars built and operated under these Special Permits relentlessly increased the weight of economic considerations in the safety decision.

Special Permits could be controlled to prevent a recurrence of this type of situation which distorts tradeoffs between economic and safety considerations. The Safety Board believes that this can be achieved by placing restrictions on the "investment" which may evolve by limiting the duration, number of shipments, or amount of equipment authorized for use under Special Permits issued in accordance with 49 CFR 170.15. By limiting the use of Special Permits to situations in which their principal purpose would be the development of experimental data to support regulatory changes, or carefully controlled responses to emergencies, the intensification of economic forces in a safety decision of the type cited above would be minimized.

The Safety Board realizes that the elimination of the Special Permits for other purposes could present difficulties in the development of new regulations designed to respond to changed conditions or information. Nevertheless, the difficulties arising from escalating "investments" involving Special Permits without appropriate limitations significantly outweigh these other difficulties.

For these reasons, the Safety Board recommends that:

- 1. The Hazardous Materials Regulations Board and the Department of Transportation Administrations act to amend 49 CFR 170.15(b), to establish appropriate limitations on the time duration, number of shipments, or amount of equipment which will henceforth be authorized under the terms of each Special Permit.
- 2. The Hazardous Materials Regulations Board monitor Special Permits in sufficient detail to achieve predetermined objectives necessary to support regulatory actions.

The Safety Board would be pleased to make our staff available for whatever further information you may desire in connection with this recommendation.

This recommendation will be released to the public on the issue date shown above. No public dissemination of the contents of this document should be made prior to that date.

Laurel, McAdams, and Thayer, Members, concurred in the above recommendations. Reed, Chairman, and Burgess, Member, were absent, not voting.

oreas on barrel

By: Oscar M. Laurel
Acting Chairman

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NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C.

APPENDIX A

REPORT OF AIRCRAFT RADIOACTIVE CONTAMINATION INCIDENT, DELTA AIR LINES, INC., DECEMBER 31, 1971

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REPORT OF AIRCRAFT RADIOACTIVE CONTAMINATION INCIDENT DELTA AIR LINES, INC., DECEMBER 31, 1971

SYNOPSIS

A small quantity of radioactive material leaked from a bulk shipment onboard Delta Air Lines Passenger Flight 925 of December 31, 1971, while the shipment was en route from the manufacturer in Tuxedo, New York, to the consignee in Houston, Texas. The aircraft, Convair 880, N8801E, was contaminated and 917 passengers had traveled aboard it before discovery of the leakage and removal of the aircraft from service at Chicago, Illinois, O'Hare International Airport on January 2, 1972. The aircraft was ferried to Atlanta, Georgia, where it was decontaminated under the supervision of the Georgia Department of Public Health and the United States Atomic Energy Commission (AEC). By telephone contacts and press releases, passengers who had flown on this aircraft between the time of aircraft contamination and its removal from service were afforded an opportunity to determine the extent of exposure to themselves and to their baggage.

II. INVESTIGATION

A. BACKGROUND

The investigation of this incident was conducted in a sequential manner beginning with the manufacturer's packaging through shipment, discovering of excessive radioactivity, subsequent action, to corrective measures as a result of this incident.

B. FIELD INVESTIGATION

1. Manufacturer/Shipper

The Union Carbide Corporation (UCC), Sterling Forest Research Center, Post Office Box 234, Tuxedo, New York, is licensed by the AEC to operate a nuclear reactor in the State of New York. The AEC retains licensing authority over reactor operations. New York is an Agreement State under Section 274 of the Atomic Energy Act of 1954, as amended, and can, therefore, regulate possession and use of nuclear materials within the state.

Radioactive Material

UCC advised that the subject shipment was a routine bulk shipment of molybdenum 99 (Mo 99) in 3 normal sodium hydroxide solution, which had a 66.5 hour half-life. This had been a standard Friday afternoon shipment to Bio-Nuclear Laboratories in Houston, Texas, on a weekly basis for the past 12 to 18 months for consignee pickup at the airport.

Processing

The material was processed in the UCC reactor and moved from there under water (shielding) to hot cell #2 where it was placed into two 500 ml. (or 1 pint) polyethylene screwcap bottles.

Bottling (Primary Container)

The bottles were approximately 7 inches high and 3 inches in diameter with a 7/8-inch inner diameter and 1 3/8-inch outer diameter neck. The bottling operation in the hot cell was performed behind a 4-foot-thick window, using a pair of mechanical manipulators each of which has two wide opposing metal fingers. The manipulators exert a force similar to that applied by the operator as they provide no mechanical advantage.

To cap the bottles, the neck of a bottle was held by one manipulator while the screwcap was closed down as tightly as possible, "finger tight," with the other manipulator. The plastic cap was

1 3/8 inches high and 1 5/8 inches in diameter.

Packaging (Secondary Container)

The bottles were placed on a conveyor cart and transported to the conveyor station at the back of the hot cell complex, where each bottle was placed, with the aid of a single manipulator, into a secondary, shielding container. This was a stainless steel/lead lined container called a "pig." The outer dimensions of the pig were 12 inches high and 8 1/2 inches in diameter. The inside space was 3 1/4 inches in diameter with a 1 7/8-inch deep inner ledge at the top. The pig had been decontaminated thoroughly and was placed in the receiving station, which was just below the conveyor station, before the bottles were moved from hot cell #2.

A shielding plug top with a neoprene type gasket was then put in place and the pig was lowered onto a dolly. The heavy shield door was opened and the shipment was wheeled out of the conveyor station to the packaging area. The plug top was bolted down onto the pig with four 1/2-inch bolts. Smears (paper swipes) were taken to verify that there was no contamination on the outside of the pig.

Outside Wooden Protective Jacket

The pig was then lowered into a wooden overcoat or jacket, the top of which was bolted down onto six 1/2-inch steel bolts. The outer jacket was a 4-inch-thick layered plywood container, the dimensions of which were 23 inches high by 23 inches in diameter. It was secured to a 5-inch-high, 28-inch square pallet to facilitate handling by forklift. Readings were then taken of the radioactivity on the surface (200 mR/hr) and at 1 meter distance (8 mR/hr). The packages were labeled, sealed with a lead seal, and moved onto the loading dock where they were smeared once more before being loaded by crane onto a company truck for forwarding. An illustration of the containers appears in Attachment A-1.

UCC had no written procedures for the maintenance of reuseable Type B pigs and wooden jackets. When these containers were returned by motor freight, they were checked for any contamination, decontaminated if necessary, and examined by personnel from the packaging area to assure that these containers appeared to be in satisfactory condition for reuse.

Contents

Each of the two polyethylene bottles in this shipment contained 283.5 ml. of Mo 99 in liquid form and the calibrated isotope specification for each was 65,200 mCi (millicuries). When packaged for shipment, each completed piece weighed 430 pounds and had a Transport Index (TI) of 8. The total shipment was two pieces at 860 pounds with a TI of 16.

The labeling of the packages was as follows:

a. Metal tag secured to outside of jacket (reproduced below)

RADIO	ACTIVE MA	TERIAL
U.S.A.	D.O.T.	S.P. 5800
Type -B		Wt. 90 kg
	RBIDE COR	RPORATION

- b. Two Radioactive Yellow-III labels on opposite sides of each jacket, (see Attachment A-2a).
- c. One address label glued to jacket, (see Attachment A-2b).
- d. "Packing" slip envelope (white with red print) glued and taped to jacket (containing UCC Order Invoice 28856 and a copy Airbill Number 006 JFK 432 4103, prepared by the shipper) (see Attachment A-3).
- e. Manila envelope taped to jacket, rubber stamped in red, "Department of Transportation Special Permit No. 5800," containing copy of the permit, (see Attachment A-4).

Transport

At 2:10 p.m., Friday, December 31, UCC delivered the subject shipment to the Delta Air Lines air freight dock at John F. Kennedy International Airport, Jamaica, New York (JFK) in their own Chevrolet Carryall, a 3/4-ton truck.

Other UCC shipments were also delivered to Delta Air Lines in the same movement. These shipments included 4 cartons of radioactive material weighing 515 pounds which were consigned to Hastings Radiochemical Works in Houston on Airbill 006 JFK 4327 4114. One piece was a pig slightly smaller than, but similar to, that consigned to Bio-Nuclear Laboratories.

The larger radioactive shipments were moved by forklift from the truck and placed onto an airline cargo cart with dropsides.

2. Carrier

Delta Air Lines, Inc., Atlanta Airport, Atlanta, Georgia, 30320, is a Delaware corporation with headquarters offices in Atlanta, Georgia. The company operates as a scheduled air carrier under a

currently effective certificate of public convenience and necessity issued by the Civil Aeronautics Board, and an operating certificate issued by the Federal Aviation Administration (FAA).

Delta personnel received the Bio-Nuclear shipment at their air freight terminal at JFK and signed for it in good order with no exceptions noted.

Receipt

The shipment was received on the Delta ramp and moved from the delivery truck onto a Delta Wollard Baggage Cart, Model BC-450, where it remained until it was taken out to the flight line for loading into the aircraft. It was not taken into the warehouse.

Load Planning

The load agent, in working the load, found he had more than 50 TI's, which is the maximum allowable on one aircraft. Therefore, he held one shipment of radioactive material destined to Houston until Delta's next departure, passenger-carrying Flight 981 of December 31, which was scheduled to depart only 2½ hours after Flight 925. This shipment was shown on airbill JFK 4327 4136. It weighed 33 pounds and had a TI of 8. Flight 981 loadpapers are Attachment A-5.

Dispatch .

Flight 925 was dispatched with a total TI of 48, consisting of two shipments to Houston in Cargo Bin 3:

No. of Pieces	Weight (lbs.)	Airbill No.	Transport Index
2	575	JFK 4327-4114	17
2	860	JFK 4327-4103 *to Bio-Nuclear	16*
and one shipment	to New Orleans in Ca	argo Bin 4:	
6	228	JFK 4377-3811	15

The captain was so advised by the Restricted Articles Notice form attached to his clearance release (see Attachment A-6). Other freight, air mail, and first class mail were also loaded in bin 3 (see Flight 925 dispatch records which are Attachment A-7).

Cargo Bins

The Convair 880 has two cargo bin areas below the passenger compartment floor, one forward of the wing and the other behind the main landing gear and hydraulic compartments, (see Attachment A-8). They are each 19 feet long by 3 1/2 feet high and each has one 38-inch-wide access door in the middle of the bin on the right side of the aircraft. However, the push-in door, cargo net, and fuselage limit the height of the entrance to 20 inches (see Attachment A-9). For convenience, Delta numbers their cargo bins #1 through #4. The forward section of the forward

bin is #1; the aft section of the forward bin #2; #3 is the forward section of the aft bin; and the aft section of the aft bin is #4.

Passenger Load

On departures from New York and New Orleans, the aircraft was occupied as shown in the following chart:

Crew: 3 Flightcrew (cockpit)
3 Stewardesses (cabins)

From New York	1st Class (Forward Cabin)	Coach (Aft Cabin)
No. of seats available	24	96
Passengers to New Orleans	1	30
Houston	0 + 1 (Nonrevenue)	19 + 1 (Nonrevenue)
Total	2	50
From New Orleans to Houston	0 + 2 (Nonrevenue)	22 + 1 (Nonrevenue)
Total	2	23

Cargo Loading

The Ramp Agent and two Ramp Service Agents who loaded the three heavy Bio-Nuclear and Hastings radioactive pieces of freight reported that the loading procedures for bin 3 were as follows:

The International Scout Conveyor - Model TC-476 was placed at the cargo bin door (see Attachment A-10). The sides of the baggage cart (in this case freight cart #12) were dropped to make it more nearly a flat bed and it was maneuvered to a position directly under the low end of the conveyor belt (see Attachment A-11). From there the first 430-pound piece was tipped on its side and lifted by two men until it started up the belt, at which time it was rolled over onto its flat top because the pallet on which it was secured extended 2 1/2 inches beyond the wooden jacket and hampered the operation by digging into the belt. It was balanced by one man as it progressed up the belt to the cargo bin door. The conveyor height was adjusted lower so that the pig could then be rolled over onto its side and worked into the cargo bin from

where it was pushed all the way forward in the bin. There was no apparent damage done to the shipments during loading, and handling was held to a minimum because of the weight. After the heavy pieces were placed, the following Houston cargo was loaded into bin 3:

No. of Pieces	Weight (lbs.)	Class
12	214	Air Mail bags
5	132	First Class Mail
9	207	Air Freight

Intermediate Stop

The compartment was opened in New Orleans; however, there was no freight or mail to be off-loaded from the forward section, bin 3, so New Orleans personnel were not involved with any of the contamination.

Radioactive Material Training

The Delta Air Lines training supervisor at JFK was not interviewed personally because he was out of town on a business trip, but he prepared a statement which reads as follows:

"My training schedule at JFK follows prescribed company schedules and material. All new employees with Delta who have contact with radioactive materials are given training in their first week of employment. In addition all employees are given recurrent training once each year on radioactive materials.

"Our source of material for training are:

- 1. Hazards of Radiation in Shipping Radioactive Cargo, (Book).
- 2. Radioactive Materials (Standard Practice 805).
- 3. Air Cargo Restricted Articles (Standard Practice 891).

"Included in this training our employees are shown the shipping labels used, the total amount of Transport Index allowed on our aircraft, and the bins we allow radioactive materials in.

"Also I instruct employees in handling, distances, and dangers should package become damaged.

"Our Load Agents, Ramp Agents and Supervisors are instructed on the above, however, they receive additional training such as notification of Pilots of all restricted articles onboard, proper entries on our load message (teletype), and those agencies to notify in case of a damaged shipment."

Cargo Off-Loading

At Houston, the four Ramp Service Agents who off-loaded the Houston cargo reported that luggage from bins 1 and 2 was off-loaded first, then the freight cargo from bins 3 and 4. They reported that the three heavy containers of radioactive materials in bin 3 were lying on their sides and were not standing in upright positions. "Nothing unusual was thought of this as they have to be turned sideways, tilted, etc., to get them in and out of Convair 880 plane cargo bin doors. There also was moisture noted on bin floor, but this is not uncommon as many times a plane is

loaded in the rain or bad weather and moisture is carried into a bin area on cargo." The two men at the foot of the conveyor belt slid the containers off the belt onto a cart. "Since these articles are very heavy, 430 lbs. each, we had to slide them off the belt and in doing so they have a tendency to fall on their side." As each container was off-loaded the men got up on the cart, set them upright, and positioned them on the cart.

Warehouse Storage

The three heavy containers of radioactive material and several small boxes containing radioactive material were then taken to the freight warehouse where they were left on the cart overnight, separated from any other airfreight. A shift change followed this activity, but the next morning, January 1, the Bio-Nuclear shipment was unloaded from the cart in the warehouse by the same man who later helped load it on the consignee's pickup truck the following morning, January 2.

Aftermath

The handler who worked inside cargo bin 3 during the off-loading at Houston was contacted at 4:30 p.m. on Sunday, January 2, and advised of the contamination problem. His work clothing was found to be contaminated, and he was given a medical examination which revealed no apparent injury. He subsequently reported a burn area on one leg which had been exposed to the contamination. An examination of this condition revealed that it was "...a chemical reaction from the solution the radioactive material was in."

3. Consignee

Bio-Nuclear, Inc., 6006 Schroeder Road, Houston, Texas, 77021, is a subsidary corporation of the American Biomedical Corporation, Dallas, Texas. It is a Texas State licensed radioactive materials processor. At the time of the incident, Bio-Nuclear did not have a Health Physicist on its staff.

They have been receiving from UCC weekly bulk shipments of liquid Mo 99 for over a year and use it to process Technetium (Tc 99), a daughter of Mo 99 with a 6-hour half-life. Tc 99 is a radioisotope used by the medical profession for diagnostic purposes. Routinely, the shipment is sent on Fridays. The consignee's plant is closed on Saturdays. The shipment is picked up early on Sundays, for Sunday night processing and early Monday distribution to customer hospitals and doctors.

About 7 a.m. Sunday, January 2, the Bio-Nuclear shipment was picked up by their driver from the Delta freight dock at Houston Intercontinental Airport. Hastings Radiochemical had previously discovered that its consignment was contaminated, and that company notified Bio-Nuclear of the possibility that the Bio-Nuclear consignment was also contaminated. The Bio-Nuclear packages were surveyed with a Ludlum Geiger counter (2000 mR range), and the reading was off the top of the scale. Traces of white powder also were found on the rim of the pig. The liquid remaining in the two plastic bottles was transferred to the extractors as quickly as possible to minimize radiation exposure. No measurements were made of the amounts actually in the bottles, but it was noted that the liquid level in one bottle was lower than those of previous shipments, and the inside of the pig was wet. The packaging containers and absorbent papers used for handling were removed to a remotely located warehouse.

Bio-Nuclear called Delta Air Lines, informed them of the findings, advised them to check the employees who handled the shipment, and gave interim instructions on decontamination procedures. After moving the contaminated containers to the warehouse, Bio-Nuclear notified the Texas State Health Department.

4. Activities After Discovery of Contamination

a. Notification

There are specific requirements for the carrier to make immediate notification to the nearest FAA facility by telephone in certain cases of dangerous article incidents. Breakage of a shipment calls for immediate notification to the shipper and the Department of Transportation (DOT) and a report within 15 days to the DOT, Hazardous Materials Regulations Board. It is required that a copy also be sent to the FAA facility which was first contacted (14 CFR Part 103.23, Part 103.28 and 48 CFR Part 171.16).

Since the shipment appeared to be in good condition at the time of consignee pickup, and the carrier was not immediately alerted to the possibility of contamination, it was several hours before all concerned parties were notified of this incident. Official records of the first few original notifications are either nonexistent or very sparse. Consequently, the attached notification chart (Attachment A-12) is a reconstruction of the approximate sequence of events since almost all times shown are estimates.

b. Postincident Activity

(1) Aircraft Movement Until Taken Out of Service

Delta Air Lines did not know that their plane, Convair 880, N8801E, was contaminated when it arrived in Houston before midnight on December 31, 1971. Consequently, the aircraft was continued in regularly scheduled passenger service until it landed at O'Hare International Airport, Chicago, Illinois, about 8 p.m., January 2. Following is a chart which shows the flight numbers and cities involved during this period of operation while the aircraft was contaminated:

Flight/Date	Origination	Intermediate Stops	Termination
#925 Dec. 31, '71	New York, N.Y.	New Orleans, La.	Houston, Texas
#998 Jan. 1, '72	Houston, Tex.	Atlanta, Ga. Dayton, Ohio Columbus, Ohio	Miami, Fla.
#952 Jan. 1, '72	Miami, Fla.	West Palm Beach	Chicago, Ill.
#939 Jan. 1, '72	Chicago, Ill.	Louisville, Ky. Atlanta, Ga.	Tampa, Fla.

Flight/Date	Origination	Intermediate Stops	Termination
#992 Jan. 1, '72	Tampa, Fla		Atlanta, Ga.
#1951 Jan. 2, '72	Atlanta, Ga.	•	Miami, Fla.
#1942 Jan. 2, '72	Miami, Fla.		Atlanta, Ga.
#955 Jan. 2, '72	Atlanta, Ga.		West Palm Beach, Fla
#954 Jan. 2, '72	West Palm Beach, Fla.	Tampa, Fla.	Chicago, Ill.
The aircraft arrived	-	t 6:30 p.m., was surv	veyed,

and taken out of service.

Ferry Jan. 2

Chicago, Ill.

Atlanta, Ga.

Aircraft Contamination

The aircraft was initially surveyed by the AEC at Chicago, O'Hare International Airport after 7:00 p.m. on Sunday Jan. 2.

Instrument:

Juno Model #7 survey meter

Readings:

- at rear cargo door 50 mR/hr.
- In center of cargo bin 3 500 mR/hr. to 3R/hr.
- In aft passenger cabin at seats 34 & 35 200 mR/hr.

The scheduled flight was cancelled and the aircraft was moved to the hangar area until it could be ferried to Atlanta.

On arrival of the ferry flight at Atlanta, the Georgia Department of Public Health, and the AEC, assisting in the emergency, again surveyed the aircraft.

Instrument:

Eberline E-500 GM type (Geiger-Muehler scanner) with 30 mg/cm² probe.

Readings:

- Contact reading on floor under seat 34-140 mR/hr.
- Highest reading on bottom of seat 35-60 to 70 mR/hr. Eberline E-120 (maximum range of 50 mR/hr).

Instrument:

Readings:

- Forward end of cargo bin (without handprobe) 3 to 4 R/hr. (estimate based on state of reading).
- Smear at forward end of cargo bin 2R/hr.
- Smears-on spots generally in middle of cargo bin 4 mR/hr. to 10 mR/hr. (contaminant could be wiped out).

- Air inlets (at side of cabin just below hatracks) above seats 34 & 35 low level traces of smearable contaminant.
- Air exit vents (outboard of and below the seats) at seats 34 and 35
 little more than a trace (see Attachment A-13 for seat locations).

Seat and floor readings were the result of direct radiation from the leaked radioactive liquid source. Smearable contamination resulted from airborne radioactive particulate (e.g., dust).

There was no contamination found at the adjustable ventilators installed over the individual passenger seats. (See Attachment A-14 for details of Convair 880, Air Distribution System.)

The only access route for air movement between the cargo compartment and the aircraft ventilating system was a 2 3/4-inch breather hole provided in the sidewall above the cargo door to permit pressure equalization between the passenger compartment and the cargo area. On depressurization, air from the cargo compartment exhausts into the outflow side of the system to the outflow valve. Air in the cargo compartment is generally static except during cabin pressure changes. (See Attachment A-9 for location of breather hole.)

(3) Aircraft Decontamination

The Georgia Department of Public Health, Radiological Health Service in Atlanta, took charge of and actually decontaminated the aircraft and was assisted by Delta Air Lines personnel. The AEC Regional Compliance Office in Atlanta, although primarily a regulatory organization, served as coordinating office. They worked with DOT, FAA, and the carrier. AEC Operations Division personnel furnished Radiological Assistance Team support where necessary.

After determining that the cargo bin was constructed with a fiberglass liner taped to the structure and a metal floor, it was decided to remove the liner from bin 3 and strip out the old tape.

Personnel who were to enter the cargo bin were dressed in full length cover-alls, rubber boots, rubber gloves and were equipped with a Martindale respirator, two dosimeters (instruments for measuring doses of radioactivity) and a film badge. The first man into the bin was allowed a maximum exposure time of 15 minutes. His dosimeters read 38 mR.

The the next man in was allowed 45 minutes to work and his exposure was not mR. The charge of the operation who was in the midst of the activity the entire time had a 100 mR reading on his self-dosimeter.

The fiberglass floor liner, when removed, showed 2-plus R/hr., as did two panels of the metal underfloor and cargo tiedown rings, which were also removed. Air tools were used and insulating material was vacuumed out. The inside was then scrubbed with liquid soap and rinsed, but was not flushed, to avoid possible spreading of the contaminant. On Monday, January 3, 1972, at 3:30 p.m., the aircraft was released. When surveyed, the readings on the aircraft structure (excluding the cargo bin liner, which was removed) had ranged from 160 mR/hr. to 2-plus R/hr. On completion of the decontamination, the maximum contact reading was only 50 mR/hr. under the aircraft belly.

On January 6, one week after the incident and more than 3 days after decontamination, the aircraft made its first landing in Tampa, Florida, where it was checked for radioactivity and was found to be contaminated. Accordingly, the aircraft was sent back to Atlanta for further checking and decontamination, as necessary. There were two spots in the cargo bin

where contact readings could be found. The tape was stripped out and no removable contamination was present. The aircraft was again returned to service.

This incident provided an example of the differences in response to tests for radioactive contamination resulting from different scanning equipment utilized, proximity to the source, and the interpretation given to the various readings.

(4) Employee and Passenger Involvement

The first consignee (Hastings Radiochemical) to receive a shipment from the subject flight, discovered the contamination by normal scanning. They checked the employees and equipment before the contamination had time to spread in their facility. By the time Bio-Nuclear was notified the following day of the possibility of contamination, their driver had picked up the shipment at the airport. However, on receipt of the shipment at the plant, they handled it as a "hot" shipment. Consequently, there was no contamination spread throughout that facility.

The first word of this incident received by the manufacturer was followed by a check of their facilities which revealed no contamination on their equipment or employees.

By the time the carrier was notified, the contaminated aircraft had been through airports in 10 cities; many employees had serviced it with numerous pieces of airline equipment; and much freight, express, and mail had been moved in its cargo compartments. Most of these could be traced, but the mail was the exception. However, the major problem confronting the airline was the 917 passengers who had flown onboard the aircraft and had their baggage in one of the cargo compartments.

The AEC established scanning stations in the various cities involved and established a set of guidelines for Delta to implement (see Attachment A-15). Meanwhile, Delta personnel started with the ticket flight envelopes and started backtracing the people who were shown to have been onboard the aircraft. More than two-thirds of the total number were contacted personally by telephone, and the press was used in certain off-route areas to advise passengers of the problem and offer professional assistance to scan them and/or their baggage.

Survey check stations were set up in the ten cities at which the contaminated aircraft had stopped. The personnel from these check stations also surveyed eight homes on request. Passengers were advised by phone and the news media that they could either come to the check stations or contact their state health agencies. Arrangements were made for the employees who had actually worked the shipment to have total body scans perfected at other places, such as local hospitals or medical schools which had the facilities to perform this task.

The results of the passenger survey indicated that neither passengers nor employees had been subjected to a personal health hazard although some had been exposed to more radioactivity then is acceptable under the concept of the lowest practical exposure of people to radiation. This information was also reported in the press.

(5) Baggage Involvement

One hundred twenty-four passengers brought 271 various articles plus two dogs to the survey check stations for examination. Numerous bags were found with a small amount of contamination, and there were some with comparatively high levels of contamination.

Contamination on a piece of luggage did not mean that the entire piece was radioactive, but that there was a spot on it which yielded a high reading. In most cases, on the smoother finish luggage, this was easily washed off, and the luggage was turned back to the owner immediately. Some of the cloth finish bags did not clean up so readily and were either stored by the airline until the radioactivity decayed or were covered with tape and returned to the owner for personal storage in some remote area of his home until such date as the radioactive would have decayed.

No total has been recorded yet for the numbers of articles that were surveyed by the other health agencies. However, if there had been any gross radioactive findings, they would

have been reported to the AEC or State authorities.

There were some instances of contamination found on baggage-handling facilities at airports served by the aircraft. Those facilities were decontaminated as soon as they were discovered.

5. Examination of the Shipping Containers

Twenty-five days after the radioactive leak occurred, the shipping containers were viewed in a remote quarantined warehouse belonging to the consignee. The items were not handled because they were still too radioactive. The following notes were made.

Subject of observation	Unit identified as #40	Unit identified as #16
Top section of wooden protective jacket Sodium hydroxide (NaOH) deposits.	Both sides of top, in line with forklift access on pallet, plywood rings were chafed and abraded. Visible salt deposits in chafed area on only one side of wooden overcoat top.	Both sides of top in line with fork-lift access on pallet, plywood rings were chafed and abraded Visible salt deposits at outside of juncture between top & bottom of wooden overcoat.
Gasket between lead- lined plug top and pig (secondary con- tainer).	Section approx. 3 in. along outer diameter, roughly 70° - 80°, was missing.	No gasket present.

Subject of observation	Unit identified as #40	Unit identified as #16
Polyethylene bottle (primary container).	Reportedly, water had replaced radioactive liquid to the top of bottle and top had been secured finger tight: Bottle resting down in beaker with some liquid in the bottle was squeezed between fingers, liquid escaped.	

Thirty-eight days after the shipping incident, the containers were viewed again after they had been returned to UCC. They were in the plant, but isolated in a roped-off quarantine area. The container parts were still too radioactive to be handled.

During this visit to the plant, a demonstration of the polyethylene bottle filling process was conducted by the hot cell operator who had filled the bottle for the subject shipment. For this demonstration, however, water was used instead of a radioactive material. The process followed that which was described earlier in this report. After the demonstration bottle was removed from the hot cell and checked for any contamination, it was picked up with gloves, and when tipped upside down, the water leaked rather freely. Then the "tightness" of the screw-cap was checked. Although it had appeared to be on securely, it was only "manipulator-finger" tight. It released and unscrewed with only very light fingertip pressure. Subsequently, the top was tightened with fingers and the thumb around the cap and the seal then contained the liquid inside.

III. CORRECTIVE ACTION

Subsequent to the incident, there was a concerted effort toward eliminating the potential for another incident involving a radioactive material leak which could contaminate cargo and baggage areas in aircraft and/or endanger passengers or the public at large.

The manufacturer, UCC, took several actions that included:

- Meeting with the Atomic Industrial Forum, which is an industrial trade association comprised of radioisotopes manufacturers, shippers, processors, etc. The Radioisotope Committee agreed to develop new, effective, and workable container leak-tests that could be adopted by the American Standards Association.
- Discontinued use of the old polyethylene filler bottle for a new one with a different sealing arrangement.
- Evaluation of an induction-welded sealing cap for the primary container.
- Primary container for liquid shipments are now leak checked to 25 inches of mercury before they leave the hot cell.
- Changed from handmade neoprene gasket for the pig to manufactured natural gum rubber

gasket for better seal.

• Consideration of a change to a plug type gasket that would fill the remaining space around the top of the polyethylene bottle.

• Pigs with gaskets to be leak checked once and then rechecked again each time a gasket is

changed.

- Consideration of a leak-check for the bottle and secondary container pig for each liquid, Type B and Iodine shipment.
- Initiating a preventive maintenance program with records kept, using newly assigned serial numbers to pigs.

• Instituted an administrative change which requires two people (packer and man who worked

hot cell) to check the packaging of each shipment.

The carrier proposed to the Civil Aeronautics Board that shippers of radioactive material in Type B packages be required to conduct a leak-test at the point of origin; and state in writing that the consignee will perform a wipe-test within 3 hours of shipment arrival at destination. This will assure that packages are safe to carry on aircraft and determine if leakage has occurred during flight. This tariff became effective March 12, 1972 and is to expire June 12, 1972. CAB Order No. 72-3-28 dismissed the complaint against it.

IV. ANALYSIS

Of primary concern in this analysis are the conditions leading to the leakage of a bulk radioactive shipment in liquid form which contaminated equipment and exposed the public to higher levels of radiation than the generally acceptable minimum. Reports of all the authorities concerned with this incident assured those people who were involved that the exposures encountered did not constitute a health hazard. It did, however, create many harrowing hours of activity and concern for the passengers on the flights; for employees who handled the contaminated package and subsequently used the contaminated equipment; and for the personnel responsible for decontaminating of equipment and scanning people and baggage for radioactivity.

There is no shortage of regulations governing the manufacture, transportation, and use of radioactive materials. Admittedly, the regulations are rather complex and spread throughout several different volumes; but they are specific in the requirement that the radioactive material must be

contained.

The manufacturer was thoroughly familiar with the product, how to handle it safely, and the Type B packaging being used, because this had been, for more than a year, a routine weekly bulk radioactive

shipment to the same consignee.

The manufacturer's employees reportedly had operated a nuclear reactor and packaged the product for shipment over the year without injury or incident. The redundant (primary and secondary container) Special Permit authorized packaging was designed to survive major accidents in transportation without releasing the contents. These requirements covered impact, as well as subsequent fire.

Possibly the aforementioned familiarity with the reusable Type B containers led to a relaxed approach in the maintenance of the stainless steel/lead-lined pigs. There was no written company procedure for assuring that each pig met the standards for reuse. The plastic inner bottles had apparently served well, and there seemed to be no reason to especially mistrust them or their security. Even for the demonstration-filling of a typical plastic bottle, the liquid (water) was not contained by the screw cap as it was installed by the operator/manipulator combination. However, it was noted that the top could easily be screwed down tightly enough with bare hands to have satisfactorily contained the liquid. Apparently, the final inner bottle seal had not been tested recently.

"This Side Up" labels were not required on the outside of the packages. If the containers are satisfactory, there should be no need for this addition. However, the outside wooden protective jacket is shaped with a pallet/platform bottom which would tend to indicate which way it should be carried, if for no other reason than to spread the load over a larger section of the cargo bin floor.

The bulk of the individual 430-pound package necessitated normal upright handling by forklift and crane. However, it did create problems when it came to loading the 28-inch-high package into a 20-inch-high access door of a CV-880 cargo bin. There was room, once inside, for the package to have been turned upright onto its pallet base. If this had been done, the bottle would have had only about 10 minutes to leak rather than approximately 4 hours. Accordingly, the radioactive liquid probably would not have leaked outside the secondary container. This would also have prevented subjecting the bottle to air pressure changes while it was upside down.

The carrier indicated that it had a training program wherein the employees were instructed in handling radioactive shipments. The AEC in Atlanta reported that they had given instruction on this subject to the carrier's management personnel for relaying to the cargo handler (Ramp Service Agent) level. Some of the Ramp Service Agents interviewed had received such instructions, but others of the cargo handling personnel indicated that the instruction had not been given to them.

Although it was preplanned, the delay by the consignee in picking up the shipment added to the magnitude of the problem, as did the loose notification procedures and the lack of a specific emergency procedures plan. These aspects delayed a timely discovery and immediate initiation of remedial measures.

Subsequent to the original interview of the Georgia Department of Public Health personnel, the Radiological Health Service representative, who was in charge of the aircraft decontamination in Atlanta, was contacted for some additional information and for clarification of some reports. During discussion of the "traces" of contamination reportedly found in the passenger cabin air inlets and air exit vents, it was determined that air vent contamination was not a problem since the trace readings were insignificant, and the origin of the contaminant was questionable. It was explained that the smears/wipes of the upper and lower grids of the ventilating system were made and placed in envelopes, then into a bag. Following this activity, the smear/wipes were made in the highly contaminated cargo compartment. These were then placed in envelopes and *all* envelopes were taken to the laboratory.

At the laboratory, the contents of the 20 to 30 envelopes, some of which were "extremely hot," were then placed inside glassine envelopes. The multichannel analyzer with a 5-inch sodium iodide crystal indicated only traces, approximately 300 counts/min. or less. This is considered to be an insignificant amount, and it is suspected that this trace amount was the result of cross-contamination of the specimens, especially since the entire air flow is into the cabin through the inlet, out of the cabin by the exit vent, past the cargo bin breather, to the outflow valve.

V. FINDINGS

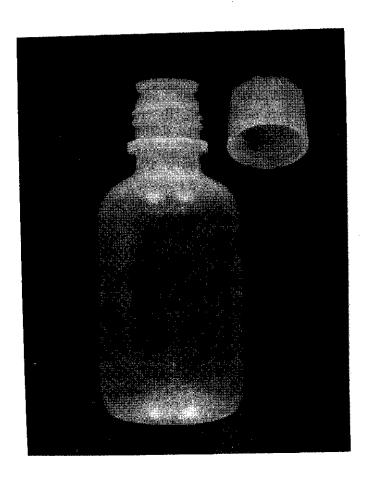
- The reusable Type 2 packaging used for transporting the subject radioactive bulk shipment in liquid form did not fulfill the containment requirements of the regulations.
- The manufacturer did not have a standard maintenance procedure for overseeing the condition of the returned Type B pigs before reuse.
- An unfortunate chance-combination of human errors resulted in this incident, i.e., plastic bottle top too loose, pig gasket in unsatisfactory condition, package rolled onto and left on its side during transport. The removal of any one of these steps from the sequence would have prevented this incident.

- The carrier's training program for handling radioactive materials had not reached all cargo handling personnel.
- A routine delay in pickup of the shipment by the consignee and the lack of a specific emergency plan for incidents such as this prevented timely discovery of the situation and initiation of immediate remedial action. This resulted in increasing the magnitude of the problem.
- Trace indications of radioactive contamination in the passenger cabin ventilating system were the result of cross-contamination of the specimens as they were taken to the laboratory.
 - Reportedly, there was no health hazard to passengers or employees involved in this incident.

VI. CONCLUSION

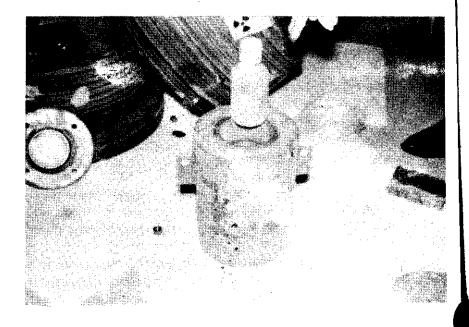
It is concluded that this incident occurred because of the improper packaging of a bulk liquid radioactive shipment in a poorly maintained reusable Type B container. A contributing factor was the transport by air with the package lying on its side.

ATTACHMENT A-1

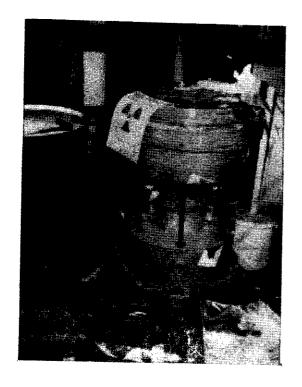


Typical PRIMARY CONTAINER
Polyethylene bottle

SECONDARY CONTAINER "PIG" Stainless steel/lead lined Bio-Nuclear package # 40



ATTACHMENT A-1-2



Typical - DOT SP-5800 SHIPPING CONTAINER Wooden protective jacket



CONTAINER #16 - Bio-Nuclear Neoprene gasket missing



CONTAINER #40 - Bio-Nuclear Section of neophrene gasket missing

ATTACHMENT A - 2



Package Label
RADIOACTIVE - YELLOW III

Bright yellow upper half White lower half

b.



FROM

UNION CARBIDE CORPORATION

STERLING FOREST RESEARCH CENTER P. O. BOX 324, TUXEDO, NEW YORK 10987

To:

BIO-NUCLEAR LABORATORIES

HOLD AT AIRPORT

HOUSTON, TEXAS

CONTENTS-MERCHANDISE

MADE IN U.S.A.

RETURN POSTAGE GUARANTEED

Address Label

RETURNABLE CONTAINERS
ARE 10 \$6 \$200,9742
TRANSPORTATION PREPAID
TO UNION CARBIDE GORP,
JUXEDO,NY, WITHIR 7 DAYS
OF RECEIPT. A CHARGE OF
\$10.00 PER WEEK WILL BE
MADE FOR CONTAINERS
HELD MORE THAN 7 DAYS.



UNION CARBIDE CORPORATION STERLING FOREST RESEARCH CENTER P. O. BOX 324, TUXEDO, N. Y. 10987

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DEPARTMENT OF TRANSPORTATION HAZARDOUS MATERIALS REGULATIONS BOARD WASHINGTON, D.C. 20590

SPECIAL PERMIT NO. 5800

This special copy permit is issued pursuant to 46 CFR 146.05-4 of the U. S. Coast Guard (USCG) Dangerous Cargo Regulations and 49 CFR 170.13 of the Department of Transportation (DOT) Hazardous Materials Regulations, as amended.

- 1. The U. S. ATOMIC ENERGY COMMISSION (USAEC) and its contractors and licensees, the DEPARTMENT OF DEFENSE and its contractors, and licensees of "agreement states" as approved by the USAEC, are hereby authorized to ship Type B quantities of any non-fissile radioactive material in either normal or special form, as provided for herein.
- 2. Each user of this permit must register his identity with this Board prior to his first shipment under the permit.
- 3. The authorized packaging consists of an interim DOT Specification 20WC wooden protective jacket, as described in Appendix A hereto, when used with any single one of the following types of inner containment vessels which must fit snugly within the jacket:
 - a. A DOT SPECIFICATION 55 (or equivalent) metal-encased shielded inner containment vessel;
 - b. A DOT Specification 2R (or equivalent) metal inner containment vessel; or
 - c. A DOT Specification 7A inner packaging which has a metal outer wall (not authorized for normal form radioactive materials).
- 4. The packaging design is based upon the ambient conditions as prescribed in Marginal C-2.4.3 of the Regulations for the Safe Transport of Radioactive Materials, 1967 Edition, International Atomic Energy Regulation (IAEA).
- 5. The authorized package meets the criteria of the International Atomic Energy Agency for Type B packaging for radioactive materials.
- 6. Prior to each shipment authorized by this permit, the shipper shall notify the consignee and, for export shipments, the competent authority of any country into or through which the package will pass, of the dates of shipment and expected arrival. The shipper shall notify each consignee of any special loading/unloading instructions prior to his first shipment.
- 7. The outside of each package must be plainly and durably marked "USA DOT SP 5800" and "TYPE B", in connection with and in addition to the other markings and labels prescribed by the DOT regulations. Each shipping paper issued in connection with shipments made under this permit must bear the notation "DOT SPECIAL PERMIT NO. 5800", in connection with the commodity description thereon.

Continuation of SP 5800

Page 2

- 8. Each package of gross weight in excess of 50 kilograms (110 pounds) must have its gross weight in kilograms plainly and durably marked on the outside of the package.
- 9. Shipments are authorized only by vessel, cargo-only aircraft, passenger-carrying aircraft, rail, and motor vehicle.
- 10. No special operational transport controls are necessary during carriage except as specified herein, and no special arrangements have been made under Marginal C-6.5 of the IAEA Regulations.
- 11. For shipments by water, the shipper or agent shall notify the USCG Captain of the Port in the port area through which the shipment is to be made, of the name of the vessel on which the shipment is to be made, and of the time, date, and place of loading. When the initial notification is given in a port area through which the shipment is to be made of the name of the vessel on which the shipment of the Port.
- 12. Any incident involving loss of contents must be promptly reported to this Board.
- 13. This permit does not relieve the shipper or carrier from compliance with any requirement of the DOT regulations, including 46 CFR Parts 146 to 149 of the USCG Regulations, except as specifically provided for herein, or the regulations of any foreign government into or through which the package will be carried.
- 14. This permit expires January 15, 1971.

Issued at Washington, D.C., this 3rd day of January 1969.

/s/E. G. Grundy, Capt. For the Commandant U. S. Coast Guard

/s/S. Schneider
For the Administrator
Federal Aviation Administration

/s/D. W. Morrison
For W. R. Fiste
For the Administrator
Federal Highway Administration

/s/Austin H. Banks
For Mac E. Rogers
For the Administrator
Federal Railroad Administration

ATTACHMENT A - 4 - 3 Page 3

Continuation of SP 5800

Address all inquiries to: Secretary, Hazardous Materials Regulations Board, U.S. Department of Transportation, Washington, D.C. 20590. Attention: Special Permits.

cc:

U. S. Coast Guard
Bureau of Explosives, AAR
Federal Highway Administration
Federal Railroad Administration
Federal Aviation Administration
Atomic Energy Control Board, Canada
U. S. Atomic Energy Commission, Mr. Kaye
Department of Defense, Mr. Edwin T. Loss



DEPARTMENT OF TRANSPORTATION HAZARDOUS MATERIALS REGULATIONS BOARD WASHINGTON, D.C. 20590

SPECIAL PERMIT NO. 5800 FIRST REVISION

Pursuant to 46 CFR 146.02-25 of the U. S. Coast Guard (USCG) Dangerous Cargo Regulations and 49 CFR 170.15 of the Department of Transportation (DOT) Hazardous Materials Regulations, as amended, and on the basis of the October 14, 1970, petition by the Idaho Nuclear Corporation, Idaho Falls, Idaho and the November 5, 1970, petition by Westinghouse Electric Company, Pittsburgh, Pa.:

Special Permit No. 5800 is hereby amended by revising paragraphs (1), (5), and (14) and by adding new subparagraphs (1a), (9a), and (11a), to read as follows:

- "1. Shipments of Type B quantities (S 173.389 (L)) of any radioactive material, in normal or special form, are hereby authorized, as further provided for herein. This packaging, when constructed and assembled as prescribed herein, with the contents as authorized herein, meets the standards prescribed in the DOT regulations, Sections 173.394(b) (3), 173.395(b)(2), and 173.396(c)(3), and 173.398(c). The fissile radioactive material content of each package may not exceed those quantities and material types as limited and prescribed in subparagraphs (a)(2)(ii), (a)(2)(iii), and (b)(2) of S 10 CFR 71.6 of the USAEC Regulations, with such packages to be shipped as either Fissile Class II or III, in accordance with the package transport index limitations or shipment limitations prescribed therein.
- "1a. Each shipper, under this permit, other than the petitioners named above, and the other previously identified petitioners, shall register his identity with this Board prior to his first shipment, and shall have a copy of this permit in his possession before making any shipment.
- "5. The authorized package described herein is hereby certified as meeting the specific requirements of the International Atomic Energy Agency's (IAEA) "Regulations for the Safe Transport of Radioactive Material", Safety Series No. 6, 1967 edition, as follows:
 - a. Marginal C-6.2.2 The package design meets the requirements for Type B packaging for radioactive materials.
 - b. Marginal C-6.2.4 The package design with fissile contents as limited by paragraph (1) meets the requirements for Fissile Class II or III shipments.
- "9a. For shipments by air, a copy of this permit must be carried aboard any aircraft transporting radioactive materials under the terms of this permit. Fissile Class III shipments by cargo-only aircraft must conform to \$173.396(g)(1). Fissile Class III shipments by passenger-carrying aircraft are not authorized.
- "11a. For shipments by water, a copy of this permit must be carried aboard any vessel transporting radioactive material under the terms of this permit.

Continuation of 1st Rev SP 5800

"14. This permit expires January 15, 1973."

All other terms of this permit, as revised, remain unchanged. The complete permit currently in effect consists of the original issue and the First Revision.

Issued at Washington, D.C.:

/s/	R. G. Schwing, Capt. R. G. Schwing, Capt. For the Commandant U. S. Coast Guard	25 November, 1970 (DATE)
/s/	S. Schneider For the Administrator Federal Aviation Administration	18 DEC 1970 (DATE)
/s/	D. W. Morrison for W. R. Fiste For the Administrator Federal Highway Administration	2 December 1970 (DATE)
	Quentin H. Banks for Mac E. Rogers For the Administrator Federal Railroad Administration	9 December 1970 (DATE)

Address all inquiries to: Secretary, Hazardous Materials Regulations Board, U.S. Department of Transportation, Washington, D.C. 20590. Attention: Special Permits.

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Continuation of 1st Rev SP 5800

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Newport News Shipbuilding & Dry Dock Co., Newport News, Va.

January 1, 1969

Interim DOT Specification 20WC

§ 178.194 Specification 20 WC wooden protective jacket

§ 178.194-1 General Requirements

- (a) Each jacket must meet the applicable requirements of § 173.24 of this chapter.
- (b) Maximum gross weight of the jacket plus the contents may not exceed the following:
 - (1) Spec. 20WC-1: 500 pounds
 - (2) Spec. 20WC-2: 500 pounds
 - (3) Spec. 20WC-3: 1000 pounds
 - (4) Spec 20WC-4: 2000 pounds
 - (5) Spec 20WC-5: 4000 pounds

§ 178.194-2 Materials of construction

- (a) The general configuration of the wooden protective jacket is a hollow cylindrical shell constucted of one-piece discs and rings of plywood or solid hardwood reinforced with steel rods.
- (b) Plywood must be exterior-grade, void-free, douglas fir (or equivalent) not more than one inch thick. Solid hardwood is authorized for Spec. 20WC-2 only.
- (c) Discs and rings must be glued together with a strong, shock-resistant adhesive, such as either of the following:
 - (1) A resorcinol-formaldehyde adhesive, which has been bonded under heat and pressure; or
 - (2) A polyvinyl-acetate emulsion, which has been reinforced with cementcoated nails. The nails must be randomly spaced and must be at least 2-1/2 times as long as the minimum thickness of the plywood discs or rings.
- (d) Full-length steel rods are required for reinforcement and lid closure. For Specs. 20WC-1 and 20WC-2, a minimum of six rods at least 0.25 inches in diameter are required. For Spec. 20WC-3, a minimum of 12 rods, at least 0.375 inches in diameter are required. For Spec. 20WC-4, a minimum of 16 rods at least 0.375 inches in diameter are required, and for Spec. 20WC-5, a minimum of 16 rods at least 0.5 inches in diameter are required. For Specs. 20WC-1 and 20WC-2, steel rods must be equally

spaced around the circumference of the rings and discs, midway between the O.D. and I.D. of the rings. For Specs. 20WC-3 and 20WC-4, bolts may be staggered alternately in two rows, at ±0.5 inches from the line midway between the O.D. and I.D. of the rings. For Spec. 20WC-5, bolts may be staggered alternately in two rows at ± one inch from the line midway between the O.D. and I.D. of the rings. Rod ends must be threaded and secured with lock nuts and steel washers, or equivalent device, to provide at least a one inch diameter bearing surface on each end. Ends of the rods must terminate 0.75 inches below the surface of the plywood for Specs. 20WC-1 and 20WC-2. For Specs. 20WC-3, 20WC-4, and 20WC-5, the ends of the rods must terminate 1.5 inches below the surface of the plywood, and that portion of each end disc which extends beyond the rod ends must be further held in place with lag screws at least four inches long.

(e) Thickness of wooden shell:

- (1) Spec. 20WC-1: At least four inches thick.
- (2) Spec. 20WC-2: At least three inches thick. The jacket must be completely encased by a steel shell at least 18-gauge thickness, such as a Spec. 17H steel drum. The steel shell must be vented by at least four 0.25 inch diameter holes, which must be covered with a durable weatherproof tape.
- (3) Spec. 20WC-3: At least five inches thick for the jacket wall, and at least six inches thick for the end discs. In addition, at least three plywood chines, two inches wide and protruding two inches beyond the outer surfaces, must be located at each end and midway along the length of the jacket.
- (4) Spec. 20WC-4: At least six inches thick for the jacket wall, and at least six inches thick for the end discs. In addition, at least three plywood chines, two inches wide and protruding two inches beyond the outer surfaces, must be located at each end and midway along the length of the jacket.
- (5) Spec. 20WC-5: At least six inches thick for the jacket wall, and at least eight inches thick for the end discs. In addition, at least five plywood chines, two inches wide and protruding two inches beyond the outer surfaces, must be located at each end and equally spaced along the length of the jacket.
- (f) Figures 1 and 2 illustrate representative designs.

§ 178.194-3 Closure

- (a) Closure for the wooden protective jacket is provided by the steel reinforcing rods. The end cap (lid) must fit tightly to the body of the jacket to prevent a heat path to the inside of the jacket. The lid joint for Specs. 20WC-3, 20WC-4, and 20WC-5 may not be co-planar with the end of the inner containment vessel.
- (b) Spec. 20WC-2. Locking ring closure, if used, must conform to § 178.104-4. Flanged closure, if used, must have at least eight steel bolts (at least 0.25 inch diameter) and lock nuts (or equivalent device), spaced not more than five inches between centers.

§ 178.194-4 Tests

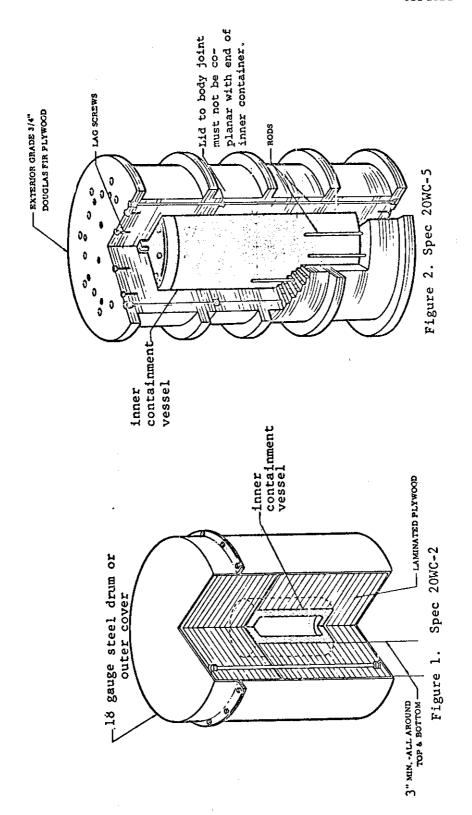
(a) Each jacket must be visually inspected for defects such as improper bonding, cracking, corrosion of steel rods, an improperly fitting closure lid, or other manufacturing defects. Particular attention must be given to any separation of the plywood discs and rings which would provide a heat path to the inside of the jacket.

§ 178.194-5 Painting

(a) Each jacket must be completely painted with a high quality exterior weather resistant paint.

§ 178.194-6 Marking

(a) Each jacket must be marked on the external surface as follows: "USA DOT 20WC-() TYPE B" and "RADIOACTIVE MATERIAL". The appropriate numeral must be inserted in the marking to indicate the appropriate Spec. 20WC category; e.g., "USA DOT 20WC-2".



ATTACHMENT A - 5

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FOR 0412 80166 NOTICE 1-70

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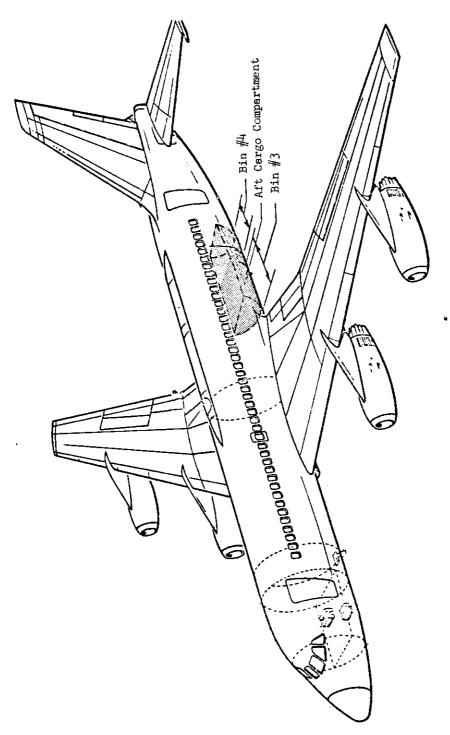
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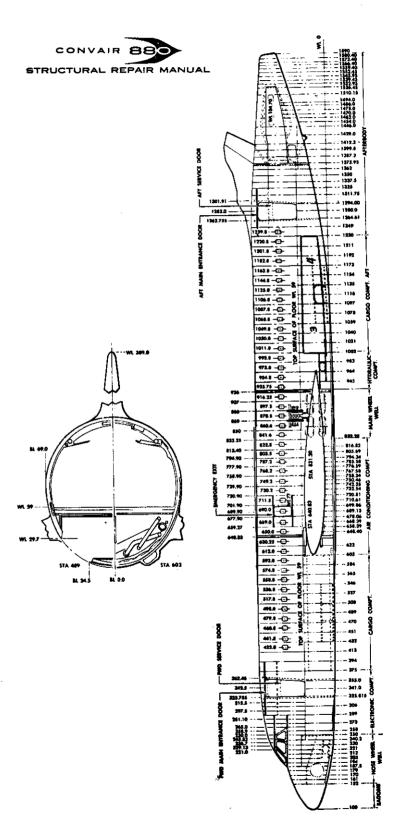
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ATTACHMENT A - 8



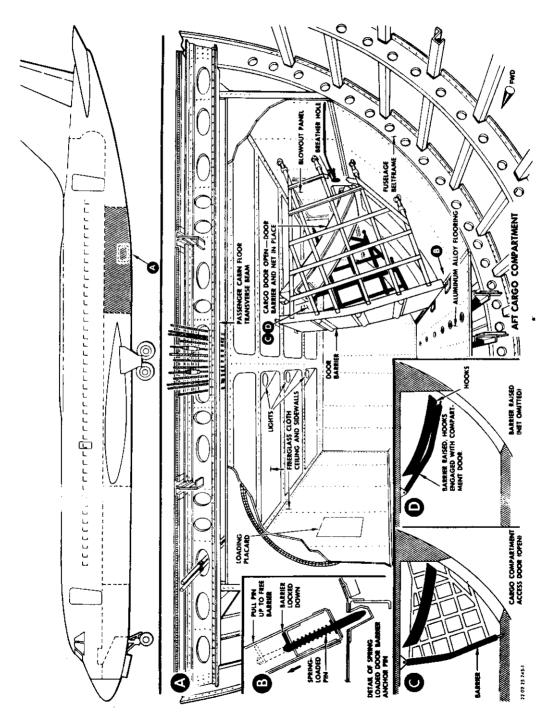


ATTACHMENT A - 8 - 2



ATTACHMENT A - 9





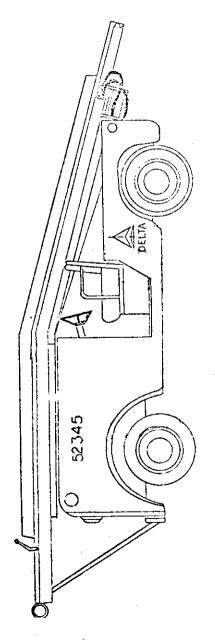
Cargo Compartments, Typical

DELTA AIR LINES, INC.

STANDARD PRACTICE

CONVEYORS

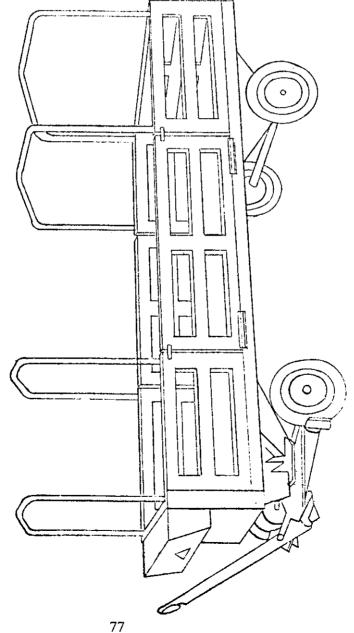
International Scout Conveyor - Model TC-476



DELTA AIR LINES, INC.

STANDARD PRACTICE

Wollard Baggage Cart - Model BC-450



RECONSTRUCTION OF SEQUENCE OF INCIDENT NOTIFICATIONS

REF.	DAY/DATE	TIME	CALLER	CALL RECEIVED BY	INFORMATION EXCHANGED
С	SAT./JAN.1	0800-0900	-	-	Hastings Radiochemical picked up shipment from airport. On return driver detected contamination during routine processing.
c	SAT./JAN.1	1330	Hastings	Hastings' Con- sultant HP- Radiation Safety Officer (RSO)	Advised him of probable contamination. (He came in, surveyed packages, and confirmed contamination.)
C	SAT./JAN.1	1430	Hastings-RSO	Texas State Health Dept.	Advised of external contamination
C	SAT./JAN.1	1445	Hastings-RSO	American Biomedical Corp Dallas (Bio- Muclear parent company)	Advised of contamination and alerted to possibility of BioNuclear shipment contamination.
С	SAT./JAN.1	afternoon	American Biomedical	BioNuclear	Advised of Hastings receipt of contaminated shipment in same consignment as theirs.
С	SAT./JAN.1	1500-1600	Hastings (Made UNSUCCESSFUL attempt to cal	Corp.	Apparently call got through to UCC boiler room. Caller would not identify problem or relay any information.
В	sun./JAN.2	0700-0800	-	-	BioNuclear driver went directly to airport to pick up shipment. (Neither driver nor Delta knew of contamination at this time.) BioNuclear subsequently verified contamination and transfered remaining contents from containers.
A	sun./jan.2	morning	<u>-</u>		Texas State Health Dept. official traveled from Austin to Houston, visited Hastings, and confirmed contamination on packages.
В	sun./JAN.2	morning	BicNuclear	Delta Air Lines (Freight)	Advised of findings of contamination, to check employees who handled shipment, and how to wash off contamination. (BioNuclear moved containers to quarantine in warehouse.)

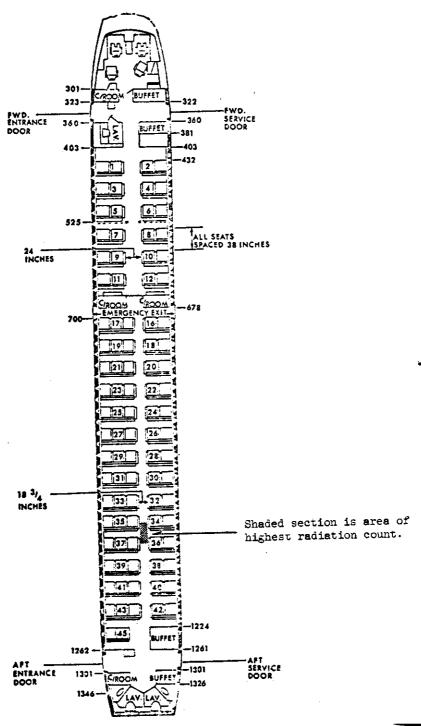
^{*}REF. A - Time reference stated by individual company or agency representative.

B - Time reference approximated by company or agency representative.

 $[\]ensuremath{\mathtt{C}}$ - Time $% \ensuremath{\mathtt{T}}$ reference approximate and reported by another party.

ATTACHMENT A - 12 - 2

REF.	DAY/DAT	E TIME	CALLER	CALL RECIEVED	RY THEODY TO THE STATE OF THE S
c 	SUN./JAN.	2 morning	Delta	Aviation Dept Airport Secur and Fire Dept	Requested evaluation of condition
A	SUN./JAN.:	2 1330	Hastings and Texas State Health Dept.	Union Carbide Corp.	To advise of contamination. UCC requested they call Bio Nuclear
A	SUN./JAN.2	1400	BioNuclear	Union Carbide	To advise package received contaminated.
	SUN./JAN.2	afternoon	BicNuclear	Texas State Dept.	To advise of contamination. (Representative, already at Houston, arrived soon after at Bicquelear.)
A	SUN./JAN.2	-	Texas State Health Dept. (called from BioNuclear)	Houston City Health Dept.	To advise of contamination. (Both proceeded to airport for survey which revealed additional areas of contamination.)
A	SUN./JAN.2	1500	Delta-Atlanta	Delta-Chicago	To advise of possible aircraft contamination. Requested AEC and Illinois Board of Health*be contacted to inspect aircraft which was due to arrive at 1830. (AEC surveyed aircraft and found it contaminated. Aircraft was taken out of service and ferried to Atlanta for decontamination.)
B S	UN./JAN.2	2330	Delta-Atlanta	Union Carbide	Requested UCC call Delta VP to answer questions.
ВМ	ON./JAN.3	0015	Union Carbide	Delta-Atlanta	In response to 2330 request.
ВМ	ON./JAN.3	0400	Union Carbide	Delta, FAA & Georgia State Health Dept. (confer. call)	To determine course of action to pursue.
в мо	ON./JAN.3	0400	Union Carbide	BioNuclear (at home)	To learn details regarding package as received.
в мо	N./JAN.3	0810	Union Carbide	N.Y. State Dept. of Health Dept. of Trans- portation Atomic Energy Comm., Regn.I Compliance	To advise known details of incident to date.
MOI	N./JAN.3	0900	Union Carbide	Another Houston Consignee	To assure his packages were not contaminated. They had been routinely checked and found to be clean.



GENERAL ARRANGEMENT-PASSENGER AREA (96 PASSENGER CONFIGURATION)





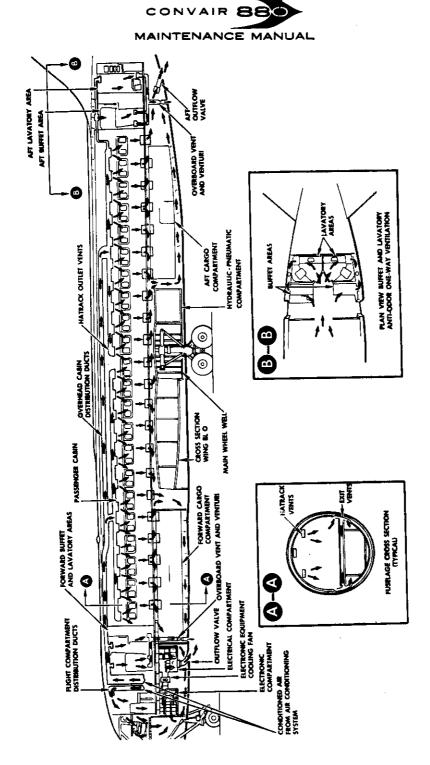
AIR DISTRIBUTION SYSTEM - DESCRIPTION AND OPERATION

l. General

The air distribution system delivers conditioned air from the air conditioning packages to the crew and passenger compartments. A schematic of the air flow is shown on Figure 1. The air distribution system is illustrated on Figure 2. Aluminum and fiberglass ducting is used to deliver the conditioned air to air inlets along the sides of the cabin just below the hatracks. The location and design of the inlets permit an even distribution of conditioned air throughout the passenger compartment with no drafts at any passenger location. The ducts and inlet vents minimize sound generation by the conditioned air as it moves through the ducts and out of the vents. Additional adjustable air inlets (ventilators) are installed above each passengers seat next to the reading light on lower surface of the hat racks. Conditioned air for the flight compartment is delivered by aluminum and fiberglas ducting and discharged above the flight crew's heads and at their leg level. Adjustable ventilators are installed above and forward of each crew seat (except observer).

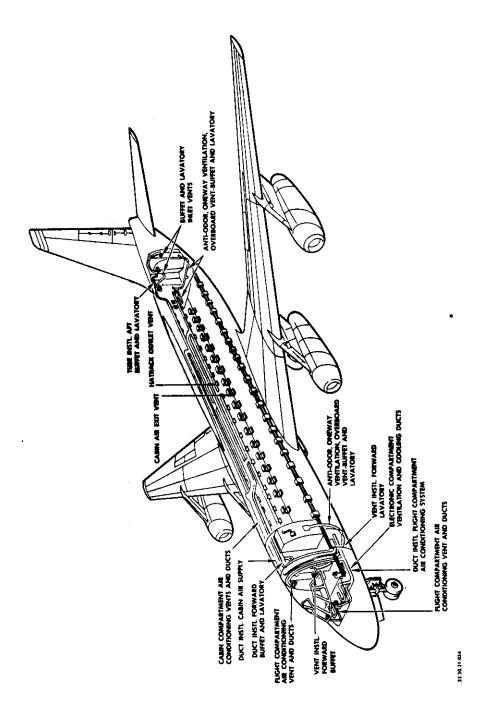
Conditioned air in the passenger cabin is exhausted from the cabin through exit vents installed outboard and below the seats. These vents direct the exhaust air into the area below the floor. The flight compartment air is also exhausted to the area below the floor. The air exhausted below the floor in the forward area of the cabin is directed through the electronics compartment for cooling and ventilation of the electronics equipment and then through the electrical compartment and overboard through the forward cabin pressure regulator and out-flow valve, or the electronic equipment cooling valve. The air exhausted below the floor in the aft area of the cabin is directed aft, around and below the baggage compartments to stabilize temperatures in the baggage compartments, and then further aft to the aft pressure regulator and outflow valve where the air is ported overboard.

To prevent odors from entering the passenger areas, all lavatories and buffets are ventilated by a one-way ventilation system. The conditioned air directed to these areas is vented directly overboard through tubing, a venturi to limit flow, and overboard vents.



Air Flow and Pressurization Schematic





Air Distribution System

INSTRUCTIONS FOR OPERATION OF THE AIRPORT SURVEY POINTS

THE ACTIONS OF THE SURVEY POINT TEAM ARE TO ASSIST DELTA AIR LINES (DAL) AND SHOULD BE AIMED AT ASSURING THE PASSENGERS OF THE AGENCY CONCERN FOR THE PASSENGER. JUDGEMENT MUST BE EXERCISED SO AS NOT TO UNDULY EXCITE THESE INDIVIDUALS. IT SHOULD BE BORNE IN MIND THAT THESE INDIVIDUALS ARE NOT INFORMED ON RADIATION CONTROL. CONSEQUENTLY, INSTRUMENT RESPONSE ON VERY SENSITIVE SCALES MAY CAUSE UNNECESSARY CONCERN IF OBSERVED BY THE INDIVIDUAL. ALSO, THE TEAM MEMBERS SHOULD BE AWARE THAT THEIR REMARKS AND CONVERSATIONS AS HEARD BY THE PASSENGERS ARE SUBJECT TO PASSENGER INTERPRETATION. REMARKS MADE IN JEST AND USE OF WORDS SUCH AS "HOT" OR EXPRESSIONS DENOTING SURPRISE OR UNDUE CONCERN BY TEAM MEMBERS MUST BE AVOIDED.

A DAL REPRESENTATIVE WILL BE THE PUBLIC CONTACT POINT FOR THE SURVEYS PERFORMED BOTH AT THE AIRPORT AND AT HOMES. IT SHOULD BE REMEMBERED THAT SURVEY TEAMS ARE SERVING IN AN ADVISORY CAPACITY TO DAL. ANY RECOMMENDATIONS TO PASSENGERS SHOULD BE MADE BY DAL. DAL WILL PROVIDE TRANSPORTATION OF TEAM REPRESENTATIVES TO HOMES FOR HOME SURVEYS.

- 1. Points are to be manned from 10:00 AM to 10:00 PM by qualified individuals daily beginning January 6, 1972, for 5 days or until no further requests are received and the survey point is shut down by the Delta Station Manager. The number of individuals making up this Survey Point Team should take into consideration that Home Survey Teams may be drawn from the Survey Point Team.
- 2. Delta Air Lines Station Managers will provide space and will assure that passengers are directed to the survey point.
- 3. The area used for survey should have the floor covered with protective paper or plastic sheeting as a precaution.
- 4. Instruments, with appropriate check sources, capable of measuring from one mr/hr to 500 mr/hr, beta-gamma, are to be available.
- 5. Decontamination supplies consisting of absorbent pads, paper towels, rubber gloves, detergent solution, plastic bags, tags, marking pencils, and radiation tags are to be available.
- 6. A record, with copy to the Division of Compliance, AEC, will be made of the survey of each individual and article on the form attached.
- 7. Instrument surveys should be made of all articles returned by passengers on the affected flights. If articles are contaminated the passenger also should be surveyed.

- 8. The action point is a contact reading of 2 mr/hr, beta-gamma.
 - a. If no reading is detected above 2 mr/hr, the passenger is informed that there is no significant contamination and he is allowed to depart.
 - b. If a reading is detected in excess of 2 mr/hr, the team will:
 - (1) Attempt to decontaminate without destruction or damage to the item.
 - (2) If decontamination is successful to 2 mr/hr, the passenger will be so informed. He will be advised that some contamination was detected and removed and an offer will be made to have his home surveyed. Judgment *must* be exercised in the expression of this offer based on the level and extent of contamination found.
 - (3) If decontamination to 2 mr/hr is not successful, the passenger will be informed that contamination was found which was not easily removed and that fixed contamination is present. The contaminated article should be tagged with the release date that decay would result in a 2 mr/hr level. The passenger should be informed of this and the fact that the article should be stored and not used until the date. Delta Air Lines will store the article if the passenger so desires. An offer should be made to have his home surveyed. Judgment must be exercised in the expression of this offer based on the level and extent of contamination found.

9. Home Surveys

- a. The home survey should be performed promptly. The passenger should be qualitatively informed of survey results by the Delta representative. Passenger property should NOT be destroyed nor confiscated. Rather, the passenger should be informed of acceptable cleaning practices, the fact that the radioactivity will disappear naturally to acceptable levels within a specified time, and some statement of hazard. The date on which decay will result in a 2 mr/hr level should be made known to the passenger.
- b. Adequate records should be maintained of the home surveys. Delta Air Lines should be informed of the results and should serve as the contact point and make all arrangements for the survey.
- c. Upon completion of a home survey, the member of the team that performed the survey should inform the AEC, Division of Compliance, HQ, telephonically of the result (301+973-1000) The caller should ask for Mr. J. R. Metzger or Mr. G. W. Roy. Calls may be made collect.
- d. If a team anticipates that a requested home survey cannot be accomplished within 48 hours, additional assistance should be requested by the AEC Radiological Assistance Team member through Radiological Assistance Team channels.

APPENDIX B

SUMMARY REPORT OF NATIONAL TRANSPORTATION SAFETY BOARD SPOT-CHECK OF AN AIR SHIPMENT OF RADIOACTIVE MATERIAL FROM OAK RIDGE, TENNESSEE, TO MONSANTO RESEARCH CORPORATION, DAYTON, OHIO, FEBRUARY 14 - 15, 1972.

Summary Report of National Transportation Safety Board Spot-Check of an Air Shipment of Radioactive Material from Oak Ridge, Tennessee, to Monsanto Research Corporation, Dayton, Ohio, February 14-15, 1971.

Prior to following the shipment of radioactive materials, Board investigators initiated discussions with Atomic Energy Commission (AEC) and Union Carbide (UCC) personnel at the Oak Ridge National Laboratory at Oak Ridge, Tennessee. It should be noted that the UCC operates Oak Ridge National Laboratory for the AEC.

AEC personnel discussed the general background of operating procedures and the details of a

radioactive materials shipment destined for Monsanto Research Corporation, Dayton, Ohio.

That shipment consisted of four 60-pound containers enclosing Americium 241 (half-life 458 years) in solid form with a total weight of 240 pounds. The four units contained a total of 689 curies and the transport index (TI) of each unit was 0.75 for a total of 3.0 TI units. Radioactive Yellow-III labels were required for this shipment which was in DOT 6M Specification containers. On February 15, 1972, the investigators visited the Oak Ridge National Laboratory with AEC and UCC personnel. Among other things, the general discussion disclosed that radioisotope shipments from Oak Ridge have diminished from approximately 13,000 shipments per year in 1961 to approximately 3,000 in 1970. This is the result of AEC phasing out of commercial involvement and the subsequent takeover by private industry. In conjunction with the discussions, a tour of Oak Ridge Laboratory was provided. This tour permitted the observation of various types of packaging, including the Type B Americium packaging. The Americium was packaged as shown in Attachment B-1 of this report.

It was learned that, on occasion, the AEC had utilized air taxi aircraft for transporting radioactive materials. It was explained that present-day utilization of this type of equipment would only occur

under special circumstances.

The investigators observed the final preparation of the specific shipment of Americium 241 to Monsanto Research Corporation, Dayton, Ohio. This preparation included examination of each container by a UCC Health Physicist who measured the TI of each container. The TI was then written in the appropriate boxes on the Radioactive Yellow-III labels, which were affixed to each container. The investigators observed that the measured TI of 0.75 per package was not rounded off to the next highest tenth, in accordance with 49 CFR 173.389(i), when entered on the labels.

The above shipment was transported in a placarded Reliable Transfer Co., van-type vehicle from Oak Ridge to the United Air Lines (UA) Freight Building at the Knoxville Airport. The transfer vehicle departed from Oak Ridge at approximately 3 p.m., arriving at Knoxville Airport at

approximately 4 p.m., where the driver unloaded the shipment.

The shipment was placed in a common storage area where it remained until aircraft loading time, which was approximately 6:30 p.m. The shipment was made on UA Flight 828, a Boeing 737, from Knoxville to Cleveland, Ohio, with an intermediate stop at Pittsburgh, Pennsylvania. This shipment was hand-loaded and placed on the floor in the foremost compartment of the forward cargo bin of the aircraft. In addition to this specific Monsanto shipment, three smaller Type A packages of isotopes were part of the cargo from Knoxville to Cleveland, Ohio. They were for further shipment to Du Page and Urbana, Illinois, and Toronto, Canada.

Examination of the flight papers for this flight (UA Flt. 828), which included the Restricted Articles Notice, showed properly the number of packages, total weight, storage location and total TI count.

Following the arrival of UA Flt. 828 at Cleveland, Ohio, the shipment of Americium 241 was off-loaded by hand and was transferred to the UA Freight Building and placed in a common storage area.

On February 16, 1972, the Monsanto shipment was hand-loaded on AA Flight 547, a Boeing 727, in the foremost bin of the rear cargo compartment, which is identified as Compartment A. These containers were placed on the floor among other cargo and baggage items.

Other than the separation of compartments by cargo nets, there were no provisions for securing the radioactive material in place on either flight.

Examination of the Restricted Articles Notice to the AA pilot revealed the following errors:

(1) The TI total showed 0.75 instead of 3.0 (four packages 0.75 each = total 3.0).

(2) The total number of curies showed .75 instead of 177, 219, 175, and 118 respectively, for a total of 689 as shown on the outside labels.

Upon arrival at Dayton, Ohio, the shipment was off-loaded by conveyor belt and transferred to the

AA Freight Building and placed in a common storage area.

Transportation from the AA Freight Building to Monsanto Research was made by Vandalia Air Freight Company. During final transportation of this material, the Board investigators did not observe an exterior placard indicating, in accordance with Title 49, Part 177.823, that radioactive material was being transported. The shipment was off-loaded by the driver at the Monsanto Research receiving building. The investigators' discussion with Monsanto personnel disclosed that immediate tests for contamination were not made upon receipt.

In order to acquaint themselves with that procedure, the investigators requested that the incoming shipment of Americium 241 be examined for contamination. This was accomplished by Monsanto's laboratory technician who conducted a wipe test with small cloth pads which were then placed in a radioactivity measuring device. The result of this test showed that there was no contamination present.

The Board investigators were advised that Monsanto Laboratory undergoes a routine inspection by AEC personnel three times a year.

