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SPECIAL EDITION

This issue of the OHM Newsletter is devoted exclusively to the subject of transport of radioactive materials.

During recent inspections of shippers and carriers of radioactive materials, it has become apparent that many packaging, marking, labeling, and other requirements for radioactive materials may be misunderstood by the shippers or carriers or both. The purpose of this Newsletter, which is being widely circulated, is to aid both shippers and carriers in becoming more familiar not only with these requirements but with their bases as well.

TRANSPORTATION OF RADIOACTIVE MATERIALS

I. BACKGROUND AND PURPOSE

Since the beginning of the relatively young atomic energy industry, i.e., about 3 decades, there has been an excellent record of safety in the transportation of millions of packages of radioactive materials. Recent estimates indicate that current shipments involve approximately 800,000 packages of radioactive materials per year in the U.S.A. Thus far, based on best available information, there have been no known deaths or serious injuries to the public or to the transportation industry personnel as a result of the radioactive nature of any radioactive material shipment. This fact can generally be attributed to the close attention which has been given by the shippers to the proper packaging of radioactive materials, and to the effectiveness of the safety standards and regulations applicable to their transportation.

Notwithstanding the excellent past record of safety, the term "radioactive" unfortunately conveys to the average person an extremely confusing aura of personal concern. The memory of the devastating destruction and violent deaths which were the aftermath of the use of the atomic bomb near the end of World War II is still very vivid in the minds of many. The more recent confusion regarding the effects of nuclear power plants on the environment and the ecology have also added to this aura of concern. This concern however has proven to be completely unwarranted as related not only to the safe uses of nuclear energy in industry, but also to the safe transportation of radioactive materials. The record of safety in transportation

of these materials clearly exceeds that for any other type of regulated hazardous commodity.

The current status of the private segment of the nuclear industry in the U.S.A. is such that the vast majority of the current shipments of radioactive materials involves small or intermediate quantities of material in relatively small packages. Most of these packages involve radioisotopes which are intended for medical diagnostic or therapeutic applications by thousands of doctors and hospitals throughout the U.S.A. and elsewhere. Many such materials are quite often of very short "half-life," and therefore must be supplied by the producer to the user via the most rapid available means of transportation. It therefore follows quite logically that the vast majority of these packages will involve air freight or air express via passenger-carrying or cargo-only aircraft. Such shipments most often involve at least two modes of transport.

II. SUMMARY OF RADIOACTIVE MATERIALS TRANSPORTATION REGULATIONS

A. ORGANIZATIONS

Under the Department of Transportation Act of 1966, the U.S. Department of Transportation (DOT) has regulatory responsibility for safety in the transportation of radioactive materials by all modes of transport in interstate or foreign commerce (rail, road, air, water), and by all means (truck, bus, auto, ocean vessel, airplane, river barge, railcar, etc.), except postal shipments. Postal shipments come under the jurisdiction of the U.S. Postal Service, originally the Post Office Department. Shipments not in interstate or foreign commerce are subject to control by a state agency in most cases.

The Interstate Commerce Commission (ICC) formerly had the jurisdiction over both the safety and economic aspects of the transport of radioactive materials by land, but the jurisdiction over safety was transferred to the Department of Transportation when DOT was formed in April 1967. The ICC (for land shipments) and the Civil Aeronautics Board (for air shipments) still exercise jurisdiction over the economic aspects of radioactive materials transport through the issuance of operating authorities to carriers, and control of shipping costs (freight rates).

Under the Atomic Energy Act of 1954, as amended, the Atomic Energy Commission also has responsibility for safety in the possession and use, including transport, of byproduct, 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,

in 10 CFR Part 71, requirements which must be met for licensees to deliver licensed material to a carrier for transport if fissile material or large radioactive sources are involved. The AEC also assists and advises DOT in establishment of national safety standards and in review and evaluation of packaging designs.

Several states have entered into formal agreements with the Atomic Energy Commission whereby the regulatory authority over byproduct, source and less than critical quantities of special nuclear material has been transferred to the states from 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 U. S. Department of Transportation to the same extent as if the transportation were subject to the rules and regulations of that agency.

The Bureau of Explosives (B of E) of the Association of American Railroads was for many years the principal technical advisor to the ICC. The B of E no longer is directly involved in the development or administration of the U. S. radioactive materials safety regulatory program.

B. REGULATIONS

The U. S. regulations for classification, packaging, marking, and labeling of packages of radioactive materials are contained in Title 49, Code of Federal Regulations, Parts 170-189. These regulations also contain the transport regulations for rail and road. Transport regulations for transport by air are in 14 CFR 103. Transport regulations for transport by water are in 46 CFR 146, which makes reference to many of the provisions of 49 CFR 171-179. The standards for packaging of "large sources" and fissile materials are contained in the AEC Regulations, 10 CFR 71. Postal Regulations are in 39 CFR 123-125. The regulation titles are as follows:

1. Title 49 - Department of Transportation's Hazardous Materials Regulations, Parts 170-189 (formerly called the ICC Regulations).

   49 CFR 170 - Rule-making Procedures of the Hazardous Materials Regulations Board.
   49 CFR 171 - General Information and Regulations.

49 CFR 172 - Commodity List of Hazardous Materials Containing the Shipping name or Description of all Articles Subject to Parts 170-189 of this Chapter.
49 CFR 173 - Shippers.
49 CFR 174 - Carriers by Rail Freight.
49 CFR 175 - Carriers by Rail Express.
49 CFR 176 - Rail Carriers in Baggage Service.
49 CFR 177 - Shipments made by way of Common, Contract, or Private Carriers by Public Highway.
49 CFR 178 - Shipping Container Specifications.
49 CFR 179 - Specifications for Tank Cars.
49 CFR 180 - Not applicable.
49 CFR 181 - 189 - Reserved.

2. Title 14 - Aeronautics and Space.

Part 103 - Transportation of Dangerous Articles and Magnetized Materials.

3. Title 46 - Transportation or Stowage of Explosives or other Dangerous Articles or Substances and Combustible Liquids Aboard Vessels.

4. Title 10 - U. S.Atomic Energy Commission Regulations.

10 CFR 71 - Packaging of Radioactive Material for Transport.

5. Title 39 - Postal Service, U. S. Post Office Regulations, Part 123. (Postal Regulations for Transport of Radioactive Matter are published in U. S. Postal Service Publication #6, April 1971.)

C. OTHER SOURCES OF REGULATIONS AND TARIFFS

Other agencies or organizations which publish regulations or tariffs on the transportation of radioactive materials are as follows:

"IATA Restricted Articles Regulations," 14th Edition 1971 - International Air Transport Association (IATA).

"Regulations for the Safe Transportation of Radioactive Materials, Safety Series #6", 1967 Edition - International Atomic Energy Agency (IAEA).

"Official Air Transport Restricted Articles Tariff No. 6-D" - Airline Publishers, Inc.

"R. M. Graziano's Tarriff No. 23, Hazardous Materials Regulations of the Department of Transportation, Including Specifications for Shipping Containers, August 3, 1969" - Bureau of Explosives, Association of American Railroads.

"Dangerous Articles Tariff No. 14, Department of Transportation Regulations for Governing Transportation of Hazardous Materials by Motor, Rail, and Water, Including Specifications for Shipping Containers, October 31, 1969" - American Trucking Associations, Inc.

III. MAJOR ASPECTS AND TECHNICAL BASES OF THE REGULATIONS

The safety regulations for transportation of radioactive materials deal with (a) containment and (b) protection of people and film from radiation emitted from the packages.

A. CONTAINMENT

The degree of containment depends on the type, form, and quantity of radioactive material being shipped in the individual container.

Small quantities, certain concentrations and manufactured goods, which contain small radioactive sources may be exempted from specification packaging, marking, and labeling under the conditions specified in § 173.391 of 49 CFR.

Under the conditions specified in §173.392, certain materials of low specific activity, e.g., uranium and thorium ores and metals,concentrations less than 0.001 mc/gm, and some objects with low-level of contamination are exempted from specification packaging, marking, and labeling when transported on a sole-use vehicle.

All other types and quantities of radioactive materials are divided into two broad classes: (1) "special form" which is a massive, non-friable, solid material or assembled into high integrity encapsulation as prescribed in §173.389(g) and which meets the criteria in §173.398(a); and (2) "normal form" (§173.389(d)) which applies to all radioactive materials which are not "special form." To determine the appropriate packaging limits, normal form radioactive materials are classified into one of seven transport groups and listed in a table of individual radionuclides (§173.390).

Varying quantities of special form and normal form radioactive materials are specified for Type A packaging, larger

quantities for Type B packaging, and in excess of Type B quantities for "large quantity" radioactive materials (§173.389(b)). General packaging requirements are given in §173.393; the Type A packaging standards, which basically are to withstand normal conditions of transport, are given in §173.398(h); Type B packaging standards, which basically are to withstand severe accident damage tests without loss of contents and minimal loss of shielding, are given in §173.398(c).

The packaging requirements for large quantities and for those radioactive materials which are fissile material (§173.389(a)) are given in the AEC's Regulations 10 CFR 71 and 49 CFR 173.396 and 173.398(c) of the DOT Regulations.

The large quantity standards, in addition to considering both the normal and the hypothetical accident test conditions, must take into account other factors, such as radioactive decay heating of the contents. Fissile radioactive materials also require consideration of the potential for accidental criticality (an unplanned nuclear chain reaction).

Prior to delivering radioactive material to a carrier for transport, either the shipper must determine that the packaging meets the requirements of a specification container as listed in 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 also is required.

The shipper must insure that, with the contents in the package ready for shipment, the package does not exceed the radiation level limits on the outside of the container (§173.393(i)) and the limits for radioactive contamination on the surface of the container (§173.393(h)). These limits provide control over the radiation exposure of individuals handling the package as well as those in the vicinity of the package.

The regulations recognize that there are practical limits to the amount of protection a shipper can provide for reducing the amount of radiation emitted from the material being shipped. In other words, 0 (zero) radiation at the surface of all shipping containers is not possible.

For film, a total dose of 10 mrems of "hard" gamma radiation exposure was chosen as an acceptable risk.

For people, the International Commission on Radiological Protection (ICRP) 1/ and the National Council on Radiation

1/ International Commission on Radiological Protection (ICRP), Publication No. 9. (Adopted September 17, 1965.)

Protection and Measurements (NCRP) 1/ and the Federal Radiation Council (FRC) 2/ recommend that individuals in the general population not be exposed to more than 0.5 rem/yr whole body dose and that on the average individuals in the general population not receive more than 0.17 rem/yr whole body dose from all sources of radiation other than natural background and medical exposure.

The FRC recommends that in the case of occupational exposure the individuals exposed should be monitored and controlled if the limits are likely to be exceeded. In addition, all exposures should be kept at the minimum practicable level. The FRC notes that insofar as an individual has a choice of occupation there is at least in principle a voluntary acceptance of the small risk potentially involved in the radiation exposure within the occupation's exposure limits.

The individual in the general population who is subjected to radiation from packages in transport, such as traveling as a passenger on an airplane or parking adjacent to a truck on the street, is not normally exposed occupationally and therefore is not in a position to decide if the small risk is acceptable. Therefore, his exposure is to be kept at a lower value.

When the size of the groups of persons in the general population, which are being exposed, becomes very large, the average genetic dose should be limited to 5 rems in 30 years.

Internal exposure, i.e., exposure of humans as a result of ingestion or inhalation of radioactive materials into the body, also has comparable limits recommended by the ICRP, the FRC and the NCRP but these will not be discussed here. For transport, Type B packaging is designed to limit the likelihood of release of contents even in a very severe accident. Contents of Type A packagings are limited so as to reduce potential exposure to persons in the event of package failure in an accident. The contamination levels specified in the regulations are chosen to be well below those which could result in significant internal exposure.

External radiation exposure of people both occupationally and as individuals in the general population is controlled during transport by several different methods. These are discussed below:

1/ National Council on Radiation Protection and Measurements (NCRP), National Bureau of Standards Handbook 59 with Supplement.
2/ Federal Radiation Council (FRC) Report No. 1, May 13, 1960.

B. CONTROL OF THE RADIATION EMITTED FROM INDIVIDUAL PACKAGES OF RADIOACTIVE MATERIALS

This control is achieved by limitation on the radiation level permitted for packages in shipment both at the surface of the package and at a distance of three feet from the surface of the package. Those limits which are specified in §173.393(i) are both necessary since the size of radioactive material packages may vary considerably. All packages having a diameter less than 21 inches are limited as to the external radiation by the surface limitation of 200 mrem/hr. For packages larger than 21 inches in diameter, the limitation of 10 mrem/hr at 3 feet from the surface of the package is controlling.

The surface limit for small packages provides control over both hand and body exposures for persons carrying or otherwise handling the package. The limitation of 3 feet limits the whole body exposure for larger packages during the handling process. Further, the limit on the radiation level at 3 feet from the packages provides control over the exposure of persons who chance to be in the vicinity of the individual package, and each of whom is presumably a member of the general population.

Segregation of radioactive material packages from film and regularly occupied areas is discussed below.

C. WARNING LABELS

Each package of radioactive material, unless exempt, must be labeled (§173.402(8)) on two opposite sides, with a distinctive warning label. Each of the three label formats, as described in §173.414, bears the unique trefoil symbol. This symbol was recommended by the ICRP in 1956 and has been adopted by the American National Standards Institute as the standard radiation symbol (N2.1-1969). The label alerts persons handling packages that the package may require special handling. If the background color of the label is all white, the radiation is minimal and nothing special is required for that package. If, however, the background of the upper half of the label is yellow, a radiation level requiring consideration may exist at the outside of the package and an indication of what controls must be exercised for that package is related to the transport index concept, discussed below. If the package bears a yellow label, with three stripes, the rail or highway vehicle in which it is carried must be placarded. Placarding is discussed in more detail further on.

D. SEPARATION OF RADIOACTIVE MATERIALS FROM PEOPLE AND UNDEVELOPED FILM, AND LIMITS ON AGGREGATION OF PACKAGES

Radiation from the individual packagings, although limited as discussed earlier, requires further control to (1) protect persons and film from more than a casual brief interval of exposure in the area immediately adjacent to the package and (2) avoid a large aggregation of packages from producing a much higher radiation level than desirable because of the additive effect of the radiation levels from the individual packages.

To provide this further control without requiring transport workers to determine radiation levels, a system of assigning a number relating directly to the radiation level at a specific distance from the package was devised. That number, first called the "radiation unit" and now termed the "transport index", is equal to the radiation level in millirem per hour at 3 feet from the nearest accessible surface of the package, §173.389(i)(1). Each package of radioactive material must be surveyed by the shipper to determine the radiation level at 3 feet from the package. A number equivalent to the number of mrem/hr measured or calculated (calculations often are made in the shipments of neutron sources) rounded up to the nearest 1/10th of a unit, is assigned the package as it is to be transported. This number is called a "transport index" (TI). If the TI exceeds zero, a yellow label is required and the TI value must be indicated on that label.

Based on the TI number, tables of separation distances between the nearest point on a radioactive material package and people or undeveloped film, are given in the regulations. Whether there is one package or a large number of packages in a vehicle or a location, the transport worker or carrier is required to read each TI, add the total number of TI's present, determine from the tables in the regulations the distance those packages must be kept from film and continuously occupied areas, and assure that those separation distances are provided.

The separation tables for motor vehicles are given in 49 CFR §177.842(b); for rail cars 49 CFR §§174.586(h)(2) and 175.655(j)(2); for aircraft 14 CFR §103.23(a); and for stowage on ships 46 CFR §146.19-35.

The projected radiation levels at the specified stowage distances, based on the assigned transport index, will vary somewhat with the size of packages. As mentioned earlier, however, the increase becomes significant only for large size packages. Because of the small number of large packages being shipped and the low probability of film or people being transported in the vicinity of such large packages, the small difference in the exposure, estimated on the bases of the calculated separation distances, is considered acceptable. Furthermore, in any collection of packages which might

produce higher radiation levels, the additional shielding and distances which are introduced because the radioactive material is distributed in a number of packages reduces the actual dose rate below that which is estimated on the basis of the combined transport index.

To limit the radiation levels from collections of packages, the transport worker is required to add the TI from all the packages present in a vehicle, or an area, and assure that the summation does not exceed the 50 TI at any time, (49 CFR §§174.586(h)(2), 175.655(j)(2), and 177.842(h); 14 CFR 103.19(b) and 103.23(a), and 46 CFR 146.19-35).

The transport index system together with the separation tables allow control over exposures of personnel handling and transporting the packages, or casually exposed to radiation in the vicinity of collections of packages.

The transport index system has also been adapted for limiting aggregations of packages containing fissile radioactive materials to avoid assembling together in one location an amount of fissile material which, under credible conditions, would support a chain reaction, i.e., "go critical." As for radiation levels, the shipper determines in accordance with specific criteria laid down in the regulations of the AEC (10 CFR Part 71, §§71.38, 71.39 and 71.40), a transport index figure (49 CFR 173.389(i)(2)) 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 (as described earlier), whichever is the higher. The transport worker, as is the case for radiation levels, adds the TI's and by complying with the limitation on the number of TI's in any one vehicle or location, limits the amount of fissile material in all types of packages to safe limits. The TI assigned to individual packages of fissile material for nuclear safety reasons takes into account that, in cases other than exclusive-use shipments, 2 times, or as many as 5 times the permitted total number of TI's in a collection of packages may be inadvertently placed together.

It will be recognized that mixing nuclear safety TI's with radiation level TI's in the course of transport increases the margin of safety for both since they are not synergistic.

E. PLACARDS

Even when labeled and stowed according to the requirements discussed above, the truck or rail car carrying any Radioactive Yellow-III labeled package must be placarded

on the outside. The placard for rail cars bears the words DANGEROUS RADIOACTIVE MATERIAL, and for trucks, the word RADIOACTIVE in letters large enough to catch the eye. The principal purposes of placards are:

1. To advise freight handlers of the presence of radioactive material with TI's inside the vehicle, or to indicate the presence of special types or shipments (e.g., a fissile Class III package, or large source package); and

2. To warn passersby and emergency crews that radioactive material shipments are in the vehicle.

This marking or placarding is intended to encourage persons not to remain in the vicinity of the vehicle unnecessarily so as to reduce exposures which would otherwise result from loitering in the vicinity. Also, the placard will alert emergency crews to the need for taking appropriate precautions in case such vehicles are involved in accidents.

IV. SUMMARY OF PRINCIPAL SHIPPERS' REQUIREMENTS IN PREPARATION AND OFFERING OF RADIOACTIVE MATERIALS PACKAGES FOR SHIPMENT

A. GENERAL INFORMATION

This section is intended to provide detailed information and references to the shippers' requirements. Such information will be useful to carrier handling personnel by bringing into perspective the shippers' requirements for proper packaging as opposed to the requirements for the carrier, which are discussed in Part V. This discussion will also serve to aid carriers in detecting cases of shippers' non-compliance.

B. SELECTION OF PROPER PACKAGING BY THE SHIPPER

Before offering a package of radioactive material to a carrier for transportation, the shipper must observe and consider many factors relating to the packaging, marking, and labeling. These requirements are summarized by the following questions which he must resolve in advance of shipment:

1. Is the material "radioactive material" by definition (§173.389(e))?

2. What radioactive material is being shipped?

3. In what form is the material? Is it in "normal form" (§173.389(d)); or is it in "special form"

(§173.389(g))? If the material is in "normal form" and is a liquid, the packaging provisions for radioactive liquids as prescribed in §173.393(g) must also be considered.

Having determined the identity and form of the material, the shipper must then determine the quantity allowable in specific types of packaging. "Normal form" materials are categorized into seven "Transport Groups" in a table of several hundred different radioactive materials (§173.390). Packaging limits for "Type A" packaging or "Type B" packaging are then established. Packaging limits for small or "Exempt" packages and radioactive materials exempt from specification packaging, marking, and labeling are also provided. "Type A" packaging is defined as that packaging which must be designed to withstand certain defined "normal" environmental and test conditions of transportation without loss of contents; as opposed to "Type B" packaging which must be designed to withstand severe accident damage test conditions without loss of contents. "Large quantities," i.e., those quantities exceeding "Type B," and "fissile radioactive materials" present more unusual and specific packaging problems. These materials are additionally controlled by the packaging standards as promulgated by the U. S. Atomic Energy Commission in its Title 10 CFR Part 71, as well as the provisions of §173.394(c), 173.395(c), or 173.396 of Title 49.

C. OTHER SHIPMENT REQUIREMENTS

Having selected the proper packaging for the specific contents, the shipper must also check for compliance with the following:

1. Radiation dose rate - the maximum radiation dose rate at the surface of the package and at three feet (TI) may not exceed certain levels (see §173.393(i) and (j)).

2. Surface contamination - loose radioactive contamination on the outside of the package may not be "significant" (see §§173.393(h) and 173.397).

3. Labels - unless the package is exempt, at least two appropriate radioactive materials warning labels must be affixed to opposite sides of the package. Either of three labels are used, based on the levels of radiation at the surface of the package and at three feet (TI) (see §§173.399, 173.402, and 173.414. The method of determination of the transport index is described in §173.389(i)).

4. Other package markings - the outside of the package must also be marked with the appropriate specification number

(see §173.24(c)(i)) or special permit number, if applicable, and also with the proper shipping name as shown in the commodity list (see §172.5).

5. Shipping papers - certain essential elements of information must also be included in the shipping paper description (see §173.427(a)(5)). These requirements also apply to packages containing small quantities and radioactive devices, (§173.391) except that the notation "no label applied" must be entered in lieu of the type of label applied.

6. Shippers' 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."

(See §§173.430, 46 CFR 146.05-11, and 14 CFR 103.3) In the case of shipments in passenger-carrying aircraft, the certificate must also state that the shipment complies with the requirements for passenger-carrying aircraft. Under FAA Regulations (14 CFR §§103.7(b)(6) and 103.19(b)), radioactive materials which are packaged, marked, and labeled in accordance with the requirements of 49 CFR for shipments by rail express, are authorized for transport on passenger-carrying aircraft; subject, however, to the additional air carrier stowage limitations based on the total transport index as prescribed in §103.23(a).

7. Security seal - the outside of each radioactive materials package must incorporate a feature such as a seal, which is not readily breakable and which, while intact, will be evidence that the package has not been illicitly opened (§173.393(b)).

8. Smallest dimension - the smallest outside dimension of any radioactive materials package must be 4 inches or greater (§173.393(c)).

9. Liquid packaging provisions (§173.393(g)) - liquid radioactive material must be packaged in or within a leak-resistant and corrosion-resistant inner container. In addition (1) the packaging must be adequate to prevent loss or dispersal of the radioactive contents from the inner container, if the package were subjected to the 30-foot drop test prescribed in §173.398(c)(2)(i); or (2) enough absorbent material must be provided to absorb at least twice the volume of the radioactive

liquid contents. The absorbent material may be located outside the radiation shield only if it can be shown that if the radioactive liquid contents were taken up by the absorbent material the resultant dose rate at the surface of the package would not exceed 1,000 millirem per hour.

10. Surface temperature of package - maximum surface temperature limits on packages, resulting from radioactive thermal decay energy of the contents are prescribed in §173.393(e). The limit is either 122 degrees F. or in the case of full load or sole use shipments, 180 degrees F.

V. CARRIER REQUIREMENTS IN HANDLING OF RADIOACTIVE MATERIALS PACKAGES

A. CERTIFICATION BY SHIPPER

Carriers may not accept for transport any packages of radioactive materials which have not been properly certified by the shipper pursuant to §173.430, 46 CFR 146.05-11, and 14 CFR 103.3(a). This certificate is relied upon by the carrier, as prima facie evidence that the packaging is in accordance with the regulatory requirements. In the case of air shipments, one signed copy of the shipper's certificate must accompany the shipment, with the originating air carrier to retain a second copy (14 CFR 103.3(b)).

B. PLACARDING

The carrier must apply the appropriate placard to the transport vehicle (rail or highway) if any RAM package on board bears a "Radioactive YELLOW-III" label (§§174.541(b) and 177.823(a)(1)).

C. STOWAGE CONTROL BY MAXIMUM TRANSPORT INDEX

The carrier must assure that the total transport index does not exceed 50 for any group of "Yellow-labeled" packages in a single transport vehicle or storage location (§174.586(h)(1), 177.842(a), 46 CFR 146.19-35, and 14 CFR 103.19(b)), and further he must assure that such groups of yellow-labeled packages are kept separated from undeveloped film shipments and areas continuously occupied by persons, in accordance with a table of storage time vs. the graded total transport index (§174.586(h)(2), 177.842(b), 46 CFR 146.19-35, and 14 CFR 103.23(a)).

D. REPORTING OF INCIDENTS

He must assure that the shipper and the Department are notified in the event of fire, accident, breakage, or suspected radioactive contamination involving shipment of RAM and

also that vehicles, areas, or equipment in which RAM may have spilled, are not placed in service again until they have been surveyed and decontaminated (§§174.588(c), 177.861(a), 171.15, 171.16, 14 CFR 103.23(b), 46 CFR 146.02-35 and 36, and 46 CFR 146.19-30 and 50).

E. SHIPPING PAPERS

Carriers must prepare and carry with the shipments the appropriate shipping papers based on the information derived from the shippers' shipping papers (§§174.510, 175.652, 177.817, and 46 CFR 146.05-12 thru 14). For water shipments, a Dangerous Cargo Manifest and storage plan is also required (46 CFR.06-12 thru 15).

F. NOTIFICATION TO PILOT (FOR AIRCRAFT SHIPMENTS)

The aircraft operator must notify the pilot in command of the aircraft of the name, type of label, quantity, and location of any "hazardous material," such as radioactive materials packages. The cargo load manifest must be conspicuously marked to indicate the presence of such packages (14 CFR §103.25).

VI. DISCUSSION OF MORE FREQUENTLY NOTED DISCREPANCIES IN RADIOACTIVE MATERIALS SHIPMENTS

This discussion is intended to serve as an aid to both shippers and carriers by making them more aware of the nature of the more frequently observed items of noncompliance in radioactive materials shipments. Such items are generally either of a safety related nature, i.e., improper packaging, excessive radiation or contamination, or an administrative nature, i.e., improper shipping paper description, illegible labels, etc.

A. BY SHIPPERS

1. Excessive radiation levels (§173.389(i)) - Fortunately, this item is not noted frequently. It does, however, rank along with improper packaging, as the most serious type of shipper violation of the safety requirements for transportation of radioactive materials. Excessive radiation levels on packages of radioactive materials are generally the result of either of two causes; (1) an excessive quantity of material in the package relative to the shielding capability of the package design; or (2) a failure to properly secure a shielded closure mechanism, a faulty closure mechanism, etc. For "special form" radioactive sources the hazard then becomes one of excessive radiation levels. For dispersible, non-"special form" radioactive materials, the hazard may then be due to both excessive radiation and possible dispersal of loose contamination. In some cases, it has been noted that suppliers

of radioisotopes of very short half-life will place into their packages at the time of loading more than the total quantity allowed for shipment with the view that at the time of actual shipment, the radiation levels will be within the limits, due to radioactive decay. Such a practice can, of course, result in a violation if the package is offered for shipment too soon, with the radiation level not having decayed to the point of being within the limits.

2. Improper packaging - This, of course, is also a most serious safety item and is closely related to the excessive radiation level in that an improper package may be one which does not incorporate sufficient thickness of shielding for the quantity of material involved. Improper packaging also may result from not using a container as authorized in the regulations or under a DOT Special Permit.

Even when an approved package is utilized, however, if it is not in its proper condition as required by its design, safety may be affected. Good quality control practices by shippers of radioactive materials are paramount. A relevant requirement of §173.22 reads as follows:

> "...the shipper shall be responsible to determine that shipments of hazardous materials are made in containers which..., have been made, assembled with all their parts or fittings in their proper place, and marked in accordance with applicable specifications..."

The above provision is cited as a reminder to shippers that no package will perform during transportation as is intended by its original design, unless it is in its proper design condition, i.e., "as good as new" when offered for transportation.

3. Lack of security seal (§173.393(b)) - This requirement appears to be the least understood and most frequently noted type of discrepancy by shippers of radioactive material. It is really a performance type requirement, wherein--

> "The outside of each package must incorporate a feature such as a seal, which is not readily breakable and which, while intact, will be evidence that the package has not been illicitly opened."

On some types of packages, i.e., steel drums, hinged lid boxes, etc., provision for a security seal is fairly simple. On many other types, i.e., wooden boxes, fiberboard cartons, much more thought and ingenuity in designing of a seal

to meet the requirements will be necessary. The use of padlocks as a security seal may not, in all cases, be appropriate since many types of padlocks may be illicitly opened and closed again without knowledge of the consignee.

4. Improper labels - Incorrect labeling of radioactive materials packages is a common deficiency. The most frequent error is "overlabeling," i.e., the use of a YELLOW-III label where a WHITE-I or YELLOW-II label would have been adequate. When done too often, such "overlabeling" can cause a loss in the distinction which is intended to be implied by the graded series of the three labels which are used to indicate the degree of control the package requires.

5. Illegible/incorrect label notations - This item should speak for itself. Needless to say, shippers should exercise care to insert legible, durable entries on the labels. These entries call for noting the "contents," "number of curies," and "transport index." In future rule making, more precise guidance is planned on this aspect. In the meantime, the entry of "n.o.s." for "not otherwise specified" under "contents" is totally inappropriate. The name of the isotope must be entered, as taken from the list of radionuclides in §173.390. Also, care should be taken to clearly indicate in the "number of curies" entry whether the quantity is in terms of curies, millicuries or microcuries. Finally, the "transport index" must be rounded up to the next highest tenth as prescribed in §173.389(i).

6. Improper or incomplete shipping paper description - The basic requirements for the shipping paper description are prescribed in §173.430 (shipper's certification), §173.427 (a)(5), and 46 CFR 146.05-12(f)(9). The first entry on the shipper's bill of lading should always be the applicable "proper shipping name" as taken from the commodity list in §172.5. Any other description or information not inconsistent therewith may follow. However, there are at present only eight different proper shipping names for radioactive materials in the commodity list. The appropriate one of these must be used. Care should be exercised to properly enter the other information as required by §173.427(a)(5). In the shipper's certification, care should further be exercised to add the notation that the shipment meets the requirements for passenger-carrying aircraft, when applicable.

7. Inadequate provision for liquid contents - The regulations prescribe certain additional packaging requirements for liquid radioactive materials. As required by §173.393(g), these are basically either of two options, i.e.,a "performance" requirement wherein the package must withstand a 30-foot drop test without loss of liquid contents, or absorbent

material must be used to absorb the liquid contents in event of breakage of the primary liquid container.

In meeting the overall provision, if the liquid absorbent option is not utilized, the shipper is then responsible to properly evaluate the liquid "containment system" of his specific packaging against the "performance" requirement option. Such shipper should be prepared to demonstrate the method in which he has determined that his packaging complies with this requirement.

B. BY CARRIERS

1. Acceptance of consignments without shipper's certification - Each of the carrier regulations (§§174.511, 175.654, 177.819(a), 14 CFR 103.3, and 46 CFR 146.05-11) prescribe a requirement that shipments of regulated hazardous materials may not be accepted by a carrier unless accompanied by the appropriate certification by the shipper that the packages have been packaged, marked, and labeled in accordance with the regulations. This certification must be signed by the shipper and it is his legal representation to the carrier that the safety requirements of the shipment are in order. Needless to say, carriers must refuse acceptance of hazardous materials shipments which are tendered to them without this certification.

2. Failure to prepare proper shipping paper description - Each of the carrier regulations (§§174.584, 175.652a, 177.817 (c), 46 CFR 146.06-14 and 15) require that carriers' manifests, waybills, etc., carry the appropriate proper shipping name and an indication of the type of label applied or the notation "no label applied," when applicable. In many cases, carriers in preparing their shipping papers, do not properly transpose these essential items of information from the shippers' papers.

3. Acceptance of radioactive materials consignments exceeding the 50 transport index maximum per vehicle - In many cases carriers either do not appear to be aware of this limitation or fail to follow it. Concurrent with this requirement, each of the carrier requlations contain a table which prescribes certain stowage distances and in certain cases stowage times for accumulations of radioactive materials packages, based on the total transport index. These stowage controls are intended to provide the necessary segregation distance of packages from areas occupied by persons or photographic film. An increased effort is needed by carriers to more completely train and educate their personnel in this requirement.

4. Failure to placard transport vehicles - For any rail or highway vehicle transporting any quantity of radioactive

materials packages bearing the radioactive YELLOW-III label, the carrier is required to display the appropriate placard. In many cases, the carrier has been noted to fail to do this. Intentional failure to placard vehicles so as to avoid certain bridge, turnpike, tunnel or other travel restrictions is a very serious offense.

For W. J. Burns
Director

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NOTE: The foregoing discussion on the regulations is not intended to be a substitute for the actual regulations. It has been prepared by the Office of Hazardous Materials as a training aid to assist both shippers and carriers in more easily and correctly applying the regulations.

All interested persons are cautioned and urged to secure and maintain up-to-date copies of the regulations, and to make direct reference to them as needed. The cited regulatory paragraph numbers throughout this summary should be of great assistance in that regard.