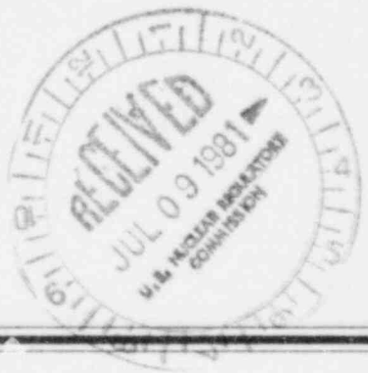
NUREG/CR-2034

Transportation of Radioactive Material in Michigan

September 1979 - August 1980



Department of Public Health
State of Michigan

Prepared for
U.S. Nuclear Regulatory
Commission

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GPO Sales Program
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U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Printed copy price: $4.75

and

National Technical Information Service
Springfield, Virginia 22161

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Manuscript Completed: April 1981
Date Published: June 1981

Division of Radiological Health
Department of Public Health
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Lansing, MI 48909

Prepared for
Office of State Programs
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
and
U.S. Department of Transportation
NRC FIN B1612

ABSTRACT

Most of the radioactive material transported through and within the State of Michigan is comprised of radiopharmaceuticals. The remainder includes radioactive waste from nuclear power plants and hospitals and uranium ore concentrate (yellowcake) from Ontario, Canada. Investigations carried out under contract with the U. S. Department of Transportation and the Nuclear Regulatory Commission revealed minor packaging and shipping document violations. Major operational problems associated with two courier companies, involving annual radiation doses in excess of 0.5 rem to vehicle drivers, were discovered. Cooperative investigations with federal agencies resulted in legal action against several companies. However, more enforcement action is anticipated and needed in order to promote compliance with federal regulations and to provide adequate radiation safety for the workers. Several radiation incidents involving transportation were reported and investigated, including a minor accident involving a yellowcake truck. No significant radiation exposure resulted from any of these incidents.

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I. INTRODUCTION

A Overview

The Michigan Department of Public Health, Division of Radiological Health, has completed the third year of investigations authorized under contract #NRC-06-77-051. This contract with the U. S. Nuclear Regulatory Commission (NRC) and the U. S. Department of Transportation (DOT) empowers the Department to study the transportation of radioactive material in the State of Michigan and to assess the impact of that transportation on the health of the citizens of the State. Observations made during the third contract year, from September 1, 1979 to August 31, 1980 are summarized and evaluated in this report. Originally a three year program, the contract has been extended to the fourth year, and investigations are continuing.

Departmental surveillance is intended to assist federal agencies in the enforcement of DOT regulations in 49 CFR Parts 171-178 and NRC regulations in 10 CFR Part 71. These regulations govern all aspects of radioactive material (RAM) transportation such as radiation limits for vehicles, areas and packages; removable contamination limits; packaging; security seals; and labeling. Minimum separation distances between RAM and live animals, undeveloped photographic film, and areas normally occupied by humans are also regulated.

The principal objectives of the radioactive material surveillance program were:

1. To determine radiation doses received by transportation workers as a result of directly handling or working in close proximity to packages containing radioactive material.

2. To gather factual information and data concerning radiation levels at transportation facilities caused by the presence of these packages.

3. To evaluate the level of compliance by shippers and carriers with packaging and shipping regulations. Factors studied include proper package labeling, assignment of accurate transport indices, placarding of vehicles, and maintenance of prescribed separation distances.

4. To obtain data on the physical condition of the packages containing radioactive material.

Most of the carriers studied were initially contacted during the first contract year. However, the constantly changing transportation industry requires some initial contacts each year. During the initial contract phase the major carriers of RAM were identified. Types of materials handled, routes followed, and transportation schedules were studied. When a carrier was located that handled significant amounts of radioactive material, the terminal was checked for location of storage and work areas, an area sketch was drawn, and worker handling data was obtained for personnel dosimetry decisions.

Investigations during this contract year were primarily in the follow-up phase. During this phase any changes were noted in the layout of the work area, the particular employees handling radioactive material, and the quantity or type of material transported. Area, personnel exposure, package, and vehicle surveys were conducted, commensurate with the handling practices. A profile of investigations is shown in Table 1.

During area surveys, radiation levels were measured and recorded around work stations, hazardous materials storage areas, and areas frequently occupied by workers. Using terminal area sketches, locations of area radiation readings and package storage areas were noted. Area monitoring devices were placed around RAM storage locations and in areas frequented by personnel.

With the aid of management, personnel exposure surveys were conducted. The workers most frequently handling RAM were identified and assigned monitoring badges. Other workers having minimal contact with RAM were assigned badges as controls. For reporting purposes, the workers were categorized by functional, work-related titles. Data is summarized in Tables 2, 3, 4, and 5.

Quantities of RAM are classified as limited quantity, Type A quantity, or Type B quantity and are packaged accordingly. Strong, tight packaging is required for limited quantities, and since May, 1979 a single exterior label, "Radioactive Materials Limited Quantity, NOS", is required. Type A quantities are shipped in Type A containers, which are usually "7A Type A" cardboard cartons. To be designated "7A Type A", a container must pass DOT tests for durability under normal transport conditions. Containers for Type B quantities are built to survive the forces of severe hypothetical accidents and are usually constructed of steel. Both Type A and Type B containers are required to have two labels placed on opposite sides of the package. These labels as specified in 49 CFR § 172.436, § 172.438, and § 172.440 are called WHITE I, YELLOW II, and YELLOW III, respectively. Each label must include the name of the radionuclide or radionuclides, the amount(s) in curies, and the Transport Index (T.I.). The T.I. is defined as the dose rate in mrem/hr at 3 ft. from the surface. No Transport Index is assigned to White I's, because the 3-foot radiation level must be less than 0.1 mrem/hr, by definition. Type A and Type B packages are labeled according to the radiation dose rate at the surface and the T.I. The respective surface and 3-ft. (T.I.) limits for each label are 0.5 and less than 0.1 mrem/hr for WHITE I, 50 and 1.0 mrem/hr for YELLOW II, and 200 and 10 mrem/hr for YELLOW III.

According to wipe tests, all packages checked were free of significant exterior contamination as required by DOT regulations.

During package surveys, cartons and overpacks containing RAM were examined for proper package labeling, shipping documents, assignment of transport indices, physical condition, security seal, isotope listing, and removable surface contamination. Radiation readings in mR/hr were obtained at the surface of the package and at a distance of three feet. The measuring process was conducted in

an area sufficiently distant from other RAM packages that the ambient radiation level was background. Maintenance of the prescribed separation distances from occupied areas, live animals, and undeveloped film was also checked. Data is summarized in Tables 6, 7, and 8.

Vehicles under surveillance were identified by carrier name and type (e.g. van, sedan, truck, airplane). For surface vehicles, radiation levels were measured along the outside surfaces and at a distance of six feet when possible and in the cab. For airplanes the radiation levels were measured in the cockpit and in areas entered by workers. Package placement and proper placarding of surface vehicles were also noted.

B. Instrumentation and Techniques

For most surveys a Victoreen Model 440 and an Eberline Model E-520 were used.

The Model 440 portable survey meter is an ion chamber type with five linear scales ranging from 0-3 to 0-300 mR/hr. It is designed to measure gamma and x-radiation over the spectral range 6.5 keV to 1.3 MeV, and to detect beta radiation. Use of the aluminum end cap provides discrimination of beta particles.

The Model E-520 is a portable Geiger-Mueller counter using an HP-270 probe with five linear scales ranging from 0-0.2 to 0-2000 mR/hr. It is designed to measure beta and gamma radiation. Beta discrimination is accomplished by a sliding shield on the probe. A thin window "pancake" probe, HP-260, can be substituted to detect low energy beta particles.

Most surveys of areas and packages employed the Victoreen Model 440. For low level gamma or beta detection the Eberline Model E-520 was used since it has more sensitive, lower scales. With the sensitive HP-260 "pancake" probe the E-520 was also used to monitor surface contamination and to field check wipe samples.

Wipe samples for removable contamination determination were taken using adhesive-backed cloth circles 4.5 cm in diameter. An area of 100 $cm.^2$ was wiped with the disk. Wipe samples were counted in the Division's Nuclear Counting Facility for gross alpha, gross beta, and gamma activity. If significant activity was found, specific radionuclides were identified and quantified using a gamma spectrometer. Of the seventy-three wipe samples taken this year, most had undetectable levels of contamination, and none exceeded the limits stated in 49 CFR § 173.397(a) and (b).

For extremely low gamma radiation levels in the field, an Eberline Model PRM-7 Micro R (μR) meter and an Eberline PRS-1 "Rascal" with a Model SPA-3, 2" x 2" NaI scintillation detector were available.

The μR meter is a special purpose scintillation crystal type gamma survey meter with four linear scales 0-25 to 0-5000 microR/hr. It is of proven value for locating small sources and measuring fluctuations in background radiation.

The "Rascal" is a digital survey meter with a single channel analyzer. When used with the SPA-3 probe, it becomes a sensitive scintillation crystal type gamma detector that reads in counts per minute. Since it is more complex to operate and has not been used extensively, the "Rascal" has yet to prove its usefulness in the program, but it has the potential to detect selected gamma energy emissions from specific radionuclides.

Alpha surveys were conducted using an Eberline Model PAC-1SAGA alpha survey meter with a Model AC-3 detector. This instrument displays meter readings of 0-2,000 CPM to 0-2,000,000 CPM with 4 scale settings.

All beta and gamma survey meters are calibrated at the beginning of each calendar quarter, and the more stable alpha survey meters are calibrated at the beginning of each calendar year by Division physicists. Exposure readings and linearity of the gamma meters are checked and adjusted using cesium-137 and cobalt-60 standards. The alpha meter is calibrated using standardized plutonium alpha sources.

Personnel and area exposure studies were made using Harshaw Chemical Company TLD-100 LiF Thermoluminescent Dosimeters (TLD's) mounted on aluminum cards. They are read using a Harshaw Model 2000-B Integrating Picoammeter and a Model 2000-C Thermoluminescence Detector. In order to minimize errors due to individual TLD chip variations, a calibration jig was built for use with the Division cesium-137 source, and each chip was individually calibrated and assigned an appropriate calibration factor.

C. Types of Shipments

Most RAM transported in the State is used for medical purposes, either diagnostic or therapeutic. Some typical materials carried are molybdenum-99/technetium-99m, iodine-131, iodine-125, iodine-123, indium-111, gallium-67, xenon-133, selenium-75, cobalt-57, cobalt-60, and chromium-51. Nearly all of these shipments are inbound to hospitals in the lower peninsula. Due to time restrictions associated with short half-life radionuclides, medical radiopharmaceuticals are flown into Detroit Metropolitan Airport aboard passenger and freight aircraft. From the Detroit area, medical radionuclides are transported by two courier companies throughout the lower peninsula. Smaller amounts of medical isotopes are used in the upper peninsula and are delivered by courier company drivers who enter the state from Wisconsin.

Nuclear power plant shipments are the next largest contributors to RAM traffic in Michigan. Spent ion exchange resin, used filters, contaminated trash and machine parts, and solidified evaporator

concentrates are shipped from the three nuclear power plants operating along the eastern shore of Lake Michigan in the lower peninsula.

Uranium ore concentrates ("yellowcake") constitute a large volume source of the RAM transported in the State. The ore is mined and processed into yellowcake in Ontario, Canada, then trucked through Michigan to a plant at Metropolis, Illinois, where it is processed into nuclear reactor fuel.

Other minor components with less probable health risk and of less public interest make up the remainder of current RAM transportation. Such carriers as industrial radiographers, physicians, and universities are being investigated on a lower priority basis. One of the State universities makes annual shipments of spent fuel from a small research reactor. Investigation of the next such shipment, unlike most other university activities, has been given a high priority.

II. AIRLINES AND AIR FREIGHT

A. Detroit Metropolitan Airport

Since the majority of RAM transported in Michigan is medical radionuclides, and since Detroit has the highest Michigan population concentration, most suppliers fly radiopharmaceuticals into Detroit Metropolitan Airport. It is more economical to deliver large air shipments to the Detroit area for subsequent surface transportation to specific users than to make many small shipments direct to individual users and cities in the rest of the lower peninsula. Pickup of radiopharmaceuticals at the airport from passenger and chartered freight aircraft is performed by Purolator Courier Corporation drivers who also deliver most of the surface transported RAM.

Passenger airlines that carry RAM on regularly scheduled flights are American, Northwest Orient, United, and Republic. In addition, a particular shipper, New England Nuclear, has chartered exclusive use flights by Baltimore Airway and Golden Eagle Aviation/Sajen Air. Some industrial and research materials are shipped as air freight on cargo-only aircraft by Federal Express and, less frequently, by Emery Air Freight. Nearly all package and overpack surveys were performed in the Detroit area. Of the Detroit area packages, most were surveyed at Detroit Metropolitan Airport as they arrived at freight terminals.

Tables 6 and 7 summarize the package and overpack surveys. An overpack is a large package, usually a nylon net bag or a large cardboard box, that contains several separate Type A packages. Containers are often 0.1 or 0.2 below the T.I. listed on the label when monitored. Frequently, this can be attributed to the decay of short half-life radionuclides while in transit. Of the packages and overpacks monitored, forty-four (41%) were more than 0.3 higher or lower than the

T.I. listed on the label. Twenty-eight (26%) were lower than the listed T.I., while sixteen (15%) were higher. Particularly when the T.I. is higher than that listed, these instances would indicate instrument or technique problems on the part of the shipper. Since most shipments do not originate in Michigan, neither the shipper's instruments nor techniques could be checked.

Table 8 lists problems encountered while surveying packages and overpacks. Individual cases are discussed further in this report under the name of the associated carrier.

Both regularly scheduled passenger flights and cargo-only flights carry RAM. Only medical and research materials are carried aboard passenger aircraft as specified in the regulations, and minimum separation distances between the RAM and the passenger area are prescribed. Although aircraft are allowed by regulations to carry up to fifty (50) total T.I. of most radionuclides, an industry imposed maximum of ten total T.I. per flight is applied to regularly scheduled passenger flights. A DOT exemption may be granted, allowing a freight airline to carry more than fifty (50) T.I. per flight, if the airline establishes a radiation protection program, including personnel monitoring, to minimize employees' radiation exposure. See Appendix C.

1. American Airlines

While a decrease in general freight shipments has caused the transfer or layoff of employees from the freight terminal, nuclear medicine traffic has increased. Shipments previously carried by other airlines are now carried by American Airlines. Mediphysics shipments carried by Northwest Orient Airlines and Mallinckrodt shipments carried by Trans World Airlines (TWA) have gone to American. The second of these changes was prompted by cancellation of the late evening TWA flight from St. Louis, MO that carried the shipment.

Shipments from Mediphysics and Mallinckrodt are very different in character. Mediphysics shipments are YELLOW II overpacks that contain mostly iodine-123 and some indium-111 and xenon-133. Generally these packages are at or slightly below the labeled T.I. Low readings are due to the short half-life (13 hours) of iodine-123. Mallinckrodt packages by contrast are YELLOW IIs and YELLOW IIIs mostly containing iodine-131. Frequently, these packages are far in excess of the labeled T.I., sometimes even being twice the labeled T.I. Currently no other agency has confirmed these observations. Two attempts were made, one by NRC and one by Federal Aviation Administration (FAA) personnel last year. The FAA investigation was thwarted by defective instrumentation as noted on page 19. No report was received on NRC findings. Although not a serious radiation hazard, the problem is sufficiently chronic to warrant further investigation. A lack of proper shipper surveys may be the cause.

Freight handling at the terminal is mechanized, utilizing hand carts and fork lifts, both of which increase the separation distances. An

area reserved for hazardous materials storage is removed from the office area and the employees' lunchroom. RAM is the usual and almost the only material to occupy this area.

Personnel and area radiation levels are monitored by means of TLD badges. Although a slight elevation of radiation levels is evident on the area monitors, negligible exposure to the workers is observed in Table 2. Contact time is kept to a minimum, and separation distance is kept to a maximum.

2. Emery Air Freight

Various industrial and medical RAM shipments are carried by Emery Air Freight. Some shippers may choose to avoid using the company because a surcharge is levied on all hazardous materials shipments. Several RAM shipments were observed at the terminal, or the papers for those that had passed through were examined. One promethium-147 shipment was examined and found to be lacking a security seal. It was held at the terminal until the shipper sent a worker to apply a seal. Most of the shipments were radium-226 being returned from a hospital to the supplier. One of the radium shipments was examined and found to be deficient on several counts: improper shipping papers, incorrect T.I. on the labels as compared to actual radiation readings, and surface radiation level in excess of 200 mR/hr. Since an FAA inspector was present, all the violations were noted, and legal action was taken against the hospital by the FAA.

3. Federal Express

Until the middle of the first quarter of the contract year, shipments of medical RAM were carried for New England Nuclear (NEN) under Federal Express exemption DOT-E 7060. These shipments were often as large as 700 to 900 T.I. and were carried on a Federal Express Boeing 727 freighter chartered for the purpose. Currently this material is carried on the surface by a NEN owned truck operated under exemption DOT-E 8308.

Many small shipments of industrial radiographic sources and other non-medical RAM are carried periodically by Federal Express on cargo aircraft. Some medical and research materials are also handled, including one biweekly outbound medical shipment. Since a weight limit is imposed on all packages, many larger sources requiring heavy shielding are not handled. Such packages may go by Emery Air Freight or by a combination of truck and air freight lines.

Two unusual contacts were made at Federal Express this year. For example, an industrial radiographer from Cleveland X-Ray Inspection, Inc. was observed, who picked up two YELLOW III packages containing iridium-192 sources, placed them in the back of an unplacarded pickup truck, and prepared to drive away. The need to placard the vehicle

was explained to him, and he left with the sources in the still unplacarded truck. Later that night he returned to the terminal with two decayed sources to ship back to the supplier. They were both mislabeled with the T.I. exceeding 1.0 on each of the YELLOW II labels. The actual T.I.s were 0.2 and 0.3 as measured by the transportation physicist. General ignorance of shipping regulations and other matters, combined with a malfunctioning meter, made the errors possible. While radiographers are still a relatively low priority group in the program, a need to increase surveillance of this group is apparent, based on the exceptionally poor performance and attitude of this individual. A mobile crew from this company was investigated during a follow-up investigation and found to be similarly deficient, as discussed under Industrial Radiographers.

A discussion with a Federal Express employee regarding TLD badge readings revealed a TLD handling problem. A badge was assigned to a worker on extended sick leave in anticipation of his return. When the unworn badge was read and found to be greater than 100 mR above background, an inquiry was made. It was discovered that some badges were being stored in a file cabinet under the freight rollers near the RAM storage area. Besides the sick worker's badge, Handler/Driver 1's badge was stored in the same location when not being worn. Upon discovery of the problem, a new location was found for badge storage.

Minor elevations in the radiation levels at area monitor stations are noted in Table 3. Although consideration of the file cabinet storage of TLDs casts doubt on the validity of the Handler/Driver 1 dose measurements, even the projected dose is less than one tenth of the permitted 500 mrem/year. All other personnel monitors indicate even less radiation exposure.

A particular survey of the terminal was performed with a μR meter, and several packages were found that were clearly radioactive, but at very low levels undetectable with ion chamber or Geiger-Mueller instruments. It is suggested that some shippers may be neglecting to label "limited quantity" packages. Surveys are now performed with the μR meter when not prohibited by the presence of larger RAM packages. Contact with recipients of questionable packages is planned to determine the contents.

4. Northwest Orient Airlines

Since losing the Mediphysics shipments to American Airlines, only small shipments made by Skycab, a freight forwarder, are received at the Northwest Orient freight terminal. These are often only "limited quantity" packages. Squibb is the manufacturer of the materials. See Appendix D, figure 1 for a photograph of a typical shipment.

One common problem with the packages is improper shipping papers. Standard air freight forms are used with no shipper certification, and some entries required by 49 CFR § 172.203(d) are omitted.

5. Republic Airlines

One day each week, when a charter flight is not needed, a moderately sized shipment from New England Nuclear is carried by Republic. The only problem with these shipments is the use of nylon net bag overpacks. Unlike rigid corrugated cardboard overpacks, no labels are attached to the bags to indicate contents or T.I. Visibility of internal package labels is poor, but is presumed sufficient by the shipper. Labeling of the bags with a T.I. total would reduce the contact time needed to determine the T.I. of the contents. As of October 1, 1980 such labeling is required by DOT regulations.

6. Trans World Airlines

Early this contract year Mallinckrodt shipments by TWA were discontinued when the late evening flight from St. Louis, MO was deleted from the flight schedule. There is no indication that any RAM is currently carried by TWA.

7. United Airlines

When a nuclear pharmacy in the Detroit area switched to using Union Carbide technetium-99m generators, United Airlines started carrying them. Currently, shipments of two or three generators per flight are received twice a week. These generators are particularly interesting because they contain more than 16 curies of molybdenum-99 when shipped and use depleted uranium shielding. Since 2 or 3 curies is a more usual amount of molybdenum-99 for most generators, 16 curies would appear to present a possible source of high radiation levels. Actual examination of a Union Carbide generator at United indicated that the shielding is sufficient to lower the radiation level to that of lead shielded generators one fifth the size.

A copy of the United Airlines checklist for RAM packages was examined. The sheet is sufficiently detailed to prevent shipment of most packages not in compliance with 49 CFR if it is used properly. The only immediately obvious improvement that could be made on the check list is to include an actual radiation survey. Time and capital investments needed for surveys may not be cost effective. Future surveillance of United should disclose no improper packages if this checklist is properly used.

8. Exclusive Use Charter Flights

One of the primary radiopharmaceutical suppliers, New England Nuclear (NEN), has been using chartered aircraft to make deliveries to Detroit Metropolitan Airport. These operate under exemption DOT-E 8308. On weekends, the time of greatest demand, a Federal Express 727 freighter has been used. As mentioned previously, this flight has been replaced by an NEN truck. Weekday flights continue, using smaller aircraft such as Piper Navajos.

Changes in the company flying the weekday runs were made this contract year, emphasizing the highly competitive nature of the air freight business. Baltimore Airways, the company that made all of the weekday flights during the last contract year, went out of business early in September. Golden Eagle Aviation was then hired. During the second quarter the airline was renamed Sajen Air.

Pursuant to the DOT exemption, loads in excess of 50 T.I. frequently are carried aboard the weekday flights, creating higher radiation levels in the cockpit as shown in Table 10. The accumulated whole body doses of the pilots must be monitored to comply with the exemption. Formerly, TLD dosimeters were provided and read by NEN. Sajen has now begun using commercially supplied film badges. Although not required by the exemption, survey instruments have been ordered for use by the pilots. These could assist the pilots in reducing absorbed dose.

Exposure to ground crew during refueling operations was estimated by time/motion studies. The usual refueling operation requires less than ten minutes, and the radiation field at the wing fill caps is normally below 3 mR/hr. According to these figures the refueler receives less than 0.15 mrem per refueling operation. While this is a negligible dose, there is a conflict with Michigan Ionizing Radiation Rules and exemption DOT-E 7060 that both require the general populace to be excluded from areas exceeding 2 mrem/hr. The possibility of having the pilots refuel the aircraft to prevent such exposure is under consideration.

B. Willow Run Airport

1. Zantop International Airlines

Zantop at Willow Run Airport, Ypsilanti has taken over the air transport of the bromine-82 labeled motor oil previously carried by Emery Air Freight. Contact with the dock workers has indicated that there may also be one inbound medical shipment each week.

Examination of the bromine-82 packages has revealed occasional lack of compliance with 49 CFR. While the packages are most frequently labeled T.I. 9 or T.I. 10, the actual meter readings indicate that the T.I. is 5 to 7 at the time of arrival at the shipping dock. About 22 hours between the original T.I. measurement and arrival at the dock would account for the discrepancy, but the actual time is only about 4 hours. Some packages were found with the DOT "7A type A" and other markings obscured by labels and shipping papers. One package was also found that exceeded the 200 mrem/hr surface limit by 20 mrem/hr. See Appendix D, figures 2 and 3 for photographs of a typical shipment.

2. First Flight Freight Service

Acting as an agent of Five Star Freight, St. Louis, Missouri, First Flight Freight Service has picked up the bromine-82 labeled motor

oil shipments and delivered them to the Zantop dock. Trucks carrying two packages were examined on two occasions upon arrival at the dock. One total load was 29 T.I., and the other was 19 T.I. The regulatory limit per vehicle is 50 T.I. In both cases the packages were placed in the right front corner of the truck bed at an insufficient separation distance from the driver. On the first occasion, a demonstration was performed showing the effect of increased separation distance. The meter readings in the driver's seat before and after moving the RAM to the rear of the truck were compared. Before moving the RAM the radiation reading in the driver's seat was 6.9 mR/hr. After moving the packages to the rear, it dropped to 0.9 mR/hr. Repetition of the incorrect loading procedure was followed by a reiteration of the previous explanation. Any future observations of this behavior by this driver will be cause for a warning directly to the company office.

III. Courier Companies

In the lower peninsula two companies, Purolator Courier Corporation and Casperson, Inc., provide a majority of the surface transportation. A nuclear pharmacy, Pharmatopes, Inc., includes courier delivery as part of the service provided by its Oak Park and Grand Rapids offices.

Upper peninsula deliveries are performed by another group of Casperson, Inc. drivers. Purolator Courier could also be serving the upper peninsula from terminals in Wisconsin and Minnesota, but a lack of cooperation by that company continues to block further study.

A. Purolator Courier Corporation (Formerly Pseudonymed as DBM)

Essentially all medical RAM that arrives at Detroit Metropolitan Airport (Metro) is picked up by Purolator Courier drivers and delivered to the Oak Park terminal. There it is sorted and routed throughout the lower peninsula. Packages of short half-life radionuclides are efficiently relayed to recipients through a system of smaller terminals.

Purolator compliance with DOT regulations has been lax, and cooperation with the surveillance program has been marginal. In January, 1980 all cooperation was formally terminated by the regional manager. Most of the TLD badges were recovered and read at that time. However, because of the uncooperative management attitude, some badges were irretrievable. Since then, surveys of vans at Metro have been performed only because individual drivers are accustomed to cooperating. Data from these encounters are included in Table 9. Many of the shipments listed approach or exceed the 50 T.I. per vehicle limit. This and the disregard for separation distances create excessive radiation levels in the drivers' seats.

In Table 4, TLD data collected before termination of cooperation is displayed. High radiation levels were recorded in the area around the sorting table and in the vehicles. Several employees approach the 500 mrem annual dose limit.

Observations before and after termination indicate that Purolator Courier is operated without regard for regulations and at the expense of radiation safety. For the benefit of the employees, the company should be compelled to comply with the applicable federal regulations.

To provide evidence to the DOT of the continuing violations, a joint investigation of one night's activities at Metro airport was performed. Besides the State physicist, a DOT radioactive materials specialist and an FAA inspector witnessed the improper loading of two vans. Neither van maintained the required separation distance nor had correct shipping papers in the driver's possession. One van also exceeded the 50 T.I. per vehicle limit. Results of this and other such investigations are forthcoming, and action against the company is anticipated.

B. Casperson, Inc.

Casperson, Inc. is headquartered in Glencoe, Illinois but employs Michigan residents on a part-time basis. These drivers work from their homes and deliver E. R. Squibb & Sons, Inc. and Mallinckrodt, Inc. radiopharmaceuticals, primarily on weekends.

In the lower peninsula, the RAM is either flown or trucked to Toledo, Ohio. Purolator Courier receives packages at the Toledo Purolator terminal and holds them for pickup by Casperson. One Casperson van is used to carry all of the RAM for the lower peninsula. In the previous contract year such vans were observed loaded over 50 T.I. upon arrival at the Oak Park Purolator terminal. Since termination of Purolator cooperation, no vans have actually been surveyed at the Purolator terminal, but conversation with the drivers indicates that the situation is basically unchanged.

In the upper peninsula, RAM is flown into Wisconsin, then picked up by a driver who delivers separate orders to several hospitals in the central area of the peninsula. No surveys are possible at the out-of-state pickup point. Much smaller quantities are handled than in the lower peninsula, so lower radiation levels result.

Data from the drivers' TLD badges is tabulated in Table 5. Drivers 1 through 8 are lower peninsula drivers, and Drivers 9 through 12 are upper peninsula drivers. All four of the upper peninsula drivers are under the 500 mrem per year limit, while four of the five lower peninsula drivers who are still working exceed 500 mrem per year.

No survey of the upper peninsula vehicles has been performed, and survey of lower peninsula trucks is currently difficult. Proposed surveys of the lower peninsula and upper peninsula trucks would

almost certainly reveal ongoing violations of 49 CFR. However, current cooperation by the workers has made TLD exchanges by mail possible. Some positive attitude by the home office toward the surveillance program is evident, but more cooperation is needed.

A radiation protection program is badly needed for the lower peninsula drivers. The purchase of a larger truck for increased separation distances is reflected in the fourth quarter drop in the exposure to Driver 2. See Appendix D, figure 4 for a photograph. Even at his current dose rate, this driver will exceed the 500 mrem annual limit in only one half of a year. No dose reduction measures have been attempted for the other drivers that exceed the dose limit.

IV. Pharmatopes, Inc.

Pharmatopes is a nuclear pharmacy service that supplies nuclear medicine to hospitals and clinics on a unit dose basis. This year another office in Grand Rapids was opened besides the one in Oak Park. The courier system for the delivery of the doses and the pick-up of technetium-99m generators at Detroit Metropolitan Airport was reviewed at the Oak Park office.

Unit doses are put into syringes and ampules, shielded by lead pigs, and carried in briefcases by drivers. The weak link in this system was the briefcases. Formerly, 3-inch cases were shimmed to 4 inches because DOT regulations specify a 4-inch minimum size for RAM packages. The briefcases were not DOT approved, since they had not undergone testing. Because of federal inquiries in another state, a private testing company was contracted, and a briefcase was found that would withstand DOT 7A type A testing. These 5-inch cases with an additional nylon web strap are being outfitted to carry the lead pigs and are replacing the older cases. These cases should prove substantially safer since they will even withstand the DOT 9-meter drop test when loaded with lead pigs.

In general, compliance with transportation regulations is satisfactory. Briefcases are carried in hatch-back cars in a "trunk" area behind the rear seat. Placarding is seldom required, except for the delivery of some therapy doses. Metal placards are used inside the car windows when required. Carelessness by one driver, as detailed in Section X, Transportation Incidents, resulted in loss of a unit dose and contamination of a street area.

A technetium-99m generator was picked up at Metro using a large four wheel drive vehicle. It was observed that the generator was placed behind the rear seat at the maximum possible separation distance and covered by a lead apron. However, the package was not blocked or braced, and the front placard was omitted. During a subsequent telephone conversation with the company, it was indicated that all four sides are now placarded on the vehicles and that a lead covered wooden box has replaced the lead apron. These improvements are indicative of a very positive company attitude about radiation safety and will be examined in the coming contract year.

V. Nuclear Power Plants

Notification of shipments to and from the three operating nuclear power plants as listed in Tables 11, 12, and 13 is received through the Michigan State Police communications system. Prenotification is also given by the plants, which enables unannounced shipment surveys. Practically all shipments are low-level waste, "low specific activity" as defined in 49 CFR § 173.389(c). Inbound new fuel is not highly radioactive and presents almost no hazard. Occasionally, spent fuel is shipped in extremely small amounts for experimental or analytical purposes. Large quantity shipments are not practical because there is no available high-level storage or waste disposal site, and the reprocessing of commercial spent fuel is currently banned by Presidential order.

A. Donald C. Cook Plant

Operation of the radioactive waste (radwaste) shipping at the Cook Plant is in compliance with DOT and Michigan regulations. Only occasional minor problems arise. All surveys show that radiation levels are kept within prescribed limits. Wipe tests of shipments show no contamination or contamination levels just above the limit of detectability. These levels are a small fraction of the DOT limits for exclusive use loads. Any problems that are encountered are corrected. For example, one shipment of three tanks of solidified liquid waste was undergoing a final predeparture survey when it was discovered that the radiation level in the truck sleeper unit exceeded 2.0 mR/hr. The truck was returned to the loading area, and the forward tank was moved back to correct the problem. If this had proved insufficient, the plant crew was prepared to rearrange all of the tanks or, if necessary, to cancel the shipment.

Last contract year, the urea formaldehyde (U-F) waste solidification process used at the Cook Plant was observed. A basic problem is unavoidable with the process. Upon aging, the U-F block inside the steel tank shrinks and releases free standing water, not permitted at burial sites. To eliminate this problem, plans were underway to switch to a sodium silicate/cement solidification process. Use of the new process was scheduled to begin after the end of the contract year. See Appendix D, figures 5 and 6 for photographs of a U-F shipment, and figure 7 of a cask enclosed waste shipment.

B. Palisades Plant

Survey of Palisades Plant radwaste shipments was made a high priority item since a shipment was made to Beatty, Nevada during the previous contract year that developed water leakage enroute or at the disposal site. By increasing Palisades Plant coverage it was hoped that the probability of observing improperly loaded or packaged shipments would be increased. As seen in Table 1, the coverage of Palisades shipments is twice that for Cook shipments. Increased surveillance continues, since some problems have been noted.

A shipment of spent ion exchange resin that was to have been shipped last year finally left during the first quarter. The delay was due to contamination of the cask and trailer by overflowing of the cask during the filling process. As examined this year, the trailer and cask had been decontaminated by removing all wooden parts and cleaning all the metal and rubber parts remaining. Wipe tests showed some residual contamination. The most contaminated wipe test showed alpha activity less than 0.6 pCi and beta activity 98 pCi ± 3 pCi from a 100 cm^2 area. Subsequent gamma spectrographic analysis showed 80 pCi ± 10 pCi of manganese-54, 450 pCi ± 20 pCi of cobalt-58, and 70 pCi ± 10 pCi of cobalt-60. Gamma results indicate 600 pCi/100 cm^2, equal to 6×10^{-6} $\mu Ci/cm^2$. The wipe is 0.6% of the 49 CFR § 173.397(b) contamination limit of 10^{-3} $\mu Ci/cm^2$.

Palisades has implemented the sodium silicate/cement solidification process and discontinued the U-F process. Fewer problems occur with free water, but filling the steel containers tends to be sloppy. Wipe tests of a shipment of these liners and boxes of trash showed fission products on the outside of the cement filled containers. The most highly contaminated wipe showed no detectable alpha activity but 1660 pCi ± 20 pCi of beta emitters. Gamma emitters totaled 2710 pCi ± 130 pCi over a 100 cm^2 area. This is only about 3% of the regulatory limit, but could be avoided by more careful filling of the containers. See Appendix D, figures 8 through 11 for photographs of a mixed waste shipment including some such liners (figure 9).

Non-uniform distribution of the fission products in the cement block has also caused some problems. Gamma emitters tend to settle to the bottom of the tank, creating high radiation levels under the trailer. In two cases additional lead shielding under the tanks was required to restrict the surface radiation to less than 200 mR/hr. The added shielding was not secured by fasteners but was merely wedged under the tanks with a hammer. Loosening and shifting of this shielding during transport could result in a violation of DOT regulations.

In August, Palisades personnel were observed loading a shipment of contaminated primary coolant filters. Near contact readings on the bare filters were approximately 300 R/hr (300,000 mR/hr). Packaging in a steel overpack reduced the contact reading to 25 R/hr. Once the cask top was secured, all surface readings were within DOT limits. Before the rain cover was placed over the top of the cask, a surface reading of 28 mR/hr was obtained. The next highest reading was 27 mR/hr on the side of the cask. No wipe samples were taken of the inner overpack, but wipe tests of the outer transportation cask and areas on the trailer where workers had walked revealed barely detectable levels of beta contamination. See Appendix D, figures 12 through 15 for photographs of the loading process.

C. Big Rock Point Plant

To date, no shipments from Big Rock have been examined for compliance with DOT regulations. Since it is the smallest plant in the State, less waste is produced, and few shipments are made.

VI. Yellowcake

Uranium ore mined in Elliot Lake, Ontario, Canada is processed into yellowcake near the mine. It is packaged in 55-gallon drums and shipped by truck through Michigan to Metropolis, Illinois for further processing. Upon entry into the State at Sault Ste. Marie, personnel at the International Bridge notify the Michigan State Police who notify the Division of Radiological Health. Each contract quarter the number of trucks is checked by phone with the Mackinac Bridge Authority. A separate log of yellowcake trucks is kept there for this purpose. Data on the passage of trucks is listed in Table 14. One truck was involved in an accident on January 22, 1980. Details are provided in Section X, Transportation Incidents. The accident occurred on a different route than that reported. Discussion with the driver showed that the route had been changed, but that the State Police had never been notified. By switching to the new route, several urban areas and a section of less desirable road were bypassed, a definite improvement. Unfortunately, one of the urban areas bypassed includes the Public Health Department offices, making the already difficult task of intercepting these trucks for examination even more difficult.

Only one truck was actually surveyed this year, the one involved in the accident. Some concern was expressed last year about the consequences of a vehicular accident involving a yellowcake truck. This accident was minimal, but the concern still is valid. Load bracing on the yellowcake trucks consists only of 2 x 4's nailed to the trailer floor behind the last row of drums. This is insufficient for normal transport conditions. A major accident could result in major contamination requiring considerable time and expense to rectify, despite the comparatively low radiological hazard involved. Although inhalation and ingestion of the yellowcake would have to be prevented during a clean up, the direct radiation hazard to area residents would probably be very low.

VII. Industrial Radiographers

Particularly since the encounter with a radiographer at Federal Express, when a general lack of concern was exhibited, an opportunity to examine the operation of a radiography crew in the field was eagerly awaited. The mobility of such crews and the tendency toward nearly inaccessible work areas makes observation difficult. One crew set up operations in the Department office parking lot and was immediately investigated for compliance with the Michigan Ionizing Radiation Rules (IRR) and DOT regulations. Compliance with the rules was deficient on several counts: use of a survey meter known to be defective, deficiencies in the use of dosimeters, and incomplete film badge records. This crew was from Cleveland X-Ray Inspection, Inc., the same company as the radiographer encountered at Federal Express.

No transportation regulation violations were noted. The vehicle was properly placarded, and radiation levels were near to background

as measured by an ion chamber survey instrument. One questionable item was found. The metal box containing the source during transport was locked but had no shipping labels. According to the radiographers, the box was not a shipping container and did not require a label because it was welded to the floor of the placarded vehicle. This point was accepted.

VIII. Railroads

Last contract year, investigations at several rail yards indicated that RAM was not being transported by rail. This situation is still extant. If spent fuel shipments resume, rail transport could be used, but Michigan nuclear power plant owners have expressed a preference for truck shipment. Since disposal facilities are not available and reprocessing is banned by Presidential order, spent fuel shipments are not anticipated in the near future. All nuclear facilities in the State routinely report all shipments before transport, and any use of the railroads will be indicated with enough advance notice to plan adequate surveillance.

IX. Waterways

A proposal to replace the steam generators at Palisades Nuclear Power Plant has been evaluated. Transport of the large steam generators may involve the use of barges on Lake Michigan. The new generators would be brought in by barge, and the old, contaminated ones would leave by barge. Contact of the Coast Guard as the appropriate branch of the DOT will be required. Other than this proposed use, there is no reason to suspect that any waterways are or will be used for RAM shipment.

X. Transportation Incidents

As the ionizing radiation control agency for the State of Michigan, the Division of Radiological Health responds to a variety of radiation incidents each year. Those occurring during the contract year and involving the transportation surveillance program are documented here.

Incident #1

Just before 8:00 A.M. January 22, 1980, the Michigan State Police notified the Division of Radiological Health that a Canadian yellowcake truck had been involved in an accident. Two physicists were dispatched to the scene. The accident occurred when a car skidded on the icy road in front of the truck. To avoid hitting the car, the truck driver braked hard and skidded into a sideswipe collision with a truck carrying scrap metal. Damage was negligible to the scrap metal truck, which was allowed to proceed onward after being

thoroughly surveyed for contamination by the physicists. The tractor unit of the yellowcake truck was disabled and had to be towed to a repair shop. One of the rear doors of the trailer unit was sheared off, but the barrels remained largely undisturbed. One barrel was punctured by a piece of scrap metal from the other truck's load, releasing a small puff of yellowcake that settled on the trailer and an adjacent barrel. Wipe tests effectively decontaminated the areas. After the damaged barrel was sealed with heavy tape, the load was transferred to an empty truck brought from Canada and was delivered to Metropolis, Illinois. Transfer of the load was monitored by Division personnel to assure proper handling. See Appendix D, figures 16 through 18 for photographs of the response to this incident.

Incident #2

This incident involved the loss of a Yellow II (T.I. = 0.1) package containing 20 mCi of phosphorus-32 on February 26, 1980. Purolator Courier claimed that this parcel was delivered to a hospital instead of being delivered to a university. Several deficiencies in the delivery/receiving processes made the mistake possible and location of the package difficult. No copy of a bill of lading was left at either the hospital or the university that could be used to double check for the correct number of packages. Copies of the driver's route sheet and of the bills of lading for both the hospital and university were obtained from Purolator Courier files. Most information on the bills of lading was typed, but some was written semi-legibly by hand, while some notes made on the route sheet were obscured before copying. In general, the information obtained from Purolator made the incident more confusing. Also, university personnel were refused admission to the Purolator terminal to look for the package. University receiving procedures have been revised in an attempt to prevent recurrence of such an incident. The package was not found, but the material in the package decayed to an exempt quantity as of July 23, 1980.

Incident #3

On July 7, 1980 a moisture/density gauge containing a radium-226/beryllium neutron/gamma source was run over by a vehicle at a road construction site. Because major damage was sustained by the instrument, the gauge was confiscated by a Division physicist and checked for source integrity. The source was not ruptured. The transportation physicist was consulted on the proper method of shipping the gauge back to the supplier, since the gauge's metal shield appeared to be cracked, and the radiation level of the packaged device was greater than the permanent shipping label indicated. A solution was reached by adding lead shielding to the shipping case, and the instrument was released to the owner for shipment.

Incident #4

On July 29, 1980 a Pharmatopes driver attempted to deliver a unit dose to a hospital. Finding it closed, she returned to the car and inadvertently left the lead shield containing a vial with 100 mCi of technetium-99m on the bumper and drove away. A short distance from the hospital the small container bounced from its perch, and the radioactive technetium was subsequently dispersed over a section of pavement and part of a lawn. Division physicists located the source after it was reported missing and supervised the clean-up. The local fire department hosed down the pavement, and a section of the lawn was confiscated. All waste from this incident was held at the Department of Public Health until decayed to background, then disposed.

XI. Interagency Cooperation

Various branches of the U. S. DOT have cooperated with the Division of Radiological Health in matters relating to radioactive materials transportation. Such interchange has been of mutual benefit, each party learning from the other.

After reading in a Michigan quarterly transportation report about packages from St. Louis frequently exceeding the label T.I., the St. Louis FAA office called to discuss the problem. Based on the Michigan information, an attempt was made to document outbound package violations at the St. Louis airport. The endeavor was foiled because of defective FAA instrumentation. Using the failure as a learning experience, advice was obtained from local radiation experts. Adequate instrumentation was ordered, and further investigation is planned.

A contact with Detroit FAA officials resulted from a minor flurry caused by a package inspection at Detroit Metropolitan airport. A package was held back by a carrier because of a Division discovered packaging deficiency, and the shipper called the local FAA office. That agency was perplexed because no local FAA inspector was involved. Further FAA investigation revealed the nature of the State surveillance program. Although local FAA officials had been contacted at the start of the program in 1977, they were not aware of the present extent of the program. Since FAA security had been directed to begin hazardous materials inspections, joint investigations of Metro and Willow Run airports were arranged. FAA officials obtained practical instruction on RAM inspection, and the State physicist was able to see immediate action to correct packaging violations.

Seeking training in the operation of radiation survey instruments, the officer-in-charge from the DOT Office of Motor Carrier Safety contacted the Division office. After some theoretical discussion and a joint trip to Metro, he was sufficiently versed in instruments and techniques to give a public presentation on the topic at a regional DOT meeting. Contact with his successor has been established, and plans are anticipated for joint investigations of both airport and nuclear power plant shipments.

Continued problems with Purolator eventually caused a DOT radioactive materials specialist to make a personal examination of the situation. Several package and shipping paper violations were documented on this trip.

XII. Summary and Conclusions

A general overview of the transportation of radioactive materials in the State of Michigan has been assembled. All major shippers and carriers are known, but some minor transporters have gone unnoticed and unidentified. As these are uncovered, they will be investigated. However, the major sources of RAM traffic must be the center of attention to secure a satisfactory return on the time invested.

As noted last year, the major sources of personnel exposure are Purolator Courier Corporation and Casperson, Inc. Purolator has terminated participation in the program, but negotiations for re-instatement are progressing. Casperson, Inc. has shown some signs of cooperation, and has voiced an interest in obtaining a DOT surface carrier exemption. Increased radiation protection is needed for both Purolator and Casperson, Inc. drivers. Federal assistance has been requested and is still required in moving Purolator Courier and Casperson, Inc. toward a radiation protection program and compliance with DOT regulations. With continued effort minor results have been noticed: Purolator has attempted to follow the 50 T.I. per vehicle regulation, and Casperson bought a larger truck to increase the RAM-to-driver separation distance. With State and Federal persistence major results may yet be achieved.

Except for some shipping paper deficiencies and Mallinckrodt mismarked packages, most of the air freight is in compliance with DOT regulations. The occasional noncompliant package is the exception rather than the rule. Maintenance of the surveillance program should eliminate most of these exceptions, since such surveillance encourages shippers to comply with regulations.

Cooperation with local DOT and FAA officials may have a similar effect. Several noncompliant shipments discovered during joint investigations are currently being processed as violations, and fines or other punitive actions may result. More similar cases may be forthcoming since more interagency cooperation is planned.

Nuclear plant radioactive waste shipments will be monitored in an effort to prevent the occurrence of problems. Although direct surveillance has not detected any defective shipments, the promise of unannounced investigations encourages diligence by the utility companies. With storage space for spent fuel being steadily filled, especially at the Big Rock Point Nuclear Power Plant, spent fuel may eventually be shipped. However, a solution to the spent fuel problem, including reprocessing, alternative storage, or disposal, must be implemented first.

Spent fuel shipment from the University of Michigan research reactor is to be investigated in the coming year. Examination of this small shipment would be in preparation for future larger power plant fuel shipments.

Provided that the program is continued in future years, coverage of mobile radiographers, well loggers, and other transporters of RAM may be increased. Very little is known about the transportation operations of these groups.

The surveillance program is valuable. Reduction of radiation exposure has been realized for transportation employees, but further dose reduction is needed.

Additional planning for responses to transportation accidents is required. While trained personnel are available to respond to incidents and have done so in the past, refinement of response capability will be a future contract related function.

XIII. TABLES

TABLE 1

FIELD INVESTIGATIONS

Radioactive Material Transporter	Number of Investigations First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Total
American Airlines	3	4	4	3	14
Emery Air Freight	3	2	1	2	8
Federal Express	3	4	5	2	14
Golden Eagle Aviation/Sajen Air	2	2	3	3	10
Northwest Orient Airlines	3	4	4	3	14
Republic Airlines	2	3	2	[illegible]	8
Trans World Airlines	3	1	2	-	6
United Airlines	-	-	-	2	2
Zantop International Airlines, Inc.	-	2	4	2	8
Casperson, Inc.	1	1	2	-	4
Purolator Courier Corporation	6	8	4	4	22
Pharmatopes, Inc.	-	-	-	2	2
First Flight Freight Service	-	-	1	1	2
Donald C. Cook Nuclear Power Plants	1	-	3	1	5
Palisades Nuclear Power Plant	3	2	-	5	10
Elliot Lake Freight Lines	-	1	-	-	1
TOTAL					130

TABLE 2

DIRECT RADIATION DOSE MEASUREMENTS
USING LiF THERMOLUMINESCENT DOSIMETERS

at American Airlines

Detroit Metropolitan Airport

Net Exposure (mR)

Station & Location	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Projected Annual
Area Monitors Over RAM Cart #1	12	186	53	31	282
#2	13	180	55	30	278
Area Monitors Near Men's Room #3	31	21	16	12	80
#4	32	21	17	11	81
Supervisor 1	3	2	2	N.R.	9
Supervisor 2	0	-	-	-	0
Handler 1	N.R.	0	1	3	5
Handler 2	1	4	7	11	23
Handler 3	19	0	2	N.R.	28
Handler 4	N.R.	0	1	0	1
Handler 5	1	- employee transferred -			1

N.R - Badge not returned

TABLE 3

DIRECT RADIATION DOSE MEASUREMENTS
USING LiF THERMOLUMINESCENT DOSIMETERS

at Federal Express, Romulus

Net Exposure (mR)

Station & Location		First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Projected Annual
Area Monitors Beside Phone	#1	10	24	6	16	56
	#2	8	21	6	14	49
Area Monitors Under Freight Rollers	#3	18	23	8	10	59
	#4	18	22	7	9	56
Area Monitors On Wall	#5	4	1	2	1	8
	#6	3	2	0	1	6
Area Monitors In Var. One	#7	3	6	7	2	18
	#8	2	5	5	2	14
Handler/Driver 1		0	29	N.R.	0	39
Handler/Driver 2		2	- transferred -			2
Handler/Driver 3		3	2	4	2	11
Handler/Driver 4		3	- transferred -			3
Handler/Driver 5		3	- transferred -			3
Handler/Driver 6		-	-	5	0	10

N.R. - Badge not returned

TABLE 4

DIRECT RADIATION DOSE MEASUREMENTS
USING LiF THERMOLUMINESCENT DOSIMETERS

At Purolator Courier Corporation, Oak Park

Net Exposure (mR)

Station & Location	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Projected Annual
Area Monitors Under Sorting Table #1	544	325	-	-	1738
#2	573	308	-	-	1762
Area Monitors Under Dispatch Window #3	156	113	-	-	538
#4	156	116	-	-	544
Area Monitors On Office Wall #5	14	13	-	-	5[illegible]
#6	14	15	-	-	58
Vehicle Monitors In Lansing Van #1	61	167	-	-	456
#2	65	150	-	-	430
Vehicle Monitors In Airport Van #3	N.R.	-	-	-	-
#4	N.R.	-	-	-	-
Vehicle Monitors In Grand Rapids Truck #5	-	97	-	-	388
#6	-	103	-	-	412
Driver 1	107	122	-	-	458
Driver 2	25	25	-	-	100

TABLE 4 cont.

DIRECT RADIATION DOSE MEASUREMENTS
USING LiF THERMOLUMINESCENT DOSIMETERS

At Purolator Courier Corporation, Oak Park

Net Exposure (mR)

Station & Location	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Projected Annual
Driver 3	11[1]	41	-	-	164
Driver 4	47	63	-	-	220
Dispatcher 1	11	5	-	-	32
Dispatcher 2	N.R.	19	-	-	76

N.R. - Badge not returned

(1) Badge not received or worn by employee. Reading not used to project annual exposure.

TABLE 5

DIRECT RADIATION DOSE MEASUREMENTS
USING LiF THERMOLUMINESCENT DOSIMETERS

at Casperson, Inc.

Net Exposure (mR)

Personnel	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Projected Annual
Driver 1	245	320	983	420	1968
Driver 2	787	796	752	265	2600
Driver 3	0	0	- resigned -		0
Driver 4	0	0	- resigned -		0
Driver 5	242	280	206	508	1236
Driver 6	0	1	- resigned -		1
Driver 8	-	-	268	6	548
Driver 9	-	10	32	35	102
Driver 10	-	270	- resigned -		540
Driver 11	-	106	45	0	201
Driver 12	-	-	164	31	390

TABLE 6

PACKAGE SURVEYS

Label	Quarter	Number	Label T.I.			Exposure Rate (mR/hr) at Surface			at 3 ft.		
			Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
I	First	0	-	-	-	-	-	-	-	-	-
	Second	1	-	-	-	0.6	0.6	0.6	0.0	0.0	0.0
	Third	0	-	-	-	-	-	-	-	-	-
	Fourth	0	-	-	-	-	-	-	-	-	-
II	First	3	0.1	0.2	0.3	4.0	6.6	9.8	0.0	0.2	0.3
	Second	9	0.1	0.2	0.4	0.3	2.3	3.0	0.0	0.1	0.2
	Third	0	-	-	-	-	-	-	-	-	-
	Fourth	3	0.1	0.3	0.7	0.5	7.4	19.5	0.1	0.2	0.5
III	First	2	2.3	2.4	2.5	40.0	48.0	56.0	1.0	1.4	1.7
	Second	5	0.1	0.9	2.0	4.8	62.4	145.	0.2	1.6	3.4
	Third	7	0.7	7.4	10.0	74.0	123.	220.	2.2	5.4	6.9
	Fourth	9	2.0	7.0	10.0	26.0	115.	230.	0.6	4.5	7.5

TABLE 7

OVERPACK SURVEYS

Label	Quarter	Number	Label T.I.			Exposure Rate (mR/hr) at Surface			at 3 ft.		
			Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
I	First	2	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0
	Second	1	-	-	-	0.1	0.1	0.1	0.1	0.1	0.1
	Third	1	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0
	Fourth	0	-	-	-	-	-	-	-	-	-
II	First	8	0.1	0.4	0.8	0.9	5.4	14.0	0.1	0.3	0.6
	Second	13	0.2	0.3	0.6	0.4	5.7	42.0	0.0	0.2	0.9
	Third	16	0.2	0.4	0.7	1.0	2.9	6.5	0.1	0.2	0.4
	Fourth	13	0.1	0.4	0.8	0.2	3.5	17.0	0.1	0.2	0.7
III	First	3	0.5	0.8	1.0	5.9	22.2	52.0	0.2	0.8	0.3
	Second	7	0.7	1.3	3.0	11.5	49.4	84.0	0.4	1.8	2.7
	Third	1	1.0	1.0	1.0	60.0	60.0	60.0	2.5	2.5	2.5
	Fourth	3	0.9	1.0	1.0	34.0	57.0	74.0	1.0	1.7	2.4

TABLE 8

IMPROPER PACKAGING

Problem Type	Occurrences
Faulty closure	2
Improper or missing shipping documents	3
Packages less than 4" minimum dimension	0
White I > 0.5 mR/hr @ surface	0
White I > 0.0 mR/hr @ 3 ft.	1
Yellow II > 50 mR/hr @ surface	0
Yellow II > 1.0 mR/hr @ 3 ft.	0
Yellow III > 200 mR/hr @ surface	2
Yellow III > 10 mR/hr @ 3 ft.	0
Label obscured	1
DOT 7A Type A approval obscured	2
T.I. not listed	1
Liquid shipment without "up" designation	1

> Greater than

TABLE 9

VEHICLE SURVEYS

Purolator Courier

Date	T.I. Carried	mrem/hr. in Cab
9/10/79	46.1	6.2
10/31/79	-	1.5
11/7/79	13.9	2.4
12/5/80	3.9	0.2
12/11/80	53.4	19.0
1/30/80	4.7	-
3/18/80	44.6	8.1
4/29/80	51.4	5.7
5/6/80	53.4	6.0
5/19/80	45.5	-
7/22/80	48.8	7.6
8/4/80	48.1	10.2
8/7/80	-	0.7
8/8/80	51.2	15.
8/8/80	14.0	13.

D. C. Cook Nuclear Power Plant

Date	In Cab	Exposure Rate (mR/hr) at Surface	at 6 ft.
11/21/79	1.0	12.	3.2
3/24/80	0.0	44. (cask) 17.5 (trailer)	7.0
4/23/80	0.3	3.2	0.9
5/8/80	0.3	3.2	1.0

Palisades Nuclear Power Plant

Date	In Cab	Exposure Rate (mR/hr) at Surface	at 6 ft.
9/5/79	-	40.	-
11/21/79	0.1	80.	5.0
11/26/79	-	145. (cask) 18.0 (trailer)	4.7
1/22/80	1.9	53.	4.4
2/14/80	0.8	11.5	3.2
7/25/80	0.3	15.	2.6
7/30/80	0.5	168.	5.2
8/14/80	0.4	28. (cask) 8.2 (trailer)	1.6
8/13/80	0.4	160.	4.4

TABLE 9 cont.

VEHICLE SURVEYS

Cleveland X-Ray Inspection, Inc.

Date	Exposure Rate (mR/hr) In Cab	at Surface
1/21/80	0.0	1.0

First Flight Freight Service

Date	Exposure Rate (mR/hr) T.I. Carried	In Cab
5/5/80	20.0	6.9
7/2/80	19.0	6.4

Pharmatopes, Inc.

Date	Exposure Rate (mR/hr) T.I. Carried	In Cab
8/8/80	2.0	).6

TABLE 10

Airplane Surveys

Baltimore Airways

Date	Exposure Rate (mR/hr) T.I. Carried	In Cockpit
9/10/79	>43.4	9.0

Golden Eagle Aviation/Sajen Air

Date	Exposure Rate (mR/hr) T.I. Carried	In Cockpit
11/7/79	2.7	0.1
10/30/79	-	0.2
12/5/79	-	0.0
12/10/79	67.8	6.8
3/18/80	38.3	22.
4/29/80	48.0	15.
5/6/80	51.8	24.
7/22/80	>48.8	15.
8/4/80	25.3	1.8
8/8/80	>64.6	7.4

> Greater than

TABLE 11

REPORTED RADIOACTIVE MATERIAL SHIPMENTS

to and from

Donald C. Cook Nuclear Power Plants

Indiana & Michigan Electric Company

Bridgman, Michigan

Date Time	Description of Shipment	Activity (curies)	Exposure Rate at 6 ft (mR/hr)	Destination
9/5/79 5:00 A.M.	New Fuel	9.9	1.65	Cook Plants
9/8/79 9:20 P.M.	Low Level Waste	0.1590	2	Barnwell, SC
9/12/79	Solidified Waste/			
11:00 A.M.	Evaporator	0.18643	2	Barnwell, SC
12:30 P.M.	Concentrates	0.52267	3	Barnwell, SC
9/18/79 8:55 A.M.	New Fuel	9.9	1.5	Cook Plants
11/3/79 6:25 P.M.	Solidified Waste/ Evaporator Concentrates	0.55193	3.5	Barnwell, SC
11/3/79 4:35 P.M.	Solidified Waste/ Evaporator Concentrates	0.470	4	Barnwell, SC
11/12/79 5:30 P.M.	Solidified Waste/ Evaporator Concentrates	0.404	6	Barnwell, SC
11/13/79 4:30 P.M.	Solidified Waste/ Evaporator Concentrates	0.25	3	Barnwell, SC
11/21/79 5:20 P.M.	Solidified Waste/ Evaporator Concentrates	0.407	2.9	Barnwell, SC
11/26/79 5:45 P.M.	Solidified Waste/ Evaporator Concentrates	0.440	2.7	Barnwell, SC

TABLE 11 cont.

REPORTED RADIOACTIVE MATERIAL SHIPMENTS

to and from

Donald C. Cook Nuclear Power Plants

Indiana & Michigan Electric Company

Bridgman, Michigan

Date Time	Description of Shipment	Activity (curies)	Exposure Rate at 6 ft (mR/hr)	Destination
12/1/79 5:00 P.M.	Solidified Waste/ Evaporator Concentrates	0.329	2.4	Barnwell, SC
12/5/79 6:20 P.M.	Spent Filter Cartridges Dry Compressed Waste	1.41	6.0	Barnwell, SC
12/5/79 7:25 P.M.	Solidified Waste/ Evaporator Concentrates	0.62	3.5	Barnwell, SC
12/11/79 4:50 P.M.	Dewatered Resin	96.7	5.0	Barnwell, SC
12/13/79 12:10 A.M.	Spent Filter Cartridges	0.24	1.3	Barnwell, SC
12/15/79 1:15 P.M.	Dry Compressibles & Conduit Pieces	4.5	0.23	Barnwell, SC
12/15/79 2:45 P.M.	Solidified Waste/ Evaporator Bottoms	0.32	1.3	Barnwell, SC
12/18/79 11:50 A.M.	Solidified Waste/ Evaporator Concentrates	0.377	1.8	Barnwell, SC
12/26/79 5:45 P.M.	Dewatered Resin	160.64	5.0	Geneva, IL
12/27/79 2:30 P.M.	Spent Filter Cartridge & Dry Solid Waste	1.73	8.0	Geneva, IL
1/7/80 2:55 P.M.	Dewatered Resin	9.8	0.2	Barnwell, SC
1/11/80 7:15 P.M.	Dry Compressed Waste & Dry Solids	1.6	3.5	Beatty, NV
1/14/80 2:50 P.M.	Solidified Waste/ Evaporator Concentrates	0.149	2.5	Barnwell, SC

TABLE 11 cont.

REPORTED RADIOACTIVE MATERIAL SHIPMENTS

to and from

Donald C. Cook Nuclear Power Plants

Indiana & Michigan Electric Company

Bridgman, Michigan

Date Time	Description of Shipment	Activity (curies)	Exposure Rate at 6 ft (mR/hr)	Destination
1/15/80 11:25 A.M.	Solidified Waste/ Evaporator Concentrates	0.15	3.4	Barnwell, SC
1/25/80 6:00 A.M.	Contaminated Tools	0.7	0.2	San Antonio, TX
2/5/80 7:00 A.M.	Sodium-24	1.5	-	Cook Plants
9:30 A.M.	Sodium-24	1.984	2.0	Cook Plants
2/8/80 7:00 P.M.	Dewatered Resin	31.1125	4	Barnwell, SC
2/11/80 2:15 P.M.	Spent Fuel Pit Racks	6.859	2.5	Beatty, NV
2/12/80 4:45 P.M.	Spent Fuel Pit Racks	18.020	1.0	Beatty, NV
2/13/80 4:45 P.M.	Spent Fuel Racks Dry Solid Waste	1.1805	1.0	Beatty, NV
2/14/80 7:20 A.M.	Sodium-24	0.507	0.6	Cook Plants
2/14/80 12:05 P.M.	Spent Fuel Pit Racks	5.326	1.4	Beatty, NV
2/17/80 4:00 P.M.	Solid Waste	0.0954	1.8	Beatty, NV
2/20/80 5:32 P.M.	Sodium-24	0.719	-	Cook Plants
2/21/80 1:05 P.M.	Dry Waste	1.15	4.0	Geneva, IL
2/23/80 6:22 A.M.	Sodium-24	0.554	1.4	Cook Plants

TABLE 11 cont.

REPORTED RADIOACTIVE MATERIAL SHIPMENTS

to and from

Donald C. Cook Nuclear Power Plants

Indiana & Michigan Electric Company

Bridgman, Michigan

Date Time	Description of Shipment	Activity (curies)	Exposure Rate at 6 ft (mR/hr)	Destination
2/24/80 6:15 A.M.	Sodium-24	0.921	2.5	Cook Plants
2/25/80 10:20 P.M.	Spent Fuel Pit Racks	0.39	1.0	Beatty, NV
2/25/80 1:30 P.M.	Spent Fuel Pit Racks	0.588	0.3	Beatty, NV
2/26/80 10:05 A.M.	Spent Fuel Pit Racks	0.745	0.045	Beatty, NV
11:45 P.M.		0.353	0.7	Beatty, NV
2/27/80 9:50 A.M.	Spent Fuel Pit Racks	1.176	0.7	Beatty, NV
2/29/80 2:30 P.M.	Spent Fuel Pit Racks	0.666	1.5	Beatty, NV
7:00 P.M.		2.9501	2.0	Beatty, NV
3/5/80 1:00 P.M.	Solidified Waste/ Evaporator Concentrates	0.13267	5.0	Barnwell, SC
3/12/80 2:15 P.M.	Dewatered Resin & Spent Filter Cartridges	4.494	9.0	Barnwell, SC
3/14/80 11:35 A.M.	Dry Solid Trash	0.175	5.0	Beatty, NV
3/18/80 5:50 P.M.	Solidified Waste/ Evaporator Concentrates	0.257	3.5	Barnwell, SC
3/19/80 5:15 P.M.	Solidified Waste/ Evaporator Concentrates	0.216	3.5	Barnwell, SC
3/24/80 8:35 P.M.	Dewatered Resin	114.3	8.0	Barnwell, SC

TABLE 11 cont.

REPORTED RADIOACTIVE MATERIAL SHIPMENTS

to and from

Donald C. Cook Nuclear Power Plants

Indiana & Michigan Electric Company

Bridgman, Michigan

Date Time	Description of Shipment	Activity (curies)	Exposure Rate at 6 ft (mR/hr)	Destination
3/25/80 2:40 P.M.	Spent Filter Cartridges	28.5	1.5	Barnwell, SC
3/28/80 5:30 P.M.	Spent Filter Cartridges	8.0	0.8	Barnwell, SC
4/3/80 7:15 P.M.	Dewatered Resin	327.	8.0	Barnwell, SC
4/4/80 12:00 P.M.	Solidified Waste/ Evaporator Concentrates	0.162	1.2	Barnwell, SC
4/9/80 12:15 P.M.	Californium-252 Calibration Unit	0.0056	0.2	Chicago, IL
4/17/80 11:35 A.M.	Dry Solid Waste	0.0141	2.6	Seneca, IL
4/22/80 6:40 P.M.	Solidified Waste/ Evaporator Concentrates	0.112	3.5	Barnwell, SC
4/23/80 8:00 P.M.	Solidified Waste/ Evaporator Concentrates	0.156	1.0	Barnwell, SC
4/24/80 10:45 P.M.	Solidified Waste/ Evaporator Concentrates	2.88	3.5	Barnwell, SC
4/25/80 6:54 P.M.	Solidified Waste/ Evaporator Concentrates	0.215	3.5	Barnwell, SC
5/6/80 11:30 A.M.	Solidified Waste/ Evaporator Concentrates	0.109	1.0	Barnwell, SC
5/8/80 11:45 A.M.	Solidified Waste/ Evaporator Concentrates	0.101	1.6	Barnwell, SC

TABLE 11 cont.

REPORTED RADIOACTIVE MATERIAL SHIPMENTS

to and from

Donald C. Cook Nuclear Power Plants

Indiana & Michigan Electric Company

Bridgman, Michigan

Date Time	Description of Shipment	Activity (curies)	Exposure Rate at 6 ft (mR/hr)	Destination
5/15/80 12:50 P.M.	Solidified Waste/ Evaporator Concentrates	0.149	0.8	Barnwell, SC
5/16/80 11:20 A.M.	Solidified Waste/ Evaporator Concentrates	0.797	0.8	Barnwell, SC
5/19/80 7:15 P.M.	Dewatered Resin	116.065	6.0	Barnwell, SC
5/23/80 11:15 A.M.	Solidified Waste/ Evaporator Concentrates	0.117	2.6	Richland, WA
5/23/80 4:30 P.M.	Solidified Waste/ Evaporator Concentrates	0.139	1.6	Richland, WA
5/27/80 3:45 P.M.	Dewatered Resin	60.6952	3.5	Barnwell, SC
5/30/80 1:05 P.M.	Dry Solid Trash	0.128	2.0	Beatty, NV
6/2/80 3:15 P.M.	Dewatered Resin	86.9	4.0	Barnwell, SC
6/4/80 11:40 A.M.	Solidified Waste/ Evaporator Concentrates	0.152	1.4	Barnwell, SC
6/9/80 2:50 P.M.	Spent Fuel Pit Rack & Trash	0.985	0.2	Beatty, NV
6/13/80 12:05 P.M.	Solidified Waste/ Evaporator Concentrates	0.146	1.5	Barnwell, SC
6/17/80 1:35 P.M.	Solidified Waste/ Evaporator Concentrates	0.078	1.5	Barnwell, SC
7/3/80 2:55 P.M.	Solidified Waste/	0.137	2.0	Seneca, IL
2:55 P.M.	Evaporator Concentrates	0.126	1.5	Seneca, IL

TABLE 11 cont.

REPORTED RADIOACTIVE MATERIAL SHIPMENTS

to and from

Donald C. Cook Nuclear Power Plants

Indiana & Michigan Electric Company

Bridgman, Michigan

Date Time	Description of Shipment	Activity (curies)	Exposure Rate at 6 ft (mR/hr)	Destination
7/8/80 11:30 A.M.	Solidified Waste/ Evaporator Concentrates	0.141	2.0	Barnwell, SC
7/9/80 12:55 P.M.	Solidified Waste/ Evaporator Concentrates	0.158	3.0	Barnwell, SC
7/9/80 3:45 P.M.	Contaminated	0.0002	less than 0.2	Madison, PA
5:05 P.M.	Equipment	0.0096	1.5	Madison, PA
7/11/80 12:45 P.M.	Solidified Waste/ Evaporator Concentrates	0.175	1.7	Barnwell, SC
7/15/80 12:55 P.M.	Solidified Waste/ Evaporator Concentrates	0.217	6.0	Barnwell, SC
5:15 P.M.	Refueling Equipment	0.0029	1.2	Madison, PA
7/16/80 6:00 P.M.	Solidified Waste/ Evaporator Concentrates	0.188	0.8	Barnwell, SC
7/17/80 1:50 P.M.	Solidified Waste/ Evaporator Concentrates	0.216	3.0	Barnwell, SC
7/18/80 1:00 P.M.	Solidified Waste/ Evaporator Concentrates	0.109	1.2	Barnwell, SC
5:15 P.M.	Dry Solid Trash	0.089	1.7	Barnwell, SC
8/1/80 10:15 A.M.	Solidified Waste/ Evaporator Concentrates	0.165	1.2	Barnwell, SC
8/5/80 12:55 P.M.	Solidified Waste/ Evaporator Concentrates	0.111	1.5	Barnwell, SC
8/7/80 12:45 P.M.	Solidified Waste/ Evaporator Concentrates	0.092	1.9	Barnwell, SC
8/12/80 11:10 A.M.	Solidified Waste/ Evaporator Concentrates	0.151	2.0	Barnwell, SC

TABLE 11 cont.

REPORTED RADIOACTIVE MATERIAL SHIPMENTS

to and from

Donald C. Cook Nuclear Power Plants

Indiana & Michigan Electric Company

Bridgman, Michigan

Date Time	Description of Shipment	Activity (curies)	Exposure Rate at 6 ft (mR/hr)	Destination
8/15/80 11:00 A.M.	Activated Charcoal Filters & Trash	0.0123	0.7	Barnwell, SC
8/19/80 11:45 A.M.	Solidified Waste/ Evaporator Concentrates	0.9	0.8	Barnwell, SC
8/21/80 9:20 A.M.	Solidified Waste/ Evaporator Concentrates	0.183	2.0	Barnwell, SC
8/27/80 12:00 P.M.	Solidified Waste/ Evaporator Concentrates	0.346	0.6	Barnwell, SC

TABLE 12

REPORTED RADIOACTIVE MATERIAL SHIPMENTS

to and from

Palisades Nuclear Power Plant

Consumers Power Company

South Haven, Michigan

Date Time	Description of Shipment	Activity (curies)	Exposure Rate at 6 ft (mR/hr)	Destination
9/6/79 11:30 A.M.	Dewatered Resin	53	7	Barnwell, SC
9/26/79 1:30 P.M.	Old Spent Fuel Rack	0.0553	9	Richland, WA
10/1/79 3:30 P.M.	Compacted Trash	1.6	10	Richland, WA
10/12/79 10:15 A.M.	Compacted Trash Contaminated Material	1.06	4	Barnwell, SC
10/10/79 12:45 P.M.	Compacted Trash	0.996	3	Barnwell, SC
10/19/79 4:00 P.M.	Contaminated Material	0.576	7	Barnwell, SC
10/22/79 12:00 P.M.	Dewatered Resin	4.2	4	Barnwell, SC
11/2/79 1:00 P.M.	Compacted Trash	3.06	9	Barnwell, SC
11/6/79 2:00 P.M.	Stud-Cleaning Machine	<0.001	<1	Windsor, CT
11/20/79 10:30 A.M.	Contaminated Material	0.306	1.5	Barnwell, SC
11/21/79 12:15 P.M.	Compacted Trash	2.66	5	Barnwell, SC
11/29/79 12:15 P.M.	Incore Detectors	271	3.5	Barnwell, SC

TABLE 12 cont.

REPORTED RADIOACTIVE MATERIAL SHIPMENTS

to and from

Palisades Nuclear Power Plant

Consumers Power Company

South Haven, Michigan

Date Time	Description of Shipment	Activity (curies)	Exposure Rate at 6 ft (mR/hr)	Destination
1/22/80 11:00 A.M.	Compacted Trash	1.485	2.0	Richland, WA
1/31/80 12:15 P.M.	Dewatered Resin	1.64	0.4	Barnwell, SC
2/14/80 12:30 P.M.	Compacted Trash	1.34	1.0	Richland, WA
3/5/80 10:15 A.M.	Contaminated Equipment	0.418	1.1	Richland, WA
3/10/80 5:00 P.M.	Compacted Trash	1.04	0.3	Richland, WA
3/12/80 9:15 A.M.	Contaminated Material	0.835	4.0	Richland, WA
4/1/80 10:15 A.M.	Compacted & Noncompacted Trash	0.92	4.0	Richland, WA
4/9/80 1:00 P.M.	Contaminated Material	0.613	2.0	Richland, WA
4/15/80 2:30 P.M.	Decontaminated Equipment	0.025	5.0	South Port, SC
4/24/80 11:30 A.M.	Compacted Trash	1.35	3.0	Richland, WA
5/2/80 11:15 A.M.	Contaminated Trash & Equipment	0.296	0.6	Richland, WA
5/7/80 4:00 P.M.	Dewatered Resin	16.6	3.0	Barnwell, SC
5/20/80 10:00 A.M.	Compacted Trash & Contaminated Material	0.36	0.7	Richland, WA

TABLE 12 cont.

REPORTED RADIOACTIVE MATERIAL SHIPMENTS

to and from

Palisades Nuclear Power Plant

Consumers Power Company

South Haven, Michigan

Date Time	Description of Shipment	Activity (curies)	Exposure Rate at 6 ft (mR/hr)	Destination
6/10/80 10:00 A.M.	Compacted Trash	0.828	4.0	Richland, WA
6/16/80 3:45 P.M.	Contaminated Equipment & Noncompressible Trash	0.085	0.6	Richland, WA
7/11/80 11:49 A.M.	Compacted Trash	0.67	4.0	Richland, WA
7/25/80 3:30 P.M.	Contaminated Trash & Solidified Concentrates	0.378	1.5	Richland, WA
7/30/80 5:15 P.M.	Compacted Trash Solidified Concentrates Metal Debris Spent Resin	0.961	0.7	Richland, WA
8/8/80 5:45 P.M.	Misc. Radwaste	0.825	5.0	Richland, WA
8/14/80 5:00 P.M.	Contaminated Filters	28.6	4.0	Barnwell, SC
8/26/80 2:00 P.M.	Solidified Concentrates	0.682	4.0	Richland, WA

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TABLE 13

REPORTED RADIOACTIVE MATERIAL SHIPMENTS

to and from

Big Rock Point Nuclear Power Plant

Consumers Power Company

Charlevoix, Michigan

Date Time	Description of Shipment	Activity (curies)	Exposure Rate at 6 ft (mR/hr)	Destination
9/14/79 3:00 P.M.	Irradiated Antimony Pins	1000	0.5	Idaho Falls, ID
10/5/79 3:00 A.M.	Solid Waste	0.9	9.1	Barnwell, SC
10/15/79 9:30 A.M.	Dewatered Resin	56.4	7	Barnwell, SC
10/25/79 10:30 A.M.	Dewatered Resin	6.08	4.5	Barnwell, SC
10/29/79 2:00 P.M.	Dewatered Resin	35.58	6	Barnwell, SC
11/1/79 2:30 P.M.	Surveillance Coupons	4.99	<0.1	Pittsburg, PA
11/19/79 9:00 A.M.	Dewatered	74.5	8.9	Barnwell, SC
2:20 P.M.	Resin	101.4	9.5	Barnwell, SC
5/28/80 4:00 P.M.	Filters & Trash	6.24	0.5	Barnwell, SC
7/17/80 5:30 P.M.	Compacted Radwaste	0.870	3.0	Richland, WA
8/25/80 4:25 P.M.	Solid Radwaste	6.4	0.8	Barnwell, SC
8/28/80 2:00 P.M.	Solid Radwaste	5.8	1.0	Barnwell, SC

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TABLE 14

REPORTED YELLOWCAKE SHIPMENTS

from

Denison Mines Ltd.

Elliot Lake, Ontario, Canada

to Metropolis, Illinois

Date Time	Number of Trucks	Activity (curies)	Exposure Rate at 6 ft (mR/hr)
9/4/79 9:40 P.M.	2	5.8/truck	5
9/7/79 9:30 P.M.	1	5.8	5
9/10/79 9:40 P.M.	2	5.8/truck	5
9/14/79 6:05 A.M.	1	5.8	5
9/17/79 11:00 P.M.	1	5.8	5
9/20/79 9:32 P.M.(1)	1	5.8	5
9/24/79 8:05 P.M.	2	5.8/truck	5
9/27/79 9:45 P.M.(1)	1	5.8	5
9/30/79 6:45 P.M.	1	5.8	5
10/1/79 7:31 P.M.	1	5.8	5
10/3/79 6:30 P.M.	1	5.8	5
10/7/79 7:37 P.M.(1)	1	5.8	5
10/9/79 8:35 P.M.	1	5.8	5

TABLE 14 cont.

REPORTED YELLOWCAKE SHIPMENTS

from

Denison Mines Ltd.

Elliot Lake, Ontario, Canada

to Metropolis, Illinois

Date Time	Number of Trucks	Activity (curies)	Exposure Rate at 6 ft (mR/hr)
10/14/79 9:08 P.M.(1)	1	5.8	5
10/16/79 4:00 A.M.(1)	1	5.8	5
10/17/79 9:00 P.M.(1)	1	5.8	5
10/19/79 9:55 P.M.(1)	1	5.8	5
10/23/79 7:39 P.M.(1)	1	5.8	5
11/1/79 9:55 P.M.	1	5.8	5
11/5/79 8:00 P.M.	1	5.8	5
11/6/79 8:45 P.M.	1	5.8	5
12/7/79 7:00 P.M.	2	5.8/truck	5
12/10/79 6:57 P.M.(1)	1	5.8	5
9:00 P.M.(1)	1	5.8	5
12/13/79 6:54 P.M.	2	5.8/truck	5
9:19 P.M.	2	5.8/truck	5
12/15/79 2:55 A.M.	1	5.8	5

TABLE 14 cont.

REPORTED YELLOWCAKE SHIPMENTS

from

Denison Mines Ltd.

Elliot Lake, Ontario, Canada

to Metropolis, Illinois

Date Time	Number of Trucks	Activity (curies)	Exposure Rate at 6 ft (mR/hr)
12/17/79 5:18 P.M.	1	5.8	5
12/18/79 3:55 P.M.	1	5.8	5
12/21/79 12:21 A.M.	1	5.8	5
7:00 P.M.	1	5.8	5
12/27/79 5:00 P.M.	1	5.8	5
1/2/80 1:50 A.M.	2	5.8/truck	5
1/4/80 6:05 A.M.	1	5.8	5
1/8/80 12:00 P.M.	1	5.8	5
1/9/80 7:50 P.M.	1	5.8	5
1/11/80 11:45 P.M.	1	5.8	5
1/18/80 2:30 P.M.	1	5.8	5
1/21/80 6:10 P.M.	1	5.8	5
1/22/80 6:50 A.M.	1	5.8	5
1/27/80 6:45 P.M.	1	5.8	5
1/31/80 8:33 P.M.(1)	2	5.8	5

TABLE 14 cont.

REPORTED YELLOWCAKE SHIPMENTS

from

Denison Mines Ltd.

Elliot Lake, Ontario, Canada

to Metropolis, Illinois

Date Time	Number of Trucks	Activity (curies)	Exposure Rate at 6 ft (mR/hr)
2/4/80 10:15 P.M.	1	5.8	5
2/5/80 8:38 P.M.	1	5.8	5
2/8/80 7:20 A.M.	1	5.8	5
2/12/80 4:03 A.M.(1)	1	5.8	5
2/13/80 3:50 A.M.	1	5.8	5
2/14/80 4:40 P.M.	1	5.8	5
2/16/80 4:00 A.M.	1	5.8	5
2/18/80 8:00 P.M.	1	5.8	5
2/20/80 11:50 P.M.	1	5.8	5
2/22/80 11:10 P.M.	1	5.8	5
2/25/80 7:15 P.M.	1	5.8	5
2/27/80 6:00 P.M.	1	5.8	5
3/1/80 6:04 A.M.	1	5.8	5

TABLE 14 cont.

REPORTED YELLOWCAKE SHIPMENTS

from

Denison Mines Ltd.

Elliot Lake, Ontario, Canada

to Metropolis, Illinois

Date Time	Number of Trucks	Activity (curies)	Exposure Rate at 6 ft (mR/hr)
3/4/80 12:07 A.M.(1)	1	5.8	5
3/5/80 7:15 P.M.	1	5.8	5
12:34 A.M.	1	5.8	5
2:05 A.M.	1	5.8	5
3/6/80 3:06 A.M.(1)	1	5.8	5
3/7/80 5:00 A.M.	1	5.8	5
3/8/80 6:31 A.M.	1	5.8	5
3/11/80 1:05 A.M.	2	5.8/truck	5
7:20 P.M.(1)	1	5.8	5
3/13/80 5:35 A.M.	1	5.8	5
3/14/80 3:15 A.M.	1	5.8	5
4:06 P.M.	1	5.8	5
11:40 P.M.	1	5.8	5
3/17/80 11:43 P.M.(1)	1	5.8	5
3/19/80 3:47 P.M.	1	5.8	5
3/22/80 10:05 P.M.	1	5.8	5

TABLE 14 cont.

REPORTED YELLOWCAKE SHIPMENTS

from

Denison Mines Ltd.

Elliot Lake, Ontario, Canada

to Metropolis, Illinois

Date Time	Number of Trucks	Activity (curies)	Exposure Rate at 6 ft (mR/hr)
3/25/80 2:45 A.M.	1	5.8	5
3/26/80 4:45 P.M.	1	5.8	5
3/29/80 2:15 P.M.	1	5.8	5
4/1/80 5:45 A.M.	1	5.8	5
4/2/80 3:30 P.M.	1	5.8	5
4/7/80 10:04 P.M.	1	5.8	5
4/8/80 7:54 P.M.	1	5.8	5
4/12/80 7:24 P.M.	1	5.8	5
4/14/80 7:45 P.M.	1	5.8	5
4/16/80 7:40 P.M.	1	5.8	5
4/17/80 11:32 P.M.	1	5.8	5
4/18/80 4:35 P.M.	1	5.8	5
4/21/80 9:20 P.M.	1	5.8	5

TABLE 14 cont.

REPORTED YELLOWCAKE SHIPMENTS

from

Denison Mines Ltd.

Elliot Lake, Ontario, Canada

to Metropolis, Illinois

Date Time	Number of Trucks	Activity (curies)	Exposure Rate at 6 ft (mR/hr)
4/23/80 7:00 P.M.	1	5.8	5
4/25/80 6:17 P.M.	1	5.8	5
4/28/80 11:20 P.M.	1	5.8	5
4/30/80 8:36 P.M.(1)	1	5.8	5
5/2/80 8:25 P.M.	1	5.8	5
5/5/80 7:45 P.M.	1	5.8	5
5/7/80 10:51 P.M.	1	5.8	5
5/8/80 12:15 A.M.(1)	1	5.8	5
5/9/80 8:13 P.M.	1	5.8	5
5/12/80 11:18 P.M.	1	5.8	5
5/14/80 9:50 P.M.(1)	1	5.8	5
5/15/80 8:35 P.M.	1	5.8	5
5/16/80 9:55 P.M.	1	5.8	5

TABLE 14 cont.

REPORTED YELLOWCAKE SHIPMENTS

from

Denison Mines Ltd.

Elliot Lake, Ontario, Canada

to Metropolis, Illinois

Date Time	Number of Trucks	Activity (curies)	Exposure Rate at 6 ft (mR/hr)
5/20/80 8:20 P.M.	1	5.8	5
5/26/80 9:50 P.M.	1	5.8	5
5/28/80 10:37 P.M.	1	5.8	5
5/31/80 12:55 A.M.(1)	1	5.8	5
6/2/80 10:22 P.M.	1	5.8	5
6/3/80 11:55 P.M.(1)	1	5.8	5
6/4/80 8:19 P.M.	1	5.8	5
6/6/80 10:59 P.M.	1	5.8	5
6/9/80 9:55 P.M.	1	5.8	5
6/12/80 1:38 A.M.	1	5.8	5
6/16/80 3:00 A.M.	1	5.8	5
11:50 P.M.	1	5.8	5
6/17/80 12:40 A.M.(1)	1	5.8	5
6/19/80 2:28 A.M.	1	5.8	5

TABLE 14 cont.

REPORTED YELLOWCAKE SHIPMENTS

from

Denison Mines Ltd.

Elliot Lake, Ontario, Canada

to Metropolis, Illinois

Date Time	Number of Trucks	Activity (curies)	Exposure Rate at 6 ft (mR/hr)
6/23/80 11:55 P.M.	2	5.8	5
6/30/80 4:00 A.M.	1	5.8	5
7/2/80 1:25 A.M.	1	5.8	5
7/7/80 3:05 A.M.	1	5.8	5
7/8/80 12:50 A.M.	1	5.8	5
7/10/80 3:13 A.M.	1	5.8	5
7/14/80 3:54 A.M.	1	5.8	5
8:35 P.M.	1	5.8	5
7/17/80 9:34 P.M.(1)	1	5.8	5
7/21/80 3:15 A.M.	1	5.8	5
7/22/80 12:25 A.M.	1	5.8	5
7/23/80 9:58 P.M.(1)	1	5.8	5
7/24/80 11:43 P.M.	1	5.8	5
7/29/80 1:53 A.M.	1	5.8	5

TABLE 14 cont.

REPORTED YELLOWCAKE SHIPMENTS

from

Denison Mines Ltd.

Elliot Lake, Ontario, Canada

to Metropolis, Illinois

Date Time	Number of Trucks	Activity (curies)	Exposure Rate at 6 ft (mR/hr)
7/30/80 9:48 P.M.	1	5.8	5
8/4/80 3:05 A.M.	1	5.8	5
8/5/80 11:40 P.M.	1	5.8	5
8/7/80 11:50 P.M.	1	5.8	5
8/12/80 1:44 A.M.	1	5.8	5
8/13/80 9:06 P.M.	1	5.8	5
8/14/80 9:36 P.M.	1	5.8	5
8/17/80 11:13 A.M.	1	5.8	5
8/19/80 7:32 P.M.	1	5.8	5
8/21/80 8:44 P.M.(1)	1	5.8	5
5:52 P.M.	1	5.8	5
8/24/80 12:00 A.M.(1)	1	5.8	5

TABLE 14 cont.

REPORTED YELLOWCAKE SHIPMENTS

from

Denison Mines Ltd.

Elliot Lake, Ontario, Canada

to Metropolis, Illinois

Date Time	Number of Trucks	Activity (curies)	Exposure Rate at 6 ft (mR/hr)
8/25/80 6:15 P.M.	1	5.8	5
8/29/80 1:20 A.M.	1	5.8	5

(1) Time is at Mackinac Bridge. All other times are at International Bridge, Sault Ste. Marie.

XIV. AREA SKETCHES

FIGURE 1
AMERICAN AIRLINES
DETROIT METROPOLITAN AIRPORT
AREA SKETCH

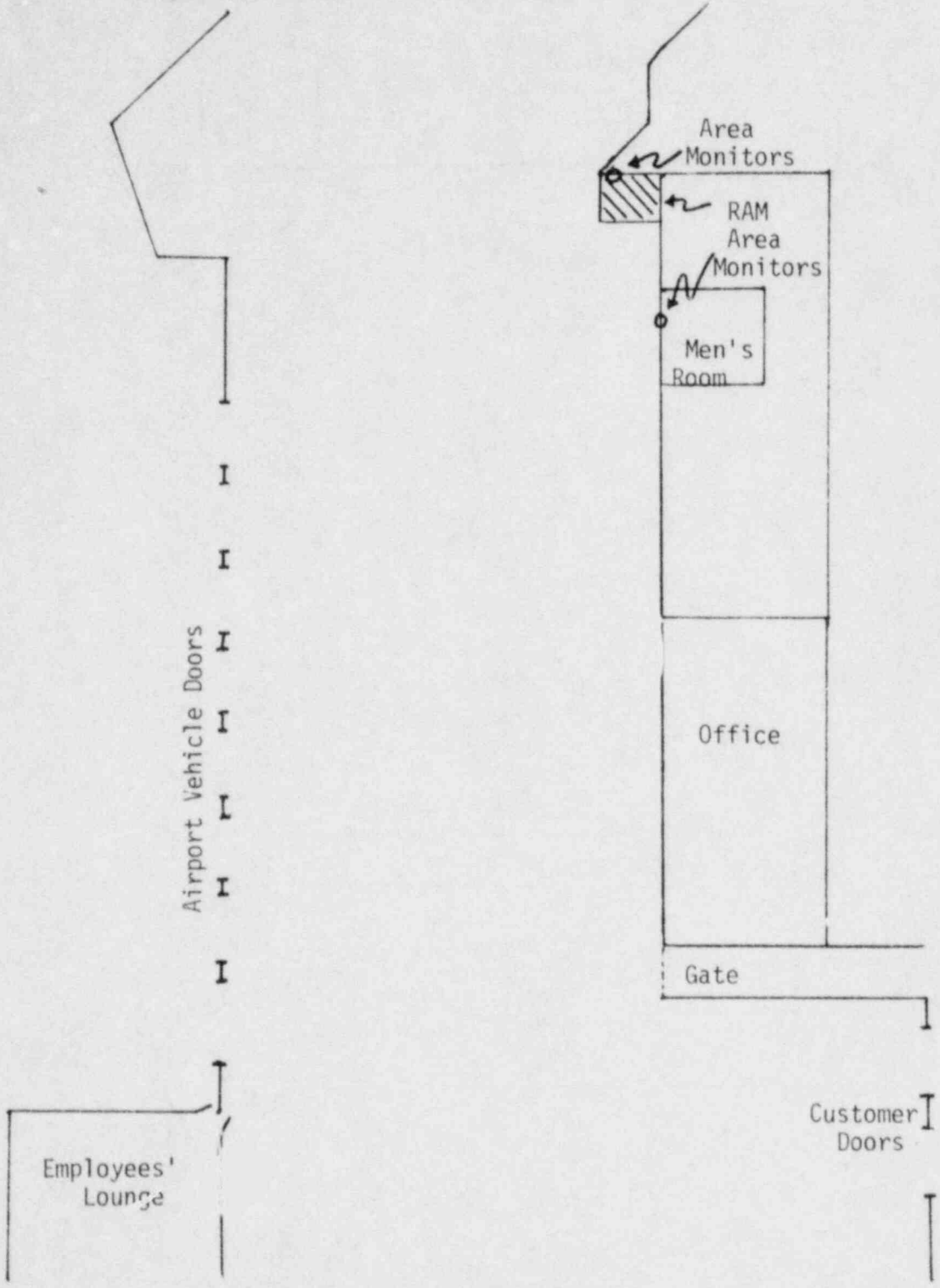


FIGURE 2
TRANS WORLD AIRLINES
DETROIT METROPOLITAN AIRPORT
AREA SKETCH

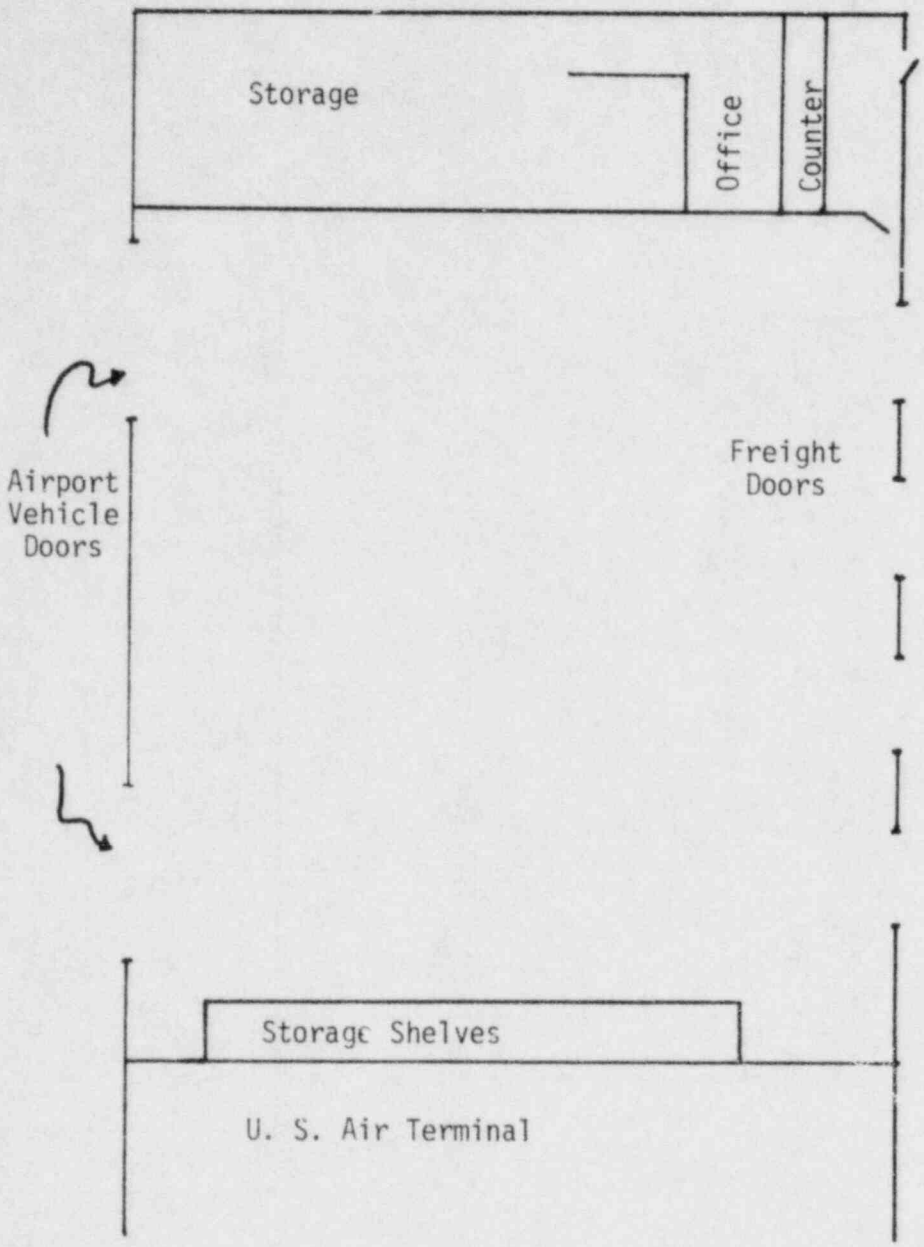


FIGURE 3
REPUBLIC AIRLINES
DETROIT METROPOLITAN AIRPORT
AREA SKETCH

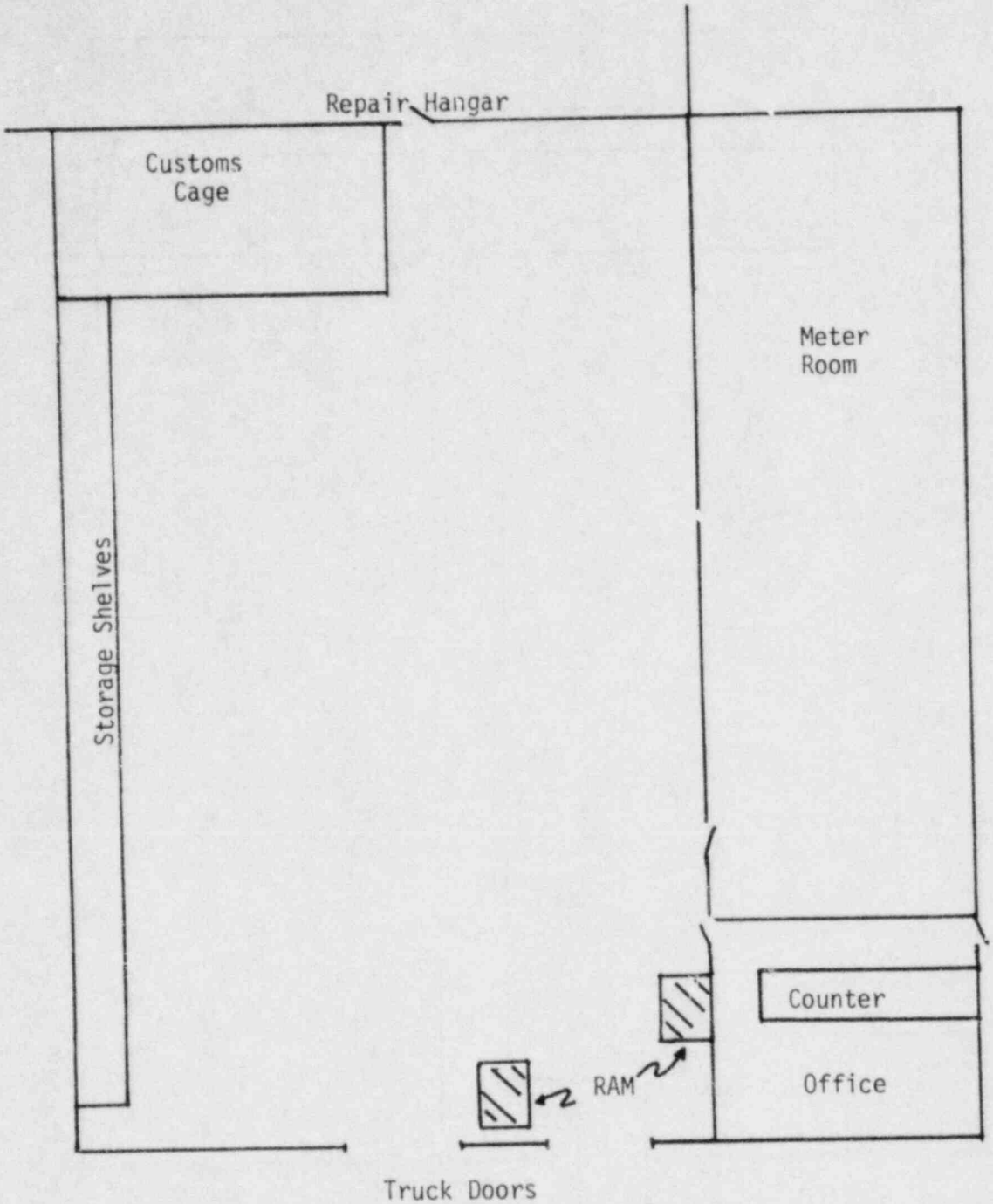


FIGURE 4
FEDERAL EXPRESS
ROMULL'S, MICHIGAN
AREA SKETCH

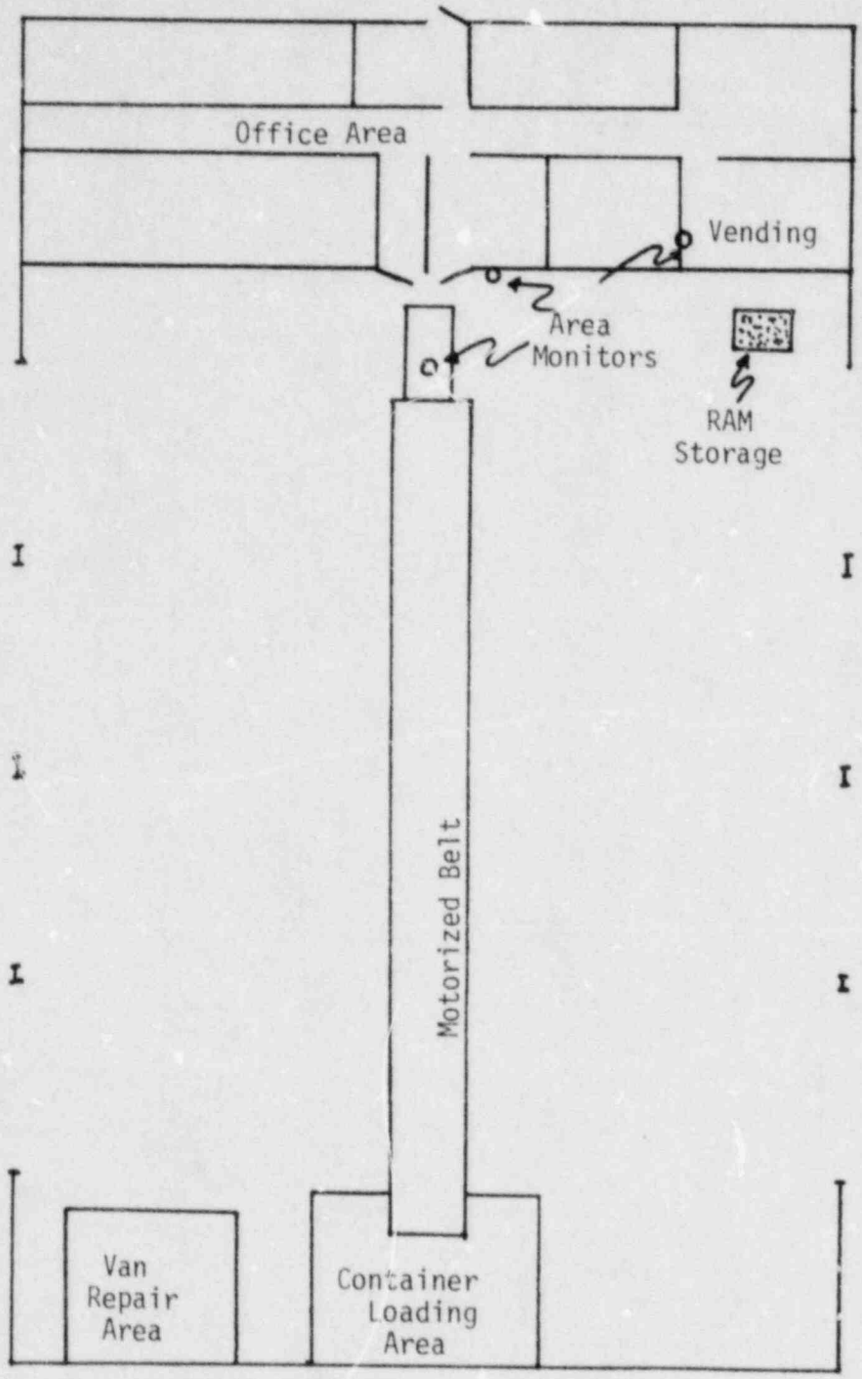


FIGURE 5
PUROLATOR COURIER CORPORATION
OAK PARK, MICHIGAN
AREA SKETCH

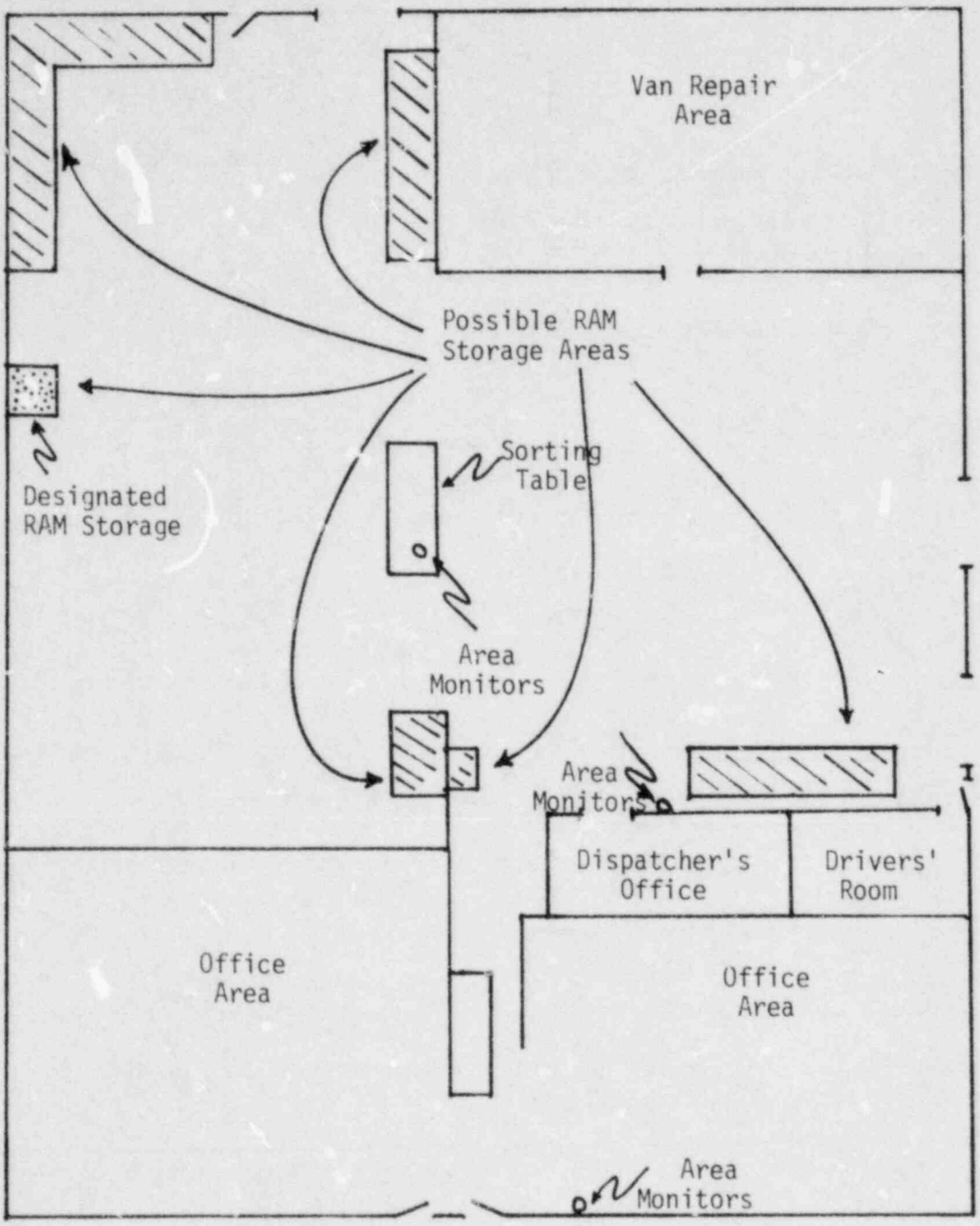


FIGURE 6
NORTHWEST ORIENT AIRLINES
DETROIT METROPOLITAN AIRPORT
AREA SKETCH

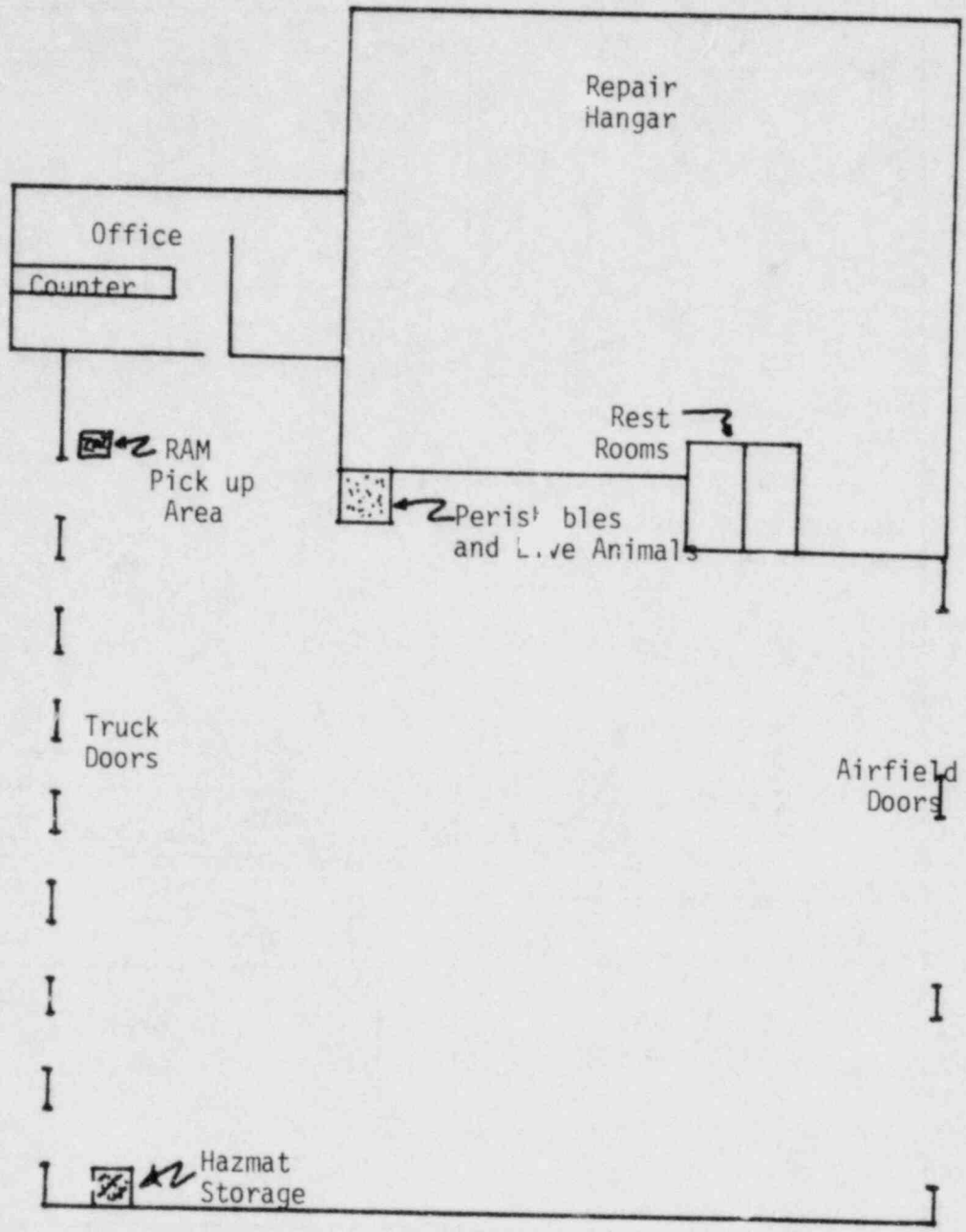


FIGURE 7
EMERY AIR FREIGHT
DETROIT METROPOLITAN AIRPORT
AREA SKETCH

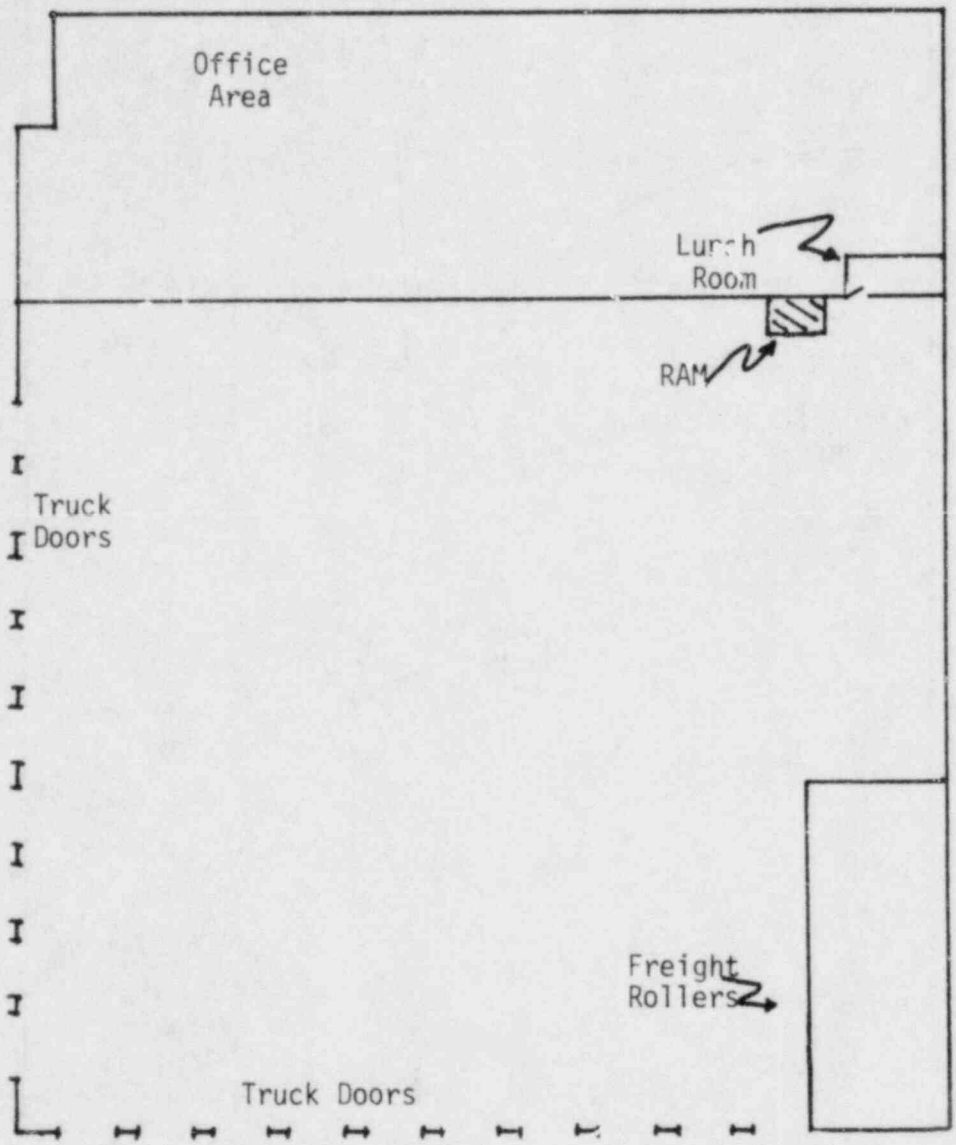
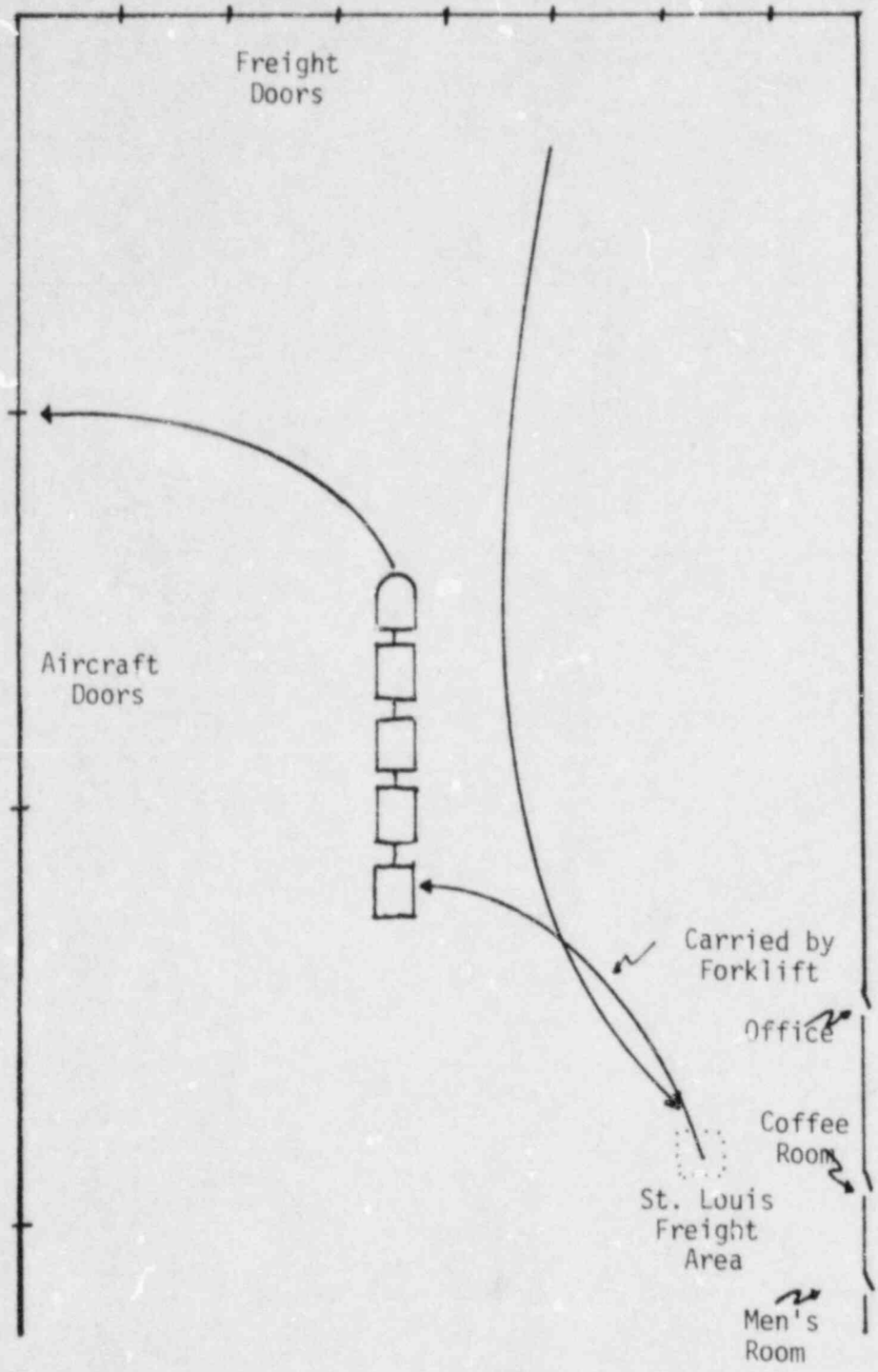


FIGURE 8

ZANTOP INTERNATIONAL AIRLINES
WILLOW RUN AIRPORT



XV. APPENDICES

APPENDIX A

STATE OF MICHIGAN

WILLIAM G. MILLIKEN, Governor

DEPARTMENT OF PUBLIC HEALTH

3500 N. LOGAN
P.O. BOX 30035, LANSING, MICHIGAN 48909
MAURICE S. REIZEN, M.D., Director

The Michigan Department of Public Health, under a contract with the U. S. Nuclear Regulatory Commission and U. S. Department of Transportation, is conducting a program for the surveillance of radioactive materials in transport. Information and data concerning radiation levels in the transportation environment due to the presence of packages of radioactive materials will be accumulated and evaluated. Objectives of this study will be:

1. To obtain information on the status of compliance by shippers and carriers with packaging requirements and transportation regulations. Proper package labeling, shipping documents, assignment of transport indices, physical condition of the packages and maintenance of prescribed separation distances will be checked.

2. To monitor radiation exposure of workers and the public. Dosimetry devices will be issued and evaluated to determine personnel and work station area exposures. Contamination surveys may be made of packages, work stations, and storage positions.

3. To gather information on compliance involving vehicles used in transport. Again, dosimetry devices will be used for monitoring personnel and vehicles. Vehicles will also be checked for proper package placement, total transport index, adequate placarding, and contamination.

Thank you for your cooperation in this radioactive material transportation surveillance program. During monitoring operations, disturbance of the normal flow of radioactive materials will be kept to a minimum.

STATE OF MICHIGAN

WILLIAM G. MILLIKEN, Governor

DEPARTMENT OF PUBLIC HEALTH

3500 N. LOGAN
P.O. BOX 30035, LANSING, MICHIGAN 48909
MAURICE S. REIZEN, M.D., Director

ATTENTION: Shipping Operations Manager

Dear Madam or Sir:

The Michigan Department of Public Health, under a contract with the U. S. Nuclear Regulatory Commission and U. S. Department of Transportation, is conducting a program for the surveillance of radioactive materials in transport. Information and data concerning radiation levels in the transportation environment due to the presence of packages of radioactive materials will be accumulated and evaluated. Objectives of this study will be:

1. To obtain information on the status of compliance by shippers and carriers with packaging requirements and transportation regulations. Proper package labeling, shipping documents, assignment of transport indices, physical condition of the packages and maintenance of prescribed separation distances will be checked.

2. To monitor radiation exposure of workers and the public. Dosimetry devices will be issued and evaluated to determine personnel and work station area exposures. Contamination surveys may be made of packages, work stations, and storage positions.

3. To gather information on compliance involving vehicles used in transport. Again, dosimetry devices will be used for monitoring personnel and vehicles. Vehicles will also be checked for proper package placement, total transport index, adequate placarding, and contamination.

Field work required in the contract includes physically checking radioactive material packages being transported into, within, and from Michigan. To assist us in ascertaining the flow and volume of radioactive packages in the state, please provide the following information:

1. Origin and destination of radioactive material shipments.

2. Types and quantities of isotopes being shipped.

3. Names and locations of airlines and trucklines used for transport by your company. For regularly scheduled shipments include flight numbers, days, times, etc.

4. Names and locations of connecting truck lines or couriers.

Thank you for your cooperation in this radioactive material transportation surveillance program. During monitoring operations, disturbance of the normal flow of radioactive materials will be kept to a minimum.

PERSONNEL MONITORING DEVICES

You are requested to wear this "radiation monitoring dosimeter" while working at your regular job which may involve handling, transporting or other contact with radioactive shipments. The dosimeter is a sensitive device which responds to the energy it absorbs from the radiation you might receive while working. The dosimeter is not itself radioactive nor does it attract radiation. It also does not "protect" the wearer from radiation. The sole function of the dosimeter is to record accurate data on actual exposures. It will be evaluated by a specialized machine in Lansing to determine the badge's exposure.

Clip the dosimeter to your shirt or shirt pocket and wear it there while working. After your shift is over, place the dosimeter in an area far from radioactive material packages with other items you normally use or carry each day, so that you will not forget it. Be especially careful not to let it go through the laundry! Be sure to remove the device if you are to have a medical or dental x-ray or a medical procedure involving radioisotopes. Since the badges are moderately expensive and can be damaged by tampering, DO NOT ATTEMPT TO OPEN THE DEVICE AT ANY TIME. To satisfy your curiosity there is a picture of the aluminum card (with the two sensitive "chips") that is inside of the black plastic case.

The dosimeter will be picked up for evaluation of radiation exposure in 1-3 months. A replacement dosimeter may be issued at that time.

A very important aspect of our study is personnel monitoring and your cooperation is greatly appreciated. If you have any questions about the wearing or the operation of the devices, feel free to call Michael McCarty or Joseph Hennigan, (517) 373-1578.

Division of Radiological Health
Michigan Department of Public Health
3500 North Logan Street
P. O. Box 30035
Lansing, Michigan 48909

APPENDIX B

VEHICLE INSPECTION DATA SHEET - TYPE: AIRPLANE

Airline _____ Shipper _____ Registration "N"# _____

Location _____ Date __/__/__ Time _____ Monitors _____

INSTRUMENT USED

Make: _____

Model: _____

Serial #: _____

Calib. Date: _____

Background: _____

CONTAMINATION SURVEY

No. Smears: _____

ID #	LOCATION	RESULTS
____	_____	_____
____	_____	_____
____	_____	_____
____	_____	_____

OBSERVATIONS: Total T.I.: _____ Ship Dcmts: _____

Secure: _____ Exclusive Use: _____

RADIATION READINGS - PACKAGE PLACEMENT - MONITOR & SMEAR LOCATIONS

(mR/hr)

Sketch Key

Monitors: 

Smears: 

REMARKS: _____

_____

_____

SURVEY CONDUCTED BY: _____

VEHICLE INSPECTION DATA SHEET - TYPE: SEDAN

Company _____ Carrier _____ License # _____

Location _____ Date__/__/__ Time _____ Monitors _____

INSTRUMENT USED

Make: _____

Model: _____

Serial #: _____

Calib. Date: _____

Background: _____

CONTAMINATION SURVEY

No. Smears: _____

ID #	LOCATION	RESULTS
____	_____	_____
____	_____	_____
____	_____	_____
____	_____	_____

OBSERVATIONS

Total T.I.: _____

Ship Dcmts: _____

Secure: _____

Exclusive Use: _____

PLACARDS Circle One: Required N/A

Front:	yes	no
Rear:	yes	no
Right:	yes	no
Left:	yes	no

SKETCH KEY:

Monitors: ◯

Smears: △

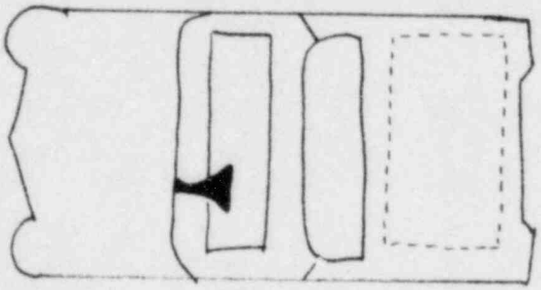
RADIATION READINGS - PACKAGE PLACEMENT - MONITOR & SMEAR LOCATIONS

(mR/hr)

Surface: _____ 6 ft: _____

Surface: _____

6 ft: _____



Surface: _____

6 ft: _____

Surface: _____ 6 ft: _____

Drivers Seat: _____

Remarks: _____

_____

_____

Survey Conducted By: _____

VEHICLE INSPECTION DATA SHEET - TYPE: TRUCK

Company _____ Carrier _____ License # _____

Location _____ Date __/__/__ Time _____ Monitors _____

INSTRUMENT USED

Make: _____

Model: _____

Serial #: _____

Calib. Date: _____

Background: _____

CONTAMINATION SURVEY

No. Smears: _____

ID #	LOCATION	RESULTS
___	_____	_____
___	_____	_____
___	_____	_____
___	_____	_____

OBSERVATIONS

Total T.I.: _____

Ship. Dcmts: _____

Secure: _____

Exclusive Use: _____

PLACARDS

	Circle One:		Required N/A
Front:	yes	no	
Rear:	yes	no	
Right:	yes	no	
Left:	yes	no	

Sketch Key:

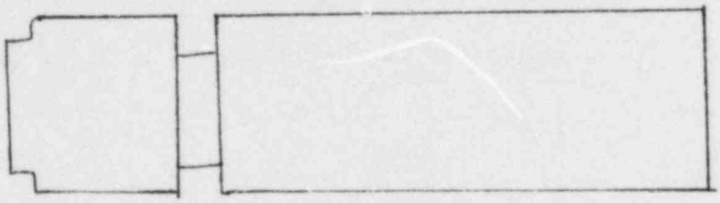
Monitors:

Smears:

RADIATION READINGS - PACKAGE PLACEMENT - MONITOR & SMEAR LOCATIONS

(mR/ hr)

Surface: _____ 6 ft: _____



Surface: _____ 6 ft: _____

Surface: _____ 6 ft: _____

Surface: _____ 6 ft: _____

In Cab: _____ Trailer Type & No. _____ License #: _____

Remarks: _____

_____

_____

_____

Survey Conducted By: _____

VEHICLE INSPECTION DATA SHEET - TYPE: VAN

Company _____ Carrier _____ License # _____

Location _____ Date __/__/__ Time _____ Monitors _____

INSTRUMENT USED

Make: _____

Model: _____

Serial #: _____

Calib. Date: _____

Background: _____

CONTAMINATION SURVEY

No. Smears: _____

ID #	Location	Results
____	_____	_____
____	_____	_____
____	_____	_____
____	_____	_____

OBSERVATIONS

Total T.I.: _____

Ship. Dcmts: _____

Secure: _____

Exclusive Use: _____

PLACARDS

Circle One:		Required N/A
Front:	yes no	
Rear:	yes no	
Right:	yes no	
Left:	yes no	

Sketch Key:

Monitors: ◯

Smears: △

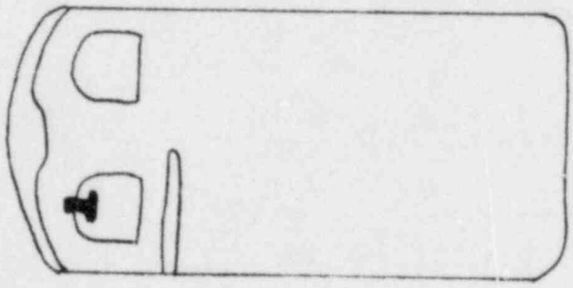
RADIATION READINGS - PACKAGE PLACEMENT - MONITOR & SMEAR LOCATIONS

(mR/hr)

Surface: _____ 6 ft: _____

Surface: _____

6 ft: _____



Surface: _____

6 ft: _____

Surface: _____ 6 ft: _____

Surface: _____

6 ft: _____

Drivers Seat: _____

Remarks: _____

_____

_____

Survey Conducted By: _____

TERMINAL OR WAREHOUSE INSPECTION DATA SHEET

Company _____ Location _____ Date/Time _____ Monitors _____

Instrument(s): Type _____ Serial No. _____ Calib. Date _____

Type _____ Serial No. _____ Calib. Date _____

Sketch Key:

- ◯ Monitor Placement
- △ Swipe Location
- □ Package Placement
- ( ) Area Readings

CONTAMINATION SURVEY

ID #	SWIPE NO.	LOC. DSCP.	RESULTS

AREA RADIATION LEVEL READINGS

NATURAL BACKGROUND _____ TOTAL T.I. PRESENT _____

ID. NO.	POSITION	RADIATION LEVEL $\frac{mR}{hr}$	REMARKS

COMMENTS: _____

ATTACHMENTS: Monitoring Device Placement Sheet, Area Sketch, Personnel Survey

PERSONNEL SURVEY

EMPLOYER: _____ LOCATION: _____ MONITORS: _____

NAME: _____ SOC. SEC. NO: _____ BIRTH DATE: _____

TITLE: _____ DUTIES: _____

1. DOSIMETER DATA

DEVICE #	DATE/TIME ISSUED	DATE/TIME RETURNED	EXPOSURE MEASURED	COMMENTS REMARKS

2. EXPOSURE ESTIMATE BASIS: _____

3. ANNUAL EXPOSURE ESTIMATE BASIS: _____

CONTAINERIZATION INSPECTION DATA SHEET

COMPANY _____ LOCATION _____ DATE _____ TIME _____

INSTRUMENT - TYPE _____ SERIAL NO. _____ CALIB. DATE _____ BACKGROUND _____

SHIPPER & ORDER NO.	TYPE OF LG. CONT NO. PKGS. IN CONT	CONTENTS ISOT.	CONTENTS Ci	LABELS LIST T.I.	LABELS NO.	LABELS TYPE	RADIATION LEVELS mR/hr SURFACE	RADIATION LEVELS mR/hr @ 3 FT.	CONTAINER SEAL	CONTAINER SIZE	CONTAINER SWIPE NO.	CONTAINER REMOV. CONT.	RMKS. NO.
REMARKS: _____													

PACKAGE INSPECTION DATA SHEET

COMPANY _____ LOCATION _____ DATE _____ TIME _____

INSTRUMENT: TYPE _____ SERIAL NO. _____ CALIB. DATE _____ BACKGROUND _____

SHIPPER & ORDER NO.	PACKAGE AUTH	CONTENTS		LABELS			RADIATION LEVELS mR/hr		PHYSICAL CONDITION				RMKS.
	TYPE COMMODITY	ISOT.	Ci	LIST T.I.	NO.	TYPE	SURFACE	@ 3 FT.	SEAL	SIZE	SWIPE NO.	REMOV. CONT.	NO.

REMARKS: _____

MONITORING DEVICE PLACEMENT DATA SHEET

Company _____ Location _____ Monitors _____ Nat. Bkgrd. _____

Device #	Location (see sketch) ID # Description	Date/Time Placed	Date/Time Retrieved	Exposure Measured	Annual Exposure w/o Bkgrd.	Rmks. No.

REMARKS: _____

TLD CARDS DATA SHEET

SITE	TLD #	READING (nC)	BKG #1 (nC)	BKG #2 (nC)	CALIB. FACTOR	NET (mR)	AVG. NET± (mR)	DATE(S) Zero/Read	DATE(S) Placed/Return	AVG. NET (mR/Day)

APPENDIX C

DEPARTMENT OF TRANSPORTATION
RESEARCH AND SPECIAL PROGRAMS ADMINISTRATION
WASHINGTON, D.C. 20590

DOT-E 7060
(THIRD REVISION)

1. Federal Express Corporation, Memphis, Tennessee, is hereby granted an exemption from those provisions of this Department's Hazardous Materials Regulations specified in paragraph 5 below to transport packages of radioactive materials in commerce subject to the limitations and special requirements specified herein. This exemption authorizes the carriage of radioactive materials aboard cargo-only aircraft when the combined transport index exceeds 50 and/or the separation criteria can not be met, and provides no relief from any regulation other than as specifically stated. Each of the following is hereby granted the status of a party to this exemption:

Express Airways, Inc., Sanford, Florida - PTE-1.
Summit Airlines, Philadelphia, Pennsylvania - PTE-2.
Atlantic Air, Inc., Baltimore, Maryland - PTE-3.
Sajen Air, Incorporated, Chesterfield, Mo., (formerly, Golden Eagle Air Services, Incorporated, Jennings, Mo.) - PTE-4.

2. BASIS. This exemption is based on Federal Express Corporation's application dated November 30, 1979, submitted in accordance with 49 CFR 107.105 and the public proceeding thereon. The granting of party status is based on the following applications submitted in accordance with 49 CFR 107.111 and the public proceeding thereon:

Express Airways, Inc.'s application dated January 22, 1980.
Summit Airlines' application dated November 6, 1979.
Atlantic Air, Inc.'s application dated November 28, 1979.
Golden Eagle Air Services, Incorporated's emergency application dated September 18, 1979 and New England Nuclear's supplemental letter dated September 17, 1979.

3. HAZARDOUS MATERIALS (Descriptor and class). Radioactive materials.

4. PROPER SHIPPING NAME (49 CFR 172.101). Specific commodity name or generic description, as appropriate.

5. REGULATION AFFECTED. 49 CFR 175.75(a)(3), 175.700(a).

6. MODE OF TRANSPORTATION AUTHORIZED. Cargo-only aircraft.

7. SAFETY CONTROL MEASURES. The carriage of radioactive materials in cargo-only aircraft operations, without compliance with the regulations cited in paragraph 5 above, is authorized provided the carriers as identified above:

a. Maintain a radiation protection program that will assure compliance with the standards set forth in the regulation of the Occupational Safety and Health Administration for employees who work in restricted areas where individuals may be exposed to radiation (29 CFR 1910.96 but excluding 1910.96(b)(2)). All personnel operating aircraft or loading and unloading the aircraft or otherwise handling the radioactive materials packages under the provisions of this exemption are considered to be in restricted areas and must wear radiation dosimetry devices.

b. Make every reasonable effort to maintain radiation exposure as far below the limits set forth in 29 CFR 1910.96(b)(1) as practicable.

c. Have available the services of a competent health physicist to supervise the carrier's radiation protection program. This person shall have a Bachelor's degree in a science or engineering subject, or its equivalent, and at least six years of responsible professional experience in health physics, at least three of which have been in applied radiation protection work, specifically including experience in the kinds of radiation protection problems likely to arise in the carrier's operation. This person shall be assigned the responsibility for carrying out condition 7b of this exemption and shall be required to make it a formal part of the radiation protection program.

d. Conduct contamination surveys of the inside of the aircraft after any abnormal occurrence or use for the transport of radioactive materials, prior to use for any other cargo, to assure that there is no significant removable radioactive surface contamination, as defined in 49 CFR 173.397.

e. Obtain written assurance from the shipper that each package of radioactive materials that the shipper offers to the carrier for transport aboard its aircraft contains no fissile material.

f. Establish procedures that will assure that persons not included under 29 CFR 1910.96(d)(2), but who may be in the vicinity of petitioner's aircraft, are not exposed to a radiation dose rate in excess of 2 millirem per hour.

g. Assess personnel radiation exposure on a monthly basis. On a quarterly basis, the health physicist shall analyze the effectiveness of prior and current efforts required by paragraph 7b, and determine what additional efforts will be taken. A report of this analysis and determination along with the results of the contamination surveys and records kept in accordance with 29 CFR 1910.96 must be submitted quarterly to the Materials Transportation Bureau, DMT-12, within 30 days after the end of each calendar quarter.

h. Obtain permission from the airport management before operating under this exemption into any airport, when the total transport index exceeds 50.

8. SPECIAL PROVISIONS.

a. A copy of this exemption and of Title 29 CFR 1910.96 must be carried aboard each aircraft used to transport packages covered by this exemption.

b. No person operating under this exemption may offer, interline, or otherwise deliver radioactive material packages totaling in excess of 50 TI's to any person for transportation in one motor vehicle unless the vehicle is being operated under authority of, and in conformance with DOT-E 8308.

c. In each aircraft with the shipping papers there must be emergency instructions for the operator and suggested instructions for emergency service personnel to follow in the event of an incident that incapacitates the operator. These instructions and procedures shall include notification of required Federal or State authorities in addition to the officials of the carrier's organization. Included shall be a listing of Federal and State authorities and their phone numbers for all States in which operations are conducted under this exemption.

d. Operators of aircraft operating under this exemption and carrying in excess of 50 TI's must file a flight plan and shall include in the remarks section a statement that cargo includes radioactive materials with a total transport index exceeding 50 and that the operation is under this exemption. In the event of an accident while operations are performed under this exemption that results in release or suspected release of contents of a package, the carrier shall immediately notifiy the Federal Aviation Command Center (202) 426-3333 of the quantity and types of radionuclides aboard the aircraft.

e. Cargo, other than fissile radioactive materials, may be carried under the provisions of this exemption, provided it is not otherwise prohibited by the regulations.

9. REPORTING REQUIREMENTS. Any incident involving release or suspected release of contents of the package must be reported to the Office of Hazardous Materials Regulation as soon as practicable. The notification requirements of 29 CFR 1910.96 shall be reported to the OHMR in lieu of the Assistant Secretary of Labor. Routine reports are required by paragraph 7g.

10. EXPIRATION DATE. January 31, 1980 for Saicn Air, Inc.; January 31, 1982 for Federal Express Corp., and PTE-1 through PTE-3.

Issued at Washington, D.C.:

MAY 28 1980

(DATE)

Alan I. Robert
Associate Director for
Hazardous Materials Regulation
Materials Transportation Bureau

Address all inquiries to: Associate Director for Hazardous Materials Regulation, Materials Transportation Bureau, Research and Special Programs Administration, U.S. Department of Transportation, Washington, D.C. 20590. Attention: Exemptions Branch.

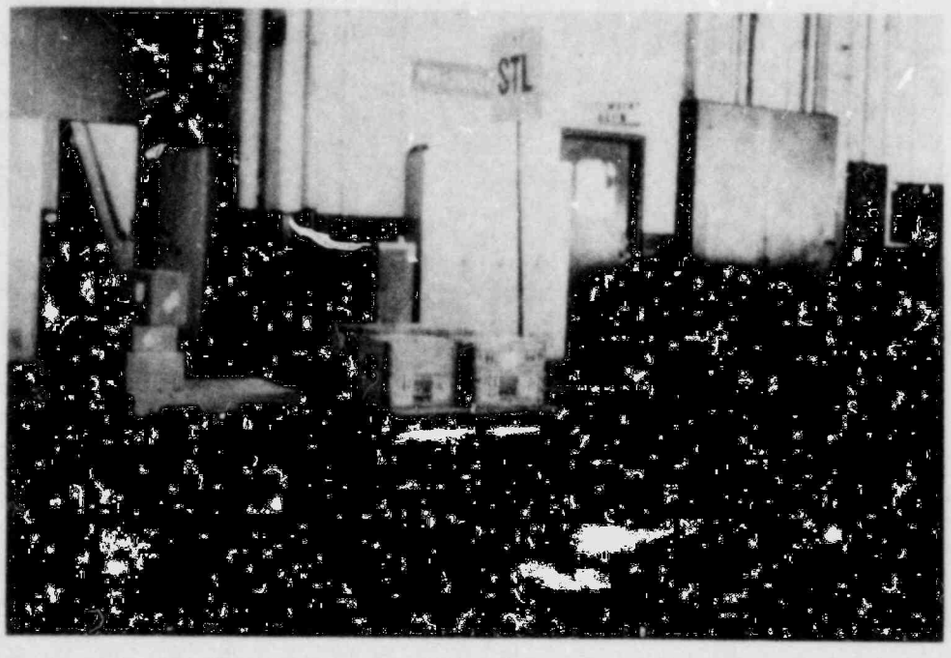
Dist: B of E, FAA

APPENDIX D

FIGURE 1

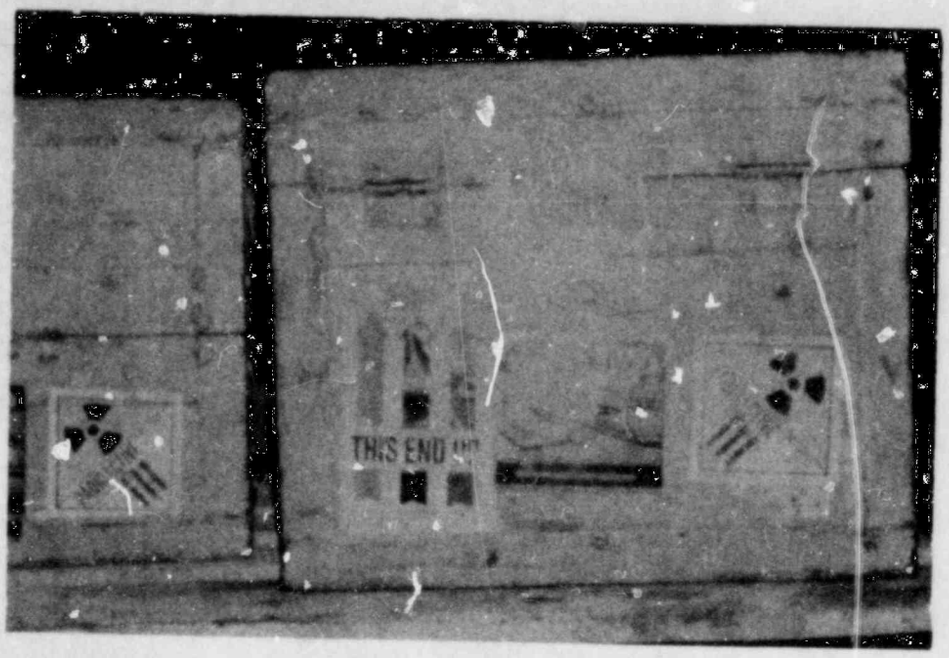
A shipment of radiopharmaceuticals in DOT 7A Type A packages and an overpack at Northwest Orient Airlines, Detroit Metropolitan Airport.

FIGURE 2



Two wood and steel, lead shielded bromine-82 labeled motor oil DOT 7A Type A packages at Zantop International Airlines, Willow Run Airport.

FIGURE 3

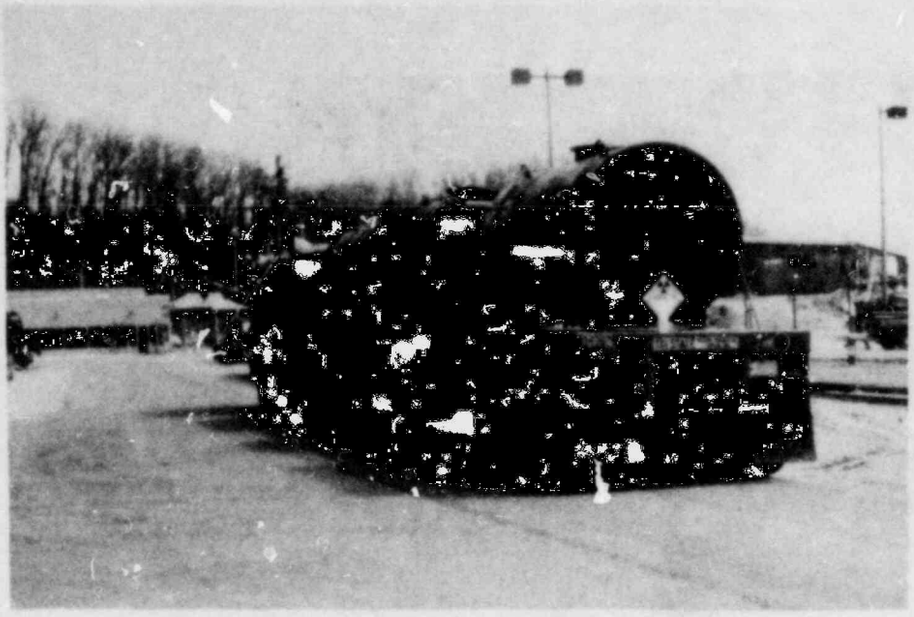


Close-up of packages showing T.I. 5 and T.I. 6 Yellow III labels.

FIGURE 4

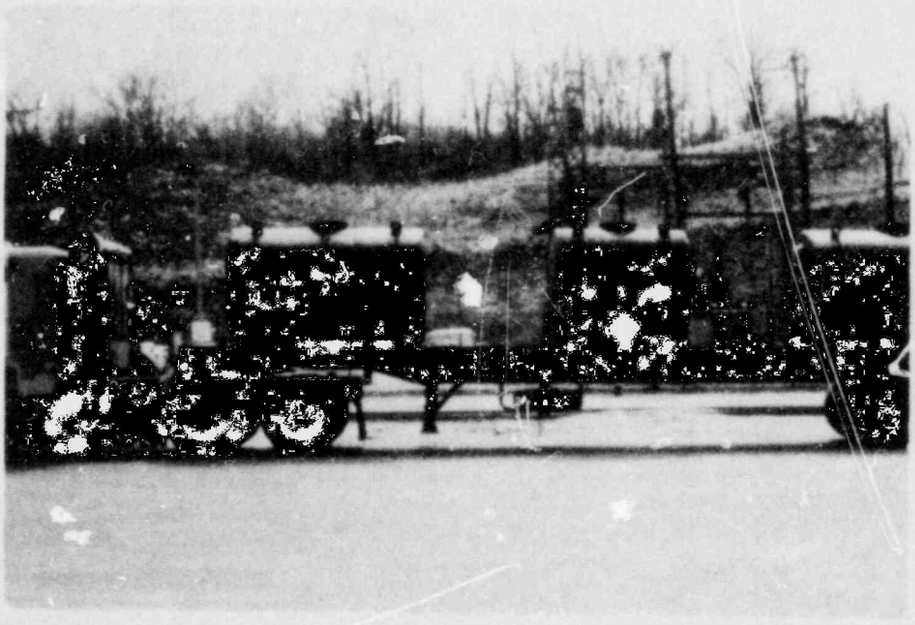
Casperson, Inc. truck purchased to replace a van and provide greater separation distance.

FIGURE 5



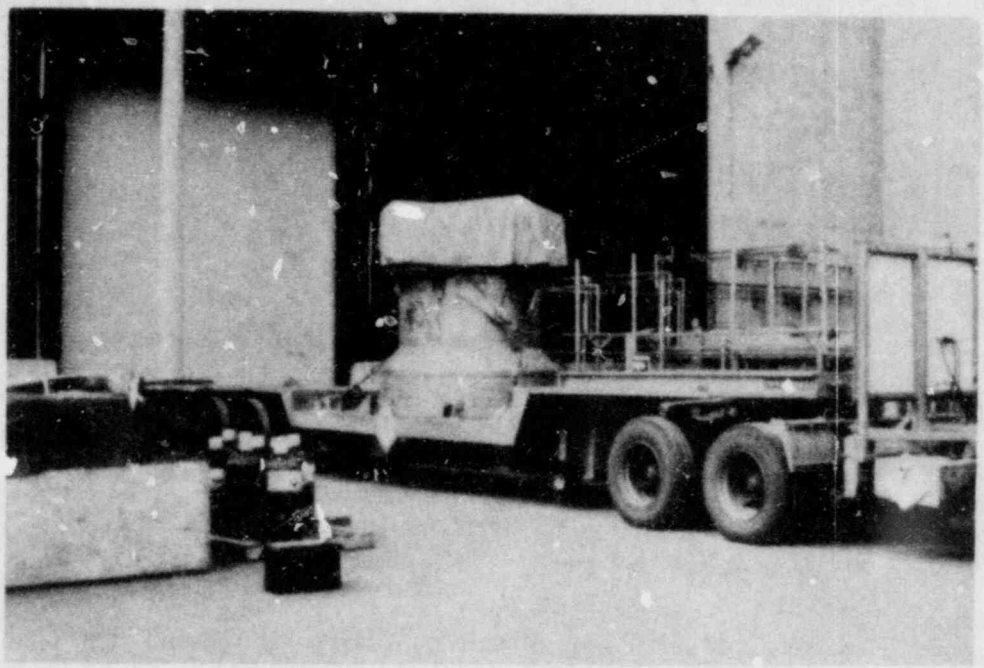
D. C. Cook Nuclear Power Plant evaporator concentrates shipment solidified in urea formaldehyde.

FIGURE 6



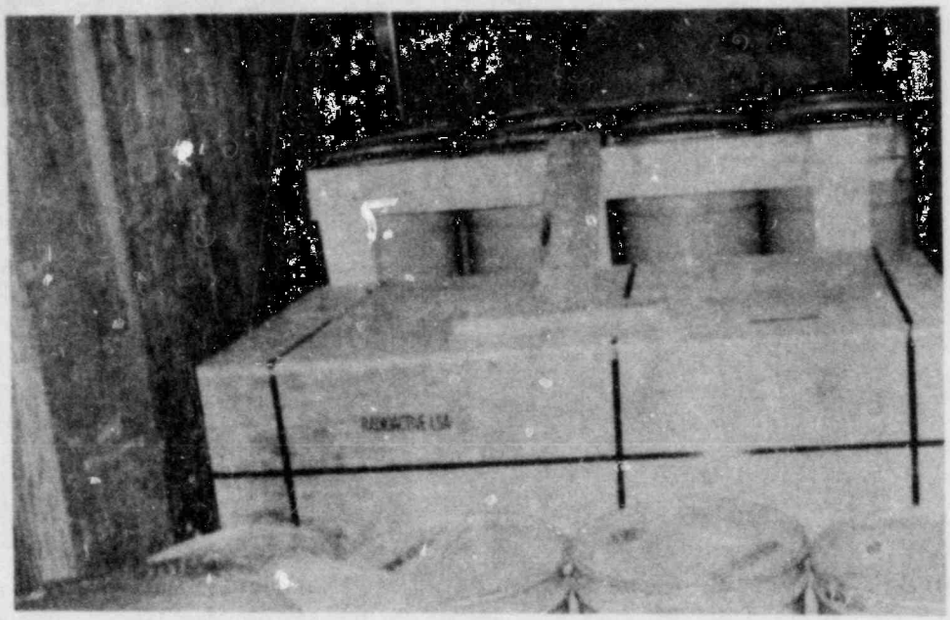
Different view showing the smaller middle tank. Three large tanks are not shipped due to weight restrictions.

FIGURE 7



D. C. Cook Nuclear Power Plant shipment in Hittman Nuclear HN-200 lead shielded cask.

FIGURE 8

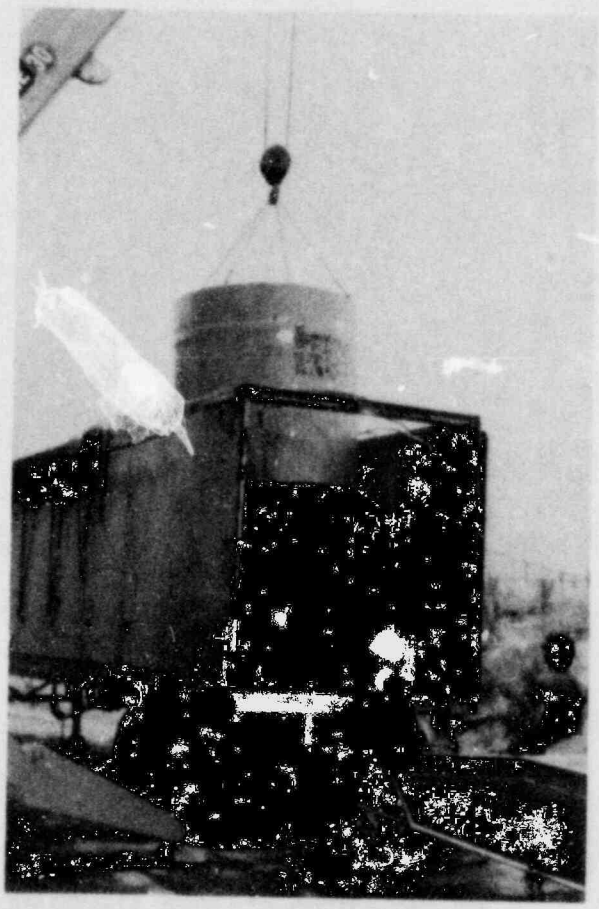


Mixed radioactive waste shipment from Palisades Nuclear Power Plant. Drums of compacted trash and boxes of non-compressible trash.

FIGURE 9

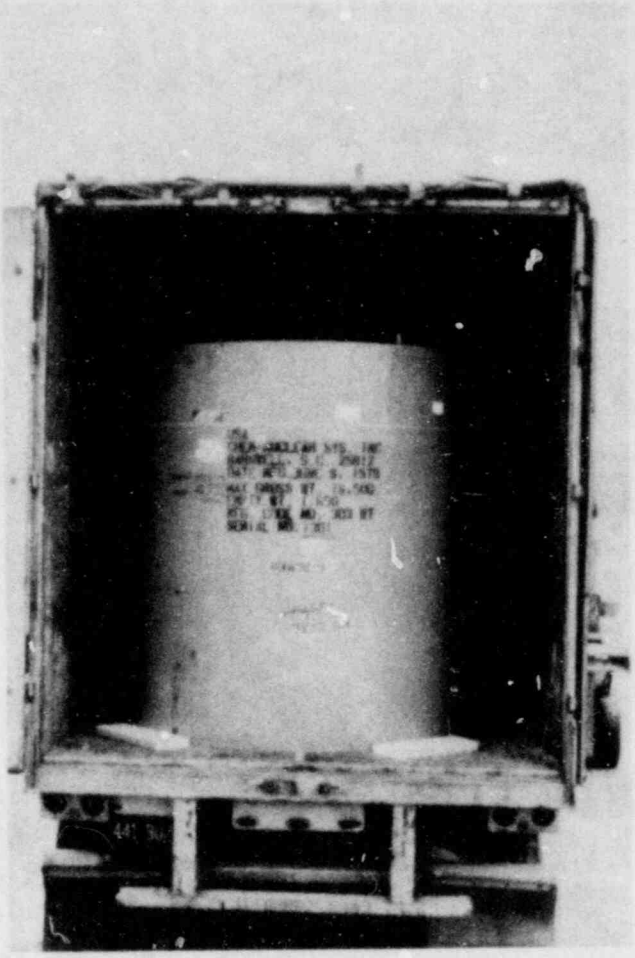
Palisades Nuclear Power Plant evaporator concentrates solidified in sodium solvate/cement, on mixed waste shipment.

FIGURE 10



Loading of an unshielded steel liner of dewatered ion exchange resin at Palisades.

FIGURE 11

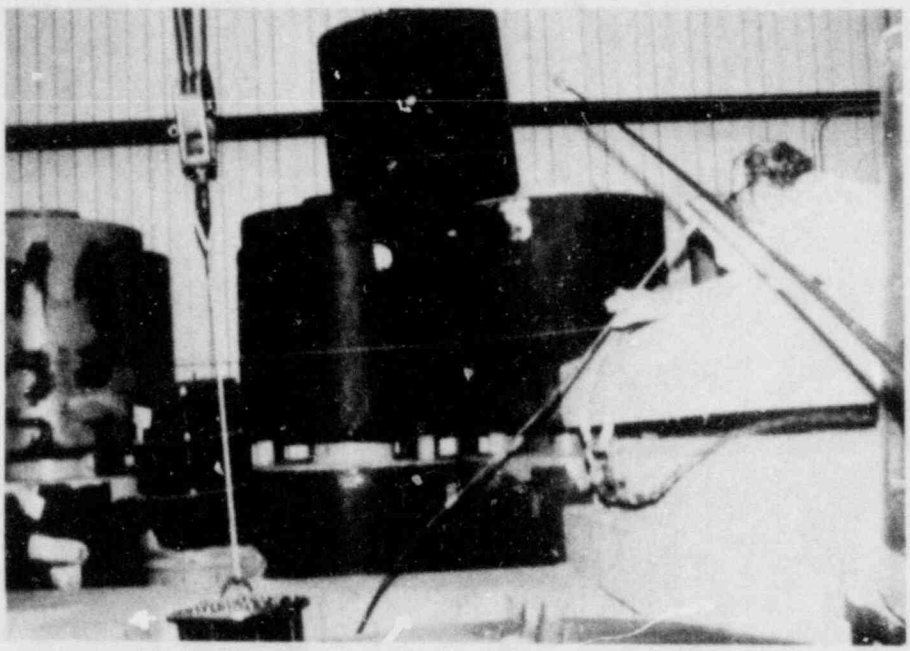


Steel liner blocked in place.

FIGURE 12

Arrival of an empty Chem-Nuclear CNSI-8-120, 4 inch lead shielded cask at Palisades Nuclear Power Plant.

FIGURE 13

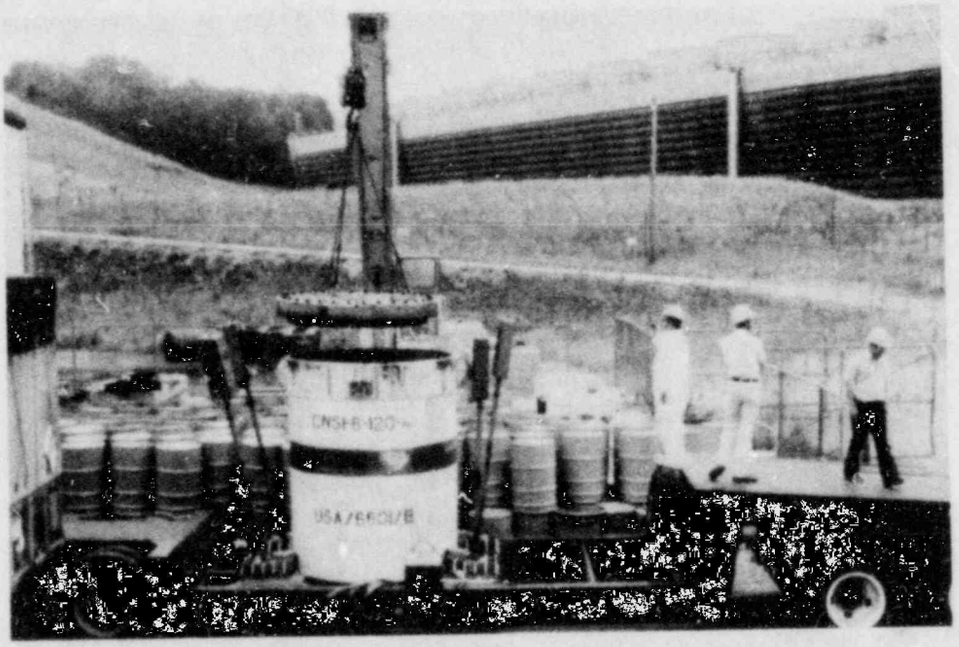


Insertion of primary coolant filters into a steel liner at Palisades waste building.

FIGURE 14

Transfer of the steel liner into the cask.

FIGURE 15



Lowering and aligning the cask lid.

FIGURE 16

Surveying damaged yellowcake trailer for alpha contamination.

FIGURE 17

Damaged yellowcake drum with tape over hole.

FIGURE 18

Transfer of the yellowcake drums to an undamaged trailer for completion of the shipment.

NRC FORM 335 (7-77) U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

1. REPORT NUMBER *(Assigned by DDC)*: NUREG/CR-2034

4. TITLE AND SUBTITLE *(Add Volume No., if appropriate)*: Transportation of Radioactive Material in Michigan

2. *(Leave blank)*

3. RECIPIENT'S ACCESSION NO.

7. AUTHOR(S)

5. DATE REPORT COMPLETED: MONTH April YEAR 1981

9. PERFORMING ORGANIZATION NAME AND MAILING ADDRESS *(Include Zip Code)*

Division of Radiological Health
Department of Public Health
State of Michigan
Lansing, Michigan 48909

DATE REPORT ISSUED: MONTH June YEAR 1981

6. *(Leave blank)*

8. *(Leave blank)*

12. SPONSORING ORGANIZATION NAME AND MAILING ADDRESS *(Include Zip Code)*

Office of State Programs
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

(Sponsored jointly with U.S. Department of Transportation)

10. PROJECT/TASK/WORK UNIT NO.

11. CONTRACT NO.: FIN B1612

13. TYPE OF REPORT: Transportation surveillance study

PERIOD COVERED *(Inclusive dates)*: September 1, 1979 to August 31, 1980

15. SUPPLEMENTARY NOTES

14. *(Leave blank)*

16. ABSTRACT *(200 words or less)*

This report describes the third year's study by the State of Michigan of the transportation of radioactive material in Michigan, during the period, September 1, 1979 to August 31, 1980. The study was performed under contract to the Nuclear Regulatory Commission and the Department of Transportation.

The study revealed that most of the radioactive material transported through and within the State of Michigan is comprised of radiopharmaceuticals. The remainder includes radioactive waste from nuclear power plants and hospitals, and uranium ore concentrate (yellowcake) from Ontario, Canada. Investigations revealed minor packaging and shipping document violations. Major operational problems associated with two courier companies, involving annual radiation doses in excess of 0.5 rem to vehicle drivers, were discovered. Cooperative investigations with federal agencies resulted in legal action against several companies. More enforcement action is anticipated and needed in order to promote compliance with federal regulations and to provide adequate radiation safety for the workers. Several radiation incidents involving transportation were reported and investigated, including a minor accident involving a yellowcake truck. No significant radiation exposure resulted from any of these incidents.

17. KEY WORDS AND DOCUMENT ANALYSIS

17a. DESCRIPTORS

Transportation, Michigan

17b. IDENTIFIERS/OPEN-ENDED TERMS

18. AVAILABILITY STATEMENT: Unlimited

19. SECURITY CLASS *(This report)*: Unclassified

21. NO. OF PAGES

20. SECURITY CLASS *(This page)*: Unclassified

22. PRICE: $

NRC FORM 335 (7-77)

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NUCLEAR REGULATORY COMMISSION
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