NUREG/CR-1194

Transportation of Radioactive Material in Michigan

September 1978 - August 1979

State of Michigan
Department of Public Health

Prepared for
U. S. Nuclear Regulatory
Commission

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ABSTRACT

Radiopharmaceuticals constitute the majority of radioactive material transported in the State of Michigan. Waste from nuclear power plants and hospitals, and uranium ore concentrate (yellowcake) from Canada make up most of the remainder. Investigations made under contract with the Nuclear Regulatory Commission and the U. S. Department of Transportation have revealed minor nuclear medicine packaging violations and more serious violations resulting in radiation exposure to workers in excess of 0.5 rem per year. These workers, who are employed by two courier companies that deliver nuclear medicine shipments, could benefit from a radiation protection program which would include instruction in proper handling of radioactive material packages and proper vehicle loading, and personnel exposure monitoring. Nuclear power plants currently store high level spent fuel wastes onsite and ship only lower level wastes. Changes in requirements have caused improvements in liquid waste solidification processes. One yellowcake truck examined was loaded in a manner suggesting that the 55-gallon drums would rupture and disperse the contents in a collision. No radioactive contamination in excess of 49 CFR limits has been detected on any shipments from any source.

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I. INTRODUCTION

A. Overview

The Michigan Department of Public Health, Division of Radiological Health, has completed the second year of investigations 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 materials 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 second contract year, from September 1, 1978 to August 31, 1979 are summarized and evaluated in this report. Since the option for a third contract year has been exercised, the program is 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 by 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 previous contract year. During the initial contact 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 contact phase. During this phase any changes were noted in the layout of the work area, the 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 until May 1979 the only labeling requirement was the word "Radioactive" on the inner container. As of 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 hypothetical accidents and are usually constructed of steel. Both Type A and Type B containers are required to have labels 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. They include the name of the radionuclide or radionuclides, the amount in curies, and the Transport Index (T.I.). The T.I. is defined as the exposure rate in mR/hr at 3 ft. from the surface. No Transport Index is assigned to White I's, because the 3 foot radiation level is less than 0.1 mR/hr, by definition. Type A and Type B packages are labeled according to the radiation exposure rate at the surface and at 3 ft. from the surface. The respective surface and 3 ft. limits for each label are 0.5 and less than 0.1 mR/hr for WHITE I, 50 and 1.0 mR/hr for YELLOW II, and 200 and 10 mR/hr for YELLOW III.

According to wipe tests, all packages 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 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 beta, gamma, and x-radiation over the spectral range 6.5 keV to 1.3 MeV. 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 can be attached 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 can also be used to monitor surface contamination and to field check wipe samples.

Wipe samples for removable contamination were taken using adhesive-backed cloth circles 4.5 cm in diameter. An area of 100 $cm.^2$ was wiped with the disk, since the contamination limits in the Michigan Ionizing Radiation Rules are expressed on the basis of 100 $cm.^2$ Wipe samples are counted in the Division's Nuclear Counting Facility for gross alpha, gross beta, and gamma activity. If significant activity is found, specific isotopes are identified and quantified using a gamma spectrometer. Of the fifty wipe samples taken this year, most have 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" Meter and an Eberline PRS-1 "Rascal" with a Model SPA-3 2" x 2" NaI scintillation detector are used.

The Micro "R" Meter is a special purpose scintillation crystal type gamma survey meter with four linear scales 0-25 to 0-500 micro-R/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 survey meters are calibrated at the beginning of each calendar quarter by Division physicists. Exposure readings and linearity of the gamma meters are checked and adjusted using Cs-137 and Co-60 standards. The alpha meter is calibrated using standardized 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 Department Cs-137 source. Failure and subsequent replacement of a circuit board in the picoammeter necessitated a restandardization of the reader system and calibration of each of the two TLD chips in each badge.

Problems have been encountered throughout the program when area monitors are placed on movable objects. For example, a monitor was affixed to a coffee machine because the workers frequented that area. The vendor owning the machine removed it with the attached monitors and installed it in a new Detroit area location. Fortunately, the TLDs were recovered by the vendor at our request, and the data was not lost. To prevent such occurrences, area monitors are now attached to load bearing walls whenever possible.

C. Types of Shipments

Most RAM transported in the State is used for medical purposes, either diagnostic or therapeutic. Some typical materials carried are Mo-99/Tc-99m, I-131, I-123, In-111, Ga-67, Xe-133, Se-75, Co-57, Co-60, and Cr-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 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 concentrate ("yellowcake") constitutes a new, growing source of the RAM transported in the State. The yellowcake is mined and processed 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 the current RAM transportation. Such carriers as industrial radiographers, physicians, and universities will be investigated on a lower priority basis.

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 in the rest of the Lower Peninsula. Pickup of radiopharmaceuticals at the airport from passenger and chartered freight aircraft is performed by DBM Courier Corporation drivers who also deliver most of the surface transported RAM.

Passenger airlines that carry RAM on regularly scheduled flights are Northwest Orient, Trans World, North Central (renamed Republic), and Eastern Airlines. In addition, a particular shipper, New England Nuclear, has chartered exclusive use flights by Baltimore Airways and Federal Express. Some industrial and research materials are shipped as airfreight 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 that contains several separate Type A packages and usually is a nylon net bag or a large cardboard box. 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, fifty-four (19%) were more than 0.3 higher or lower than the T.I. listed on the label. Thirty-four (12%) were lower than the listed T.I., while twenty (7%) 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 or technique could be checked.

Table 8 lists problems encountered while surveying packages and overpacks. Individual cases are discussed under the carrier where each was noted.

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. An industry imposed maximum of ten total T.I. per flight is also applied. Aircraft are allowed by regulations to carry up to fifty total T.I. of most radionuclides. A DOT exemption (E7060) may be granted which allows a freight airline to carry more than fifty T.I. per flight if the airline establishes a radiation protection program, including monitoring, to minimize employees' radiation exposure.

B. Northwest Orient Airlines

Northwest Orient Airlines is the passenger airline that most regularly transports RAM. A flight from Newark, New Jersey carries a shipment from Medi + Physics six or seven days per week and frequently carries E. R. Squibb & Son, Inc. overpacks assembled by Skycab, a freight forwarder. The total T.I. occasionally exceeds five, but is usually one to three. A hazardous materials area is delineated in the freight terminal away from the office area and from the perishable shipments area where live animals are held. Most shipments are not held in the hazardous materials area since they are usually picked up less than an hour after arriving at the terminal.

Problems have been noted with some packages. Some had radiation levels that exceeded the limits for the particular label on them. A Medi + Physics YELLOW II read 84 mR/hr at the surface (limit 50 mR/hr) and a Capintec, Inc. WHITE I read 9.5 mR/hr and 0.2 mR/hr at the surface and at 3 ft., respectively, as compared with the limits of 0.5 and 0.0 mR/hr, respectively. Three Medi + Physics packages were shipped with the T.I. space left blank. One Squibb package had a YELLOW II label, but the labeled T.I. was in the YELLOW III range.

In one instance a Northwest Orient dock worker was observed placing a live dog on a fork lift along with a shipment of RAM. As a live animal, the dog should have been separated from the RAM.

C. Trans World Airlines

Trans World Airlines carries shipments from Mallinckrodt, Inc. on a semi-regular basis. RAM is frequently shipped but does not appear every night as at Northwest Orient. Some problems are encountered with surveying packages at TWA, since the DBM Courier Corporation driver is frequently waiting at the dock when they arrive. One limitation of the voluntary surveillance program is that surveillance must not delay shipments in transit. Those packages that have been examined are frequently above the listed T.I. when measured. The Federal Aviation Authority in St. Louis, Missouri is currently investigating these shipments at the point of origin. Several YELLOW III overpacks have been observed with listed T.I.s lower than the 1.0 T.I. lower limit for YELLOW IIIs. These should have been labeled as YELLOW IIs.

D. American Airlines

American Airlines has been a frequent RAM carrier, but during the fourth quarter only one shipment was seen at the freight terminal. Previously, enough radiopharmaceuticals were carried to warrant institution of a continuous personnel monitoring study. As shown in Table 2, the area monitors have declined in exposure paralleling the decline of RAM traffic. Personnel exposure, which was not high even during the first quarter, declined to background levels with the decline in traffic. American Airlines formerly received Skycab overpacks and may handle them again in the future.

An ongoing type of shipment with some problems has been observed on the American dock. Such shipments are pallets full of WHITE I cartons from Miles Laboratories in Ontario, Canada. Republic Airlines carries them to Detroit, and then transfers them to Air Wisconsin using the American Airlines freight terminal. These shipments consistently bear only one, rather than two, WHITE I labels, and the cartons are not labeled as being DOT 7A type A approved.

Perhaps these shipments are actually limited quantity shipments that are mislabeled. If this is the case, only strong, tight packaging is required, and only one limited quantity, "not "WHITE I" label per carton is needed.

E. North Central Airlines - Republic Airlines

North Central Airlines merged with Southern Airways during the fourth contract quarter of this year. The resultant corporation is called Republic Airlines. At the beginning of this contract year North Central was a semi-regular carrier of RAM from New England Nuclear. As the year passed, more shipments were carried by Baltimore Airways charter flights. By the fourth quarter nearly all of the RAM was going by charter except for the Canadian shipments previously mentioned.

F. Eastern Airlines

Eastern Airlines was not known to carry any RAM until the third contract quarter when a DBM Courier driver mentioned a regular pickup there. The regularly scheduled shipment was minor, being one WHITE I per week. Even this was discontinued after a May 1, 1979 schedule change rearranged the Eastern flight schedule. Periodic contact is planned to observe any return of RAM traffic.

G. Federal Express

Federal Express carries more RAM than any other air freight line. Industrial radionuclide sources are carried frequently but irregularly, and a biweekly outbound shipment of medical isotopes is picked up in Ann Arbor. Sufficient amounts of radioactive materials are handled at the terminal to justify assignment of TLD monitors to personnel, areas, and the Ann Arbor van. Data is shown in Table 3. The area monitors beside the phone and under freight rollers show significant exposure at or near the non-occupational limit of 500 mrem per year. These two monitoring stations are near the hazardous materials area where RAM is often held. Since no excessive exposures are apparent on any of the personnel badges and the maximum personnel exposure is about 1/10 of the maximum area

exposure, no concern over the area exposures is warranted. As shown in Table 9 the vans surveyed were well below the 50 T.I. load and 2.0 mR/hr driver's seat limits. Each of the three vans was carrying one of the biweekly outbound shipments from Ann Arbor. Since Federal Express will not accept for shipment any package over 70 pounds in weight, larger radioactive materials packages requiring heavy shielding and many YELLOW IIIs with higher transport indices are not handled. The three listed vans contain typical loads.

Midway through the contract year, Federal Express began making a weekly charter flight for New England Nuclear each Saturday under a DOT exemption. Each flight now carries 800 to 900 T.I. when it lands at Detroit Metropolitan Airport. The two observed flights delivered over 170 T.I. to a waiting DBM Courier vehicle. Placement of over 50 T.I. in the truck is the only flaw observed in handling the Saturday charter flight. Federal Express monitors exposure to the flight crew by a survey instrument carried aboard the plane and by film badges worn by each crew member. Exposure to the ground crew is determined by company issuance of two self-reading pocket chambers to representative workers. As shown in Table 10, Department data indicates that the radiation levels in the cockpits are low, especially considering the magnitude of the loads. This is accomplished by using a Boeing 727 and taking advantage of the airplane size to place the load far away from the crew.

The future of Federal Express in RAM transportation will bear surveillance. With the recent opening of several new offices in Michigan, coverage is expanded from the Detroit area to the entire southern half of the Lower Peninsula. Most hospitals and major universities are now in reach of the system, which may start to carry more RAM.

Federal Express training of personnel, especially hazardous materials specialists, is excellent. Drivers load RAM to the rear of the vans and use containerization and hand carts to minimize contact time with packages. Packages that are submitted for shipment but are not in compliance with regulations are rejected by hazardous materials specialists. Since the out-of-compliance packages are not transported, even for return to the sender, conscientious compliance with regulations by shippers is encouraged.

Some of these problem packages at Federal Express were rejected for obvious reasons. For example, an Ir-192 source shipped by a hospital was rejected for packaging and labeling discrepancies. Primarily, the curie listings on the shipping papers and on the labels did not match. A survey of the carton revealed that the surface reading was 200 mR/hr, the maximum for a YELLOW III, and that the measurement at three feet was 5.2 mR/hr (over five times the labeled T.I. of 1.0).

By contrast a suitcase containing an instrument was submitted for shipping as a "Radioactive Device, N.O.S." For such shipments the maximum allowable surface reading is 0.5 mR/hr. Since this case had a measured surface reading of 4.5 mR/hr it was rejected. A mere visual examination would not have been sufficient.

A third problem package observed at Federal Express contained a six curie Ir-192 source. The case was well made of thick metal and was padlocked shut. The key to the padlock was inserted in the lock and held there by a lead and wire "security seal" that was twisted on and not actually sealed. The key could have been easily turned and the case could have been opened without disturbing the "seal".

H. Emery Air Freight

For a short time the biweekly medical shipment that had been carried by Federal Express was diverted to Emery Air Freight. With attention drawn to the company, hazardous materials records for the previous month were reviewed. Initial contact with the company over a year earlier had indicated one or two packages of RAM per week to be the usual load. The records search revealed that the typical transport indices for these packages were 9.0 and 10.0, and therefore worth further study.

During the third quarter, three of these large packages (T.I. = 10.0, 10.0, and 9.0) and several smaller packages were examined. The larger ones were made of steel and lead and contained Br-82 labeled motor oil for testing piston ring durability. Each weighed over a hundred pounds. The radiation levels measured were considerably lower than indicated by the transport indices. Actual readings taken at three feet were 6.4, 6.4, and 4.7 mR/hr, respectively. Even with the 35.4 hour half-life of Br-82, the readings should have been higher for a 9-10 T.I. shipment. The possibility exists that the package contained some Br-82m in addition to Br-82. Since the half-life of Br-82m is 6.2 minutes, a package containing that isotope would quickly become less radioactive.

The only problem associated with these packages was a tendency to shed labels. In two separate investigations, a YELLOW III label was found stuck to the cement floor in the hazardous materials area, and another package had only one of the two required labels. It is speculated that the containers had a film of oil on them that interfered with label adhesion. According to wipe test data, any material on the exterior of the containers was not radioactive.

Shortly after investigations were begun at Emery Air Freight, the brominated oil packages stopped appearing. During the fourth quarter no RAM of any kind was found, and no employees recalled seeing any. Either production has been temporarily suspended, or another carrier has been employed.

I. Baltimore Airways

Baltimore Airways has functioned as a small air freight company for the purposes of this study. Under a DOT exemption New England Nuclear charter flights started during the second quarter. By the fourth quarter the schedule had increased to five flights each week, Monday through Friday. A list of the surveyed flights appears in the second section of Table 10. The conditions of the exemption permit the plane to carry more than 50 T.I. per flight and to exceed the usual 2.0 mR/hr limit in the cockpit, both of which actually occurred. As required by the exemption, all pilots wore film badges. Six wipe tests for removable contamination were made on three randomly selected planes. No detectable contamination was found.

Loading of the airplanes varied from pilot to pilot. Small sections of lead shielding for use in front of the larger packages and load restraint straps were available, but not always used. Failure to use these devices could raise the cockpit radiation level and could permit the hazard of heavy, loose cargo in rough weather. A load restraint cage located behind the pilots' seats would protect the pilot, but part of the control panel would not be protected. Also, the balance of the aircraft could be affected by a shifting load.

Just after the contract year ended, Baltimore Airways went out of business. Investigation of the new carrier will follow in the third contract year.

III. COURIER COMPANIES

Once radiopharmaceuticals are delivered to the Detroit area, they are distributed by surface transportation. Two companies, DBM Courier Corporation and Casperson Inc., perform most deliveries to the Lower Peninsula using trucks and vans.

A. DBM Courier Corporation

DBM Courier picks up all medical isotopes delivered by air to Detroit Metropolitan Airport. Shipments are taken to a DBM terminal and sorted for delivery by routes. The Detroit area terminal feeds packages into a network of local terminals that relay them north and west over the entire Lower Peninsula. Speed and efficiency enable DBM to deliver short half-life medical isotopes within closely prescribed time limits.

Unfortunately, the radiation safety concern, and training of employees and supervisors is deficient. By stacking more than 50 T.I. in one place, unnecessarily high radiation fields are often created both in vehicles and in the terminal. A summary of DBM van surveys is included in Table 9. Of particular note are the four trucks that carried over 100 T.I., ranging from 2 to 3 1/2 times the 50 T.I. limit. The two trucks carrying over 170 T.I. were surveyed after they received the RAM delivered by two Federal Express Saturday charter flights. Direct observations and conversations with workers indicate that similar overloading occurs every Saturday. In the terminal piles of RAM exceeding 50 T.I. have been observed on several occasions. In one instance a worker was noticed leaning on a pile of technicium generators in such a manner that the gonadal radiation field was 110 mR/hr.

Exposure data from area and personnel monitors are shown in Table 4. High area readings noted in surveys are reflected by area monitor readings, particularly at the sorting table. Drivers 1 and 6 have projected annual doses close to the 500 mR/year limit applied to non-radiation workers, while Driver 2 and Dispatcher 2 have projected annual doses over 500 mR/year. This data has been difficult to gather because the employees are frequently assigned to other jobs while being monitored, and non-monitored employees are assigned to high exposure duties. Employee turnover is high, and the management's lack of concern for radiation safety is reflected in a difficulty of recovering badges. Monitoring data, surveys, and observations indicate that DBM Courier needs a formal and continuing radiation safety and training program.

B. Casperson Inc.

Casperson, Inc. carries nuclear medicine for both Mallinckrodt, Inc. and E. R. Squibb & Sons, Inc. on weekends. Although the company office is in Chicago, a small group of Michigan residents are employed as part-time drivers. The RAM for the Lower Peninsula is flown into the Toledo, Ohio airport where it is picked up and delivered to the Toledo DBM Courier office. Casperson drivers pick up the RAM from the Toledo DBM terminal for distribution in Michigan.

As shown in Table 9, the exposure rates in Casperson vans were far over the 2.0 mR/hr limit, and the 50 T.I. per vehicle limit was also exceeded. The severity of the situation is demonstrated by the exposure data in Table 5. Four of the six drivers are projected to exceed the 500 mR/year dose limit. Drivers 2 and 6 have even exceeded that limit in one quarter, and have projected annual doses in excess of 2000 mrem. A radiation protection program is needed for Casperson drivers.

IV. RAILROADS

Three major railroads (Conrail, Chesapeake and Ohio, and Grand Trunk Western) were investigated to determine the extent and hazard of RAM transportation by rail. Initial contacts were made in the Lansing area, but all contacts directed investigations toward the Detroit area. Subsequent investigations revealed only one railroad employee who had ever seen a "Radioactive" placard on a rail car. Surveys of major rail yards with the Eberline Micro-R meter failed to detect any RAM shipments. The sensitivity of the survey technique was confirmed when two cars containing small amounts of naturally occurring RAM were found. One was a tank car of automobile paint, and the other was a car of "rock phosphate".

Two conditions normally exclude RAM from rail transport. Much RAM in common use, such as radiopharmaceuticals, which are the bulk of present RAM traffic, have a short half-life and must be transported from the manufacturer to the user in a matter of hours. The speed and reliability factors preclude rail transport. Also, most railroads do not ship "less than car load lots" (LCL). RAM shippers do not have enough RAM going to one state at one time to fill a box car. Although it is possible that a freight forwarder could assemble a car load of shipments and include something radioactive, such an occurrence has not happened within the memory of current rail workers. Current railroad records confirm this information.

Of all RAM shippers, nuclear power plants are the most likely to use railroads. At the present time all spent fuel is being stored onsite. However, if offsite facilities become available, the large, heavily shielded containers could be shipped by rail. Truck shipments would carry smaller, lighter, lower capacity shipping casks. Nuclear plants could also ship by rail large contaminated machine parts that are too large or heavy for a truck.

V. NUCLEAR POWER PLANTS

Notice of shipments to and from the three operating nuclear plants, as listed in Tables 10, 11, and 12, are received through the Michigan State Police communications network. An additional routine prenotification system has been implemented to enable unannounced investigations of shipments. In order to anticipate and comprehend future shipping problems, the waste processing and shipping procedures of Donald C. Cook and Palisades Nuclear Power Plants were reviewed and observed. Since the Department does not have the authority to stop trucks in transit, all survey readings and wipe samples were taken before the trucks left the plant property. Big Rock Point Nuclear Plant has not been visited yet because prolonged shutdown of the plant has limited the need for radioactive waste processing and shipping.

Practically no high level waste in the form of spent fuel is being shipped because there is currently no available repository, and reprocessing is banned by Presidential order. Since this need is unlikely to be relieved in the near future, two of the operating nuclear power plants have applied for license changes to permit an increase in spent fuel storage capacity. Both Donald C. Cook and Big Rock Point plants plan to install higher density storage racks in the existing spent fuel pools, a process that has almost been completed for the Palisades Plant.

A. Donald C. Cook Plants

Processing of evaporator bottoms was observed at the Donald C. Cook Nuclear Power Plants. The bottoms are mixed with a urea formaldehyde polymer and pumped into steel tanks with a catalyst. Any water that is not included in the solidified mass is absorbed by expanded vermiculite that is added to the top surface after solidification. Three filled tanks containing 4000 gallons of waste are loaded on a flat bed trailer for a total cargo weight of 38,000 lb. and shipped to Barnwell, South Carolina for burial. Two surveys of such trucks showed that the gamma radiation levels of both were well below regulatory limits. Cook health physicists using plant owned meters generally had higher gamma survey readings than Department readings made at the same time. Both meters were of the ionization chamber type, and both were in-house calibrated. Wipe tests from both investigations showed either no detectable activity or activity just above the limit of detectability. None were over the regulatory limits for removable contamination.

Other wastes such as trash, spent ion exchange resin, and contaminated machine parts are also shipped. These will be subjects of future investigations.

B. Palisades Plant

Palisades Nuclear Power Plant used a similar urea formaldehyde method for processing evaporator bottoms. Smaller tanks were used which had a hole at the bottom for draining off liquid that was not included in the solidified block. New Palisades tanks were examined outside of the waste processing building where they were stored in the open. The exterior of the tanks had patches of surface rust where the red primer paint had been abraded. This resulted in a "used tank" appearance but not a loss of structural integrity.

Despite draining of the filled tanks, not all liquid was eliminated. Small water pockets remained inside the block and were released as the block shrank with age. When the liquid was released it was prevented from attacking the steel tank by an asphalt lining. Due to the corrosive nature of the liquid, however, even a small defect in the lining would allow perforation of the steel.

Because of such an occurrence at Beatty, Nevada involving several tanks shipped from Palisades during July and several similar leakages from other plants, the Nevada burial site was temporarily closed, and the NRC implemented stringent measures to avoid future recurrences. For these reasons the urea formaldehyde process has been abandoned at Palisades, and a contractor is processing waste with a sodium silicate/cement process. This is a temporary measure until an asphalt encapsulation process which eliminates all water is installed.

A trailer loaded with 55-gallon drums of compacted and non-compactable trash was surveyed and wipe tested. Gamma readings and all four wipes were well below regulatory limits. Two of the wipes had no detectable activity. Two had detectable but insignificant amounts of beta activity.

C. Big Rock Point Plant

Big Rock Point Nuclear Power Plant is the only operating nuclear plant where direct surveillance of waste shipments has not been initiated. Since this plant is the smallest and produces the least waste, it has the lowest priority of the nuclear operating plants. Only 4-10 RAM shipments are made per year. However, two of these shipments per year contain cobalt-60 which is produced commercially in the reactor core by neutron activation of Co-59. A single shipment contains as much as 525,000 curies of Co-60. Activities for the coming year will include investigation of waste processing and shipping at Big Rock Point, including the shipment of Co-60.

VI. YELLOWCAKE

Elliot Lake Freight Lines Ltd. is a Canadian trucking company that began hauling loads of uranium ore concentrate (yellowcake) through Michigan to Metropolis, Illinois in March. This material was carried by rail until the carrier, as the result of an accident, tightened its load restraint requirements for yellowcake cars, reducing the amount of cargo carried per car, and making trucking more economical. Telephone notification of yellowcake shipments is provided from the International Bridge, Sault Ste Marie through the Michigan State Police notification system that previously was used only for shipments to or from the State's nuclear power plants. Yellowcake shipment data is listed in Table 14 and includes information provided by the Mackinac Bridge Authority on a quarterly basis. In all, 62 trucks carrying yellowcake (including one truck carrying raw ore) passed through Michigan during the contract year, compared with 101 nuclear plant shipments.

The arrangement of investigations is difficult because the route passes no State Weigh Stations, and there are no known scheduled stops in Michigan. However, the route passes through Lansing near the Department of Public Health offices. One truck was stopped enroute with the cooperation of the Michigan Public Service Commission (PSC) which has the authority to stop vehicles in transit. A survey revealed low gamma radiation levels that were well under regulatory limits and well below the levels reported by the shipper. An alpha meter survey revealed some spots on the trailer contaminated in excess of 1000 CPM with a background of less than 100 CPM. Wipe samples were taken and counted in the Department's Nuclear Counting Facility, revealing as high as 282 pCi/100 cm^2 removable alpha contamination. Patches of yellow dust visible on the exterior of the drums were verified by wipe test analyses to be yellowcake. The trailer load was not adequately secured. Standard 55-gallon drums filled with yellowcake were placed in a single layer on the floor of an enclosed trailer. The barrels were not in close-packed array, but had large enough spaces between each other to permit shifting. Two 2 x 4's nailed to the floor behind the last row of drums were the only load restraints used. The shipment was also in violation of several general transportation regulations and was subjected to fines and citations by the PSC. Future joint DPH/PSC investigations are planned.

Due to Departmental concern about a possible accident on the International Bridge at Sault Ste Marie or the Mackinac Bridge at St. Ignace, recommendations have been issued to implement proper precautions. Although the health hazard of yellowcake is relatively low, bridge traffic stoppage and the specter of yellowcake powder being wafted by winds over the Soo Locks and Sault Ste Marie, or over the Straits of Mackinac, Lake Huron, Lake Michigan, Mackinaw City, or St. Ignace is awesome.

VII. TRANSPORTATION INCIDENTS

Incident #1

On February 26 an airplane carrying Na-24 sources to Donald C. Cook Nuclear Plant from the University of Missouri had a brake failure and veered off the runway at Ross Field, Benton Harbor into a snowbank, damaging the landing gear and propeller. The sources were secured in the plane and were undamaged. Physicists from the plant examined the sources and, finding them undamaged, transported and used them as planned. Evaluation of verbal and written reports from the Cook Plant were deemed satisfactory without an onsite investigation.

Incident #2

On March 1 a medical test kit containing 5 μCi of I-125 was run over by a vehicle at North Central Airlines, Detroit Metropolitan Airport. Our investigation revealed that only a bottle containing a non-radioactive solution was broken, while the I-125 bottle remained intact. The kit was repacked and forwarded to the alerted laboratory. This incident

occurred while the package was being transferred between two planes as part of an airmail shipment. It apparently fell from a baggage cart that was loaded over the height of the side gates or slipped past a chain curtain without discovery at the time of loss. The shipper (Clinical Assays, Cambridge, MA) caused temporary confusion by enclosing the wrong shipping papers with the kit. According to the shipping documents, the kit contained 50 μCi of tritium, a mistake that was discovered during a phone call to the shipper. North Central's operations manual that covers many emergency circumstances, including problems involving radioactive materials, was consulted by employees at the discovery of the incident. Although a minor delay occurred because the phone number in the manual was outdated, the Chicago NRC office was reached, and the message was relayed to the Michigan Department of Public Health. The night supervisor accepted a card with the State emergency number, but stated that he would not use it, having to follow the established company policy of calling the NRC as prescribed in the manual. Examination of the operations manual showed that it contained only notification procedures, but had no information on immediate emergency response that could be useful in a more serious incident. If the employees are required to refer to the manual, it should be enlarged to provide more complete information.

Incident #3

On March 17 Burlington Northern Air Freight, Romulus discovered that a 30-gallon can containing RAM had opened in transit. A Department physicist from the Inkster office responded to the incident. Since the drum and the instrument inside were undamaged, it was closed and shipped. A follow-up visit two days later (during a routine visit to the nearby airport) filled in some missing details. Shipping papers were never found to accompany the drum. The instrument was to be shipped to Baraboo, Wisconsin from North Branch, Michigan, but was loaded on the wrong vehicle and arrived at the company's international terminal instead. The papers probably went with the other truck. Burlington encountered difficulty in getting radiological assistance. The carrier's employees tried to find the phone numbers of different agencies in the phone book and finally called the local health department in desperation. They were then given the number of the State Police, who contacted this Division. With the memory of the recent incident in mind, workers readily accepted two DOT booklets on safe handling of RAM and a Division Radiation Emergency Assistance Card.

Incident #4

On March 23 Michigan State Police reported that a truck and driver transporting an Ir-192 radiography source had failed to arrive at their destination and that an all points bulletin had been put out on the truck. In spite of clear placarding and having stopped the truck for speeding on the expressway, the police could not locate the vehicle. The driver was unable to find the job site, and eventually returned to the company's home office. As a corrective action, the company has instructed the drivers to notify the home office by phone if such circumstances recur.

Incident #5

On May 24, a truck carrying a plutonium-beryllium well logging source collided with a car that turned in front of it. Three occupants of the car were killed by the impact, but the truck sustained only minor damage, and the source appeared unharmed. The company removed the source from service until leak tests confirmed that it was undamaged. Evaluation of verbal and written reports was deemed to be sufficient without an onsite investigation.

Incident #6

On June 26, an overpack shipped by Skycab and containing two I-125 test kits and a Co-60 package was run over after bouncing out of a baggage cart that lacked any closure device, such as curtains or doors. Investigation by the Division was somewhat hampered by mislabeling of the overpack. The Co-60 package label was copied and placed on the overpack, but the I-125 was not noted. Contamination of the pavement and workers was prevented by the cardboard overpack, which completely contained the dry powder I-125 compound. After being wipe tested and found to be uncontaminated, the Co-60 carton was released. The remains of the kits were confiscated for disposal with other Departmental radioactive waste. Since the federal emergency phone number listed in the Airline Emergency Manual was out-of-date, the newest NRC number was given to the terminal manager. Several DOT booklets which outlined an emergency response plan were left with the manager when it was discovered that no radiation emergency instructions were included in the manual.

VIII. INSTABILITY

A number of specific occurrences have demonstrated that the transportation business, and particularly the transport of RAM, is constantly changing. What is an adequate knowledge of transportation patterns on one day may be outdated less than a week later. Following are examples of major changes during this second contract year.

North Central Airlines and Southern Airways merged to form Republic Airlines. Many more cities are now served and it is now possible to fly freight from more areas without transfer between airlines.

American Airlines was a major carrier of RAM a year ago but has carried almost nothing during the fourth quarter.

Eastern Airlines was discovered to carry a minimal amount of medical isotopes. Even that was discontinued but may return or increase beyond the previous level.

Federal Express has expanded service to include the most populous part of the state. A slight increase in the number of packages containing radioactive material has been noted, but more important is the possibility of a much greater increase in the future.

Saturday charter flights by Federal Express for New England Nuclear were initiated and have increased to eight or nine hundred T.I. per weekly flight. Smaller New England Nuclear charter flights Monday through Friday made Baltimore Airways the major airline carrying RAM. Just after the end of the contract year, Baltimore Airways went out of business and was almost immediately replaced by a similar company.

Shortly after investigation of brominated oil shipments via Emery Air Freight were begun, the shipments were terminated. The new shipper will be located and investigated.

Uranium ore concentrate (yellowcake) was carried by rail until increased safety demands made trucks a more cost-effective transport mode. Yellowcake shipments through Michigan comprised 38% of the reported nuclear power plant/yellowcake shipments for the fourth contract quarter.

IX. SUMMARY AND CONCLUSIONS

In the past two years sufficient information has been gathered to construct a reasonably accurate picture of the major aspects of the transportation of radioactive materials in the State of Michigan. More effort must yet be expended to complete the picture and to keep abreast of the continual changes that occur.

With a reasonable knowledge of the southern portion of the State well established, the northern areas bear more investigation, especially the Upper Peninsula. Since virtually no radiopharmaceuticals are transported across the Straits of Mackinac, and such shipments appear to arrive by vehicle through Wisconsin, the assistance of the Wisconsin radiation control agency may be sought.

Expansion of the TLD monitoring program to include Northwest Orient Airlines will be considered since Northwest is now one of the regular carriers. However, the time and number of TLDs required for the present program are already a major portion of the amounts available. Upper Peninsula investigations may also indicate a need for additional TLD monitoring.

With expansion of the program, emphasis must be maintained on a significant goal: to reduce the radiation exposure and increase the radiation exposure concern of 1) DBM Courier Corporation employees and 2) Casperson Inc. drivers. Casperson drivers are receiving larger radiation doses, but reduction of these doses could be relatively simple since there are fewer employees, and the employees are concerned about their radiation exposure. DBM Courier employees on the other hand, are a more difficult target for improvement because DBM management and employees consider radiation control as an infringement on their work schedules. However, DBM is a national corporation, and any improvement could have national effects. Ideally, DBM and Casperson employees should be declared radiation workers. They would then be monitored for exposure and would benefit from the establishment of a radiation control training program.

Since Michigan's contract only allows transportation surveillance, and the initiative for establishment of a radiation control program rests with the company, it appears that federal action will be required.

As a consequence of the transportation contract work, a variety of contacts have been made with other governmental agencies. Investigation of a radiopharmaceutical manufacturer in St. Louis, Missouri was begun by the Federal Aviation Administration in St. Louis and by the Chicago NRC office. Both agencies have contacted the Division of Radiological Health for information on the packages examined at Detroit Metropolitan Airport. Continuing investigation of flagrant violations by DBM Courier Corporation has progressed toward possible prosecution. This has involved the Bureau of Motor Carrier Safety Division (BMCS) of the U. S. DOT, including the local officer-in-charge who contacted MDPH for training in the use of field instruments and for consultation about the application of DOT regulations. On the basis of this training and consultation, he made a presentation on the topic before a regional BMCS meeting. An inquiry by the Illinois Health Department was prompted by the Department's investigation of Casperson, Inc., whose home office is in Illinois.

In the future the interstate aspects of RAM transportation may require further contacts outside of the State, and importation of RAM from Canada may necessitate international contact with Ontario, Canada. To deal with the broad range of RAM transportation, interagency cooperation is essential.

Two years having elapsed, only one year remains on the original three year transportation surveillance contract. Enough has been learned to know that one more year is insufficient to adequately evaluate the transportation of radioactive material in the State. A continuous program is needed to answer the public concerns about radioactive material transport in Michigan.

TABLE 1

FIELD INVESTIGATIONS

Radioactive Material Transporter	Number of Investigations First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Total
American Airlines	6	6	13	7	32
Baltimore Airways	-	2	11	6	19
Eastern Airlines	-	-	2	-	2
Emery Air Freight	-	-	7	7	14
Federal Express	8	6	15	12	41
North Central (Republic) Airlines	7	5	10	4	26
Northwest Orient Airlines	6	7	13	9	35
Trans World Airlines	8	5	13	7	33
Casperson, Inc.	-	-	3	3	6
DBM Courier Corporation	5	8	15	9	37
Conrail	-	1	4		5
Chesapeake and Ohio Railroad	-	1	-	1	2
Grand Trunk Western Railroad	-	1	-	-	1
Donald C. Cook Nuclear Power Plants	-	-	1	1	2
Palisades Nuclear Power Plant	-	-	-	3	3
Elliot Lake Freight Lines	-	-	1	-	1
Total					259

TABLE 2

DIRECT RADIATION DOSE MEASUREMENTS
USING LiF THERMOLUMINESCENT DOSIMETERS

at American Airlines

Detroit Metropolitan Airport

Net Dose (mrem)

Station & Location		First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Projected Annual
Area Monitors Over RAM Cart	#1	93	9	11	4	117
	#2	93	4	9	4	110
Area Monitors Near Men's Room	#3	19	35	1	1	56
	#4	20	9	0	0	55
Supervisor 1		2	0	0	N.R.	3
Supervisor 2		6	0	0	N.R.	8
Supervisor 3		3	0	0	N.R.	4
Handler 1		5	0	0	0	5
Handler 2		5	0	0	N.R.	7
Handler 3		8	0	0	N.R.	11
Handler 4		-	0	0	0	0

N.R. - Badge not returned

TABLE 3

DIRECT RADIATION DOSE MEASUREMENTS
USING LiF THERMOLUMINESCENT DOSIMETERS

at Federal Express, Romulus

Net Dose (mrem)

Station & Location		First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Projected Annual
Area Monitors Beside Phone	#1	60	44	240	16	360
	#2	59	46	220	16	341
Area Monitors Under Freight Rollers	#3	344	33	16	117	510
	#4	294	39	18	103	454
Area Monitors On Wall	#5	18	0	9	0	27
	#6	21	1	4	0	26
Area Monitors In Van One	#7	6	0	0	0	6
	#8	5	1	0	0	6
Supervisor 1		10	22	9	0	41
Handler/Driver 1		4	40	1	0	45
Handler/Driver 2		12	0	N.R.	N.R.	24
Handler/Driver 3		6	22	0	0	28
Handler/Driver 4		7	4	0	0	11
Handler/Driver 5		-	-	-	0	0

N.R. - Badge not returned.

TABLE 4

DIRECT RADIATION DOSE MEASUREMENTS
USING LiF THERMOLUMINESCENT DOSIMETERS

AT DBM Courier Corporation, Oak Park

Net Dose (mrem)

Station & Location		First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Projected Annual
Area Monitors On Wall (Position 1)	#1	-	-	174	N.R.	696
	#2	-	-	172	N.R.	688
Area Monitors On Wall (Position 2)	#3	-	-	626	61	1,374
	#4	-	-	612	59	1,342
Area Monitors Under Sorting Table	#5	-	-	1,300	906	4,412
	#6	-	-	1,450	892	4,684
Area Monitors Under Dispatch Window	#7	-	-	730	356	2,172
	#8	-	-	685	321	2,012
Area Monitors On Office Wall	#9	-	-	6	4	20
	#10	-	-	5	5	20
Vehicle Monitors In Lansing Van	#1	-	-	N.R.	25	100
	#2	-	-	N.R.	19	96
Vehicle Monitors In Airport Van	#3	-	-	N.R.	N.R.	-
	#4	-	-	N.R.	N.R.	-
Driver 1		124	80	89	96	389
Driver 2		439	N.R.	1	4	592
Driver 3		10	lost	4	N.R.	28
Driver 4		37	9	0	1	47
Driver 5		26	N.R.	-	-	104

TABLE 4 cont.

DIRECT RADIATION DOSE MEASUREMENTS
USING LiF THERMOLUMINESCENT DOSIMETERS

AT DBM Courier Corporation, Oak Park

New Dose (mrem)

Station & Location	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Projected Annual
Driver 6	207	148	10	98	463
Driver 7	46	22	43	46	157
Driver 8	-	-	2	67	138
Dispatcher 1	126	31	11	-	224
Dispatcher 2	75	185	N.R.	-	520

N.R. - Badge not returned

TABLE 5

DIRECT RADIATION DOSE MEASUREMENTS
USING LiF THERMOLUMINESCENT DOSIMETERS

at Casperson, Inc.

Net Dose (mrem)

Personnel	Fourth Quarter	Projected Annual
Driver 1	132	528
Driver 2	586	2,344
Driver 3	2	8
Driver 4	0	0
Driver 5	212	848
Driver 6	501	2,004

TABLE 6

PACKAGE SURVEYS

Label	Quarter	Number	Label T.I.			mR/hr @ Surface			mR/hr @ 3 ft.		
			Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
I	First	1	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0
	Second	1	-	-	-	0.8	0.8	0.8	0.0	0.0	0.0
	Third	6	-	-	-	0.0	1.7	9.5	0.0	0.1	0.2
	Fourth	1	-	-	-	0.05	0.05	0.05	0.0	0.0	0.0
II	First	58	0.1	0.3	0.6	0.1	6.4	25.0	<.1	0.2	0.5
	Second	7	0.1	0.2	0.3	0.0	2.5	11.0	0.0	0.04	0.1
	Third	12	0.1	0.3	0.5	0.3	19.1	84.0	0.1	0.4	1.8
	Fourth	24	0.1	0.3	0.7	0.2	5.4	52.0	0.0	0.2	1.7
III	First	20	0.2	2.6	9.0	5.5	41.7	108.	1.0	1.6	4.6
	Second	1	0.1	0.1	0.1	0.4	0.4	0.4	0.0	0.0	0.0
	Third	19	3.0	3.0	10.0	0.8	56.0	200.	1.5	2.4	6.4
	Fourth	7	0.5	1.1	1.5	4.2	53.7	140	0.1	1.4	2.5

TABLE 7

OVERPACK SURVEYS

Label	Quarter	Number	Label T.I.			mR/hr @ Surface			mR/hr @ 3 ft.		
			Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
I	First	1	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0
	Second	0	-	-	-	-	-	-	-	-	-
	Third	4	-	-	-	0.0	0.1	0.1	0.0	0.0	0.0
	Fourth	1	-	-	-	0.1	0.1	0.1	0.0	0.0	0.0
II	First	10	0.8	1.3	1.5	0.2	9.7	46.0	0.0	1.3	1.5
	Second	15	0.1	0.3	0.5	0.0	2.8	8.8	0.0	0.1	0.3
	Third	44	0.1	0.3	2.3	0.0	5.8	48.0	0.0	0.2	0.4
	Fourth	35	0.1	0.4	0.8	0.1	6.7	65.0	0.0	0.2	1.2
III	First	6	1.2	2.0	3.0	10.0	31.7	46.0	.9	2.0	2.3
	Second	5	1.0	1.4	2.2	0.4	33.4	45.0	0.4	1.3	2.1
	Third	7	0.4	0.5	1.8	1.9	32.8	48.0	0.1	1.4	2.0
	Fourth	5	1.0	1.8	2.5	8.2	27.0	40.0	0.4	1.2	1.9

TABLE 8

IMPROPER PACKAGING

Problem Type	Occurrences
Faulty closure	2
Incomplete or missing shipping documents	1
Packages less than 4" minimum dimension	0
White I > 0.5 mR/hr @ surface	1
White I > 0 mR/hr @ 3 ft.	2
Yellow II > 50 mR/hr @ surface	4
Yellow II > 1.0 mR/hr @ 3 ft	0
Yellow III > 200 mR/hr @ surface	0
Yellow III > 10 mR/hr @ 3 ft.	0
Yellow II label where a Yellow III is required	2
Yellow III label where a Yellow II is required	8
Only one label per package	27
Carton not DOT 7A Type A approved	28
T.I. not listed	3

TABLE 9

VEHICLE SURVEYS

Federal Express

T.I. Carried	mR/hr In Driver's Seat	Maximum @ Surface	Maximum @ 6 ft.
2.8	0.6	2.0	0.2
2.6	0.3	1.4	<0.1
3.8	0.2	1.0	0.2

DBM Courier Corporation

T.I. Carried	mR/hr In Driver's Seat	Maximum @ Surface	Maximum @ 6 ft.
105.9	24.0	25.0	9.0
14.3	1.0	3.0	0.8
105.9	25.0	54.0	15.0
8.4	1.7	-	-
-	7.0	-	-
171.3	20.0	120.	15.0
-	5.6	-	-
41.4	5.5	25	7.1
14.4	1.5	6.0	1.5
39.9	0.9	8.0	3.8
3.2	2.6	-	-
55.3(1)	3.4	12.0	3.6
6.8	0 8	25.0	1.0
7.6	0.2	2.0	-
32.3	4.4	27.0	-
>44.4	6.0	-	-
177.0	40.0	100.	10.0
-	0.3	-	-

TABLE 9 cont.

VEHICLE SURVEYS

DBM Courier Corporation

T.I. Carried	mR/hr In Driver's Seat	Maximum @ Surface	Maximum @ 6 ft.
30.2	3.0	-	-
9.6	0.8	-	-
49.6	2.5	-	-
45.6	4.8	-	-

Casperson, Inc.(2)

T.I. Carried	mR/hr In Driver's Seat	Maximum @ Surface	Maximum @ 6 ft.
-	42.0	60.0	6.9
53.8	44.0	51.0	8.0

(1) Van was from Toledo, Ohio, DBM terminal and lacked regulatory placarding.

(2) No physical load restraints in van.

TABLE 10

AIRPLANE SURVEYS

Federal Express

T.I. Carried	mR/hr in Cockpit
-	0.7
792.5	0.5

Baltimore Airways

T.I. Carried	mR/hr in Cockpit
36.5	1.6
82.7	15.0
<8	0.4
5.7	0.0
26.1	1.5
5.7	0.4
-	0.0
76.7	6.8
-	0.6
>40	14.0
-	10.0
>40	12.5
-	0.8
43.6	7.0
45.9	8.0
5.4	0.3
30.2	7.0
-	0.6
41.1	10.0

>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	Curies	mR/hr. at 6 ft.	Destination
9/8/78 9:45 a.m.	Solidified Waste Solid Waste	0.501	1.5	Barnwell, SC
9/26/78 10:00 a.m.	Solidified Waste Evaporator Sludge	1.168	5.0	Barnwell, SC
10/19/78 10:30 a.m.	Solidified Waste Evaporator Sludge	0.0598	3.4	Barnwell, SC
10/23/78 10:50 a.m.	Solidified Evaporator Sludge	0.1929	3.5	Barnwell, SC
11/7/78 7:45 p.m.	Solid Waste	0.2786	8.0	Barnwell, SC
11/9/78 11:40 a.m.	Solidified Waste Evaporator Sludge	0.1067	1.0	Barnwell, SC
11/29/78 6:15 p.m.	Solidified Waste	0.209	4.0	Barnwell, SC
11/30/78 2:56 p.m.	Solidified Waste Evaporator Sludge	0.1195	2.5	Barnwell, SC
12/14/78 1:35 p.m.	Dewatered Resin	54.14	5.0	Seneca, IL
12/28/78 2:00 p.m.	Solidified Waste	0.23394	2.2	Barnwell, SC
1/15/79 1:30 p.m.	Solidified Evaporator Waste	0.04945	2.5	Barnwell, SC
1/16/79 9:50 a.m.	Solidified Evaporator Waste	0.094857	3.2	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	Curies	mR/hr. at 6 ft.	Destination
3/2/79 7:00 a.m.	Sodium-24	0.600	-	Cook Plants
3/3/79 1:15 p.m.	Dry Compressed Waste	0.1322	5	Barnwell, SC
3/6/79 6:00 p.m.	Sodium-24	0.200	-	Cook Plants
3/8/79 5:00 p.m.	Sodium-24	0.000555	-	Cook Plants
3/8/79 5:05 p.m.	Sodium-24	1.34	1.5	Cook Plants
3/11/79 5:10 p.m.	Sodium-24	1.34	1	Cook Plants
3/14/79 8:30 a.m.	Sodium-24	0.500	0.7	Cook Plants
3/13/79 2:15 p.m.	Solidified Waste/ Evaporator Concentrates	0.299	1.6	Barnwell, SC
3/14/79 3:15 p.m.	Solidified Waste/ Evaporator Concentrates	0.3258	2.1	Barnwell, SC
4/3/79 11:20 a.m.	Solidified Waste/ Evaporator Concentrates	0.4847	2.8	Barnwell, SC
4/4/79 9:20 a.m.	Solidified Waste/ Evaporator Concentrates	0.60808	4	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	Curies	mR/hr. at 6 ft.	Destination
4/20/79 4:25 p.m.	Solidified Waste/ Evaporator Sludge	0.377	3.2	Barnwell, SC
4/21/79 6:35 p.m.	Solidified Waste/ Evaporator Sludge	0.39161	3.7	Barnwell, SC
4/25/79 5:40 p.m.	Solidified Waste/ Evaporator Sludge	0.42118	2.8	Barnwell, SC
4/26/79 4:30 p.m.	Solidified Dewatered Resin	0.385	0.01	Barnwell, SC
4/27/79 11:00 p.m.	Solid Construction Waste Material	0.3532	5	Barnwell, SC
5/3/79 4:30 p.m.	Solidified Waste/ Evaporator Concentrates	0.27988	3	Barnwell, SC
5/4/79 12:10 p.m.	Solidified Waste/ Evaporator Concentrates	0.5898	8.5	Barnwell, SC
5/4/79 12:10 p.m.	Dewatered Resins	0.06736	less than 1	Barnwell, SC
5/7/79 4:50 p.m.	Solidified Radwaste	2.86	10	Barnwell, SC
5/18/79 11:05 p.m.	Solidified Waste/ Evaporator Concentrates	0.464	3	Barnwell, SC
5/24/79 10:45 a.m.	Solidified Waste/ Evaporator Concentrates	0.4982	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	Curies	mR/hr. at 6 ft.	Destination
6/5/79 10:50 a.m.	Solidified Waste/ Evaporator Concentrates	0.2427	2.5	Barnwell, SC
6/6/79 5:00 p.m.	Solidified Waste/ Evaporator Concentrates	0.18092	1.6	Barnwell, SC
6/8/79 7:30 p.m.	Rad-waste	0.733	4	Barnwell, SC
6/12/79 10:15 a.m.	Solidified Waste/ Evaporator Concentrates	0.22326	2.5	Barnwell, SC
6/29/79 10:15 a.m.	Solidified Evaporator Bottoms	0.274	2.0	Barnwell, SC
6/29/79 2:15 p.m.	High Level Filter Material	1.911	6	Barnwell, SC
7/8/79 6:30 a.m.	Low Level Waste	0.1843	3.8	Barnwell, SC
7/12/79 1:30 p.m.	Dry Compressed Waste	0.1211	4.5	Seneca, IL
7/19/79 10:00 a.m. 11:05 a.m.	Solidified Evaporator Concentrates	0.228 0.336	4 3	Barnwell, SC Barnwell, SC
8/2/79 10:10 a.m.	Dry Compressibles Spent Filter Cartridges	1.041	3	West Chicago, IL
8/8/79 12:45 p.m.	Nuclear Fuel	6.6	1.65	Cook Plants

TABLE 12

REPORTED RADIOACTIVE MATERIAL SHIPMENTS

to and from

Palisades Nuclear Power Plant

Consumers Power Company

South Haven, Michigan

Date Time	Description of Shipment	Curies	mR/hr at 6 ft.	Destination
9/13/78 9:00 a.m.	Evaporator Concentrates	0.108	1.5	Barnwell, SC
9/20/78 9:20 a.m.	Evaporator Concentrates	0.319	1.8	Barnwell, SC
9/28/78 10:00 a.m.	Evaporator Concentrates	1.298	2.5	Barnwell, SC
10/4/78 10:00 a.m.	Evaporator Concentrates Compacted Trash	1.27	8.0	Barnwell, SC
10/11/78 10:30 p.m.	Evaporator Concentrates Compacted Trash	0.51	3.0	Barnwell, SC
10/19/78 10:15 a.m.	Dewatered Resin	51.8	4.0	Barnwell, SC
10/25/78 10:00 a.m.	Evaporator Concentrates	0.466	3.0	Barnwell, SC
10/26/78 11:00 a.m.	Dewatered Resin	18.8	1.5	Barnwell, SC
11/19/78 9:00 p.m.	Solidified Evaporator Concentrates	0.723	2.0	Barnwell, SC
11/9/78 11:50 p.m.	Solid Waste	7.53	0.8	Barnwell, SC
11/14/78 4:30 p.m.	Used Filters	2.48	6.0	Barnwell, SC
11/17/78 3:00 p.m.	Used Filters	19.82	4.0	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	Curies	mR/hr at 6 ft.	Destination
11/9/78 9:00 p.m.	Solidified Evaporator Concentrates	0.723	2	Barnwell, SC
11/9/78 11:50 a.m.	Solid Radioactive Waste	7.53	0.8	Barnwell, SC
11/14/78 4:30 p.m.	Used Filters	2.48	6	Barnwell, SC
11/17/78 3:00 p.m.	Used Filters	19.82	4	Barnwell, SC
12/1/78 2:30 p.m.	Evaporator Concentrates/ Compacted Trash	0.859	7	Barnwell, SC
12/18/78 10:00 a.m.	Evaporator Concentrates/ Compacted Trash	1.688	7	Barnwell, SC
12/18/78 3:15 p.m.	Used Filters	13.9	4	Barnwell, SC
12/27/78 11:00 a.m.	Dewatered Resin	14.8	5	Barnwell, SC
1/25/79 6:00 p.m.	Evaporator Concentrates/ Compacted Trash	0.85	8	Beatty, NV

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	Curies	mR/hr at 6 ft.	Destination
3/2/79 9:30 a.m.	Solid Waste Compacted Trash	0.168	3	Barnwell, SC
3/8/79 10:00 a.m.	Evaporator Concentrates Compacted Trash Non-compacted Trash	0.696	6	Beatty, NV
3/29/79 9:00 a.m.	Evaporator Concentrates Compacted Trash Non-compacted Trash	0.526	6	Beatty, NV
4/21/79 12:45 p.m.	Evaporator Concentrates Compacted and Non-compacted Trash	0.676	9	Beatty, NV
5/22/79 3:25 p.m.	Spent Filter Elements	9.6	8	Barnwell, SC
6/6/79 9:00 a.m.	Contaminated Trash	0.609	8.5	Beatty, NV
6/25/79 10:30 a.m.	Dewatered Resin	22.9	2.5	Barnwell, SC
6/27/79 10:00 p.m.	Evaporator Concentrates Non-compacted Trash	0.942	6	Beatty, NV
8/2/79 9:30 a.m.	Compacted Trash and Dewatered Resin	1.08	5	Barnwell, SC

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	Curies	mR/hr at 6 ft.	Destination
10/10/78 7:45 p.m.	Co-60 rods	367,250	3.8	Dickerson, MD
10/11/78 11:45 p.m.	Co-60	2.1		Barnwell, SC
10/23/78 12:50 p.m.	Co-60	12.0	0.65	Barnwell, SC
3/1/79 2:15 p.m.	Cobalt-60 rods	525,000	8	Dickerson, MD
3/22/79 3:00 p.m.	Fuel Inspection Tools	0.3mCi/gm	7	Richland, WA
4/1/79 11:30 a.m.	Boron Rods	400	0.1	Pleasanton, CA
6/20/79 3:10 p.m.	Compacted Low Level Waste	1.214	9.6	Richland, WA

TABLE 14

REPORTED YELLOWCAKE SHIPMENTS

from

Denison Mines Ltd.

Elliot Lake, Ontario, Canada

to Metropolis, Illinois

Date Time	Number of Trucks	Curies	mR/hr at 6 ft.
3/20/79	1	-	-
3/22/79	1	-	-
3/26/79	1	-	-
3/29/79	1	-	-
4/15/79	2	-	-
4/17/79	2	-	-
4/18/79	1	-	-
4/19/79	3	-	-
4/21/79	1	-	-
4/23/79	3	-	-
4/24/79	1	-	-
4/25/79			
1:25p.m.	2	5.8/truck	5
1:40p.m.	1	5.8	5
4/26/79			
2:30p.m.	1	5.8	5
4/27/79	1	-	-
4/30/79			
12:05a.m.	1	5.8	5
1:45p.m.	1	5.8	5
3:00p.m.	1	5.8	5
4:00p.m.	1	5.8	5
5/1/79	2	-	-

TABLE 14 cont.

REPORTED YELLOWCAKE SHIPMENTS

from

Denison Mines Ltd.

Elliot Lake, Ontario, Canada

to Metropolis, Illinois

Date Time	Number of Trucks	Curies	mR/hr at 6 ft.
5/2/79			
4:10p.m.	1	5.8	5
9:32p.m.	1	5.8	5
9:41p.m.	1	5.8	5
5/3/79			
3:27p.m.	1	5.8	5
5/4/79	1	-	-
5/6/79			
7:32a.m.	1	5.8	5
5/10/79			
7:11p.m.	1	5.8	4
5/14/79			
10:02p.m.	1	5.8	5
5/16/79			
5:30p.m.	1	5.8	5
5/21/79			
10:00p.m.	1	5.8	5
5/23/79			
3:20a.m.	1	-	-
5/29/79			
2:00a.m.	2	5.8/truck	5
5/31/79			
9:34a.m.	1	-	-
6/4/79			
9:21p.m.	2	-	-
6/5/79			
8:55p.m.	1	-	-

TABLE 14 cont.

REPORTED YELLOWCAKE SHIPMENTS

from

Denison Mines Ltd.

Elliot Lake, Ontario, Canada

to Metropolis, Illinois

Date Time	Number of Trucks	Curies	mR/hr at 6 ft.
6/7/79 5:33p.m.	1	5.8	5
6/11/79 3:04p.m.	1*	5.8	5
7/4/79 4:53p.m.	2	-	-
7/5/79 11:30a.m.	2	5.8	5
7/9/79 9:34p.m.	2	-	-
7/12/79 5:00p.m.	2	5.8/truck	5
7/19/79 3:47p.m.	1	5.8	5
10:15p.m.	1	5.8	5
7/24/79 2:15p.m.	1	5.8	5
8/13/79 9:49p.m.	1	-	-
8/15/79 10:40p.m.	1	5.8	5
8/28/79 6:20p.m.	1	5.8	5
8/30/79 6:33p.m.	1	5.8	5

* Shipment is raw ore, not concentrate

FIGURE 1

AMERICAN AIRLINES
DETROIT METROPOLITAN AIRPORT
AREA SKETCH

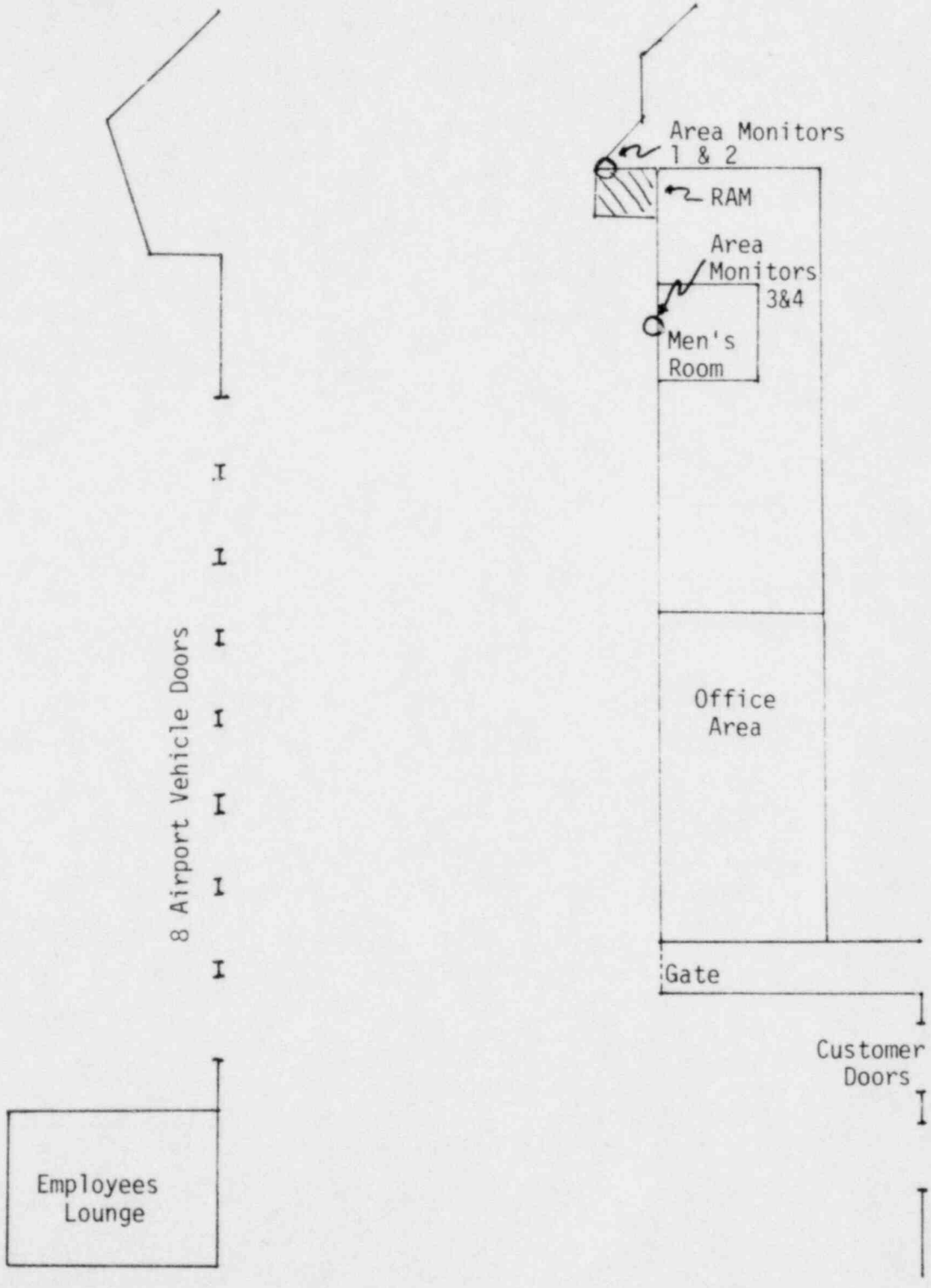


FIGURE 2

TRANS WORLD AIRLINES (TWA)
DETROIT METROPOLITAN AIRPORT
AREA SKETCH

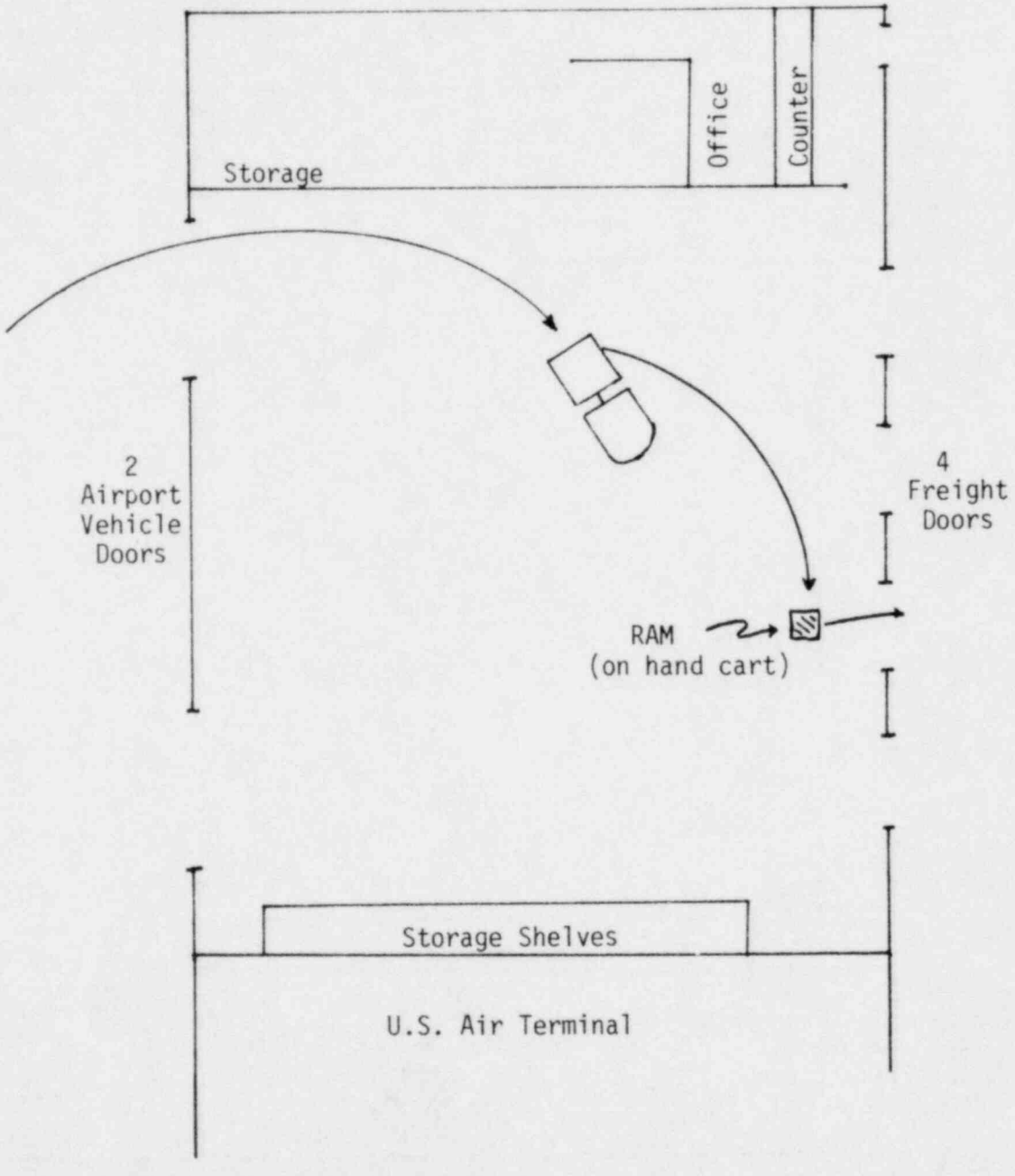


FIGURE 3

REPUBLIC AIRLINES
DETROIT METROPOLITAN AIRPORT
AREA SKETCH

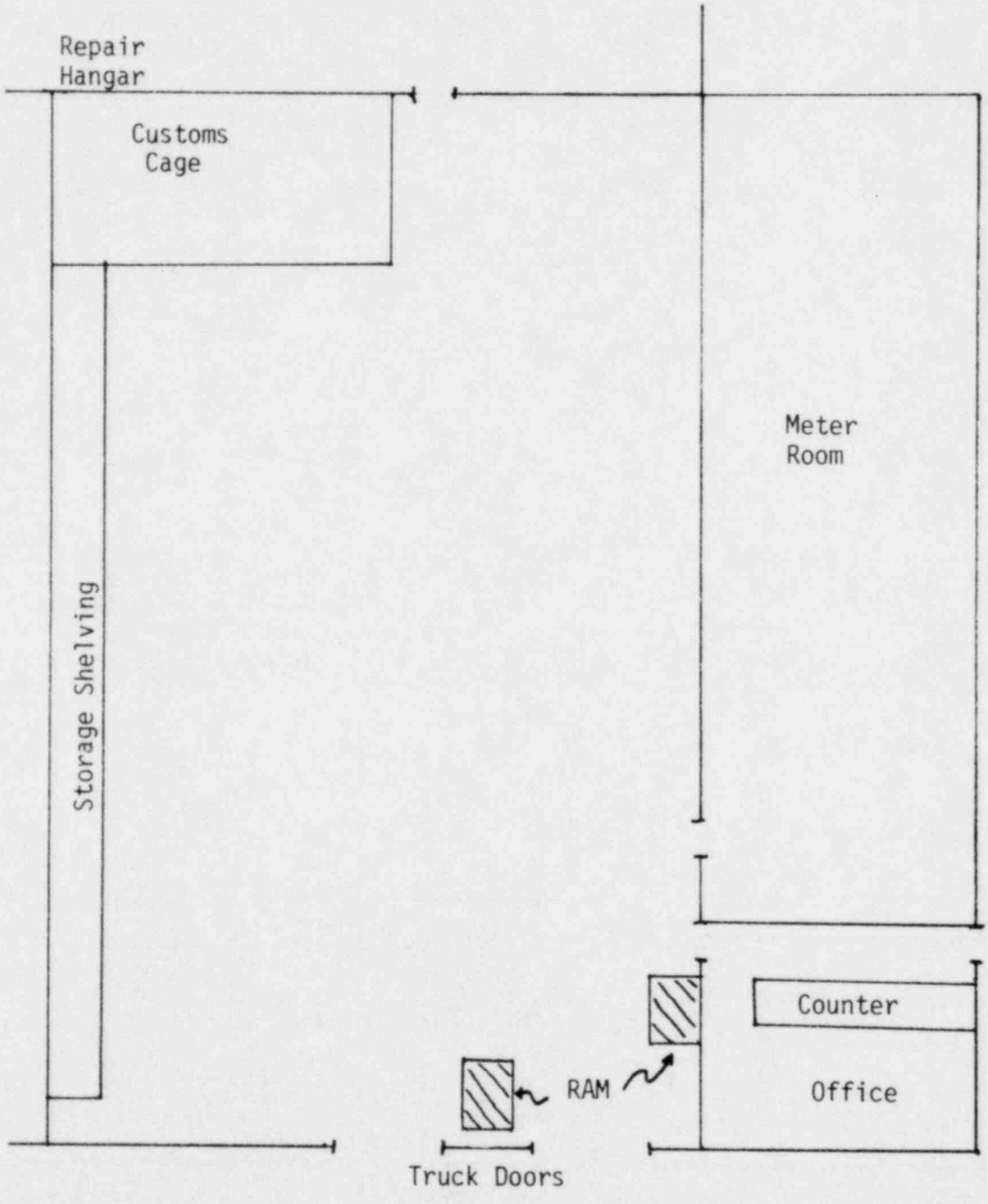


FIGURE 4

FEDERAL EXPRESS
ROMULUS
AREA SKETCH

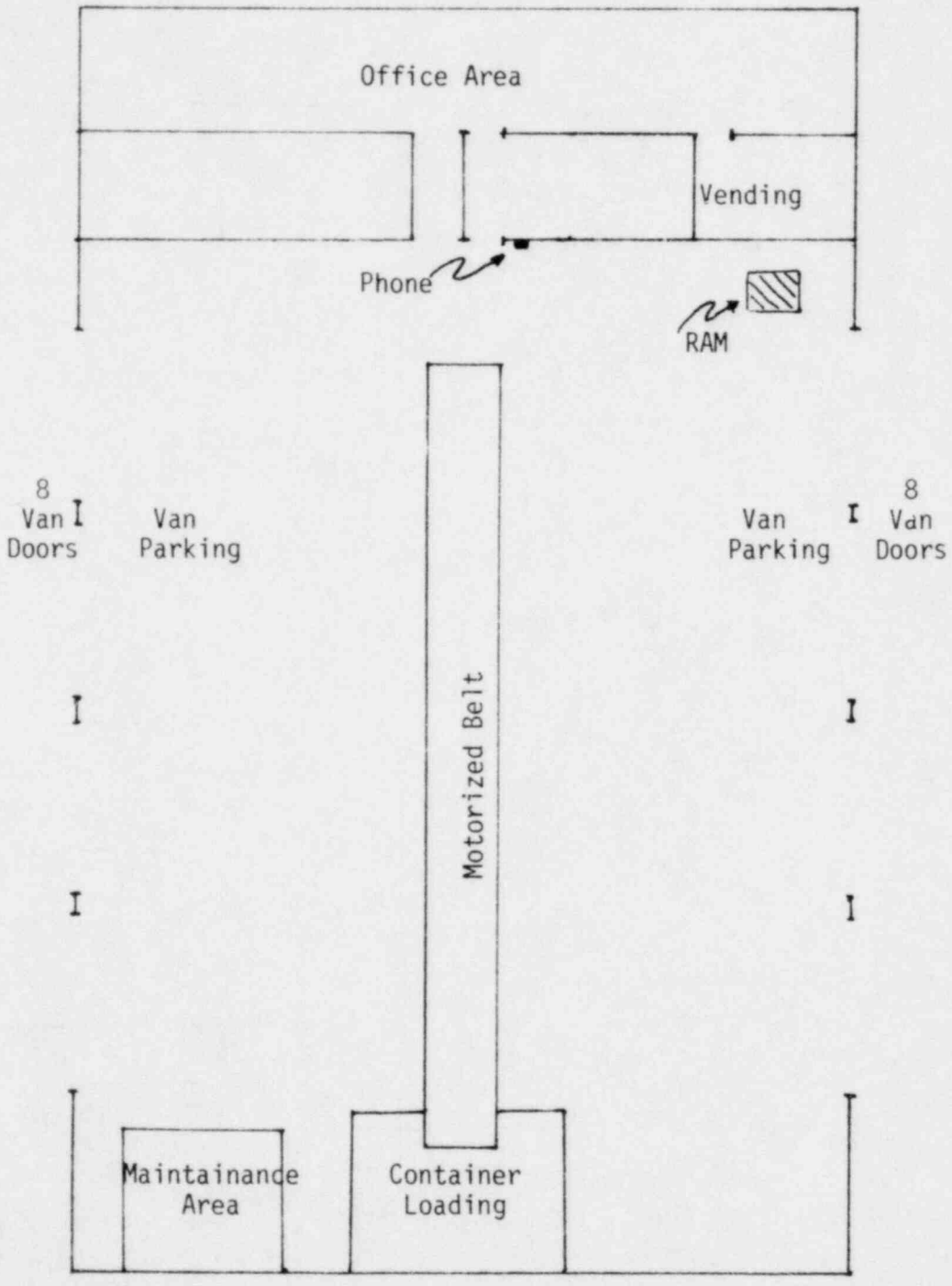


FIGURE 5

DBM COURIER CORPORATION
OAK PARK
AREA SKETCH

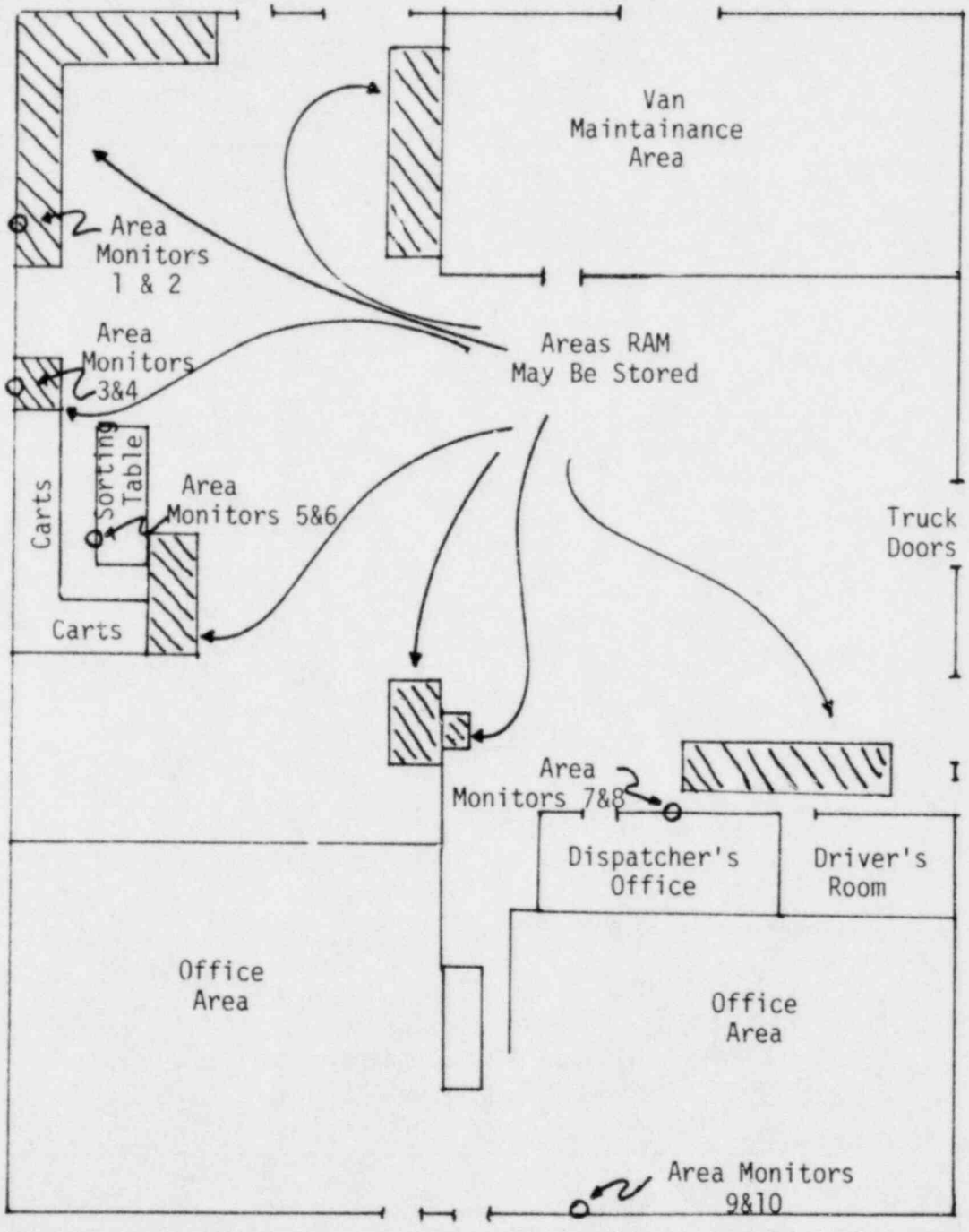


FIGURE 6

NORTHWEST ORIENT AIRLINES
DETROIT METROPOLITAN AIRPORT
AREA SKETCH (9-15-78)

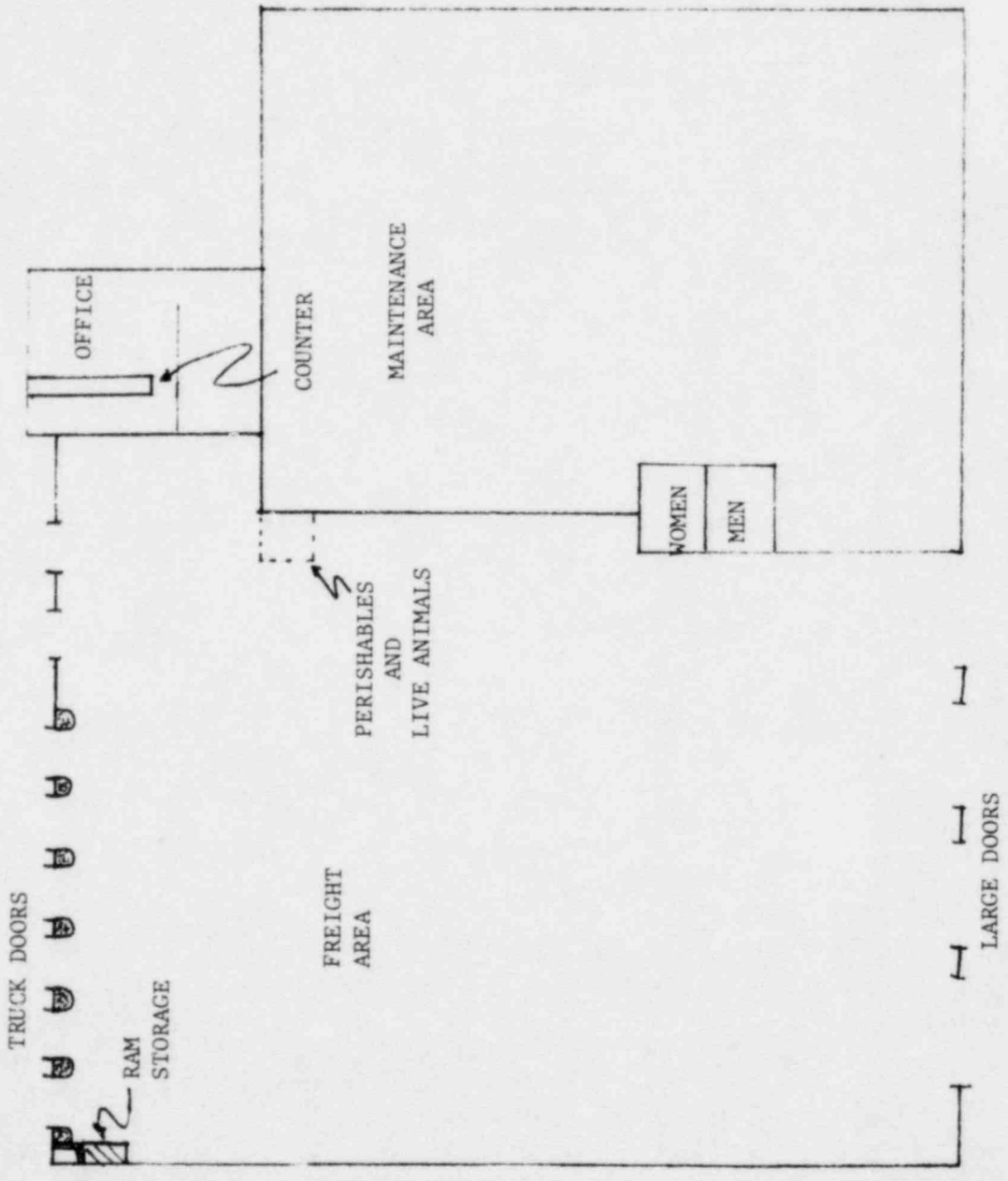
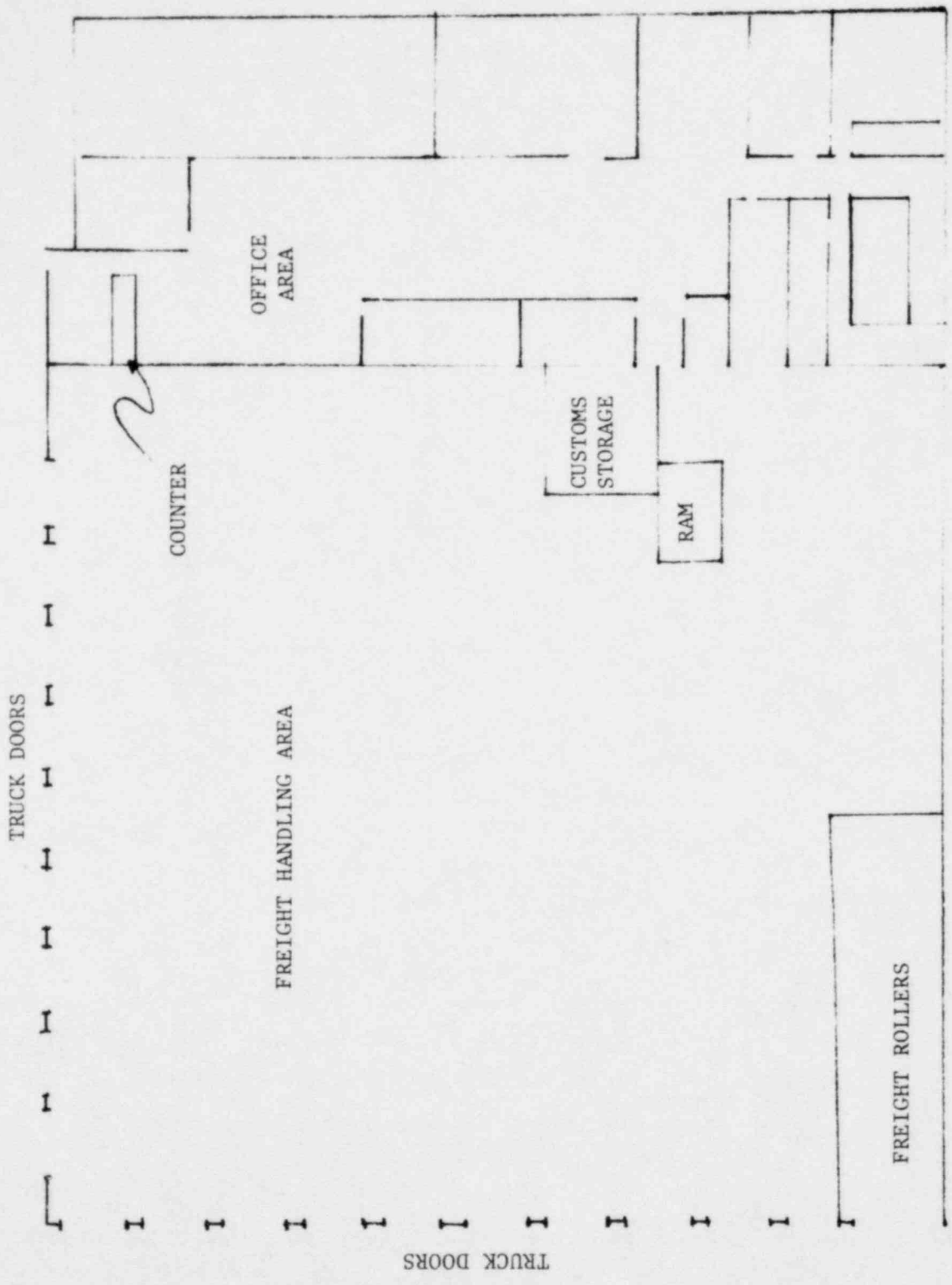
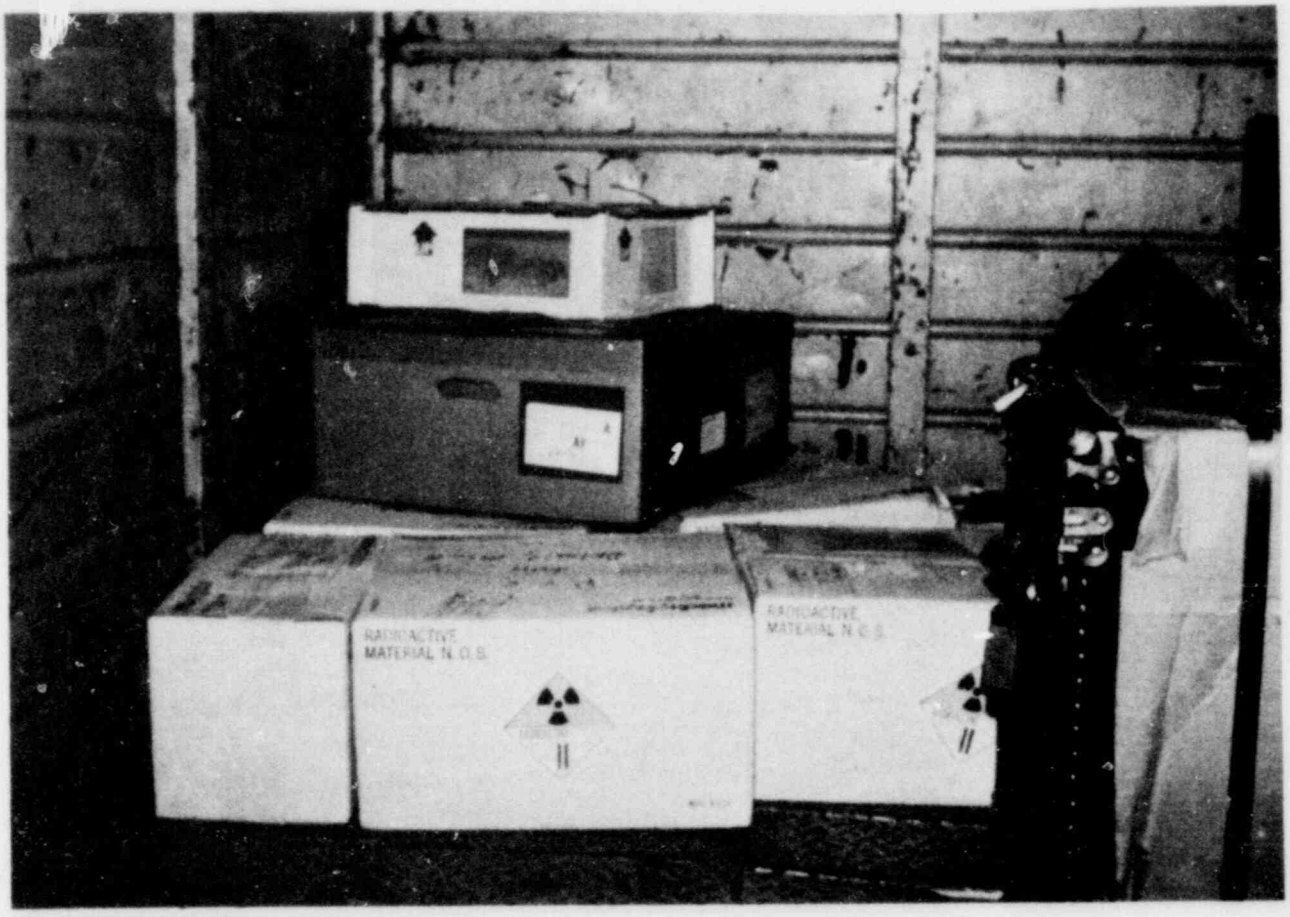


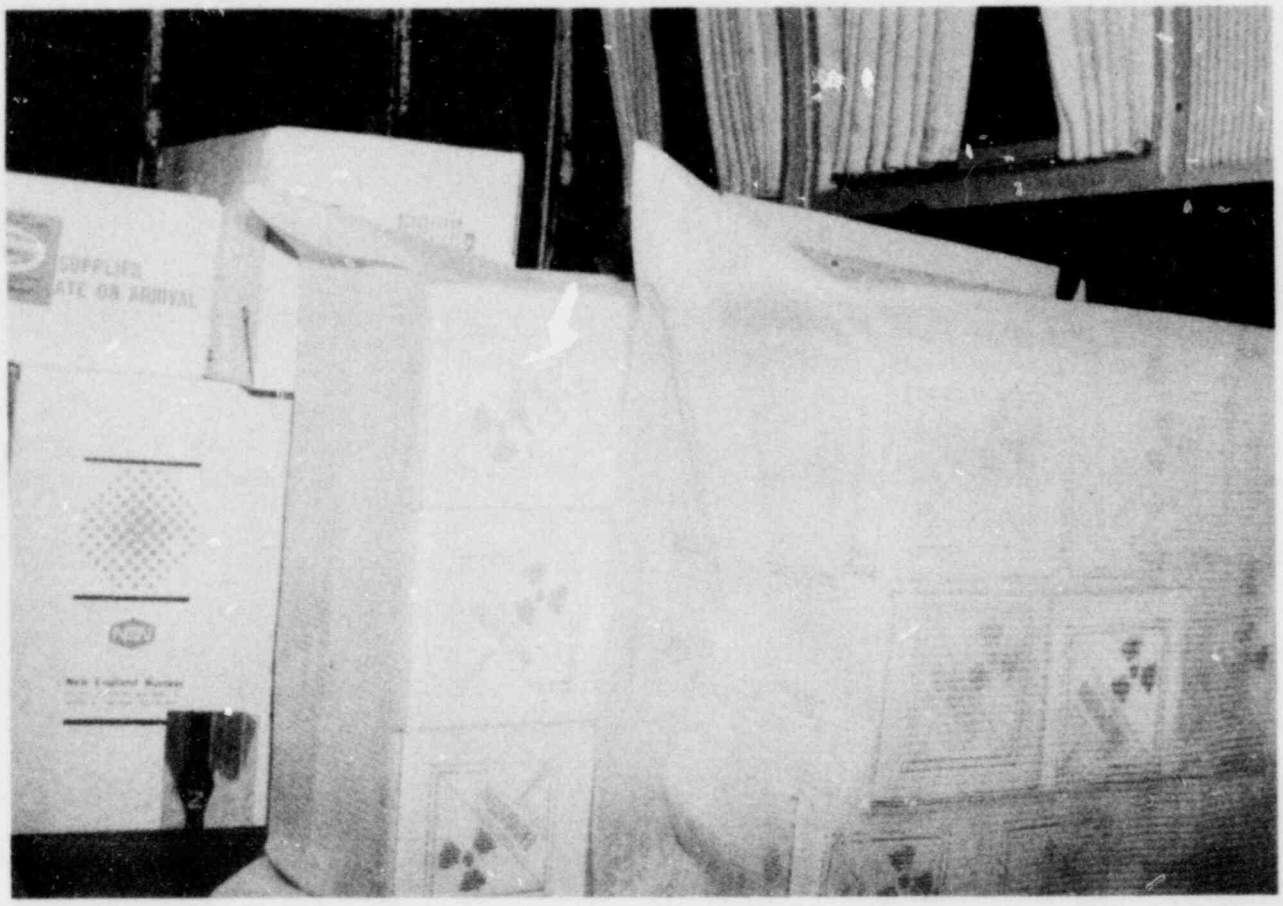
FIGURE 7

EMERY AIR FREIGHT
DETROIT METROPOLITAN AIRPORT
AREA SKETCH (4-23-79)



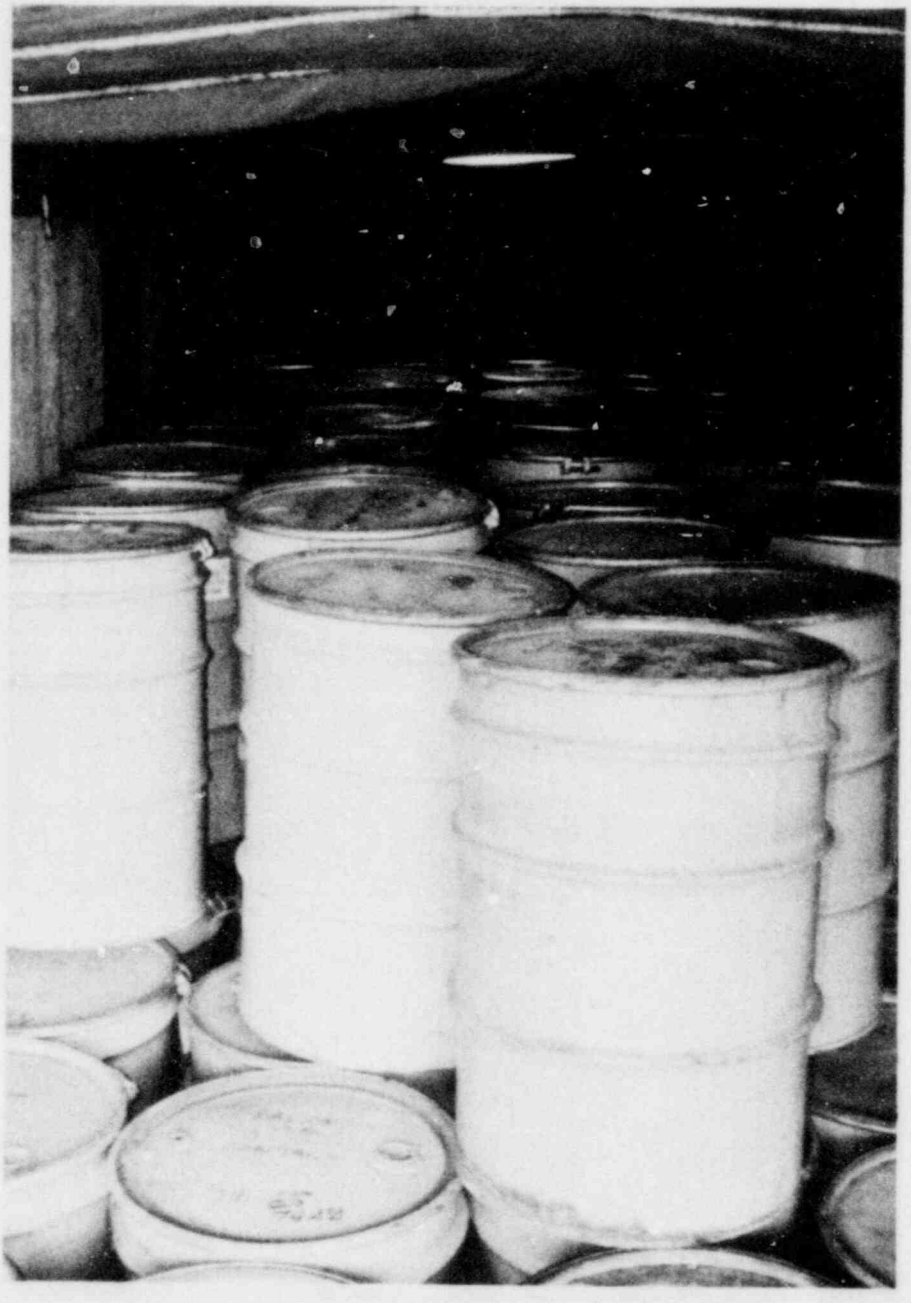


Photograph 1. Inside of Baggage Cart (note carton of live animals on top)

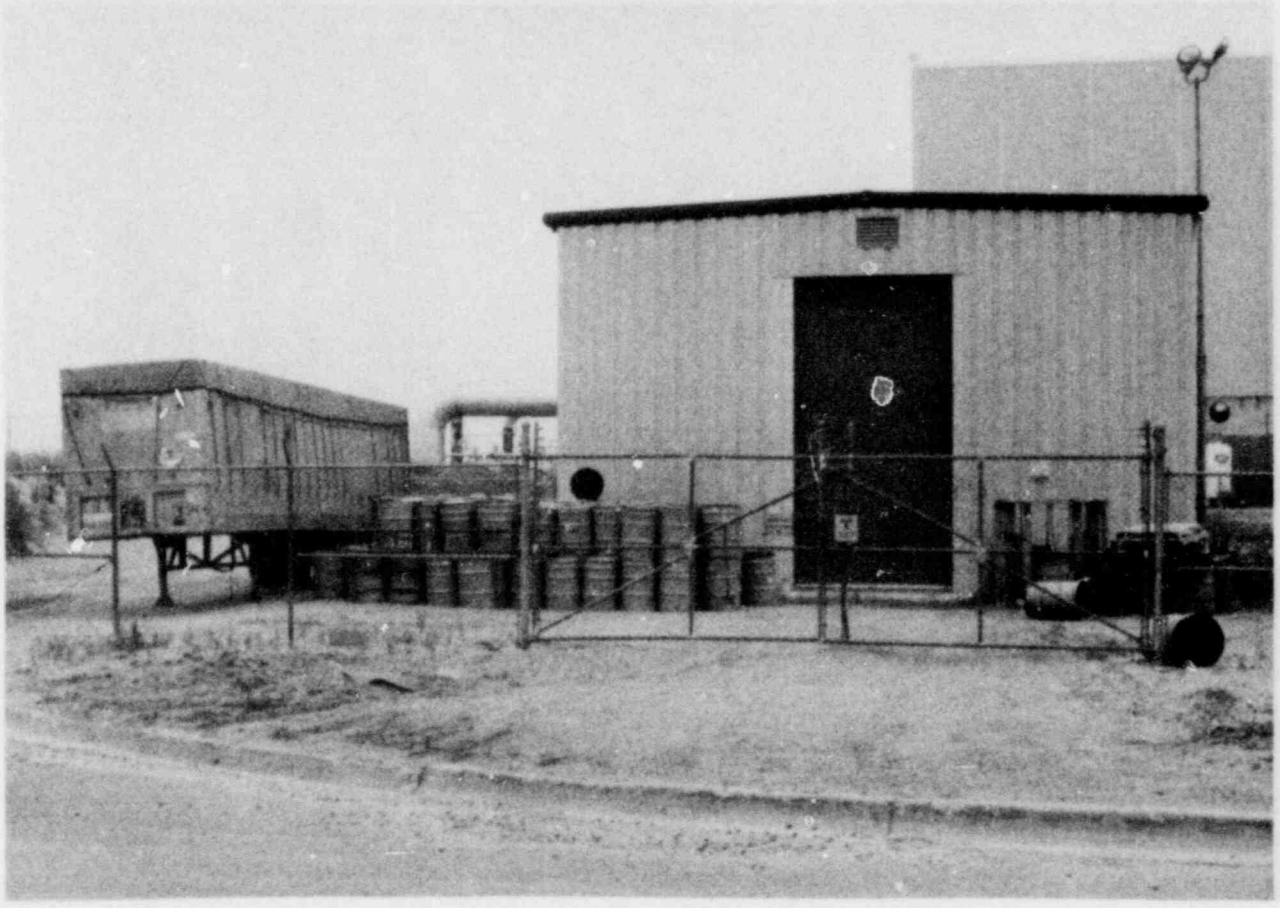


Photograph 2. Inside of Small Sole Use Flight Airplane

Photograph 3. Exterior of Sole Use Flight Airplane



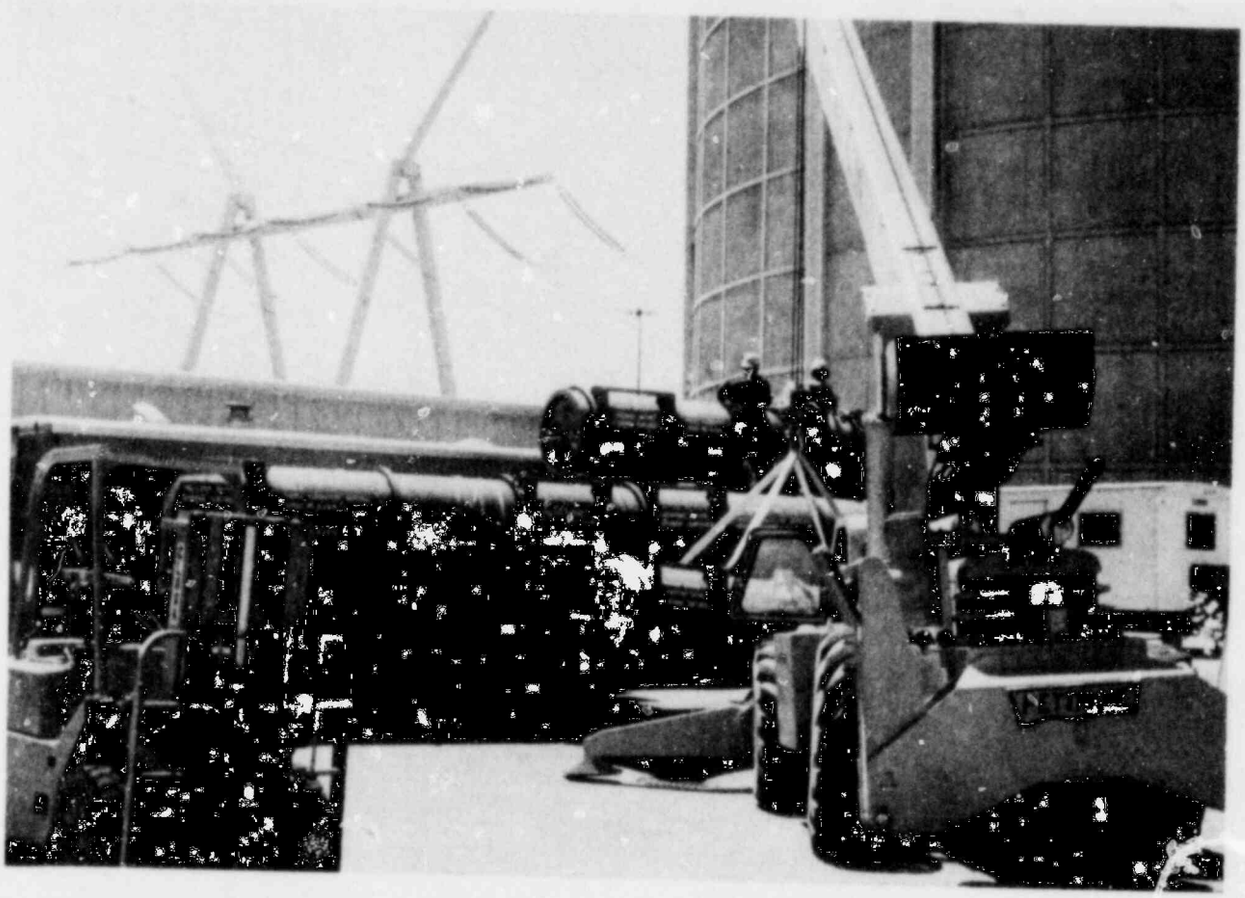
Photograph 4. Interior of Trailer



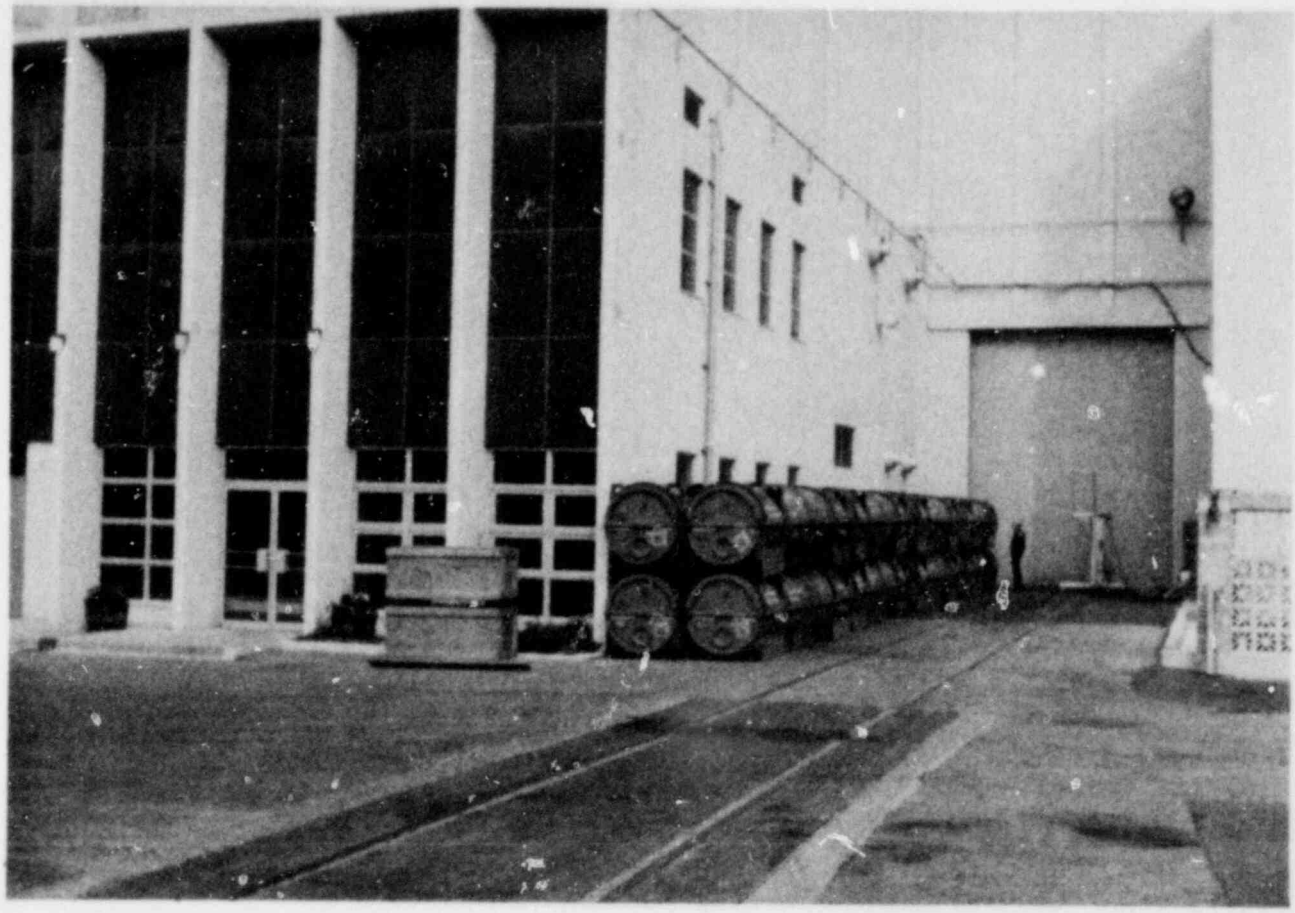
Photograph 5. Trailer Next to Waste Building

Photograph 6. Lifting Container of Fuel

New Fuel Arriving at Palisades Nuclear Power Plant



Photograph 7. View Showing YELLOW II Labels



Photograph 8. New Fuel Next to Office Wall

WILLIAM G. MILLIKEN, Governor

MAURICE S. REIZEN, M.D., Director

STATE OF MICHIGAN
DEPARTMENT OF PUBLIC HEALTH
3500 N. LOGAN, P.O. BOX 30035, LANSING, MICHIGAN 48909

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.

WILLIAM G. MILLIKEN, Governor

MAURICE S. REIZEN, M.D., Director

STATE OF MICHIGAN
DEPARTMENT OF PUBLIC HEALTH
3500 N. LOGAN, P.O. BOX 30035, LANSING, MICHIGAN 48909

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:

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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

VEHICLE INSPECTION DATA SHEET - TYPE: AIRPLANE

Airline _____ Shipper _____ Registration "N"# _____

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

INSTRUMENT USED CONTAMINATION SURVEY No. Smears: _____

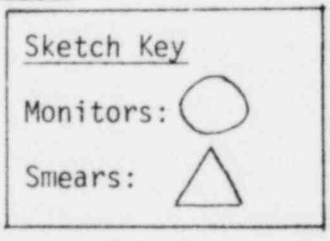
Make: _____	ID #	LOCATION	RESULTS
Model: _____	___	_____	_____
Serial #: _____	___	_____	_____
Calib. Date: _____	___	_____	_____
Background: _____	___	_____	_____

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

Secure: _____ Exclusive Use: _____

RADIATION READINGS - PACKAGE PLACEMENT - MONITOR & SMEAR LOCATIONS

(mR/HR)



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: △

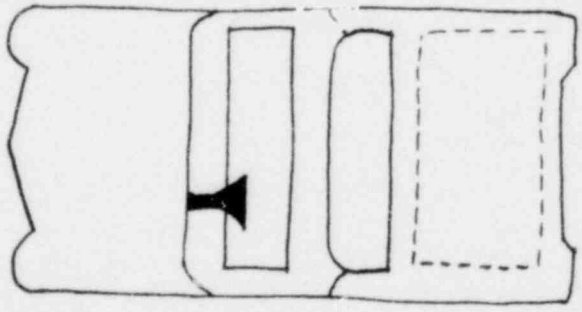
RADIATION READINGS - PACKAGE PLACEMENT - MONITOR & SMEAR LOCATIONS

(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.: _____

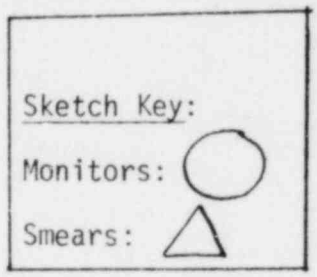
Ship. Dcmts: _____

Secure: _____

Exclusive Use: _____

PLACARDS Circle One: Required N/A

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

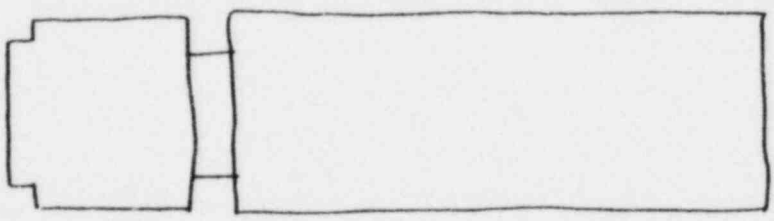


RADIATION READINGS - PACKAGE PLACEMENT - MONITOR & SMEAR LOCATIONS

(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:

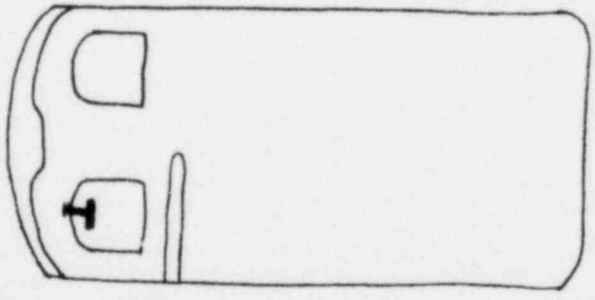
RADIATION READINGS - PACKAGE PLACEMENT - MONITOR & SMEAR LOCATIONS

(mR/HR)

Surface: _____ 6 ft: _____

Surface: _____

6 ft: _____



Surface: _____

6 ft: _____

Surface: _____ 6 ft: _____

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		LABELS			RADIATION MR/HR LEVELS		CONTAINER				RMKS.
	ISOT.	Ci	LIST T.I.	NO.	TYPE	SURFACE	@ 3 FT.	SEAL	SIZE	SWIPE NO.	REMOV. CONT.	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 MR LEVELS 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)

NRC FORM 335 (7-77)

U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

1. REPORT NUMBER (Assigned by DDC)
NUREG/CR-1194

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 March YEAR 1980

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 April YEAR 1980

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.
NRC-06-77-051

13. TYPE OF REPORT Report of data collected during surveillance of radioactive material in transport in Michigan

PERIOD COVERED (Inclusive dates)
September 1, 1978 to August 31, 1979

15. SUPPLEMENTARY NOTES

14. (Leave blank)

16. ABSTRACT (200 words or less)

This report describes a one-year study conducted by the State of Michigan on the transportation of radioactive material into, within and through the State of Michigan from September 1, 1978 to August 31, 1979. The data collected during the monitoring process are contained in this report. The data relate to personnel radiation exposures, condition of packages, handling practices, and general adherence to regulations governing the safe transport of radioactive materials.

17. KEY WORDS AND DOCUMENT ANALYSIS

17a. DESCRIPTORS

17b. IDENTIFIERS/OPEN-ENDED TERMS

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