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Transportation of Radioactive Material in Kentucky

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Abstract

Shipments of radioactive materials were surveyed to determine the types of materials, pattern of transportation and magnitude of activity, the extent of compliance with shipping regulations, and the radiation exposure to persons handling the materials. The transported radioactive materials were categorized as (1) local delivery service, (2) air carrier, (3) nuclear pharmacy, (4) highway carriers, (5) nuclear fuel cycle. The shipments with the most numerous packages were radiopharmaceuticals. The shipments indicating the greatest volume or amount were those associated with the nuclear fuel cycle. The transportation workers whose radiation exposures were measured did not receive excessive doses from radioactive materials, but practices for reducing the radiation doses can be instituted and are discussed in the report.

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Abbreviations

A list of abbreviations used in this report and their meaning is set forth below.

DOT -- U. S. Department of Transportation
HEO -- Highway Enforcement Officer
KDHR -- Kentucky Department for Human Resources
KYDOT -- Kentucky Department of Transportation
LRC -- Kentucky Legislative Research Commission
LSA -- Low Specific Activity
mR/hr -- milliroentgen per hour
mrem -- millirem
NRC -- U. S. Nuclear Regulatory Commission
PGDP -- Paducah Gaseous Diffusion Plant
RAM -- Readioactive Material
TI -- Transport Index
UF_6 -- Uranium Hexafluoride

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Transportation of Radioactive Material in Kentucky

Introduction

Due to the increasing use of radioactive materials in all aspects of our society, the Kentucky Department for Human Resources (KDHR) considered it essential that a comprehensive study be initiated of the various modes of transport of these materials in and through the Commonwealth. It was thought that the geographical location of Kentucky would make the state an excellent site for the collection of data with respect to academic, medical, and industrial radioactive material shipments, as well as radioactive waste transport. Even with the Maxey Flats Nuclear Waste Disposal site closed, the highways of Kentucky offer one of the most direct routes for shipping radioactive wastes from neighboring states to Barnwell, South Carolina. In addition, regular shipments from the U. S. Department of Energy Gaseous Diffusion Facility in Paducah, Kentucky, to other processing installations in the Eastern United States would seem to make Kentucky an excellent location to obtain radioactive material shipment data from pre-use to disposal.

The U. S. Nuclear Regulatory Commission (NRC) and the U. S. Department of Transportation (DOT) have sponsored a series of surveillance programs to obtain information on the degree of compliance with regulations in handling, packaging, labeling, and the radiation exposure to persons through external radiation and radioactive contamination (1). This report describes the study undertaken in Kentucky as a part of this series.

Objectives

The objectives of this study were to establish traffic flow patterns, personnel exposures due to delivery and handling, quantities and types of radioactive materials in transport, and adherence to all applicable regulatory requirements. Additionally, data gathered was to be an aid in evaluating the areas of the Commonwealth and modes of transportation that present the higher risk potential for extended study. The possibility of legislation, regulations, and regulatory guides resulting from the data obtained as well as the establishment of a permanent program in state government was to be evaluated as the study developed.

The proposed approaches to this study are described below. In cooperation with the affected agencies of the Kentucky Department of Transportation (KY DOT), i.e., Division of Highways and Motor Transportation, origin and destination surveys were to be conducted on selected highways, vehicles were to be checked at weigh stations throughout the Commonwealth, and KY DOT Highway Enforcement Officers (KY DOT/HEO) were to be equipped with radiation detection instrumentation to further facilitate the selection of highway areas for more detailed scrutiny. With the voluntary aid of private business, we were to locate, survey, and monitor the major air, rail, and river routes utilized for the transportation of radioactive materials in and through Kentucky. The last objective of this study was to be accomplished by locating, surveying, and monitoring the holding terminals of the trucking firms, transfer firms, and package expediting firms in Kentucky.

Thus, our initial goal was to determine the routes of transportation throughout the Commonwealth which are used most frequently to carry radioactive materials and, therefore, would represent the greatest risk to our citizens.

Scope of Work

The scope of the contract requirements is outlined below:

1. To obtain data on the physical condition of the packages and exclusive use vehicles.

2. To gether factual information and data concerning radiation levels in the transportation environment due to the presence of packages of radioactive materials.

3. To determine doses received by workers and others as a result of exposure to these shipments.

4. To obtain information of the status of compliance with the packaging requirements and the regulations for transport of radioactive materials by shippers and carriers, as related to such factors as package labeling, assignment of transport indices, and maintenance of prescribed separation distances.

5. To obtain data on worker compliance with instructions for handling packages of radioactive materials.

6. To conduct origin and destination surveys on selected highways and conduct vehicle surveys at weigh stations.

Methodology

At the beginning of the study, contact was made with our 250 radioactive material licensees. We wished to learn how much radioactive material they received, by what mode, the carrier if known, and in some cases information on radioactive waste disposal. This informal survey concluded that about 10,580 curies of radioactive material come into the Commonwealth annually (excluding teletherapy sources). This involved about 5,170 separate packages or shipments. This survey also revealed that about 8,000 cubic feet of radioactive waste is generated annually by our largest radioactive material users.

These responses then led us to generate a list of 31 carriers to contact for possible inclusion in this study. We also contacted air carriers operating in, out of, and through our three major airports, i.e., Bluegrass (Lexington), Standiford (Louisville), and Greater Cincinnati. We also met with freight forwarders and interstate carriers who had terminals in the Commonwealth. In all of these meetings we explained the purposes and planned activities of the study and obtained the cooperation of the carriers in order to gain the necessary access and information. Copies of the requests for information to licensees and carriers are in Appendix A.

Generally, all persons thought to be useful to this study were sent a letter explaining who we were, what we wished to do, and how they could help us. This was followed up by a telephone call to see if they had received the letter, to see if they had any questions, to explain in more detail what we wished to do, and to set up a convenient time for an initial visit. During this initial visit, information was obtained concerning the handling of radioactive materials and the responses to our letters were verified. If it was determined that the visited facility would be useful for inclusion in the study, schedules for follow-up visits and details of data gathering were worked out. Many times during the visit, a view of the facility was conducted, personnel important to the study were determined, and a practice survey performed so we could adjust our work to their requirements. After this, a routine schedule was set up for our survey work.

In some instances, the company involved had appropriate instrumentation and agreed to keep certain data for us. In this latter case, we visited only occasionally to check out their work, review their documents, and answer any questions which may have arisen. If the company kept personnel film badge data on their employees, and we were allowed access to that information, this data was recorded. Copies of the forms used to collect the data generated by these visits and surveys are in Appendix B.

All surveys were undertaken with the permission and cooperation of the carriers. Interference with normal handling and scheduling was kept to a minimum as much as possible. Situations that could result in elevated radiation exposures were brought to the attention of the supervisors and changes in practices for reducing such radiation exposures were recommended during the study.

As the reader progresses through the report, he will notice few company names appear in the discussion. Several of the companies would release information only if it could be protected as part of their business enterprise. Kentucky by statute and an administrative regulation sets forth those documents which can be excluded from public inspection and the information discussed is within the purview of these exclusions. When specific information is set forth, the companies are identified by alphabetic symbols where necessary. However, a list of companies contacted appears in the appendices.

Instrumentation

Radiation detection instrumentation used by the staff during this study is outlined below:

Two Eberline RO-3 ionization chamber instruments were used extensively throughout the study. In addition, the staff had access to one Eberline RO-1 ionization chamber and one Eberline PIC-6A ionization chamber. All instruments were calibrated at six-month intervals.

Four Eberline E-120 geiger counters with HP-190 thin window beta-gamma probes were used in the low level survey checks. These were calibrated at intervals of one year.

Additionally, if the need warranted, the staff had access to an Eberline Rascal PRS-1 with an Eberline SPA-3 two-inch by two-inch NaI (Tl) crystal for very low level gamma emitters. All nine (9) instruments discussed above were calibrated by Eberline at their West Columbia, South Carolina, facility.

In addition to the instrumentation used by the staff, Kentucky Highway Enforcement Officers were equipped with Civil Defense survey instruments and other equipment as detailed in a later section.

Personnel exposure studies and environmental monitoring were performed using the appropriate TLD service purchased through Eberline Instrument Corporation.

Findings and Discussion

Due to the many ways in which radioactive materials may move through the Commonwealth, we have broken this subject up into several sub-sections to allow an easier understanding of the study and its findings.

1. Rivers, Waterwa[illegible] Lakes

Rivers, waterways (meaning the navigable portions of rivers suitable for commercial traffic), and lakes have been historically important to Kentucky as a major means of moving bulk goods. A total of 1,453 miles of waterway, all connected to the Ohio and Mississippi River systems directly or by means of locks and dams, provided for over 195 million tons of handled goods in 1976. Over 49% of these materials were accounted for by coal shipments (2).

During this study, contacts were made with the U. S. Coast Guard offices in Cincinnati, Ohio, and Louisville, Kentucky. Information obtained from these offices indicated no radioactive material as cargo was carried on the rivers from a zone starting in Pittsburgh and ending at the southern border of Kentucky.

Although it appears no radioactive materials are carried as cargo, some radioactive material is transported along the rivers incidentally for specific applications. For example, a ship building company occasionally requires the services of an industrial radiography company. Likewise, some work on the lock and dam systems

requires the use of soil density gauges along the river at construction sites. These specific applications tend to be isolated instances and would not be considered in conflict with the assessment above.

A nuclear power station is under construction near Moscow, Ohio, near the Ohio River. Part of their operations plan includes the barge shipment of spent fuel elements across the Ohio River to a railroad terminal access point for further shipment to a reprocessing site. However, the power station does not yet have an operating license and at present there are no operating spent fuel reprocessing facilities.

2. Interstate Transport Carriers

Due to Kentucky's geographic location in the border area of the North and South, Kentucky tends to be a crossroads for the movement of bulk materials both on a north-south and an east-west flow pattern. This traffic is facilitated in its movements by five (5) interstate highways and nine (9) Kentucky parkways.

Since KDHR only regulates intrastate shipments of radioactive material, we turned for assistance to the KY DOT, in particular the Bureau of Vehicle Regulation and their Highway Enforcement Officers (HEO's). KY DOT regulates the safety aspects of transportation, but not the hazardous materials requirements as detailed in the Federal Code of Regulations. We enlisted the aid of the KY DOT/HEO to gather data on the flow of radioactive materials on Kentucky's highways for us. This project was agreeable to the KY DOT and KDHR, and a training session for HEO's was set up in April, 1979.

After this training session, several members of each KY DOT enforcement district were given Civil Defense CDV-777 training kits. Each kit consisted of a CDV-700 GM instrument, a CDV-715 and a CDV-720 ion chamber instrument, along with CDV-750 personnel dosimeter equipment. The purpose of the training and instrumentation was to enable them to gather information for us on the original destination of radioactive material shipments and perform measurements around vehicles. They were to check the driver's area, the surface of the vehicle, and six feet from the surface of the vehicle. They were also to check for compliance with DOT placarding requirements and to check the adequacy of the shipping document. A copy of the form used is attached in Appendix B. Another training session with the HEO's was conducted in December, 1979, as a refresher course with more emphasis on instruments, emergency response, and transportation requirements.

Information obtained to date indicates Interstate 75 is the most frequently used route for radioactive materials movement. The HEO information from I-75 indicates about two (2) shipments of radioactive waste per day toward the end of the study, and about two (2) shipments per week at the beginning of this study, moving to the Barnwell Waste Disposal Site via Chem-Nuclear vehicles. One shipment of unirradiated nuclear power reactor fuel rods moved through the Commonwealth from North Carolina to the Zimmer Nuclear Power Station in Moscow, Ohio. There are expected to be more shipments of unirradiated fuel as this power station gets closer to becoming operational.

Seven shipments of spent reactor fuel moved north through the Commonwealth from Florida Power and Light on its way to Battelle in Ohio. We were also notified by the NRC of a shipment of spent fuel scheduled to be transported through the Commonwealth from the University of Missouri to Savannah River. This shipment was routed so as to avoid major metropolitan areas and thus was forced to move along some of Kentucky's less traveled roads. This routing traversed almost the entire west to east direction of the state. Confirmation was never received that this shipment took place.

Sixty shipments of thorium oxide moved north through the Commonwealth from North Carolina to Ohio. This material was shipped in exclusive use vehicles as LSA. Surveys on one shipment indicated readings well within DOT regulations. The maximum reading on the surface was 35 milliroentgen per hour (mR/hr) at contact and about 3 mR/hr at six (6) feet from the vehicle. The exposure at the driver's area was less than 1 mR/hr.

At least one shipment of "slightly enriched solid Uranium Hexafluoride fissile material" from Tennessee to Pennsylvania moved through the Commonwealth. Surveys of the shipment indicated the maximum reading at contact to be 0.6 mR/hr and the driver's area to be less than 0.05 mR/hr. The vehicle did not have all four 'RADIOACTIVE' placards nor the required transport permit. With this exception, uranium hexafluoride shipments will be discussed in a separate section.

More radioactive material in the form of gauges, sources, and waste is known to travel through the Commonwealth, but so far we have been unable to obtain a reasonable handle on such movements. Hopefully, with the second training session of HEO's we may receive more detailed information on such material movements.

3. Intrastate Transport Via Commercial Carriers

Kentucky has a number of terminals and depots for commercial carriers operating in Kentucky due to its location in the transportation system. We concentrated on efforts in the Lexington, Louisville, and Northern Kentucky areas. Since these three areas have the greatest population, we assumed most of the carriers would have terminals in or near these cities. Again, working with the personnel in KY DOT and checking local telephone books, we contacted, in writing or in person, a total of 43 companies. Because some companies have more than one branch or terminal in different cities acting autonomously, we counted each branch separately as a carrier for a total of 53 carriers. A listing of the carriers contacted during this study appears in Appendix C. Information obtained from these visits suggests that carriers fall into three categories in relation to the transport of radioactive materials.

The first category are those carriers who never or rarely (less than 1 or 2 shipments/year) transport radioactive material. Forty-two (42) or 79% of the carriers surveyed could be classified in this first category.

The second category would include those carriers who generally transport radioactive material on a routine basis, but the volume transported is quite low. These carriers generally transport for one customer, and the frequency ranges from once every four to once every six weeks. The packages are almost exclusively labeled White I or Yellow II, and only one Yellow III package was shipped in recent years, which was a sealed source. These packages usually contained used industrial gauges, small quantities of source material, and an occasional shipment of radioactive waste. Seven (7) or 13% of the carriers could be classified in this category.

The third category would include those carriers who generally transport radioactive material on a routine basis. These carriers generally transport for one customer and the frequency in some cases is daily. We have several which move uranium hexafluoride between the gaseous diffusion plants in Kentucky, Ohio, and Tennessee. One carrier transports source material from its own warehouse to distribution points out-of-state on a routine basis but the total quantity is fairly low. Another carrier collects radioactive waste from many sources through the state, collecting the material in one storage location, and then transporting the material to the South. Four (4) shippers or 8% could be classified in this category.

Information obtained from these carriers indicates that generally only small amounts of radioactive materials are transported by this mode. Generally, no exposure control evaluations are performed except for the carriers in the third category.

4. Parcel Services, Taxies, and Postal Services

Discussion with personnel at parcel services in our major metropolitan areas indicates that the only radioactive material they transport is packaged as White I. The total volume that is moved via this route appears to be quite small. No personnel exposure data is recorded.

At the beginning of this study, we discovered that one licensee had radiopharmaceutical packages shipped via a commercial passenger air carrier to a large metropolitan area. These packages arrived singly at a semi-regular frequency. Upon the arrival of a package, contact was made with a particular taxi company. A taxi under an exclusive use contract was dispatched to pick up the package which was then placed in the trunk of the taxi and delivered to the licensee's facility. The package was labeled Yellow II with a TI of 0.1. This delivery system was discontinued in the Spring of 1979. A package expediting service is presently utilized for the delivery of this package.

Discussion with personnel at postal services indicate that they are not aware of any packages being shipped which contain radioactive material.

5. Licensees - Kentucky and Other States

The Commonwealth has a variety of licensees ranging from warehousing for distribution under an NRC licnese to mobile nuclear medicine facilities and radiopharmacies. The ones more important from the standpoint of transportation were visited. A listing of those licensees considered more important from this standpoint and who participated in this study appears in Appendix D.

One licensee uses its own vehicles in the transport of smoke detectors. These shipments are exempt from transport labeling and placarding but were of interest to us from a material movements and a routing standpoint. In excess of 20,000 detectors are kept in the warehouse, and in any one month some 3,000 units are shipped. All movements are via the interstate highways.

Three radiopharmacies operate in Kentucky although only two are licensed by Kentucky. The other one is licensed by the NRC. All of these companies receive their radiopharmaceuticals via package expediting services. Almost all materials are delivered to cus-

tomers in private company vehicles although all use the small package delivery services to transport material to their farthest customers. Personnel exposure information from two of these companies indicates that the drivers' exposures are relatively minor. A further discussion of these exposures appears in Appendix E. The delivery personnel for the package expediting services would be assumed to receive more exposure due to the routine handling of 6 and 12 curie generators plus therapy sources shipped in. One radiopharmacy company agreed to keep records of shipments and the results of package surveys. These records were made on a form supplied to them by our agency. We audited this program. Each radiopharmacy delivery vehicle had a set of emergency restrictions taped to the passenger side sunvisor. Three accidents have been known to occur. No material was released and no damage to transport containers occurred.

Other licensees transport small quantities of source material. The mobile nuclear diagnostic services appear to present little exposure to the driver, who usually functions as the technologist. One large metropolitan university kept incoming shipment records and surveys on a form we supplied. We also audited this program. One licensee transports minute quantities of special nuclear material in his business.

One area of particular concern for us was out-of-state licensees who bring in radioactive material to perform a job and then leave the state. Their duration of stay varies from a couple of hours to several weeks. For fiscal year 1979, the last time frame for which data is available, we had 210 entries into the state with a total of about 10,050 curies of material. We have checked no more than 10% of these but find they are complying with DOT labeling, placarding, and exposure level requirements. A breakdown of this information appears in Appendix F.

The only significant problem related to transportation activities we encountered with our licensees was during a routine radioactive materials compliance inspection. We discovered that a nuclear soil density device containing 40 millicuries of americium 241 was shipped in a package labeled Yellow III as radium 226 with 0.0045 millicuries and with a TI of 1.0.

Additionally, we discovered one instance where a licensee was shipping several used medical generators to the manufacturer. The package had a Yellow III label on it with the right hand red I on the label partially marked out.

During the time frame of the study, there were two packages lost in the transportation system. One medical package labeled White I with a TI of 0 was supposed to be in a shipment lot according to the notification for loading of hazardous materials accompanying the cargo. However, the package could not be located. As of the end of the contract, no notification had been received that the package had been located.

A 12.5 curie sealed source was being shipped from a licensee in Kentucky to Louisiana using a source exchanger. The shipping papers accompanying the package arrived in Louisiana at the package expediting terminal, but the indicated source was not present. After an initial search did not locate the source, several states along the transport route were notified of a possible device lost en route. The cargo was eventually located in Tennessee at one of the package expediting terminals. The cargo arrived without accompanying shipping papers so the terminal transport personnel placed the package in the restricted article area and waited for someone to inquire. Subsequently, the shipment continued on to its destination without incident. The total time required to complete the shipment was 69 days.

6. Railroads

Railroads were for many years the chief means of moving people and goods throughout the nation. Historically, railroads have been championed as the "makers of the West" and insofar as freight movements, they still generally hold up to that standard today. The importance of rail to Kentucky, both in moving coal and in promoting economic growth, is still strong. In 1977, there were 3,757 miles statewide in the railroad system and carriers hauled over 23 billion ton-miles of goods. The major portion of this tonnage is coal haul. (2)

This rail network reaches most parts of the Commonwealth and provides intrastate and interstate linkages. The trunkline routes extended primarily North-South, traversing Kentucky en route from the industrial North and Midwest to most parts of the South. Secondary routes within Kentucky provide East-West connections focusing mainly on Louisville. East-West routes are conspicuous by their absence in Southern Kentucky. (3)

Information was obtained from the Paducah Gaseous Diffusion Plant (PGDP) as to rail transportation routes and destinations. Blair, Tennessee, and Teays, Ohio, and Norfolk and Portsmouth, Virginia, are the four general origin and destination cities were material is moved by rail. No information as to total tonnage moved by

this mode is available. Information obtained from PGDP indicated the transport index of a single shipment would vary between 0.4 and 10.0 depending upon the package and contents.

In Appendix G we have set forth the carriers and routings for the rail shipments. On the map as Appendix H we have highlighted these routes for the ease of the reader.

7. Air Carriers

Kentucky is served by three major airports. These are Bluegrass Field, Lexington; Standiford Field, Louisville; and Greater Cincinnati, Covington. Other small airports serve Kentuckians both from airports located in Kentucky and surrounding states. We concentrated our work at the three major airports as these are served by many carriers and we would have the biggest chance of intercepting radicactive material packages in this manner. We are considering the small package expediting services in a separate category from the air carriers.

At these three airports a total of 24 air carriers were contacted. A listing of these commercial air carriers is contained in Appendix I. Please note that the appendix contains fifteen entries since some carriers have offices located at two or more airports. Both companies identifying themselves as passenger airlines as well as those identifying themselves as air freight or air cargo airlines were visited. Of those visited 21 indicated they carry no radioactive material. Only 2 carriers indicated that they had carried material once in over a year. Only 1 carrier indicated it had carried material more than a couple of times in the past year. These were packages which were going out of the country and were medical in nature. This was an expected result, considering the nature of hazardous material cargo and the safety requirements of commercial air carriers.

8. Uranium Hexafluoride

Due to the location of Kentucky and the relative locations of three gaseous diffusion plants at Paducah, Portsmouth, and Oak Ridge, it was felt that this subject should be treated in a separate section. We have dealt exclusively with the PGDP, and the information pertains to that plant.

The PGDP utilizes both highway and rail as modes of transport. The tonnage of material receipts, shipments, and shipping containers was approximately 50 million pounds for fiscal year 1979. The transport index of a single shipment would vary between 0.4 to 10.0 depending on the package and contents. The inbound and outbound shipment activity consists of the following types of radioactive material:

1. Uranium hexafluoride (depleted) as LSA,

2. Uranium hexafluoride (enriched) as Fissile, and

3. Uranium tetrafluoride (depleted) as LSA.

A discussion of the movement by rail has appeared earlier. PGDP identified nine (9) companies which move the material by highway. A highway map of these material movements appears in Appendix J. Several of these carriers were contacted as part of this contract and one was willing to participate in further study.

The carrier was quite willing to participate in the study. He shared routing information and employee exposure data. He also was willing to cooperate by allowing us to take part in vehicle surveys. A map has been prepared showing the routes this carrier uses for the transport of radioactive material and appears in Appendix K.

Employee exposure data is presented in Appendix L. In general, the exposure is minimal, with a low of 0 and a high of 66 mrem per calendar quarter.

These vehicles were surveyed with staff members present at various times. Exposure rates were measured at the driver's seat and measurements of maximum exposure rates at the surface and at six feet from the vehicle were made. The maximum exposure rate measured for each of these locations is set forth below for both a full load and also for empty cylinders being returned to the facility.

Load	Driver's Area (mR/hr)	Contact (mR/hr)	Six Feet Away (mR/hr)
Full	.3	2.5	1.0
Empty	0	22	3.6

A complete summary appears as part of Appendix M.

Instructions concerning possible emergenices have been prepared by the uranium hexafluoride carrier. A copy of these instructions is in each truck and each driver is given a copy. The instructions list the potential hazards both from a radioactivity and corrosiveness standpoint. The instructions further elucidate actions involving a spill or leak, fire, and first aid. Also, each driver has a radioactive material manual for reference and instructions.

9. Package Expediting Services

The information presented so far indicates that a very limited amount of radioactive material moves into the Commonwealth with the exception of the source material associated with the gaseous diffusion plants and the movement of some material through the state via the interstate highway system. However, since Kentucky does have a number of radioactive material licensees, the method by which they obtain materials must be considered as an important part of this study.

The package expediting services fill this need in Kentucky. They perform this service utilizing aircraft delivering material to a major airport, and then small delivery vehicles disperse the material over a wide area. The delivery of radiopharmaceuticals to hospitals, private offices, universities, and pharmacies is almost exclusively by this mode. Also, most academic sources appear to move by this route along with a fair number of industrial-type gauging devices.

A diagram of a typical terminal and storage area for these companies is in Appendix N. It appears that they all tend to be of the same basic design except for the dimensions.

The package expediting services were contacted during this study and were willing to assist us. We were interested in route information, package integrity, labels, transport index, storage areas, personnel monitoring, and environmental monitoring of vehicles and storage areas. Appendix O lists those companies contacted during this study.

During this study a total of 714 packages moving through the package expediting services have been inspected and surveyed. In Appendices P & Q we have set forth the information indicating the problems discovered. The most common problem discovered was that the measured TI was higher than the recorded TI. The discrepancies involving the radiopharmaceuticals and their labels, in particular the TI, was not confined to one or two shippers. From the information obtained all known radiopharmaceutical shippers were involved at one time or another, but no one shipper consistently appeared to be involved. The isotopes involved in the label discrepancies included iron-59, iodine-123, gallium-67, xenon-133, iodine-131, and molybdenum 99/technetium 99m generators. The two most common isotopes involved were molydenum 99/technetium 99m generators and iodine-131 therapy sources. Most package TI's were within 2 mR of the observed TI, but in some instances exposure rate differed from the labeled value of the TI significantly. For example, based upon our measurements, some TI's were up to three times too large or small. About 10% of the packages were under TI'ed. It is interesting to note that in spite of the TI differences, apparently no packages had a surface dose rate greater than that specified by the label limit. This is apparently explained by the assumption that if there were any questions about the package, it was labeled with the next higher label classification.

Due to the nature of package expediting services and routing, it was difficult to determine what drivers consistently carried RAM. Many times routes were altered or the driver who had been carrying RAM no longer carried RAM. Likewise, drivers changed routes as they progressed in seniority. These factors, in addition to others such as the loss of the TLD badges furnished, presented difficulties in obtaining personnel exposure data. The values which were obtained are given in Appendix R.

In Appendix S the results of two quarters of environmental monitoring are presented. In Appendix T we have set forth additional calculations of personnel exposure based on time and motion studies at the airports and the frequency of material shipments. From the information gathered we conclude most employees receive minimal exposure from the handling of RAM packages.

Vehicle surveys performed in conjunction with the package surveys indicated low levels of exposure to the driver's area, at the vehicle surface, and at six feet from the surface. Appendix M presents a summary of this data. One survey indicated a level at the driver's seat of greater than 2 mR/hr. It was suggested that the load be rearranged. This was done and a re-survey indicated the level had dropped to 1 mR/hr. The original RAM package arrange-

ment was based upon the driver's wish to keep hazardous material within sight and easy reach. This meant behind the driver's seat. This was not company policy.

One service kept a copy of the shipping papers of every package that went through its facility from January, 1979, through May, 1979. This gave us an excellent record of routing and material movements in Kentucky. Some other companies kept similar documents for about a one-month time frame.

It should be noted that during the time this study was made, some of the volume of radioactive material transported by air appeared shifted to transport by highway. For example, the transport of some molybdenum 99/technetium 99m generators have been converted to this mode. This had led to increased activity in curies to account for the extra travel time. In one instance a regular shipment of a 1.67 Ci generator was increased to 2.19 Ci after such a change. Also, the TI increased from 2.5 to 6.7.

Most radioactive material is unloaded from the aircraft onto a vehicle and then taken to the terminal. There the packages are sorted and placed into the route vehicles. Thus, there is practically no "storage" of radioactive material at these facilities. "Storage" generally consists of a package to be held for a customer. The customer is notified and he picks up the package within a few hours. Generally, the stored packages are Type B and tend to be industrial devices.

Environmental monitoring at a dispatcher's office indicated some possible problems. The second quarter of 1979 monitoring recorded a total of 288 mrem (net). The third quarter of 1979 monitoring revealed a total of 44 mrem (net). Monitoring at other facilities indicated no high readings, and we have been unable to discover the reason for these readings. It is known the monitor was taken down from the wall where it was originally placed due to the painting of the dispatcher's office. It was reattached to the wall opposite the wall to which it was originally attached. The dispatcher's office is about 75 feet away from the radioactive material storage area. However, where vehicles are loaded for shipment, radioactive material could be as close as 15-20 feet away due to the location of the loading bays. Our spot checks and visits indicate that total TI in the building is below 50 on any given day. Due to the interest this dispatcher's office has generated, we also monitored the office for 50 days in the first part of 1980. This time the net reading was 24 mrem.

10. Other

In Appendix U a summary of transportation accidents involving radioactive material is set forth. These are included for completeness and as an indication of problems encountered by our staff.

Recognizing the seriousness and complexity of the problems associated with the Maxey Flats nuclear waste disposal site in Kentucky, the 1978 General Assembly directed that a special advisory committee composed of legislators, university experts, citizens, and state agency personnel be created to have oversight of all matters related to nuclear waste in the Commonwealth. (4) Due to the nature of this committee and the subjects which they were interested in, KDHR was requested to give a presentation concerning this transportation surveillance program. A copy of the report submitted to the committee is attached as Appendix V. The attachment to that report is not included as it is a restatement of the scope of this contract. This report was well received and many committee members' questions were answered concerning the flow of radioactive materials in and through the Commonwealth.

Conclusions and Recommendations

Radioactive material movement through the Commonwealth tends to be in a few concentrated areas. Radiopharmaceuticals and uranium hexafluoride are the most common shipments. Industrial gauging is an infrequent shipment, but does account for a substantial quantity of activity in its movements. Typically, the industrial sources range from a few tenths of a curie up to 100 curies. The areas of interstate shipment of radioactive material is where we are lacking information. Only a few of the shipments in interstate commerce have been observed during this study. Hopefully, with the cooperation of the Highway Enforcement Officers, our knowledge will be more complete.

From the personnel and environmental monitoring performed, it appears that limited exposure to employees is the general rule. Even the drivers for radiopharmacies and uranium hexafluoride carriers receive very limited exposure in the course of their work.

It is also interesting to note that about as much radioactivity moves into and out of the state on temporary jobs as is presently used in the Commonwealth. It should also be noted that the material used under reciprocity tends to be in the multi-curie range.

Some generalizations can be made based upon this study. The most common single package shipments are radiopharmaceutical in nature. With the exception of generators, these packages are in the millicurie range. The occasional shipments of spent fuel would have to be classified as containing the most activity, generally stated in hundreds of thousands of curies. The bulk of material moving appears to be uranium compounds with about 50 million pounds annually moving by rail and highway. It appears from this study that the overwhelming majority of packages shipped meet the applicable U.S. DOT rules and regulations.

The following recommendations in regard to any future studies undertaken are offered:

1. Training of state highway enforcement officers should be undertaken. This training has the potential to increase emergency response capacity and can create a network of data generation. This data generation is especially useful in assessing interstate transport and should be begun early in the study.

2. Coordination and cooperation between states in supplying data on interstate shipping is also essential for a handle to be obtained on this information.

3. Large facilities (in this instance the gaseous diffusion plants in Portsmouth and Oak Ridge) should be contacted early in the study in order to evaluate the effect of these facilities on material transport.

4. Information derived from routine materials compliance inspectors proved beneficial and easily obtained and should be a part of any future study.

5. Mass mailings, such as the ones described, should be undertaken early in a study as was done here. This served to organize activities and eliminate unproductive interviews.

6. Whenever possible, personnel exposure data should be collected early and large allowances should be made for problems such as encountered here.

7. Area monitoring should be conducted with an outlook for situations such as the dispatcher's office mentioned in the text. Also, an area posted "Restricted Area" may not always be the one actually used on a day-to-day basis.

As a final note, it is difficult to assess what permanent impact this study will have on the transportation of radioactive materials in Kentucky. Certainly, some carriers became conscious of our interest and some drivers became more aware of the packages being carried, taking more appropriate precautions. Less certain is whether this awareness permanently altered conduct of these persons. In any event, the majority of those contacted showed a professional attitude on this subject. Many of the apparent violations of Appendix P and Appendix Q originated primarily with the shippers, with whom little impact could be expected and little observed. Of greatest benefit were the contacts and communications opened up between our agency and other agencies, both within and outside Kentucky.

References

1. Los Alamos Scientific Laboratory, "Summary Report of the State Surveillance Program on the Transportation of Radioactive Materials", U. S. NRC Report NUREG-0393 (1978).*

2. Kentucky Department of Transportation, "Transportation Facts and Figures", Kentucky Department of Transportation Report (July 1977)

3. Karan, P. P. and Mather, C., Editors, "Atlas of Kentucky", The University Press of Kentucky (1977)

4. Kentucky Legislative Research Commission, "Report of the Special Advisory Committee on Nuclear Waste Disposal (1979 Supplement)", LRC Research Report No. 167 (1980)

*Available for purchase from the NRC/GPO Sales Program, U.S. Nuclear Regulatory Commission, Washington, DC 20555, and the National Technical Information Service, Springfield, VA 22161.

Appendix A

C ..RTMENT FOR HUMAN RESOURCES
COMMONWEALTH OF KENTUCKY
FRANKFORT 40601

BUREAU FOR HEALTH SERVICES

The Kentucky Department for Human Resources, Radiation Control Branch is beginning a comprehensive study of radioactive material transport within the Commonwealth. In order to make a thorough evaluation, we are requesting your voluntary cooperation. Listed below is the information we are asking you to provide this office:

1. The name, address and telephone number of the firm or firms delivering or picking up shipments of radioactive materials in your area of Kentucky that you deal with,

2. The number of shipments of radioactive materials that you received or originated in 1977, and

3. The type and quantity of radioactive materials received or originated by you in 1977.

We would like to take this opportunity to thank you for your cooperation with this study. Should you have any questions in this matter contact Douglas Beasey at (502) 564-3700.

Very truly yours,

Charles M. Hardin

Charles M. Hardin
Manager
Radiation Control Branch

CMH:gj

Appendix A

L ARTMENT FOR HUMAN RESOURCES
COMMONWEALTH OF KENTUCKY
FRANKFORT 40601

BUREAU FOR HEALTH SERVICES

The Kentucky Department for Human Resources, Radiation Control Branch is beginning a comprehensive study of radioactive material transport within the Commonwealth. In order to make a thorough evaluation, we are requesting your cooperation. The aims of this initial study are:

1. To locate firms transporting shipments of radioactive materials,

2. Establish traffic flow patterns for radioactive material shipments,

3. To obtain an estimate of the quantities of radioactive materials being shipped throughout Kentucky for 1977, and

4. To initiate an evaluation of the hazards to personnel associated with the transportation of radioactive materials.

Should your firm be involved with the transport of radioactive materials in Kentucky, please provide any information available consistent with the four areas of interest outlined above, or contact:

Douglas Beasey
Senior Radiation Physicist
Radiation Control Branch
275 East Main Street
Frankfort, Kentucky 40601
(502) 564-3700

Our thanks in advance for helping us in this matter.

Very truly yours,

Charles M. Hardin

Charles M. Hardin
Manager
Radiation Control Branch

CMH:gj

Appendix B

TERMINAL OR WAREHOUSE INSPECTION DATA SHEET

LOCATION _____ DATE _____ TIME _____ MONITORS _____

INSTRUMENT(S): TYPE _____ SERIAL NO. _____ CALIB. DATE _____

AREA SURVEY

1. Radiation levels in areas occupied and capable of being occupied by personnel

   Area monitoring placement: (provide sketch)

   Area monitoring results: (use data sheet)

2. Areas surveyed for contamination: (indicate on sketch)

   Contamination survey results:

3. Radioactive material package placement (provide sketch)

   Total transport index in any one location:

   Separation of packages from people and film:

PERSONNEL SURVEY

1. Identify person(s) exposed to significant amounts of radiation--and provided with personnel monitoring devices--by name, title, Social Security number, employer, and brief description of duties:

2. Provide sketch showing time and motion study in relation to normal package storage, identifying present radiation levels:

   Provide estimated annual radiation exposure as determined by a time and motion study:

3. Personnel monitoring devices provided to persons: (use data sheet)

   Device Number:

   Name of Individual:

   Social Security No.:

   Date of Birth:

   Estimated Exposure:

PERSONNEL MONITORING DATA SHEET

NAME _____ BADGE NO. _____

TITLE _____

SOCIAL SECURITY NUMBER _____ DATE OF BIRTH _____

EMPLOYER _____

TERMINAL LOCATION _____

WORKING TIMES _____

Badge Wearing Record: place X in column only when worn.

DATE	WHOLE BODY	FINGER	DATE	WHOLE BODY	FINGER

REMARKS:

_____

Appendix B

VEHICLE INSPECTION DATA SHEET

LOCATION_____ DATE_____ TIME_____ MONITORS_____

INSTRUMENT(S): TYPE_____ SERIAL NO_____ CALIB. DATE_____

VEHICLE(S): TYPE_____ CARRIER_____ EXCLUSIVE USE?_____

VEHICLE SURVEY

1. Radiation levels: Cab_____ Outside Surface_____

   Background_____ 6 ft. from outside surface_____

2. Identify areas surveyed for contamination:

   Contamination survey results:

3. Radioactive material package placement: (provide sketch)

   Total transport index in the vehicle:

4. Adequate shipping documents:

5. Adequate placarding:

PERSONNEL SURVEY

1. Identify person(s) exposed and significant amounts of radiation--and provided with personnel monitoring devices--by name, title, Social Security number, employer, and brief description of duties:

2. Provide an estimate of annual exposure and its basis:

3. Personnel monitoring devices provided to person(s): (use data sheet)

   Device Number:

   Name of Individual:

   Social Security No.:

   Date of Birth:

   Estimated Exposure:

PACKAGE INSPECTION DATA SHEET

ORGANIZATION _____

LOCATION _____ DATE _____ TIME _____ MONITORS _____

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

CONTACT _____ TEL. NO. _____ MAILING ADDRESS _____

SHIPPER & ORDER NO.	PACKAGES				LABELS				RADIATION LEVELS MR HR		REMOV. CONT.	PACKAGE SEAL	SIZE	COM.	
	PKG AUTH	TYPE	CONTENTS TSOT	CONTENTS CI	TRANS. INDEX	NO.	TYPE		SURFACE	@3 FT.					

Appendix C

Truck Companies Operating Terminals in Kentucky Contacted During This Study

Bestway Express
Branch Motor Freight
Bronaugh Motor Express
Bullet Express
Consolidated Freight
Cooper-Jarrett
Crown Trucking
Davis Transport
E and G Motor Express
East Texas Motor Freight
Eck Miller Transportation
Epes Transport
Factor Services
General Highway Express
Hazard Express
Interstate Motor Freight System
Jones Motor Company
Lexington Cartage
McDaniel Motor Express
McLean Trucking Company
Mallinckrodt
Morning Star Freight
Oak's Truck Line
OK Trucking
Overnite
Pacific Inter Mountain Express
Paschall Truck Lines
RAD Services
Red Arrow Delivery
Sheppherd Truck Lines
Smith's Transfer
Spector Freight Systems
Star Transfer
Stewart Truck Lines
Texas Continental Trucking Co.
Tri-State Motor Transport
Turner Expediting
United Trucking
Vincent-Fister
Wilson Freight
Yeary Transfer
Yellow Freight Systems
Viking Truck Lines

Appendix D

Licensees Participating in This Study

LICENSEE

Actus, Inc.
Mallinckrodt
National Electric Coil
Nuclear Pharmacy, Inc.
Nuclear Transport & Storage
Pharmatopes, Inc.
Sensor-tec
Square D
Shepard, Hightower & Anderson
University of Kentucky
University of Louisville

Appendix E

Radiopharmaceutical Delivery Personnel Exposure (net)

Company	Driver	Jan-Sept 79 Exposure
A	A1	152 mrem whole body

Company	Employee	Jan-July 79 Exposure
B	B1	58 mrem whole body
	B2	16 mrem whole body
	B3	0
	B4	0
	B5	0
	B6	0
	B7	0
	B8	0
	B9	0

Employees B1 and B2 also elute generators and prepare radiopharmaceutical kit doses and therapy doses. Other employees are drivers and/or office staff.

Film badge record information supplied by company under study.

Appendix F

Out-of-State Licensees Entering Kentucky to Perform Work in FY 79

Category	No. Companies	No. Entries	Approx # of Ci Involved
Industrial Radiography	18	130	10,400
Wireline Service	6	70	140
Soil Density	9	9	less than 1
Other	1	1	less than .1

This gives a total number of entries of: 210

This gives a total number of companies of: 34

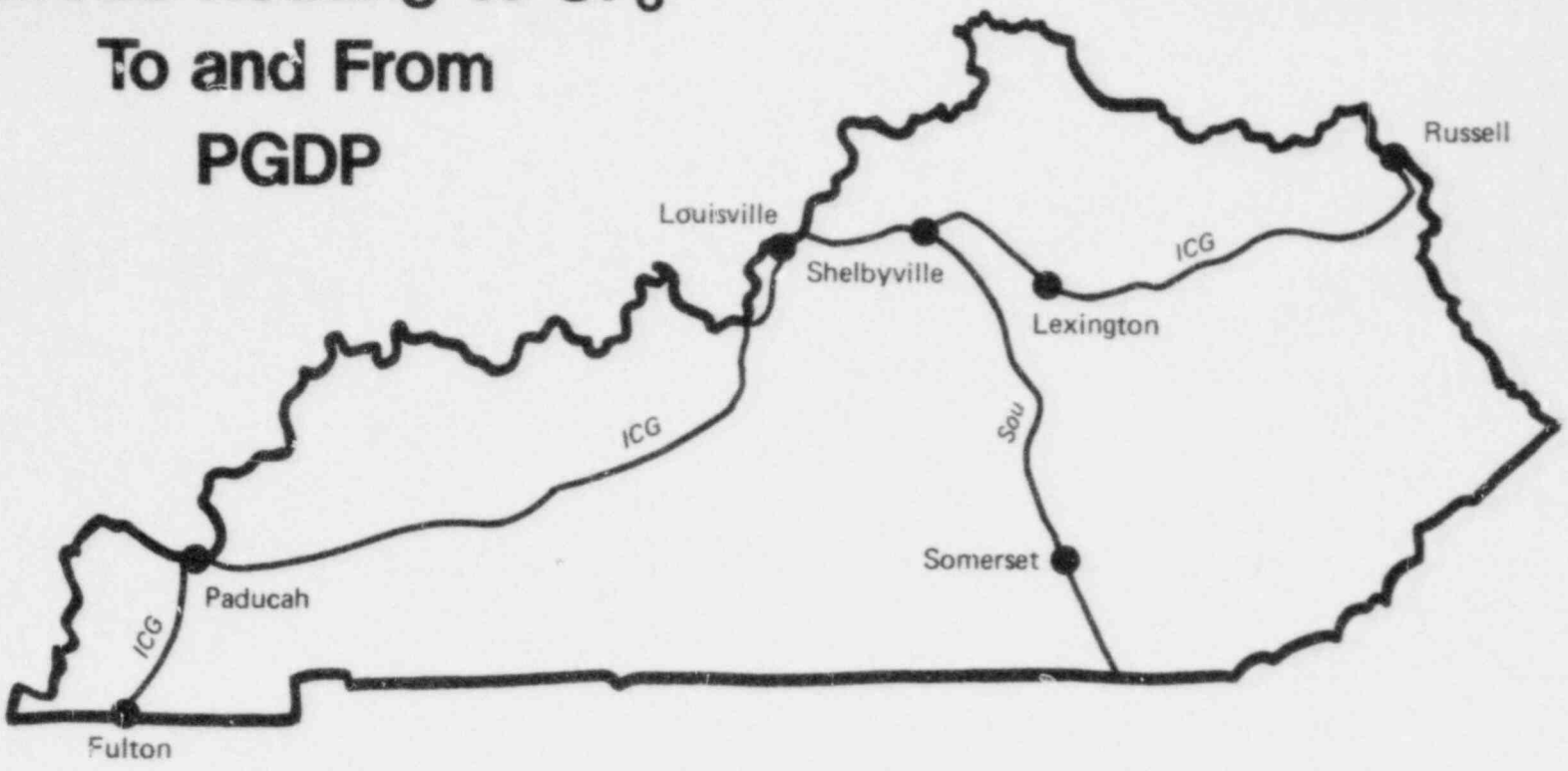
This gives a total number of curies moving in the state as: 10,541

Appendix G

Shipments by Rail

Material	Origin/Destination	Carrier	Routing
Fissile-UF6 (enriched) LSA-UF6 (Depleted)	Blair, TN	ICG-Sou	Paducah, Princeton, Central City, Louisville Shelbyville Lawrenceburg Danville, Somerset Harman, TN
Fissile-UF6 (enriched) LSA-UF6 (Depleted	Teays, OH	ICG-	Paducah, Princeton, Central City, Louisville, Shelbyville Frankfort, Lexington, Russell
LSA-UF6 (Depleted)	Norfolk, VA	ICG	Paducah, Fulton, Jackson, TN
LSA-UF6 (Depleted)	Portsmouth, VA	ICG	Paducah, Fulton, Jackson, TN

Railroad Routing of UF_6 To and From PGDP

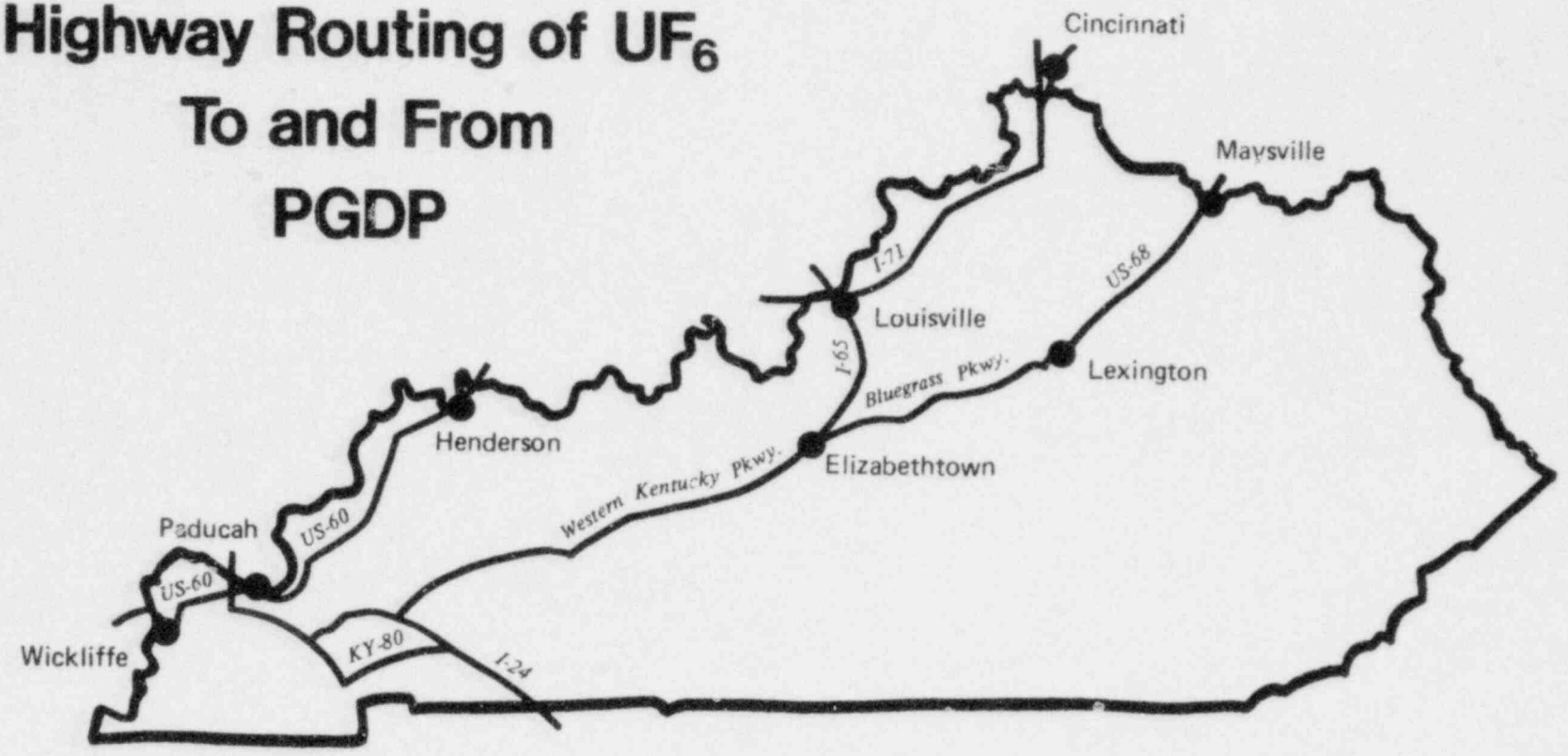


Appendix I

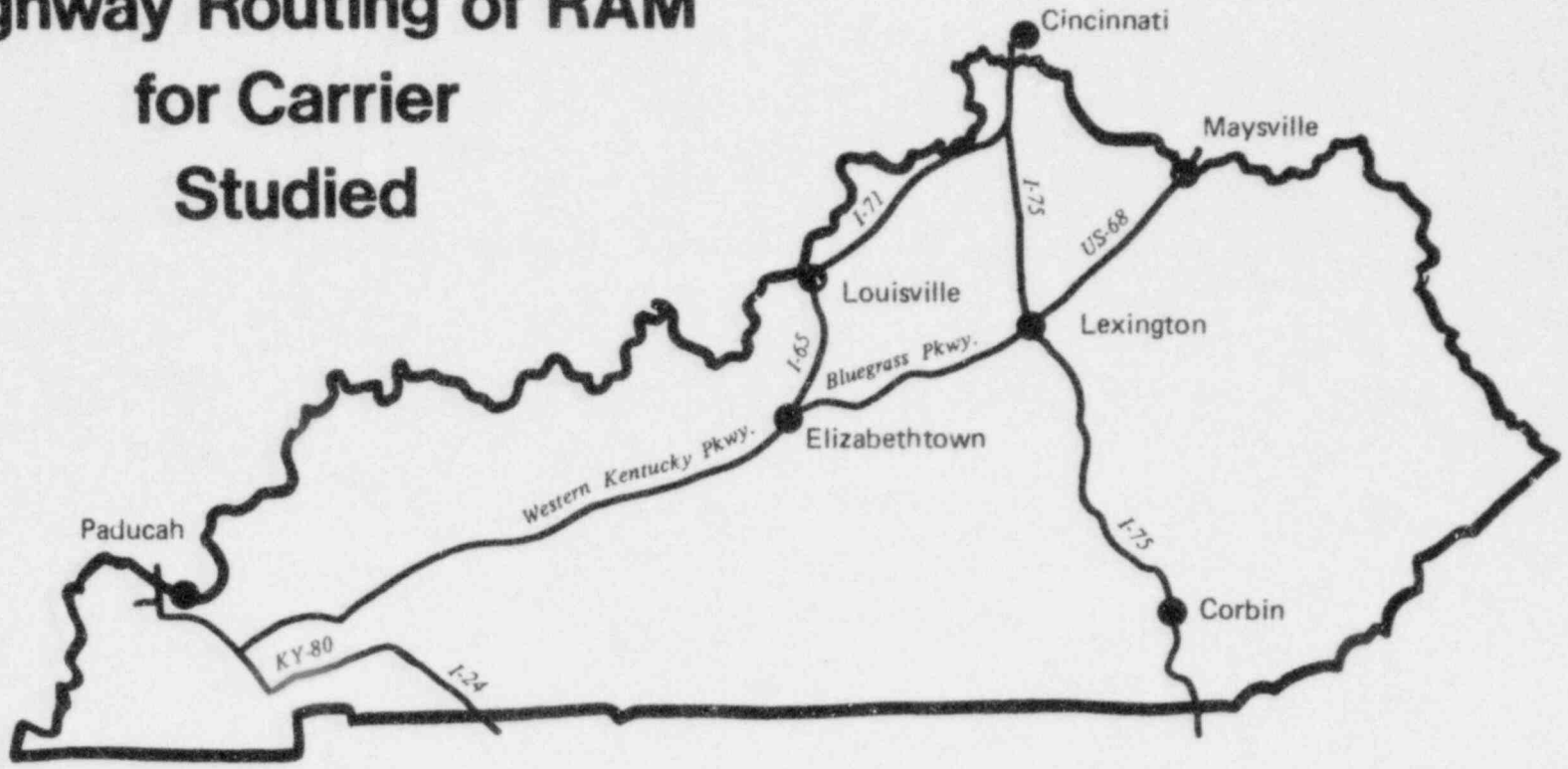
Airline and Air Cargo Companies Contacted During the Study

Air Express International Corporation
American Airlines
American Air Freight Systems
Delta Air Freight
Delta Airlines
Eastern Airlines
Emery Air Freight
Federal Express
Flying Tiger Air Cargo
Ozark Airlines
Pan Am Airlines
Piedmont Air Freight
Piedmont Airlines
TWA Air Cargo
U. S. Air

Highway Routing of UF_6 To and From PGDP



Highway Routing of RAM for Carrier Studied



Appendix L

Uranium Transport Carrier Personnel Exposure (Net) Information (mrem)

Employee	1st Qtr 78	2d Qtr 78	3d Qtr 78	4th Qtr 78	1st Qtr 79	2d Qtr 79
A	40	47	18	37	40	30
B	66	15	0	48		18
C	30	21	0	15	23	0
D	27	29	0	16	10	0
E	42	0	0			
F	0	0	0			
G	0					
H		30	0	15	12	14
I			0	10	0	20
J			0	0	10	15
K					0	0
L					17	0
M					0	12
N					0	0
O						56

Data obtained from film badge records supplied by carrier.

Appendix M

Summary of Surveys of RAM Transport Vehicles

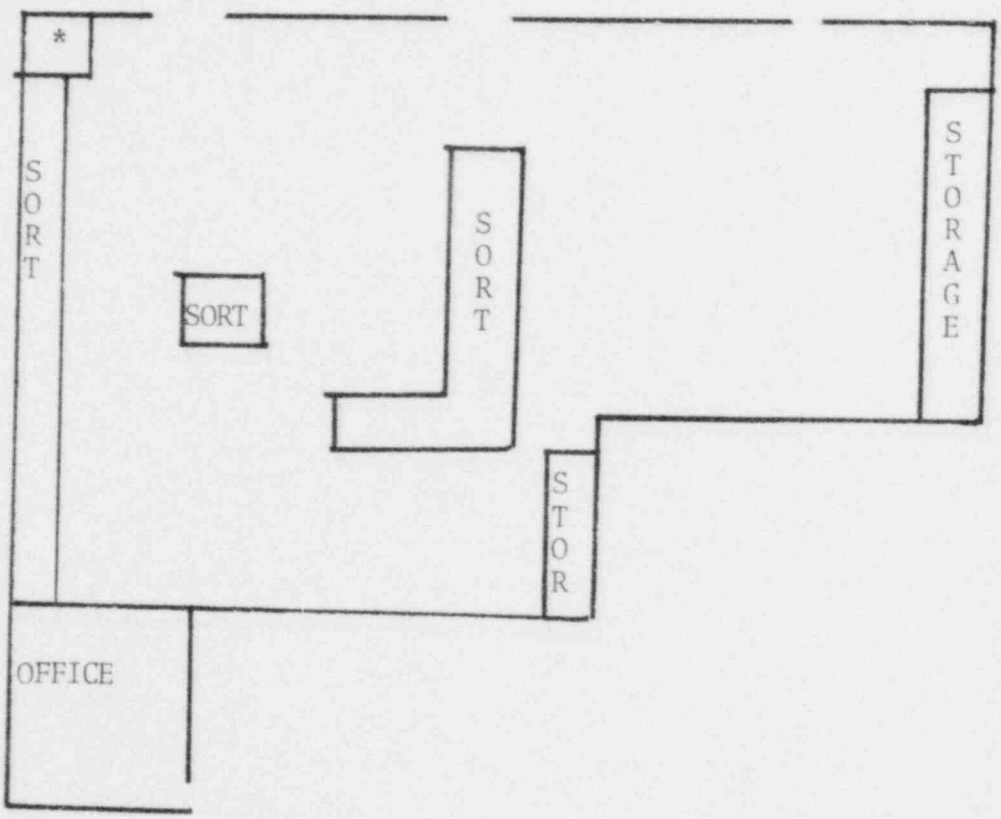
	Radiopharmaceutical	Educational, Industrial, Research	Nuclear Fuel Cycle
# Vehicles	30	2	12
Rad levels mR/hr			
Cab avg. (max)	.24 (1.7)	.2 (.4)	.5 (1)
Surface avg. (max)	.72 (2.4)	.6 (11)	9.5 (35)
6' distance avg. (max)	.35 (3.8)	1.8 (3)	3 (3.6)
TI avg (max)	.81 (5.1)	.6 (1)	5 (10)
Proper Shipping Documents	yes	yes	yes
Placards	yes	no*	no**

* 1 of 2 not placarded on all four sides

** 2 of 12 not placarded on all four sides

Appendix N

Sketch of Typical Terminal and RAM Storage Area



* Restricted Article Area

Most packages are not stored in restricted article area, but are loaded directly onto vehicles; little or no exposure to personnel in terminal related work would be expected.

Appendix O

Package Expediting Services Contacted During the Study

Airborne Freight
Air Cargo, Inc.
Associated Air Freight
Cape Air Freight
Cincinnati Air Cargo
Emery Air Freight
Federal Express
Priority Dispatch
Purolator
Wits Air Freight

Appendix P

Radiopharmaceutical Radioactive Package Survey Findings

1.	Total number of packages inspected and surveyed	681
2.	No label (one or both sides)	5
3.	Wrong label (contents)	1
4.	TI observed less than TI label	21
5.	TI observed = TI label	598
6.	TI observed greater than TI label	62
7.	Security seal broken	0
8.	No or improper security seal	0
9.	Package authority not listed or covered	0
10.	Proper shipping name missing or unlisted	0
11.	Surface dose rate greater than Yellow II limit	0
12.	Surface dose rate greater than Yellow III limit	0
13.	Nonspecification package	0
14.	TI not recorded	16
15.	Special form material not labeled a special form	0
16.	Greater than 50 TI in storage	0
17.	Storage separation distances less than allowed	0
18.	Package marked with old package authority	0
19.	Shipping certificate illegible, incomplete or data recorded did not agree with labels	2
20.	Package missing in shipment	1
21.	Number of packages labeled White I	47
22.	Number of packages labeled Yellow II	357
23.	Number of packages labeled Yellow III	255
24.	Number of packages requiring no label	22
25.	Contamination checks performed on	45
26.	Removable activity above DOT limits	0

Appendix Q

Radioactive (Other than Radiopharmaceutical) Package Survey Findings

1.	Total number packages inspected and surveyed	33
2.	No label (one or both sides)	3
3.	Wrong label (contents)	1
4.	TI observed less than TI label	0
5.	TI observed = TI label	31
6.	TI observed greater than TI label	2
7.	Security seal broken	0
8.	No or improper security seal	0
9.	Package authority not listed or covered	0
10.	Proper shipping name missing or unlisted	0
11.	Surface dose rate greater than Yellow II limit	0
12.	Surface dose rate greater than Yellow III limit	0
13.	Nonspecification package	0
14.	TI not recorded	0
15.	Special form material not labeled as special form	1
16.	Greater than 50 TI in storage	0
17.	Storage separation distances less than allowed	0
18.	Package marked with old package authority	0
19.	Shipping certificate illegible, incomplete or data recorded did not equal its labels	0
20.	Packages missing in shipment	1
21.	Number of packages labeled White I	9
22.	Number of packages labeled Yellow II	13
23.	Number of packages labeled Yellow III	1
24.	Number of packages requiring no label	10
25.	Contamination checks performed on	11
26.	Removable activity above DOT limits	0

Appendix R

Personnel Monitoring by Commonwealth of Selected Persons

Company	Employee	Time Frame	Total Days	(mrem) Exposure (Net)
C	C1	2d Qtr 79	50	0
C	C2	2d Qtr 79	50	0
C	C2	3d Qtr 79	60	17
C	C3	2d Qtr 79	50	0
C	C4	3d Qtr 79	60	34
E	E4	2d Qtr 79	50	23
E	E1	3d Qtr 79	60	0

Appendix S

Environmental Monitoring by Commonwealth of Selected Sites

Company	Time Frame	Total Days	(mrem) Exposure (Net)	Location
D	2d Qtr 79	50	289	Dispatch Office
C	2d Qtr 79	50	29	RAM Storage Area
C	2d Qtr 79	50	0	Delivery Vehicle
D	2d Qtr 79	50	23	Delivery Vehicle
D	3d Qtr 79	50	44	Dispatch Office
D	1st Qtr 80	50	24	Dispatch Office

Appendix T

Calculated Exposure for Materials Handlers and Drivers

1. Driver for Company C averages two (2) loads per month of RAM and material would remain in vehicle about two (2) hours. Measurements indicate typical load would result in 1 mR/hr at driver's area. The average TI per load is 3. It is also estimated that it takes the driver less than three (3) minutes to load the vehicle with packages. Hence, driving exposure would be calculated as:

   2 loads/mo X 1 mR/hr X 2 hrs/load X 12 mo/yr. = 48 mR/yr.

   Likewise, driver's handling exposure would be calculated as follows:

   3 mR/hr X 26 loadings/yr X 3 min./loading X 1 hr/60 min = 4 mR/yr

   Thus, we would estimate exposure to this driver as 13 mR per quarter.

2. Three material handlers for Company A average unloading an aircraft once a week which has RAM as cargo. The average TI per load is 3. It takes about five (5) minutes to unload the aircraft completely. We have assumed that the personnel were near the RAM for about 5 minutes and calculate their exposure as follows:

   3 mR/hr X 52 loads/yr X 5 min/load X 1 hr/60 min = 13 mR/yr

   Thus, three material handlers would average about 4 mR per quarter.

These exposure calculations would seem to be fairly applicable to the employees we have observed. Some employees exposure would be longer, especially those who have the longer runs along with more activity. In particular, a run may last up to four hours with RAM which has a TI of 5. Calculations like those above would give about 200 mR/yr or about 50 mR per quarter. However, this would probably involve no more than four or five individuals with these trips.

Appendix U

Transportaion Accidents Involving Radioactive Material

Briefly set forth below are incidents or accidents involving the transportation of radioactive material in Kentucky during the period of this study.

September 1978. Soil Density Gauge Ran Over. A driver of a livestock tractor trailer rig did not heed road construction signs and drove through a construction area in which soil density gauges were being used. Gauge was crushed by truck and source exposed. Source integrity not breeched. Source recovered by manufacturer.

December 1978. Vehicle Accident - Radioactive Source. Tractor trailer rig transporting two packages of radioactive material involved in one-vehicle accident. Radioactive sources were undamaged and neither was their packaging. Packages transferred and continued their trip.

February 1979. Found Radioactive Material. Company found two radiopharmaceutical gererators on property after loading private truck with material. Generators traced to local hospital. Thirty-six other generators recovered. Generator cores still intact. Minimal exposure to personnel involved. Generators still intact after quite a bit of abuse. Generators returned to user.

March 1979. Train Accident. Train carrying uranium hexafluoride derailed in a "tunnel" in a major metropolitan area. No damage to train cars and no contents escaped. Cars righted and continued their journey.

April 1979. Leaking Shipment. Tractor trailer rig loaded with uranium hexafluoride cylinders was pulled over by Highway Enforcement Officers on what appeared to be leaking contents. Liquid coming from truck was not associated with the load. Load contents were intact. Vehicle and load continued their journey.

August 1979. Leaking Shipment. Tractor trailer rig loaded with thorium oxide in drums was pulled over by Highway Enforcement Officers on what appeared to be leaking contents. Liquid coming from truck was not associated with the load. Load contents were intact. Vehicle and load continued their journey.

August 1979. Abandoned Vehicle. Trailer, without tractor, located and found to be placarded "Radioactive". Upon verification, shipper and carrier were located and load was not radioactive material. Proper placards applied. Load taken to destination.

October 1979. Vehicle Wreck. Rented truck carrying industrial gauge through the Commonwealth was involved in an accident. Vehicle sustained damage

to rear and area where gauge was located. Gauge and source undamaged. Device transferred to new vehicle and continued its journey.

December 1979. Abandoned Vehicle. Tractor and trailer rig placarded "Radioactive" left at commercial truck stop. Load was one large cask, placarded. Tractor broke down and company was awaiting replacement. Load continued on two days later.

KENTUCKY TRANSPORTATION SURVEILLANCE PROGRAM

Report of Activities to the Special

Advisory Committee on Nuclear Waste Disposal

April 30, 1979

Morehead, Kentucky

KENTUCKY TRANSPORTATION SURVEILLANCE PROGRAM

The Commonwealth of Kentucky has a number of interstate highways which provide ready, convenient, direct routes between a number of facilities in the nuclear fuel cycle, medical, industrial, and academic use of isotopes and other related activities which are carried out within the borders of the Commonwealth. Due to all this diverse transportation activity, the Department for Human Resources was concerned that it did not have reliable information of the radioactive material shipments coming into the state and being used in the State. Some of the problems complicating this knowledge is the transport of materials intrastate with its destination being i: the State nor a reliable knowledge of the material simply flowing through the Commonwealth from its origin onward to its destination. Due to the above, this Department sought a contract with the U. S. Nuclear Regulatory Commission (NRC), Washington, D.C., to provide for the surveillance of radioactive materials associated with transportation. Several other states in the U. S. have been awarded such contracts including such states as Illinois, Pennsylvania, South Carolina, North Carolina, Michigan and others. The Commonwealth was awarded a contract which began on October 1, 1978.

This contract is a tripartite agreement between the Department for Human Resources representing the Commonwealth of Kentucky and the Flight Standards Service of the Federal Aviation Administration, Bureau for Motor Carrier Safety of the Federal Highway Administration and the Materials Transportation Bureau, all three of these representing the U. S. Department of Transportation and the Administrative Contracts Branch of the NRC. The contract is initially for a one-year period with the option to be extended for two one-year periods. The principal objectives of this contract are: 1) To obtain data on the physical condition of the packages and exclusive use vehicles; 2) To gather factual information and data concerning radiation levels in the transportation environment

due to the presence of packages of radioactive materials; 3) To determine doses received by workers and others as a result of exposure to these shipments; 4) To obtain information of the status of compliance with the packaging requirements and the regulations for transport of radioactive materials by shippers and carriers as related to such factors as package labeling, assignment of transport indices and maintenance of prescribed separation distances; 5) To obtain data on worker compliance with instruction for handling packages of radioactive materials; and 6) To conduct origin and destination surveys on selected highways, conduct vehicle surveys at weigh stations and equip Commonwealth vehicles with radiation detection instrumentation to facilitate the selection of highway areas for further study.

In summary, some of the initial work involved surveys of facilities utilizing radioactive material included such questions as who transported radioactive material to their facility, i.e., private carrier, contract carrier, individual persons, etc. Interest also existed in how much waste was generated at these facilities and how they disposed of it. If disposal was via a commercial company, information on how often was disposal occuring, how much was being disposed of, and of course the carrier or person was obtained. Trucking depots, terminals and carriers were identified in the Commonwealth and if they were identified as a carrier or transporter of radioactive material, information concerning the types, quantities, volumes, destinations, etc., was obtained from the companies for their transportation of radioactive materials. This similar type of information gathering was done at Commonwealth airports and of some of the "exclusive use" vehicles used by certain companies located in the Commonwealth. An outline of the specific subtasks spoken to in this paragraph can be reviewed in Attachment A.

After analyzing all the above information obtained from licensees, carriers and transporters, information required by the contract was set out to be gathered. Some of the other activities under this contract involved department personnel

holding two separate training sessions with the Kentucky Department of Transportation highway enforcement personnel. These officers are stationed at weigh stations and patrol the major highways and interstates of the Commonwealth. Their main contribution to the study will help to identify traffic patterns of radioactive material throughout the Commonwealth. Our staff periodically visits open weigh stations to give any aid and assistance and answer any questions which these personnel may have encountered during their work shifts.

Visits with a number of common carriers within the Commonwealth has resulted in enlisting their aid in the study. Some carriers carry natural uranium or uranium hexafluoride between gaseous diffustion plants located in the Eastern United States. Contracts have been made with airlines and air freight companies serving the Commonwealth and have identified certain carriers and transporters whom will be surveyed regularly and taking data from regularly. Reliable information concerning the compliance of shippers with the Department of Transportation regulations as far as they pertain to radioactive material is being obtained. The aid of a nuclear pharmacy in Louisville, a major university in both Louisville and Lexington to assist us with their relevant data collection for transportation has been enlisted.

Certain companies permit accompaniment, either in the vehicle or behind the vehicle at random times, of their carriage of radioactive materials so that time studies can be performed in order that an estimate of doses to drivers and other associated personnel can be formulated. Certain company vehicles are routinely monitored at the drivers' location, an inventory of packages is performed and a check of the transporter with compliance with DOT placarding regulations. Certain airport employees who unload packages from air freight companies which transport radioactive material have been monitored. This is also in the same effort to help estimate exposure to personnel involved in such activities involving radioactive material. Commercial thermoluminescent dosimeters have

been recently obtained to be used as personnel monitors on certain warehousemen and drivers, to be used as area monitors in certain facilities and corporations, and also to be used in vehicles to get an estimate of the dose to drivers in addition to their personnel monitoring badge. Contacts with other companies are continuing in order to determine their routes in Kentucky, highways, times, materials carried, etc., in an attempt to get reliable information on what is actually being transported throughout the Commonwealth.

During some of the required surveys, some problems have been uncovered. There appears to be a tendency that the package is not labeled with the proper and correct transport index. Cases have been found where the index is one number and the actual measured index is higher. The reverse of this situation has also been found, although not as often, such that the labels stated one index number and a substantially lower number was measured. Vehicles have also been observed not to be properly placarded in accordance with DOT requirements. For example, in the last quarter for which information is available, the study included a survey of 240 packages of radiopharmaceuticals with 37 incidents of insufficient transport index. Nine transport vehicles were surveyed in conjunction with the package surveys whenever the situation allowed. Of these nine surveys, two placarding violations were observed.

In addition to the material discussed above, companies are beginning to release access to personnel exposure records. Such company records of this nature and information are invaluable in trying to estimate and apply the dose to other drivers and associated warehouse personnel when they work near radioactive material.

As may have been observed from this discussion, this contract is strictly for data gathering with emphasis on exposure to personnel involved and with compliance with DOT requirements for posting and placarding. It is hoped that this contract will be extended for at least one year, preferable two years, so we may get as good information as possible on the transport of radioactive materials

throughout the Commonwealth.

NRC FORM 335 (7-77)

U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

1. REPORT NUMBER *(Assigned by DDC)*: NUREG/CR-1671

4. TITLE AND SUBTITLE *(Add Volume No., if appropriate)*: TRANSPORTATION OF RADIOACTIVE MATERIAL IN KENTUCKY

2. *(Leave blank)*

3. RECIPIENT'S ACCESSION NO.

7. AUTHOR(S)

5. DATE REPORT COMPLETED: MONTH July YEAR 1980

9. PERFORMING ORGANIZATION NAME AND MAILING ADDRESS *(Include Zip Code)*:
Kentucky Department for Human Resources
Bureau for Health Services
Radiation Control Branch
275 East Main Street
Frankfort, Kentucky 40621

DATE REPORT ISSUED: MONTH September 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
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15. SUPPLEMENTARY NOTES

14. *(Leave blank)*

16. ABSTRACT *(200 words or less)*

Shipments of radioactive materials into, within or through Kentucky were surveyed to determine the types of materials, pattern of transportation and magnitude of activity, the extent of compliance with shipping regulations, and the radiation exposure to persons handling the materials. The transported radioactive materials were categorized as (1) local delivery service, (2) air carrier, (3) nuclear pharmacy, (4) highway carriers, (5) nuclear fuel cycle. The shipments with the most numerous packages were radiopharmaceuticals. The shipments indicating the greatest volume or amount were those associated with the nuclear fuel cycle. The transportation workers whose radiation exposures were measured did not receive excessive doses from radioactive materials, but practices for reducing the radiation doses can be instituted and are discussed in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

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