NUREG/CR-0931

TRANSPORTATION OF RADIOACTIVE MATERIAL IN GEORGIA

August 1977 - September 1978

M. W. Carter
J. T. Gasper
B. Kahn

Office of Interdisciplinary Programs
Georgia Institute of Technology

Prepared for
U. S. Nuclear Regulatory Commission

NUREG/CR-0931

TRANSPORTATION OF RADIOACTIVE MATERIAL IN GEORGIA

August 1977 - September 1978

Prepared by
M. W. Carter
J. T. Gasper
B. Kahn

Manuscript Completed: June 1979
Date Published: July 1979

Office of Interdisciplinary Programs
Georgia Institute of Technology
Atlanta, GA 30332

Prepared for
Georgia Department of Human Resources
Atlanta, GA 30334

for

U. S. Department of Transportation

and

Office of State Programs
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555
NRC FIN No. B1612

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) radiopharmaceutical packages, (2) packages for industrial, research or educational use, (3) teletherapy and radiography sources, and (4) nuclear fuel cycle shipments. Radiopharmaceuticals constituted the most numerous shipments, but the highest curie amounts were in spent fuel elements. The transportation workers whose radiation dose rates were measured did not receive excessive increments from the radioactive materials, but practices for reducing their radiation doses can be instituted and are recommended.

TABLE OF CONTENTS

LIST OF TABLES

501 159

Acknowledgments

We wish to thank staff members of the Radiological Health Unit, Georgia Department of Human Resources, for their contributions to the study, particularly Mr. Willard Ingram for participating in all aspects of the program, Mr. Jerry Morris for providing useful information and Messrs. Richard Fetz and Charles Tedford, who headed the Radiological Health Unit at the beginning and end of the study, respectively, and worked closely with the participants in this study. We also wish to express our appreciation to Mr. Donald Gibbons, NRC, for his advice, the management and staff of the radioactive materials carriers listed in Appendix A-1 and of the Atlanta airport for their cooperation in permitting access and providing information, and the staff of the Atlanta office, Department of Transportation, for the information that they provided.

Transportation of Radioactive Material in Georgia

Introduction

Large quantities of radioactive materials are transported in numerous shipments throughout the United States. The Federal agencies responsible for regulating these materials and their shipments -- the Nuclear Regulatory Commission (NRC) and the Department of Transportation (DOT) -- have sponsored a series of surveillance programs to obtain information on the degree of compliance with regulations in handling, packaging, and labelling, and the radiation exposure to persons through external radiation and radioactive contamination. This report describes the study undertaken in Georgia as part of this series. The study was expanded to obtain also an overview of the extent of radioactive materials (RAM) shipments in the state.

A wide variety of RAM shipments must be considered. The survey programs sponsored by DOT and NRC(1) have concentrated on radiopharmaceutical packages, which constitute the most numerous shipments. These usually contain a few curies (Ci) or less of a radioisotope, in many instances must be shipped rapidly because the isotope is short-lived, and are transported to a considerable extent on scheduled passenger flights. A much smaller number of packages of radioisotopes is destined for industrial, educational, and research purposes. These usually have wider ranges of types and amounts of radionuclides. The larger curie amounts are shipped by airfreight. Radiation sources for medicine (teletherapy) and industry (radiography) can be considered a third category; they are fewer in number but often higher in curie amounts. Characteristically, they are transported back and forth by truck. Finally, widely different radioactive materials are transported to maintain the nuclear fuel cycle. These range from ore through processed nuclear (fissile) materials to spent fuel elements and radioactive wastes. In past years, many of these materials were for research, development, and test programs, but commercial nuclear power production is now a major source.

Transportation of radioactive materials is regulated in 49 CFR Parts 171-178 and 10 CFR Part 71. The regulations specify packaging, sealing, and labelling, limit external radiation at the package surface and nearby as well as surface contamination, restrict carriers and amounts carried of a nuclide, and require training of workers. The maximum dose equivalent rate is 200 millirem/hour (mrem/hr) at the surface of a package and 10 mrem/hr at 3 ft from the surface; in a sole-use vehicle that carries packages with exposure rates greater than the above, it is 200 mrem/hr at the external vehicle surface, 10 mrem/hr at 6 ft from the vehicle surface, and 2 mrem/hr at an occupied position (e.g., the driver's seat) in the vehicle. The degree of control to be exercised over a package is designated by the Transport Index (TI) placed on the package, which for the usual package is the highest number of mrem/hr at 3 ft from the surface. Packages are labelled Category I if dose equivalent rates are $\leq$0.5 mrem/hr at the surface, Category II if $\leq$50 mrem/hr at the surface as well as $\leq$1.0 mrem/hr at 3 ft from the surface, and Category III if higher than these values. Maximum permissible surface contamination is 100 picocurie per square centimeter (pCi/cm^2) for beta-gamma-emitting radionuclides and 10 pCi/cm^2 for alpha-emitting radionuclides, except that higher levels are permitted for the natural radionuclides. Limited quanti-

ties of radioactive materials--for which maximum amounts are specified in 49 CFR 173.391, the surface radiation dose rate does not exceed 0.5 mrem/hr, and no significant radioactive surface contamination exists--must be marked "radioactive" only on an inner container.

The findings in earlier surveillance studies showed no public health or safety problem, but some doses between 500 and 2,500 mrem/yr to handlers who work for freight forwarders -- the firms that deliver to and from carrier terminals(1). These elevated doses appear to be associated in many instances with dose rates above 2 mrem/hr at drivers' seats in forwarders' vehicles. A study of exposure to handlers at the St. Louis airport found typical values of 0.24 milliroentgen (mR) per TI handled and an average contact time of 1.1 min per TI, leading to inferred annual exposures as high as 440 mR from this work(2). The study also showed that office presonnel at cargo docks may be exposed to approximately 100 mR/yr from RAM.

In the present study, possible shippers, carriers, and receivers of radioactive materials transported in Georgia were contacted to obtain more information on the pattern and extent of such shipments. Radioactive materials shipments were surveyed in terminals at and near the Atlanta airport, which is a center of airborne transportation for Georgia and the entire southeastern U.S. Handling practices were observed. Radiation dosimeters were given to selected workers and placed at RAM storage locations to determine personnel exposures. Several trucks bearing radiation sources and materials related to the nuclear fuel cycle were met by prearrangement in transit and inspected for radiation exposure and surface contamination. On the basis of these observations, the magnitude of RAM shipments in Georgia is estimated, items of non-compliance with regulations are reported, and the extent of radiation exposure to workers is indicated. Recommendations are presented for maintaining radiation exposures at levels as low as reasonably achievable.

Procedures

At the outset of the study, planning meetings were held with staff members of the Georgia Radiological Health Unit, an advisor to DOT/NRC in RAM transportation from the Los Alamos Scientific Laboratory, local officials of FAA and DOT, and airport administrators. Information concerning carriers was provided by staff of the Georgia Public Service Commission

The carriers listed in Appendix A-1 were informed of the study by means of the letter given in Appendix A-2, and subsequently telephone calls were made and meetings were held with all of them except as noted in Appendix A-1. Discussions were also held with other airfreight forwarders at Atlanta airport that do not transport RAM except possibly on infrequent occasions. The carriers consisted of passenger air lines, air freight lines, air freight forwarders, a truck courier company that was both air freight forwarder and interstate carrier, interstate truck lines, and railroads. The purposes and planned activities of the study were described in these meetings and the cooperation of the carriers was obtained to gain access and information. The topics of discussion are summarized on the check list in Appendix A-3. In addition to these carriers, originators of RAM

shipments such as nuclear power stations and the Georgia Institute of Technology Research Reactor were contacted, as well as receivers such as Nuclear Pharmacy, Inc. of Atlanta. The Georgia Radiological Health Unit provided information concerning teletherapy and radiography sources and nuclear fuel cycle shipments. No list of RAM carriers was available at the beginning of the study, and many points of contact were found through others.

At the air freight, freight forwarder, and courier truck terminals, the following activities were undertaken:

1. Information on the number and contents of RAM shipments was obtained from records such as air bills and transfer logs.
2. Information on the movement and handling of RAM packages was received from supervisors to guide surveillance scheduling.
3. Terminals were surveyed for external radiation exposure to determine the radiation background and typical levels due to RAM shipments.
4. Thermoluminescent dosimeters (TLD's) were placed on walls and pillars at RAM storage and control (background) locations, and given to supervisors for issuing to handlers. The TLD's were collected and read at 3-month intervals.
5. RAM packages were inspected during periodic surveillance trips for packaging and labelling in compliance with regulations.
6. External radiation exposure rates were measured during these surveys at the surface and 3 ft from the surface of packages, and surface contamination was measured by wipe test.
7. Radiation exposure rates and surface contamination levels were measured in courier trucks.
8. RAM handling practices were examined to estimate exposures to workers and to consider changes for reducing exposures.

The survey meters for gamma-ray exposure rates were ionization chambers from NCA (Model CS40A) and Jordan Nuclear Company (Model AGB). They were calibrated in terms of mR/hr at 3-month intervals with a 10-mg Ra-226 source checked by NBS. The factor for converting mR to mrem ranges from 0.5 to 0.9 for the measured gamma rays, depending on the location of the tissue in the body. A 5-cm-dia.x5-cm NaI(Tl) detector with count-rate meter was used as a more sensitive, although qualitative, area survey meter. The TLD's were LiF chips, 0.12"x0.12"x0.035", used in sets of 4 per plastic container. Exposures were determined with a Harshaw reader that had been calibrated in terms of mR by chips exposed to the Ra-226 source. Cloth wipes 1.8" in diameter were counted with a beta-particle detector; if readings were elevated, the wipes were analyzed with a Ge(Li) detector and spectrometer to identify radionuclides by gamma-ray energies.

Surveys of multicurie shipments by truck were arranged on the basis of shipment information provided by the originator and scheduling information from the carrier. At the roadside meeting place, the trucks were surveyed for external radiation levels at the surface, six feet distant, and in the cab. Surface contamination was checked with wipes over defined areas. Shipping records and placards were examined for compliance with regulations.

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 supervisors and state officials, and changes in practices for reducing such radiation exposures were recommended during the study.

Results and Discussion

Radiopharmaceutical Packages

Radiopharmaceutical packages constitute the most numerous RAM shipments in Georgia and appear to result in highest personnel radiation exposure, but represent only a small fraction of the curie value of all shipments. The typical weekly shipping rate was approximately 300 RAM packages through Atlanta, as shown in Table 1. More than half are Mo-99 generators that average 1 Ci per package and range as high as 3 Ci. Other radioisotopes in frequent use are I-131, I-125, Xe-133 and Ga-67. Most of the radiopharmaceuticals other than Mo-99 are shipped in millicurie amounts and less as indicated in the summary of monitored radiopharmaceutical RAM in Appendix B-1, hence Mo-99 generators generally are associated with the highest TI values, and the total curies are due mostly to Mo-99. Many additional shipments are in the limited quantity category; although no external markings were required at the time of the study, approximately 300 per week were recognized because they were marked as such on the package or they were sent by radiopharmaceutical producers and identified as material that would be expected to contain radionuclides. Amounts such as those shown in Table 1 were observed on several occasions in the study period, although fluctuations occurred. A more detailed distribution is shown in Table 2 for the RAM radiopharmaceuticals destined for Georgia.

Radiopharmaceuticals were shipped to Georgia during the period of study from 10 suppliers -- 4 for Mo-99 -- by chartered truck from St. Louis, chartered plane from Newark, and on regularly scheduled flights of two passenger airlines. The truck from St. Louis unloaded some RAM at Birmingham, others at the courier truck terminal in Atlanta, and took the RAM remaining on the truck to Orlando. The chartered flight unloaded some RAM at Charlotte and was emptied at Atlanta airport. These RAM were placed directly on a courier truck for transfer to the courier truck terminal, a 15-minute drive from the airport. Both truck and plane arrived once weekly on Saturday night. Deliveries on regularly scheduled flights occur throughout the week. The RAM packages were left in the freight terminals of the two airlines for brief intervals -- typically a few minutes to a few hours -- until pickup by courier truck for transfer to the courier truck terminal. Shipments of RAM on the other passenger airlines serving Atlanta airport were rare: as indicated in Appendix B-2, one package per week was shipped by the three other airlines (see Appendix A-1) combined.

In addition to the packages unloaded at Atlanta airport, some remain on airplanes for shipment to other airports and others are transferred from one plane to another. It is not known how many pass through without transfer. The transfers at one of the two airlines, given in Appendix B-3, suggest that possibly one-tenth of the RAM packages handled by the airline ground workers are transferred between planes and that nine-tenths are unloaded.

Table 1

Weekly Shipments of Radiopharmaceutical Packages at Atlanta, June 5-11, 1978

Inbound			Outbound		
	Number of packages			Number of packages	
Carrier	Mo-99	Other RAM	Destination	Mo-99	Other RAM
Chartered flight	25	21	Georgia	55	61
Chartered truck	111	11	Other states		53
Scheduled airlines	75	82	North Carolina	42	
			Florida	56	
			Alabama	43	
			Tennessee	15	
Total	211	114		211	114

Notes: 1. Information is based on package inspection for chartered flight, freight bills for chartered truck, and air bills for scheduled airlines as identified by examination of truck courier's RAM log.

2. Listing does not include approximately 300 limited quantity packages recognized by markings or shipper.

501 165

Table 2

Average Weekly Curie Content, TI, Category and Destination of RAM Packages

	Radiopharmaceutical packages delivered in Georgia, February 1978	Industrial/research/educational packages handled by international airfreight carrier, 1977-1978	
No. of packages	186		1.8
Activity, Ci	52		14,000
Transportation Index	114		0.55
No. in Category - Limited quantity	57		0.2
I	14		0.7
II	53		0.7
III	55		0.?
No. of isotopes (Mo-99)	48	(H-3)	0.5
(I-131)	37	(Ir-192)	0.2
(I-125)	29	(Kr-85)	0.1
(other)	72	(other)	1.0
destination (no. of towns)	33	(no. in)	0.4
(no. of locations)	87	(no. out)	1.4

Notes: 1. values for radiopharmaceutical packages are from Appendix B-4

2. values for industrial, research, and educational packages are from Appendix C-1

The RAM packages are distributed at the truck courier terminal for delivery to the Atlanta area, Georgia outside Atlanta, and locations in the nearby states of Florida, Alabama, South Carolina, North Carolina, and Tennessee. Shipments to South Carolina are sent to a North Carolina redistribution center. The radiopharmaceuticals, together with other RAM and non-RAM packages, are carried on approximately 80 daily routes out of Atlanta by the courier; RAM packages especially are shipped on express routes. Most RAM packages were transported on approximately 10 of the routes, mainly on late Sunday, early Monday and Friday.

The pattern of shipments is constantly changing in number of packages, types of radionuclides, carriers, and schedule. In the course of the study, a second chartered truck was added to carry RAM from St. Louis to Memphis, so that the original truck no longer unloaded there but went directly to Atlanta from where its route was extended to Miami. A second chartered plane from Newark was added with Tallahassee as destination, eliminating truck courier shipments of these packages from Atlanta. An airfreight carrier that had delivered many of the RAM packages to the passenger airlines went into receivership and was replaced by another.

An extensive geographical distribution of RAM packages from Atlanta throughout Georgia is shown in Appendix B-4. In Atlanta, one major receiver of radiopharmaceuticals was a laboratory that prepared radioisotopes for subsequent use in hospitals. Although most shipments were from supplier to user, a few radioisotope tubes, needles, and seeds were returned by hospitals to suppliers, and occasionally a package with insufficient or illegible labelling or address was returned by the carrier.

Information concerning origins, destinations, contents and exposures was obtained by direct observation during surveys, from airbill copies retained by carriers, and from a RAM log maintained by the truck courier. Detailed information concerning out-of-state deliveries was difficult to obtain from the courier because the airbill copies for these were almost illegible. Air bills of RAM packages were not conveniently accessible at the airlines because they are filed together with the far greater volume of non-RAM air bills.

A complicating factor in determining TI values of radiopharmaceutical packages was the practice of shipping multiple packages by passenger flights combined in "overpacks." These were usually labelled with TI values equal to that of any one component package, presumably because self-shielding reduced the cumulative TI. The overpacks were taken apart at the truck courier terminal. Some discrepancies in adding curie amounts occurred because air bills for short-lived isotopes such as Mo-99 showed higher activities by as much as 1.3 than the bills accompanying the packages; the latter probably were corrected for decay to the delivery date.

The package survey detailed in Appendix B-1 is summarized in Table 3 in the form utilized by the DOT and NRC(1). Of 242 inspected radiopharmaceutical packages, 43 improper items were observed. The 24 instances of elevated TI values all referred to small increments, the highest measured value being only 0.9 TI above the label value. No incident of serious package damage and resulting personnel exposure or area contamination was observed or reported during this period at the survey locations.

Table 3

Summary of RAM Package Survey

	Item	Number of Occurrences
1	No label	0
2	Wrong label	3
3	TI observed < TI label	202
4	TI observed = TI label	16
5	TI observed > TI label	24
6	Security seal broken	0
7	No or improper security seal	2
8	Package authority not listed or covered	6
9	Proper shipping name missing or unlisted	0
10	Surface dose rate > Yellow II limit	0
11	Surface dose rate > Yellow III limit	0
12	Nonspecification packages	0
13	Detectable or removable contamination, but no removable activity above DOT limits	1
14	TI not recorded	1
15	Special form material not labeled as special form	1
16	Greater than 50 TI in storage	1
17	Storage separation distances less than allowed	1
18	Package marked with old package authority	1
19	Shipping certificate illegible, incomplete, or data recorded did not agree with labels	6

Note: Items 1-16 are those utilized by DOT and NRC in survey summary.

501 168

The vehicle survey is presented in the DOT/NRC summary form (1) in Table 4. Average radiation levels in cabs were well above background; they were above 2 mR/hr in 16 of 26 vehicles. From exposure rate measurements above 2 mR/hr, one could infer violations of requirements for appropriate separation distances or maximum TI of 50 per vehicle in 49 CFR Part 177.842. Occasional elevated exposure rates of even the highest values of 50 mR/hr would not be expected to cause over-exposure to the driver of the vehicle carrying RAM from the chartered flight on the weekly route from airport to terminal for a 15-minute drive, but repeated exposure rates of 16 mR/hr on the weekly route to Charlotte for a 5-hour drive could well lead to overexposure. Radiation placards were missing in some instances, as indicated. Surveys could not be completed for many vehicles because of the promptness with which courier vehicles departed when loaded.

The highest exposure at the courier truck terminal (D) of dosimeters (TLD's) placed at freight terminals at the Atlanta airport and vicinity, shown in Table 5, was 4.6 R/yr, compared to background exposure in the range of 50 to 100 mR/yr. At the two airline terminals C and G, the highest exposure rate was 2.6 R/yr. Exposures to persons at these locations would be approximately one-fourth of these values during a 40-hr week, and further reduction can be expected due to workers moving about. On the other hand, the TLD's were not necessarily at points of highest exposure.

The radiation exposures to persons measured by personnel dosimeters issued for two quarters at terminals D and C were below 500 mR/yr, as shown in Table 6. The highest exposures, received by drivers of courier trucks, were 220 and 200 mR during the half year of observation, relative to control values of approximately 50 mR. The voluntary arrangements for personnel dosimetry in this study, however, resulted in some questionable data. In certain instances, dosimeters were observed not to be worn, to remain at the distribution location, or to be placed at an exposure location (see #9). On the basis of the reported values, few persons were exposed to twice background rates, and the highest increment above background was 340 mR/yr. Slightly elevated values were observed even for a secretary and at a control location at terminal D, but none was found at the airline terminal C.

Handling practices were observed at airline terminal C to determine why radiation exposures were not detectable, compared to values as high as 400 mR/yr at the St. Louis airport(2). Workers held each package only for a few seconds while placing it from the sideloader onto a pushcart and then again when stacking it for collection by the courier truck driver. The cart is pushed for approximately 1 minute. Thus, if a worker handles 10 boxes per week for 10 seconds each at an average exposure rate of 10 mR/hr, handling would contribute $10 \times \frac{100}{3600}$ mR = 0.28 mR and pushing the cart $10 \times \frac{1}{60}$ = 0.17 mR per week for a total of 0.45 mR/week or 23 mR/yr. This increment would not be clearly observable at a background of 100 mR/yr because the background may fluctuate to this extent. The lower value compared to the St. Louis airport would reflect both fewer packages with relatively high TI values handled per worker and more rapid handling. Because the present observations are only qualitative, they need to be repeated with direct dosimetric measurements.

501 169

Table 4

Summary of Surveys of RAM Transport Vehicles

	Radiopharmaceutical	Industrial, Research & Educational	Nuclear Fuel Cycle
No. of vehicles	35	6*	11
Radiation levels, mR/hr			
Cab avg. (max)	7.9 (50) (26 checked)	0.1 (1 checked)	0.1 (0.3) (2 checked)
Surface avg. (max.)	38 (120)	0.9	3.3 (7.5)
6-ft distant avg. (max)	5.3 (12)	0.1	0.5 (1.9)
TI avg. (max)	90 (207)	---	6.5 (20) (2 checked)
Excessive removable contamination	0 of 3 checked	0 of 6 checked	0 of 11 checked
Package placement	appropriate except for full loads	drums & boxes, full load	not applicable
Proper shipping documents	5 of 5 checked	1 of 1 checked	10 of 10 checked
Placards	3: appropriate 3: 1 each missing	6 of 6 checked were appropriate	10 of 11 checked were appropriate**

* These consisted of one shipment of low-specific activity waste from 3 Atlanta universities to Barnwell, SC and five trailers with drums containing radioactive carcasses, from Texas to Barnwell, SC, returned to Texas because waste was not accepted

** The truck that did not have placards was inspected by Georgia DHR staff member; a fine was levied by DOT on truck company

Table 5

Radiation Exposure Rates at RAM Carrier Terminal Sites

TLD LOCATION	Quarterly Exposure, mR 11/3/77 to 2/2/78	2/2/78 to 5/8/78	5/8/78 to 8/7/78	8/7/78 to 11/6/78	Summed Annual Exposure, mR
Terminal A					
1 C - Office	27	37	24	25	110
2 C - Whse	22	36	---	---	---
3 - RAM area	290*	220	53	50	---
4 - RAM area	M	46	---	---	---
Terminal B					
5 C - Office	22	30	---	---	---
6 C - Office	23	26	---	---	---
7 - RAM area	210	28	---	---	---
8 - Time clock (RAM in vicinity)	60	48	---	---	---
Terminal C					
9 C - North wall	44	50	29	36	160
10 C - East wall	32	13	34	37	120
11 - Inbound RAM area	250	74	M	210	---
12 - Outbound RAM area	34	M	23	23	---
S1 - Shelf (inbound, not designated hazardous)	750	1,090	500	220††	2,600
Terminal D					
13 C - Office	34	39	32	42	150
14 C - Store room	43	50	20	25	140
15 - Dispatcher's window	M	160	106	160	
16 - North wall, middle	410	410	280	360	1,460
17 - South wall, exit route	1,030	2,380	600	590	4,600
18 - South wall, load'g zone	490	390	310	540	1,700
19 - North wall	---	2,390**	M	1,030	
Terminal E					
20 C - Office	---	20	---	---	---
21 C - Office	---	15	14	14	---
22 - RAM area (center)	---	53	19	55	---
23 - RAM area (left edge)	---	40	---	---	---

501 171

Table 5 (cont'd)

Terminal F (old building to 10/15)						
24 C	- Office, Operations	---	27	24	22#	---
25 C	- Office	---	24	---	---	---
26	- RAM area	---	25	---	154##	---
27	- RAM area	---	74	21	24	---
Terminal F (new building from 10/16)						
1 C	- Office	---	---	---	11	---
2 C	- Break Room	---	---	---	13	---
3	- RAM area	---	---	---	23	---
4	- RAM area	---	---	---	29	---
5	- RAM area	---	---	---	36	---
Terminal G						
28	- Office	---	77***	73***	73***	---
29 C	- Cargo area, no RAM	---	M	14	16	---
30	- RAM area, outbound	---	17	18	14	---
31	- RAM area	---	140	200	41	---
32	- RAM area (terminating area)	---	66	34	43	---
S2	- RAM area (terminating area)	---	---	---	32	---
S3	- Cooler wall	---	---	---	88***	---
2 C	- Office	---	---	23	22	---
4	- RAM area	---	---	33	50	---

Notes:
1. C denotes Control TLD's
2. M denotes missing
3. Location code is given in Appendix B-1

* TLD was originally positioned adjacent to the RAM packages under the rollers; when the area was repainted, TLD was positioned on the office side instead of the RAM side for several weeks before retrieval date.

** TLD was positioned in a new work area in which a RAM package (Ir-192, 94.5 mCi, TI 1.0) was held pending disposition instructions. Package was seen on January 19 and again on March 9, 1978.

*** Elevated reading due to concrete block materials of wall.

† TLD's not positioned because company planned to move May 15, 1978.

†† TLD attached to rack which was repositioned to non-RAM area 3-4 weeks before retrieval.

At location 8/1/78 to 10/15/78 (company moved 10/10/78).

At new RAM location opposite side of terminal from 8/16/78 to 10/15/78.

Table 6

Personnel Radiation Exposure Rates at RAM Carrier Terminals

TLD Location	Quarterly exposure, mR 5/11/78 to 8/9/78	8/16/78 to 11/15/78
Terminal D		
Control TLD	25	57
1 Office secretary/telephone operator	71	36
2 Driver - Atlanta to Montgomery, AL (Rt 023)	59	69
3 Driver - Atlanta to Montgomery, AL (Rt 028, Sunday)	42	160
4 Driver - Atlanta to Macon, GA (Rt 039)	33	65
5 Driver - Atlanta area (Rt 024)	31	60
6 Driver - Atlanta to Chattanooga, TN (Rt 014)	39	60 (2)
7 Weekend Dispatcher	32	87
8 Driver - Atlanta to Charlotte, NC (Rt 018 part time) & Orlando, FL	101	120
9 Driver - Atlanta to Charlotte, NC	32	580 (3)
10 Driver - Atlanta area (Rt 068)	70	78
11 Driver - Atlanta Airport (Rt 035 weekdays)	NR (4)	64
12 Courier Terminal Sorter	40	NR
13 Courier Terminal Sorter	NR	53
14 Dispatcher	39	56
15 Terminal Sorter		NR
16 Terminal Sorter		55 (5)
17 Driver - Atlanta to Montgomery, AL (Rt 028)		59 (6)
Terminal A (1)		
Control TLD	23	27
1 Customer Service Agent (CSA) at counter	28	NR
2 Cargo Handler	27	NR
3 Night Supervisor	28	28
4 Driver (Pick up RAM at GA Tech)		

Table 6 (cont'd)

Terminal C (7)		Quarterly exposure, mR 5/11/78 to 8/9/78	8/16/78 to 11/15/78
	Control TLD	30	25
1	(B) Sr Air Frt Uniform Sales Clerk (office 2nd floor)	17	26
2	(C) SCSA Special Service Agent	24	23
3	(C) CSA Add-to/Special Service & inbound	29	24
4	(C) SCSA Delivery	30	24
5	(C) SCSA inbound	NR	25
6	(A) CSA Floor	26	24
7	(A) CSA Add-To	30	NR
8	(A) CSA Sorter	25	25
9	(A) CSA Special Service Agent	28	25
10	(D) SCSA Floor	30	25
11	(D) SCSA Special Service Agent	25	19
12	(D) SCSA Special Cargo	NR	24
13	(D) SCSA Sorting Area	28	24

NOTES: (1) Location code is given in Appendix B-1.

(2) For two-month period (August 16 to October 16).

(3) Retrieved on November 30, 1978 from truck 15195. Driver would wear TLD while loading and then attach TLD to wire partition (screen) between driver's seat and RAM cargo while working on non-RAM.

(4) NR: not recovered.

(5) For two-month period (man terminated job mid-October 1978).

(6) Duplicate for TLD #3, but driver never wore #17. TLD was still attached to instruction sheet in TLD box.

(7) Shift: (A) 2315-0700 hr.
(B) 0800-1700
(C) 1500-2330
(D) 0700-1515

501
114

Industrial, Research, and Educational Packages

The flow of industrial, research and educational packages at Atlanta airport consists usually of a few non-recurrent shipments. Two airfreight carriers transport most of the packages. The shipments by the international carrier listed in Appendix C-1 and summarized on a weekly basis in Table 2 are indicative of the few packages, large variety, high average curie amounts, and low TI values.

The packages flown out of Atlanta airport by the international airfreight carrier were delivered by interstate truck from nearby or local producers of the radioisotopes such as the Oak Ridge National Laboratory at Oak Ridge, Tennessee, and the Georgia Institute of Technology in Atlanta. The other major airfreight carrier shipped domestic packages at approximately the same frequency, but detailed shipping information was not available at its local office; examples can be seen in the surveyed shipments listed in Appendix C-2. Packages were delivered from the airfreight carrier terminals near the Atlanta Airport by courier truck to industry, laboratories, and colleges in Georgia and contiguous states. In such deliveries, all types of RAM packages were transported together. Many of the packages shipped by air from Atlanta consisted of RAM returned to the sender after use; in a few cases, packages were returned because of labelling or delivery problems.

The extent of compliance with regulations is indicated in Tables 3 and 4 in the DOT/NRC format. Packages containing RAM for these purposes are included in the total of Table 3. No incidents leading to radiological problems of high exposure or contamination were observed or reported for packages or the vehicles that carried them.

The site exposure rates measured at airfreight carrier terminals A,B, E, and F at or near Atlanta airport in Table 5 show a maximum value of 480 mR/yr at the RAM area of terminal B. This value, if applicable to the area of highest exposure, suggests exposures below 500 mR/yr to workers. Because only an occasional RAM shipment is handled by these airfreight carriers, relatively low exposure values would be expected. For the same reason, however, RAM packages are not handled in as uniform a manner as at the airline and courier truck terminals; locations for storing RAM are subject to change, for example, and RAM packages may remain for longer periods.

Personnel exposures measured for two 3-month periods at terminal A are given in Table 6. No elevated radiation exposures were observed at this airfreight carrier terminal in that the values from 23 to 28 mR/quarter were within the range of background.

Medical and Industrial Radiation Sources

The Georgia Radiological Health Unit has licensed 22 Co-60 teletherapy units in Georgia. These sources each usually contain between 5,000 and 11,000 Ci when new, and are usually exchanged for a new source after decay by one half life, that

is, after 5 years. Two Cs-137 sources of approximately 2,000 Ci each are also licensed, but the 30-year half life eliminates the need for frequent renewals. Additional sources, unlicensed by the State, are maintained at federally licensed military and VA hospitals. A few large Co-60 and Cs-137 sources are also used for research. Thus, at least 5 large radiation sources per year would be expected to be transported in Georgia.

Monitored shipments are listed in Table 7 but none was observed while on a vehicle. Shipments on interstate trucks from Texas and Canada are usual for these teletherapy sources, but some have been transported by ship to Atlantic coast ports and then taken by truck to their final destination, and the returned sources may reverse this route. Teletherapy sources may also be shipped to other states through Georgia by truck, although none was encountered during the study.

Industrial radiography units, usually containing approximately 100 Ci Ir-192, are utilized widely to check the integrity of welds in beams and pipes in situ. At present, 21 of these are licensed in Georgia and out-of-state units -- generally from Alabama and Louisiana -- are registered for extended use at the rate of approximately one per week. Other units may be used in the State for short periods under reciprocal licensing agreements with other states.

These portable units are transported by truck from job to job. New sources of the isotope, which has a 74-day half life, are shipped by airfreight carrier and forwarders. Three shipments by airfreight -- two of new Ir-192 sources and one of a return -- were monitored as indicated in Table 7. Because of the relatively short half life, such replacement shipments occur 2-3 times per year for each source.

The sources monitored in transit (see Table 7) were in compliance with regard to records and external radiation, and showed no surface contamination. External radiation exposures measured at terminal F, which appeared to handle all of the Ir-192 sources shipped through Atlanta airport, were only slightly elevated above background values, as shown in Table 5.

Nuclear Fuel Cycle Materials

The information on the various RAM shipments in Georgia by truck summarized in Table 8 is based on information provided by the Georgia Radiological Health Unit, NRC Region II, nuclear power station operators and the interstate truck companies listed in Appendix A-1. Detailed information from some of these sources is given in Appendices D-1 to D-7. The following categories of RAM shipments appear to be common in Georgia:

1. Monazite ore shipped mostly from the port of Charleston, SC to Chattanooga, TN for processing.
2. Uranium hexafluoride shipped from and to enrichment plants.
3. Spent fuel shipped to and from the Savannah River Plant at Aiken, SC.
4. Radioactive waste for burial at the Barnwell, SC site.
5. Laundry from nuclear facilities for washing at a laundry in Macon, GA.

Not included for consideration in this report are nuclear devices, materials and wastes shipped by the Department of Defense.

Table 7

Monitored Teletherapy and Radiography Shipments

Date	Location*	Amount, Ci	Isotopes	TI	Category II	Category III	Destination
October 1977							
17	F	21	Ir-192	1.0	1		California
December 1977							
21	B	6,370	Co-60	1.0		1	Georgia
30	N	24,700	Co-60	4.0		1	Georgia
January 1978							
4	O	3,000	Co-60	10.0		1	Georgia
February 1978							
15	B	4	Ir-192	0.1	1		California
15	F	46	Ir-192	1.0	1		California**
21	F	100	Ir-192	2.0		1	Georgia†

* See Appendix B-1 for location code
** Arrived by truck, out by air
† Arrived by air, out by truck

501 177

Table 8

Nuclear Fuel Cycle Shipments by Truck in Georgia, June 1977-June 1978

Type	Origin	Destination	Period	No.	Curie
Radioactive waste	Brown's Ferry NPS, AL	Barnwell, SC	July 77-June 78	185	1,450
	Hatch NPS, GA	Barnwell, SC	July 77-June 78	46	340
	Crystal River NPS, FL	Barnwell, SC	July 77-June 78	40	480
	Turkey Point NPS, FL	Barnwell, SC	July 77-June 78	93	680
	Ingalls Shipbuilding, MI	Barnwell, SC	1977	16	10
Contaminated clothing	Hatch NPS, GA	Macon, GA	July 77-June 78	49	-----
	Ingalls Shipbuilding, MI	Macon, GA	1977	26	-----
Spent fuel	Miami, FL (Port)	Aiken, SC	June 14,1977	3	1,020,000
	Miami, FL (Port)	Aiken, SC	June 16, 1977	1	100,000
	Savannah, GA (Port)	Aiken, SC	September 21, 1977	1	610,000
	Miami, FL (Port)	Aiken, SC	December 20, 1977	2	450,000
	Savannah, GA (Port)	Aiken, SC	January 3, 1978	1	1,060,000
	Miami, FL (Port)	Aiken, SC	January 3, 1978	1	340,000
	Aiken, SC*	Chatsworth, CA	March 31, 1978	1	130,000
	Turkey Point, FL	W. Jefferson, OH	May 2, 1978	1	390,000
	Turkey Point, FL	W. Jefferson, OH	May 12, 1978	1	390,000
UF_6	Oak Ridge, TN	Savannah, GA	June 28, 1978	4	13

Notes: 1. See Appendices D-1 to D-4 for waste shipment data provided by nuclear power stations (NPS's); waste shipment data from Ingalls Shipbuilding Yards at Pascagoula, MI, is from reference 3.

2. See Appendix D-5 for shipment data provided by interstate trucker; addtional spent fuel and UF_6 shipments were monitored, as indicated in Appendix D-7.

3. See Appendices D-2 and D-6 for shipments of contaminated clothing.

* Inspected by Georgia state staff while trailer was parked at truck stop awaiting repair of tractor engine.

The few shipments of spent fuel elements by truck constitute by far the greatest curie amount transported in Georgia. These shipments are infrequent and have not been according to any regular schedule. Radioactive waste shipments by truck from the reporting nuclear power stations have been frequent -- typically on a twice-weekly schedule -- and would be expected to remain so. These shipments are usually on a regular basis during routine operation for power generation, but may increase during reactor shutdown for refueling or repair. All stations in Georgia and nearby states that are known to ship wastes through Georgia except the Farley Plant in Alabama reported the data given in Appendices D-1 to D-4.

Waste shipments from more distant nuclear power stations also pass through Georgia, although records of these have not been obtained. As a result of the closing of waste repositories in New York, Illinois, and Kentucky to nuclear power station wastes in the past year, the Barnwell repository has received regular waste shipments from stations such as Quad City, Dresden and Zion in Illinois. At least some shipments from these stations are carried by truck through Georgia (others may go via North Carolina) as indicated by an accident (without any radiological exposure consequences) that occured in northwest Georgia to a truck carrying such a shipment.

The results of truck surveys summarized in Table 4 indicate that all shipments except one were in compliance with regard to external radiation exposure, labelling, and records. Wipe tests showed the radionuclides Mn-54, Co-58, Co-60, Ag-110m, Cs-134 and Cs-137 in most instances, but consistently at levels below 100 pCi/cm^2. All surveys of waste shipments were by prearrangement. The nuclear power station operator indicated dates of shipment and roadside inspection was scheduled with the carrier.

The information on shipments through Georgia of RAM by railroad given in Appendix D-8, provided by one group of railroads, shows 184 loads in 19 months. With two exceptions, the shipments passed through Georgia without originating or terminating there. None of these was monitored. Some indicated categories are not sufficiently descriptive to determine the material. The second major railroad serving Atlanta indicated that no RAM was transported between July 1977 and May 1978.

Conclusions and Recommendations

Radioactive materials are extensively transported in Georgia. The magnitude and potential impact were viewed as follows in this study, which for convenience characterized RAM in the indicated categories:

1. Radiopharmaceutical Packages. Atlanta is a major distribution center for the southeast. Approximately 300 packages per week were delivered, amounting to about 10,000 Ci per year. Most of the curie amount and external radiation was due to Mo-99 generators, which also constituted over one-half of the packages. The packages are delivered to Atlanta by chartered truck, chartered plane, and scheduled passenger flights, and are distributed by one truck courier over numerous scheduled routes. Elevated radiation exposures were found with site and personnel dosimeters, but no persons were observed to be exposed to 500 mR/yr or higher

from RAM.

2. Industrial, Research, and Educational Packages. These materials, transferred at Atlanta airport between airfreight carrier and forwarder both into and out of state, are estimated to consist of 2-4 packages per week, of which the contents amount to somewhat less than 1,000,000 Ci per year. Much of the activity was in a few shipments of H-3. The external radiation exposure from these RAM in terms of TI was very much less than for radiopharmaceutical RAM.

3. Medical and Industrial Radiation Sources. Several dozen Co-60 teletherapy sources (5,000-11,000 Ci each) and Ir-192 radiography sources (100 Ci each) in the State must be renewed at regular intervals -- approximately every 5 years for Co-60 and several times per year for Ir-192. The former are shipped by truck or boat and truck into the state, the latter by truck or airfreight and forwarder. Old sources are returned by the same routes. The radiography sources are usually portable, carried by truck to the examination sites. The shipped sources monitored in Atlanta showed no elevated radiation levels.

4. Nuclear Fuel Cycle Shipments. In a 12-month period, 12 special truck shipments carried spent fuel that contained 4,400,000 Ci mixed fission products through Georgia. Some of these were from overseas reactors, shipped into port in Georgia and Florida and then transported to DOE-contractor laboratories; others were from nuclear power stations in Georgia and nearby states. External radiation exposures at the monitored trucks were extremely low. Surface contamination was detectable but low.

   On a more regular basis and at much lesser curie levels, 1 to 4 shipments per week of radioactive wastes were carried by special truck from each of four commercial nuclear power stations in Georgia and neighboring states to a burial site in South Carolina. The shipments averaged approximately 10 Ci each; surveyed external radiation exposures and surface contamination were very low to non-detectable. Numerous shipments from other stations are believed also to pass through Georgia, but records of these have not been obtained. One transportation accident occurred during this period, but without radiation exposure or contamination.

   Other shipments of radioactive materials included nuclear materials such as thorium mineral and uranium hexafluoride, and contaminated laundry. Some shipments were by truck, others by rail. One group of railroads reported 34 shipments in a 19-month period.

Elevated radiation exposures were observed to result mainly from handling radiopharmaceutical packages. Because freight handlers as a matter of practice transfer these so rapidly, normal handling practice for the present number of packages appears to result in dose equivalents well below 500 mrem/yr. Due to the same rapid processing, RAM packages stored throughout airfreight terminals of scheduled passenger airlines do not remain in place long enough to cause significant radiation doses to nearby workers. Somewhat

longer storage can occur at the truck courier terminal and at air freight terminals where industrial, research, and educational RAM packages are handled. The highest potentials for radiation exposure rates are to drivers of trucks that carry these RAM packages.

Non-compliance with regulations concerning shipping and labelling RAM packages was noted in between 5 and 10 percent of surveyed packages. These items do not appear to have increased personnel radiation exposure to any significant degree, except possibly to drivers who transported multi-TI shipments of radiopharmaceuticals; in no case was a serious incident or accident including radiation exposure or contamination observed.

Several practices to define and minimize radiation exposure in RAM freight handling are recommended. Principally, wearing personnel dosimeters and posting area dosimeters should be required for freight carriers and forwarders that deal with RAM in excess of a specified TI value per year to determine the potential hazard. At terminals where RAM packages are stored for more than brief periods, storage areas should be distant from routine activities, clearly marked, and identified for all personnel as locations to be avoided if possible. Storage periods for high-TI packages at the freight terminal should be limited to prevent lengthy retention of packages that are not delivered for one reason or another. Drivers of RAM-carrying trucks need to be trained in loading to maintain RAM packages at a distance from the cab and to pack highest TI packages at the greatest distance. Lead shielding should be used wherever exposure rates otherwise exceed 2 mR/hr or could result in overexposure of the driver on an annual basis. Larger trucks can often be used to provide additional distance between driver and high-TI packages.

Concerning regulations that control shipments of radioactive materials, a requirement that handlers, drivers, and other workers who are exposed to RAM (other than limited quantities) in transit wear dosimeters appears a desirable first step in assuring that exposures be as low as practicable. Lack of clarity in the definition of sole-use vehicles may result in elevated dose rates to drivers. Use of overpacks as a technique for increasing TI values per shipment needs to be examined from the viewpoint of regulatory intent.

The information-gathering process concerning industrial, research, and educational RAM packages begun in this study should be continued; for example, some of the carriers mentioned in the report that have not been monitored in detail should be included in future surveys, and the described approaches for dose reduction to handlers applied to these carriers. More detailed information concerning the exposure rates of drivers should be obtained by expanding the dosimetry program begun in this study. Various techniques for dose reduction should be tested for drivers and handlers that receive elevated doses.

Transportation of multicurie amounts by truck, mainly of nuclear fuel cycle materials but also of teletherapy and radiography sources, averages more than a shipment per day in Georgia. The full extent was not determined in this study because both origination and destination were outside Georgia in most instances, but it is recommended that the study be continued to obtain more complete information. No occurrences of non-compliance, radiation exposure

or significant contamination were found in this study for these categories although one instance of non-compliance was reported by the state agency in this period. In view of the large curie amounts and the resulting potential, if not for exposure and contamination then at least for public concern and traffic disruption is case of accident, it is recommended that a system be developed for providing information on these RAM transfers to the appropriate state and federal officials. During the study, only spent fuel shipments and teletherapy transfers were reported to state officials. It appears desirable that sufficient information concerning non-routine transfers be provided so that state officials will be prepared to handle appropriately and promptly any accident or incident to that shipment.

References

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

2. Luszczynski, K. et al. "Radiation Exposure of Air Cargo Workers at the St. Louis International Airport", Health Phys. 35, 523-527 (1978)

3. Miles, M.E., G.L. Sjblom, and J.D. Eagles, "Environmental Monitoring and Disposal of Radioactive Wastes from U.S. Naval Nuclear-Powered Ships and Their Support Facilities, 1977", Dept. of Navy Report NT-78-1 (1978)

Appendix A-1

RAM Carriers in Georgia Contacted in Study

Airlines

Passenger:
- Delta Airlines
- Eastern Airlines
- United Airlines*
- Piedmont Airlines*
- Southern Airlines*

Freight:
- Airlift International
- Federal Express
- Flying Tigers**
- Emery*

Railroads

- Family Lines System
- Southern Railway†

Truck Lines

Airfreight forwarder and interstate:
- Purolator Courier

Airfreight forwarder:
- Shulman Air Freight**
- Airborne Freight
- Cape Air Freight
- Profit by Air

Interstate carrier:
- Theatres Service Co.
- Superior Trucking Co.
- Tristate Motor Transit Co.
- Home Transportation Co.
- Thurston Trucking Co.

Note: Contact by letter and telephone, but no meeting with Southern Railway, Theatres Service Co., Tristate Motor Transit Co., and Home Transportation Co.

* Very few RAM packages were handled

** Opened in Atlanta in March 1978; Shulman Air Freight went into receivership near end of study

† Reported by letter that no RAM were handled July 1977 - May 1978

501 184

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF INTERDISCIPLINARY PROGRAMS
205 OLD CIVIL ENGINEERING BUILDING
ATLANTA, GEORGIA 30332

ENVIRONMENTAL RESOURCES CENTER
(404) 894-2375

BIOENGINEERING CENTER
(404) 894-2375

Dear Sir:

We have been requested by the Georgia Department of Human Resources to study the transportation of radioactive material in this State in accord with a contract between the Department and the U.S. Department of Transportation associated with the U.S. Nuclear Regulatory Commission. The purpose of the study is to obtain information concerning the pattern of transporting radioactive materials, an estimate of radionuclide identity and quantity, observations of handling conditions and procedures, and measurements of radiation exposures to those directly involved in the handling. The information will be used to assess currently applicable regulations and procedures and to recommend improvements if needed.

For this purpose, we would appreciate it if you or your representative would meet with members of our staff to describe to them your procedures in handling radioactive material, discuss the patterns of movement and quantities as you know them, and permit us to make observations and measurements at your facilities. We would also like to obtain your recommendations for changes. The members of our staff assigned to this study are Dr. Bernd Kahn, Mr. John Gasper, and Ms. Catherine Card. Persons from the State and Federal agencies named above may accompany them at times. Our staff will be responsible for the following activities at your facility on a non-interference basis:

-obtaining information from the facility manager or his representative;
-observing the storage and handling of radioactive material;
-examining records and labels of radioactive material;
-measuring radiation levels with survey meters and dosimeters;
-examining for contamination by smear tests.

I would like to emphasize that our study is intended only to collect information; it is not a regulatory inspection. Our staff members have been instructed to conduct the study with a minimum of inconvenience to your activities. If they should observe any potentially hazardous condition they will call it promptly to the attention of the facility manager.

We will telephone you within the next two weeks to arrange a schedule for our study. Please let me know when a problem arises, or if we can provide any additional information. All our observations will be reported in writing at the end of this one-year study, and we would be glad to provide you with a copy of the report.

Thank you again.

Sincerely yours,

Melvin W. Carter
Director

501 185

MWC/e

cc: Mr. Willard Ingram, Georgia Department of Human Resources

Appendix A-3

Transportation of Radioactive Materials in Georgia:

Questionnaire

Co. Name_____Contact_____Date_____

1. Do you use radiation dosimeters?
2. Do you use radiation survey meters? Type?
3. May we take photographs?
4. May we place TLD's in handling area and issue them to personnel to determine radiation dose rates?
5. Can we have access to records from July 1977 to the present to determine the number of packages handled, type, contents, amount, shipper and final destination?
6. Can we obtain permission to make sketches and layouts to chart the movement of RAM?
7. Can we obtain permission to make an area radiation survey to measure the radiation background?
8. How many handlers are employed per shift?
9. What is the scheduling of RAM and when are most RAM shipped?
10. Are there any exclusive use vehicles?
11. What is your method for placarding vehicles?
12. Where is RAM stored and how are RAM positioned at this terminal?
13. Where is undeveloped film stored?
14. Who are the shift supervisors we should work with?
15. Do you have written procedures for handling RAM?
16. Which companies ship the most RAM?
17. What category of RAM do you normally handle?
18. What other contacts would be beneficial in gathering data for the study?
19. Other information:

501 186

Appendix B-1

Monitored Radiopharmaceutical Packages

Date	Location*	Amount, Ci	Isotopes	TI	Limited Quantity	Category I	Category II	Category III	Remarks
October 1977									
4	C	4.2	Mo-99, I-125	7.7	1			5	U**
4	D	0.029	C-14, H-3, I-125 P-32, Be-7, and Pb-210	0.2	1		2		OP**
4	K	0.028	H-3, P-32, Pb-210, I-125	0.2	7	4	2		U
4	C	0.017	P-32	0.5			5		out
5	E	0.060	Ra-226	4.6				1	out
5	K	0.00022	I-125	---	3				out
6	K	0.02	I-125	0.2			1		1 out
7	C	0.28	Mo-99, I-125	0.5		1		1	2 out
7	C	0.11	Ga-67, Xe-133	0.1		2	1		3 out
7	J	0.8	Mo-99	2.5				1	1 out
7	F	0.096	Ir-192	1.0				1	1 out
7	C	6.8	Mo-99	9.8				5	1 out
26	J	0.000003	Co-57	0.1			1		----
27	J	0.74	Mo-99, H-3, Ga-67, I-131	5.2	3	2	1	3	----
28	J	0.012	I-131	0.8			2	1	----
30	J	18.7	Mo-99, I-131	27.8	1			22	4 M**
30	J	14.3	Mo-99, Ga-67, Xe-133	42.3		5	3	11	NM
30	J	19.4	Mo-99, Ga-67. Xe-133	61.0		2	1	18	NM
30	J	4.5	Mo-99	6.6				8	NM 8 out
November 1977									
3	K	1.3	Mo-99	2.5				1	NM out
3	C	2.9	Mo-99, Ga-67	8.9			1	4	NM
4	K	1.7	Mo-99	3.0				1	NM
4	K	6.8	Mo-99, Yb-169 P-32	10.2			2	4	1 NM 3 out
4	J	10.7	Mo-99	15.5				9	NM 3 out
4	J	7.4	Mo-99, I-131. Cr-51	11.1			2	5	NM 7 out
6	J	5.8	Mo-99	6.0	3			2	----

501 187

Date	Location	Amount, Ci	Isotopes	TI	Limited Quantity	Category I	Category II	Category III	Remarks
6	D	4.8	Mo-99, I-125, C-14	4.9			1	3	3 out
6	J	1.1	Ga-67, Xe-133, Co-57, Co-60, Cs-137	1.6			9		9 out
6	J	0.73	Xe-133	---		10			10 out
6	J	6.8	Mo-99, Ga-67	24.0				8	8 out
6	J	7.5	Mo-99	10.2				9	NM
6	J	0.56	Mo-99, I-131	2.2			1	2	NM
6	J	8.7	Mo-99	11.8				9	1 M
6	J	8.8	Mo-99	32.5				9	NM
6	J	9.0	Mo-99	28.5				9	4 M
6	J	U	Mo-99	6.5				2	NM 2 out
6	J	U	Mo-99	33.5				9	NM 9 out
7	J	0.079	Ga-67, Xe-133, Tl-201	0.5		4	1		NM 2 out
13	H	11.9	Mo-99	35.5				9	NM
13	H	7.9	Mo-99	26.0				9	NM
13	H	0.017	Tl-201, Ga-67	0.5		1	1		NM
13	H	13.9	Mo-99	42.0				9	NM 9 out
13	H	0.9	Mo-99, U	4.0		2	3	2	NM 7 out
13	H	7.0	Mo-99	20.5				5	NM 5 out
13	H	1.4	Mo-99	4.0				1	NM 1 out
January 1978									
19	J	0.12	Ir-192, I-131	1.7			1	2	1 out, OP
February 1978									
15	K	----	U	---	4				4 out
March 1978									
1	J	0.001	I-131	0.1			1		
1	J	U	U	---	5				
3	J	0.016	Ir-192	1				1	
3	J	U	U	---	2				
9	J	0.069	I-131	2.4			11		

501 188

Date	Location	Amount, Ci	Isotopes	TI	Limited Quantity	Category I	Category II	Category III	Remarks
9	J	0.0011	I-125	0.1	2		1		
9	J	0.008	Ga-67	0.3			1		
9	J	0.005	P-32	0.1			1		
9	J	0.003	H-3	---		1			
9	J	----	U	---	2				
16	J	0.005	I-125	---		1			U, OP
30	C	9.4	Mo-99	29.5				16	NM, OP
30	C	0.000001	Co-57	---	1				NM, OP
30	C	0.005	Se-75	0.1			1		NM
30	C	0.015	S-35	---		1			NM
30	C	0.01	P-32	0.1			1		NM
30	C	0.000011	Ba-133	0.1			1		NM
April 1978									
5	F	0.117	Ir-192	1.0				1	out
13	C	0.000042	I-125	---	2				
13	C	0.006	H-3, I-125	---		1			OP, U
13	C	17.0	Mo-99	14.5				11	10 OP; U 1 out
13	C	0.0100	H-3, I-125	---		1			OP
13	C	0.0062	I-131, Se-75	1.1				1	out
13	C	1.0	H-3, C-14	---		1			OP, U
13	C	0.000002	I-125	---	2				1 out
13	C	U	C-14	---	1				U
13	C	U	I-125	---	1				U
13	K	0.000020	I-125	---	1				
13	K	0.00025	H-3	---	1				
13	A	0.009	Ga-67	0.3			1		out
20	C	9.8	Mo-99	15.8				9	8 OP, 8 U
20	C	0.0012	I-131	0.5	1		1		OP, U
20	K	0.002	Cr-51	0.1			1		out
20	K	0.000005	I-131	---	1				out

Date	Location	Amount, Ci	Isotopes	TI	Limited Quantity	Category I	Category II	Category III	Remarks
20	K	0.000010	I-125	---	1				out
20	K	0.000007	Co-57, Co-58	---	1				
20	D	5.1	Mo-99	7.8				4	3 OP, 1 out
20	D	0.0015	Ga-67	0.3			1		
20	C	0.005	H-3	---		1			OP, U
May 1978									
18	J	5.8	Mo-99	18				10	removed from OP, 7 out
18	J	0.047	I-131	1.5				1	out
18	J	0.000003	Co-57	0.1			1		out
18	J	0.000009	Cs-137	---		1			out
18	C	12.1	Mo-99	9.0				5	4 OP, U, 1 out
18	C	0.0000032	I-125	---	1				OP, U
18	D	0.024	Ga-67	0.4			1		OP, U
18	D	0.005	I-131	0.2			1		OP, U
18	D	0.0000003	I-125	---	1				OP, U
June 1978									
8	C	10.5	Mo-99	19.0				10	7 OP, U, NM
8	D	5.4	Mo-99	9.7				6	6 OP, U, NM
8	D	0.000014	I-125	---	2				NM, U
8	D	0.0012	Se-75	0.2			1		NM, U
8	D	0.000002	Co-57	---	1				NM
9	J	24.	Mo-99	35.1				18	14 NM, 10 out
9	J	0.018	I-131	1.5				1	1 NM
9	J	0.0064 0.012	I-131 Se-75	1.2				1	1 NM, out
9	J	0.00088	I-131	0.3			1		
9	J	15.3	Mo-99	19.5				8	8 out
10	J	29.	Mo-99	88.5				25	8 out
10	J	0.045	Ga-67	1.1			7		4 out
10	J	0.78	Xe-133	---		14			7 out
10	J	0.002	Tl-201	---		1			out
11	J	60.	Mo-99	82.4				50	to Orlando, NM
11	J	0.13	I-131	2.4			2	2	to Orlando, NM
11	J	41.	Mo-99	55.6				42	to Charlotte, NM
11	J	0.23	I-131	4.2			1	4	to Charlotte, NM

Date	Location	Amount, Ci	Isotopes	TI	Limited Quantity	Category I	Category II	Category III	Remarks
11	J	13.5	Mo-99	19.7				19	NM
11	J	0.028	I-131	0.7			1	1	NM
July 1978									
8	J	10.8	Mo-99	32.7				9	out
8	J	0.036	Ga-67	0.9			5		out
8	J	0.41	Xe-133	---		6			out
8	J	0.004	Tl-201	---		2			out
8	J	10.8	Mo-99	32.5				9	out
8	J	0.036	Ga-67	0.9			5		out
8	J	0.41	Xe-133	---		6			out
8	J	0.004	Tl-201	---		2			out
9	J	39.	Mo-99	53.9				42	to Charlotte, NM
9	J	18.2	Mo-99	57.0				17	
9	J	0.012	Ga-67	0.3			3		
9	J	0.32	Xe-133	---		7			
9	J	0.012	Tl-201	---		1			
9	J	0.255	I-131	6.1			3	2	to Charlotte, NM
9	J	14.2	Mo-99	20.8				20	NM
9	J	0.039	I-131	1.0					1 OP, NM
26	C	0.0044 0.012	I-125 Ga-67	0.4			1		OP; U
26	C	0.0015	Xe-133	0.1			1		out
September 1978									
23	J	U	Mo-99	90.5				26	U; NM
24	J	14.75	Mo-99	21.6				19	1 out; NM
24	J	0.038	I-131	1.0				1	OP; NM
24	J	68.206	Mo-99, I-131 P-32, Co-57	103.3			7	53	41 out; NM

* See following page for location code

** U: Unknown
OP: Overpack
M: Monitored
NM: Not monitored

Shipments are inbound for Georgia unless otherwise specified.

501 191

Location Code

A	Airborne Freight
B	Airlift International
C	Delta Airlines
D	Eastern Airlines
E	Emery Air Freight
F	Federal Express
G	Georgia Tech
H	Hangar #1 Atlanta Airport
I	Profit By Air, Inc.
J	Purolator Courier Corp.
K	Shulman Air Express
L	from TVA Brown's Ferry Nuclear Power Plant, TN enroute to Barnwell, SC
M	GA enroute to ERDA Aiken, SC
N	Superior Rigging & Erecting Co. to CDC Atlanta from Carada
O	DeKalb General Hospital from Ft. Worth, TX
P	from SRP enroute to Chatsworth, CA
Q	from Dover Air Force Base, DE, to Barnwell, SC via Augusta, GA
R	from Turkey Point Nuclear Power Plant, FL enroute to Batelle Nuclear Research Center, West Jefferson, OH (monitored at exit 70, I-75 south of Atlanta.)
S	from Oak Ridge, TN enroute Garden City Terminal, Savannah, GA (monitored on Rt 331 East, Exit 78, I-75 south of Atlanta.)
T	from Oconee Nuclear Power Plant, Seneca, SC enroute to Crystal River Nuclear Power Plant, FL (monitored on Rt 331 East, Exit 78, I-75 south of Atlanta.)

Appendix B-2

Monthly Summary of Packages at Airlines
that are Occasional RAM Carriers

Airline	Month, 1978	Number of Packages				
		Ltd	I	II	III	Total
U	May	-	1	2	-	3
	June	-	-	-	-	0
	July	1	-	-	-	1
V	May	-	-	2	-	2
	June	-	-	-	-	0
	July	-	-	-	-	0
W	May	1	1	1	-	3
	June	-	-	2	-	2
	July	-	1	2	-	3

Notes: Information was obtained from three scheduled passenger airlines at Atlanta airport.

Ltd = Limited Quantity

501 193

Appendix B-3

Monthly Summary of Outbound RAM Packages Monitored by
RAM Special Agent at Terminal C Atlanta

Month, 1978	Radionuclide				Activity,		Category				No. of Packages
	I-125	I-131	Mo-99	Others	Ci	TI	Ltd	I	II	III	
July	5	8	20	37	18.7	47.3	4	13	22	31	70
August	2	2	15	29	20.6	39.7	2	8	17	21	48
September	4	3	7	8	9.6	21.6	3	2	6	11	22
Totals	11	13	42	74	48.9	109.1	9	23	45	63	140

Note: Activity could not be determined from the filed air bills for 16 packages

Appendix B-4

Distribution of Georgia RAM Shipments by Courier Trucks
from Atlanta in February 1978

Destination (no. of locations)	Radionuclide				Activity, Ci	TI	Category			
	I-125	I-131	Mo-99	Others			Ltd	I	II	III
Albany (2)	2	4	8	4	5.00	7.6	6	-	4	3
Athens (4)	3	2	-	21	0.011	1.8	11	4	6	1
Atlanta (21)	45	40	38	88	66.0	134.5	63	32	48	53
Augusta (8)	24	31	24	57	37.2	87.1	51	10	41	30
Americus (1)	-	4	4	4	3.1	4.8	-	4	4	4
Bainbridge (1)	2	1	3	-	0.75	1.4	2	-	1	3
Blairsville (1)	0	-	-	1	---	---	1	-	-	-
Brunswick (2)	0	2	4	17	4.1	6.9	8	1	7	4
Canton (1)	0	2	4	1	2.0	3.0	-	1	2	4
Carrolton (2)	0	1	0	2	0.007	0.3	0	0	3	0
Columbus (7)	11	7	20	8	19.8	41.1	16	-	8	22
Dalton (1)	-	1	4	2	3.6	12.1	2	-	1	4
Douglas (1)	-	1	1	2	0.73	2.3	2	-	1	1
Dublin (1)	2	1	4	3	6.9	7.7	4	-	2	4
Ft. Oglethorpe (1)	-	3	4	-	4.0	5.1	-	-	3	4
Gainesville (2)	1	-	4	1	1.8	8	2	-	-	4
Hartwell (1)	-	-	3	1	0.72	3.0	1	-	-	3
Jesup (1)	-	-	-	1	---	---	1	-	-	-
LaGrange (2)	-	3	-	5	0.02	1.0	3	-	5	-
Macon (3)	-	7	9	40	9.6	19.6	5	2	34	10
Milledgevill (2)	6	5	8	3	4.1	11.9	7	0	6	9

Appendix B-4 (cont'd)

Destination (no. of locations)	Radionuclide				Activity, Ci	TI	Category			
	I-125	I-131	Mo-99	Others			Ltd	I	II	III
Moultrie (1)	-	2	4	2	2.0	3.1	2	-	2	4
Newnan (2)	-	-	4	1	2.0	2.8	1	-	-	4
Rome (2)	1	4	8	3	6.6	15.3	4	-	3	8
Savannah (8)	12	10	11	9	13.5	44.2	16	-	13	13
Tifton (1)	1	4	4	4	1.5	3.3	5	-	4	4
Thomaston (1)	-	2	5	-	1.1	8.2	-	-	2	5
Thomasville (1)	2	6	4	1	3.0	5.4	3	-	5	5
Toccoa (1)	1	-	-	-	---	---	1	-	-	-
Valdosta (1)	1	2	4	4	6.0	8.6	4	1	2	4
Warner Robbins (1)	-	1	4	-	0.75	1.3	-	-	1	4
Watkinsville (1)	-	-	-	1	---	---	1	-	-	-
Waycross (2)	1	2	2	5	1.5	2.6	5	-	3	2
Totals	115	148	192	290	210.	454.	227	55	211	221

Notes: 1. This information, from filed freight bills identified by entries in the couriers RAM log, is incomplete because some bills were not completely legible. For 31 packages, the category is unknown; for 36 packages, the TI is unknown; for 4 Mo-99, 1 I-131, 26 I-125, and 10 other radionuclides, the activity is unknown.

2. The limited quantity (Ltd) category includes packages listed as "small quantity" and "test kits"; it can be associated with I-125 and "other" radionuclides. Additional packages in this category may have been transported unrecognized.

Appendix C-1

Monthly Summary of Industrial, Research, and Educational RAM
on Airfreight Carrier at Atlanta, Georgia

Month	Radionuclide				Activity, Ci	TI	Category			
	H-3	Ir-192	Kr-85	Others			Ltd	I	II	III
September 1977	1	1	--	13	20.	1.7	6	2	7	0
October	-	-	2	3	125.	2.5	1	1	2	1
November	-	1	--	4	104.	7.2	0	0	1	4
December	2	-	--	3	36,400.	1.1	0	2	3	1
January 1978	2	-	2	4	30,300.	7.7	0	2	4	2
February	-	2	1	2	3,260.	2.3	0	0	4	1
March	5	1	--	2	143,000.	1.3	0	6	2	0
April	2	1	--	2	103,000.	0.5	2	2	1	0
May	5	0	0	0	125,000.	0	0	5	0	0
June	4	1	0	11	115,000.	0.8	2	9	5	0
July	4	2	0	1	91,500.	1.2	0	4	3	0
Total* (11 mos.)	25	9	5	45	648,000.	26.3	11	33	32	9

* Several radionuclides, TI values, and categories could not be determined from freight bills that provided this information.

Appendix C-2

Monitored Industrial, Research, and Educational RAM Packages

Date	Location	Amount, Ci	Isotopes	Transportation Index	Ltd	I	II	III	Destination
October 1977									
5	B	25.	Kr-85	0.8				1	Singapore
5	K	0.070	Po-210	---		1			Georgia
17	A	100.	Kr-85	1.6				1	England
26	B	0.02	Po-210	---		2			Mexico
November 1977									
3	F	0.060	Cs-137/Am-241	0.5			1		California*
December 1977									
20	B	15,000	H-3	---		1			England
20	B	0.25	U-235	0.1			1		France
20	G	0.002	Na-24	1.5				1	Ohio
21	G	0.0001	Sn-113	---			1		Georgia
March 1978									
23	F	0.2	I-131	4				1	South Carolina
23	F	0.030	S-35, P-32	0.1			1		South Carolina
23	F	0.000020	U-normal	---	1				South Carolina
23	F	0.0000001	C-14	---	1				South Carolina
30	F	0.00009	Cs-137	0.1			1		Georgia
30	F	0.002	Au-195	---	1				Massachusetts

Appendix C-2 (cont'd)

Date	Location	Amount, Ci	Isotopes	Transportation Index	Ltd	I	II	III	Destination
April 1978									
4	Q	32.	Kr-85	34.2				18	Delaware to South Carolina**
13	B	0.001	depleted sodium diuranate	---	2				Puerto Rico
May 1978									
8	F	0.003	Na-24	0.3			1		Ohio
11	F	0.012	Co-57 Au-195	0.6			2		Tennessee
May 1978									
11	F	0.0008	Co-57	0.1			1		Tennessee
11	F	0.006	Au-195	---		1			Tennessee
July 1978									
26	B	0.025	Fe-59	0.2			1		Mexico
26	B	1.5	Kr-85	2.0			2		Arizona
August 1978									
10	B	0.1	Tc-99	0.1		1			England

* Checked, not monitored
** Monitored by staff of Bureau of Radiological Health, South Carolina

Appendix D-1

Summary of RAM Shipments from Brown's Ferry Nuclear Power Plant, Decatur, AL

Month	No. of Shipments	Activity, Ci
July 1977	5	31.4
August	11	42.5
September	14	297.9
October	15	69.4
November	21	163.5
December	15	84.1
January 1978	20	205.2
February	15	89.5
March	15	31.4
April	15	143.5
May	20	189.
June	19	104.
Totals	185	1451.

Notes:
1. These shipments contained mixtures of Ce-144, Cr-51, Ni-65, Na-24, I-131, La-140, Ba-140, Cs-137, Zr-95, Nb-95, Mo-99, Cs-134, Co-58, Sr-90, Mn-54, Zn-65, Co-60, Fe-59, Sb-124, and Ag-110m.
2. All shipments were to the Barnwell, SC burial grounds.
3. Shipments were reported by the Tennessee Valley Authority, the station operator.

501 200

Appendix D-2

Summary of RAM Shipments from
Edwin I. Hatch Nuclear Plant, Baxley, GA

Month	No. of Shipments to: Chem-Nuclear, Barnwell, SC	Applied Physical Tech., Atlanta, GA	Southern Space, Macon, GA (Laundry)	Activity, Ci	TI
July, 1977	3	1	1	11.3	23.5
August	4	1	2	60.5	56.1
September	3	2	---	3.2	45.4
October	2	1	1	10.3	47.5
November	2	1	1	3.2	14.1
December	4	1 E	1	18.1	20.0
January, 1978	3	1	2	7.0	77.8
February	2	2 E	---	4.4	30.0
March	5	1 E	27	6.2	51.1
April	5	3 E	10	22.1	67.8
May	4	---	2	15.6	50.0
June	9	---	2	183	51.2
Totals	46	14	49	344.9	534.5

Notes:
1. Shipments to Chem-Nuclear usually consist of Co-58, Co-60, and Zr-95 or Cr-51, Zn-65, Co-58, Co-60, Mn-54, Zr-95, Cs-134, Cs-137, Sb-124, Fe-59, and Sb-122.
2. Shipments to Southern Space usually consist of Cr-51, Zn-65, Co-58, and Co-60.
3. Shipments were reported by the Georgia Power Co., the station operator.

501
201

Appendix D-3

Summary of RAM Shipments from the
Crystal River Nuclear Power Plant, Crystal River, FL

Month	No. of Shipments	Activity, Ci
July, 1977	7	46.2
August	1	0.6
September	0	0
October	0	0
November	2	0.1
December	6	3.6
January, 1978	0	0
February	1	0.5
March	2	0.2
April	4	3.6
May	10	301.
June	7	129.
Totals	40	481.8

Notes: 1. Shipments were to the Barnwell, SC burial ground.

2. Shipments were reported by the Florida Power Co.; the station operator.

501 202

Appendix D-4

Summary of RAM Shipments from the Turkey Point Nuclear Power Plant, Florida City, FL

Month	Activity, Ci	No. of Shipments
July 1977	29.5	8
August	40.1	6
September	39.1	8
October	10.4	4
November	22.9	5
December	121.1	9
January 1978	48.8	9
February	28.8	7
March	234.4	12
April	47.7	7
May	52.1	12
June	1.2	6
Total	676.1	93

Notes: 1. Shipments were to the Barnwell, SC burial grounds.

2. Shipments were reported by the Florida Power and Light Co., the station operator.

501 203

Appendix D-5

Monthly Summary of RAM Shipments by
Interstate Truck Company

Month	TI	Activity, Ci	Shipment Category LSA	II	III
June 1977	3.7	1,020,000	3		4
July 1977	---	----	1		
September 1977	5.7	610,000	1	4	1
November 1977	0.9	5.37	1	2	
December 1977	7.6	450,000	13	2	2
January 1978	10.4	1,660,000		2	3
February 1978	---	----	2		
March 1978	---	----	1		
Totals (8 mos.)	28.3	3,850,000	22	10	10

Notes: 1. LSA = low specific activity.

2. June 1977 shipments included the 3 shipments of spent fuel listed in Table 8 and 1 shipment (4 cartons) of waste from the Hatch Plant to Lycoming, NY.

501 204

Appendix D-6

RAM Shipments by Truck to Laundry, 1977*

Origin	Radionuclides	No. of shipments	Average no. of drums	Avg. exposure rate per drum, mR/hr
Hatch Nuclear Power Plant, Baxley, GA	Mixed fission products	75	17	2
Ingalls Shipbuilding Yard, Pascagoula, MI	Co-60	26	29	0.1

* Reported by Phoenix Technology Corporation for laundry located at Macon, GA.

Appendix D-7

Monitored Nuclear Fuel Cycle Shipments by Truck

Date	Location	Amount, Ci	Isotopes	TI	Category	Remarks
November 1977						
21	L	0.5	dewatered resins, U-235, fission & activation products	--	LSA	Cask, thru GA
December 1977						
12	L	4.2	dewatered resins	--	LSA	Cask, thru GA
20	M	206,000	U-235, fission products	3.7	III	Thru GA
20	M	247,000	U-235, fission products	[illegible]	III	Thru GA
20	G	0.4	Low-level nuclear waste: uranium, fission & activation products	---	LSA	197 cc tainers GA to Barnwell, SC
March 1978						
31	P	130,000	Radioactive spent fuel	0.3	III	Thru GA
May 1978						
2	R	390,000	Spent fuel, U-235, Pu-239, mixed fission products	4.0	III	Thru GA, (trailer w/ personnel barrier)
12	R	390,000	Spent fuel, U-235, Pu-239, mixed fission products	12.0	III	Thru GA, (trailer w/ personnel barrier)
June 1978						
28	S	12.8	Uranium hexafluoride fissile (containing 0.7% U-235)	20.0	III (4)	Thru GA
July 1978						
28	T	700,000	Spent fuel, mixed fission products	10.0	III	Thru GA, (trailer w/ personnel barrier)
August 1978						
10	T	700,000	irradiated fuel assembly	2.1	III	Thru GA, cask USA 6698-BF mounted on trailer w/barrier, part of 4 shipments

501 206

Appendix D-8

RAM Shipments by Railroad in Georgia, June 1976 - December 1977

	Origin	Destination	Month	Year	Loads
STCC 49-26310	Thorium Nitrate, solid				
	Savannah, GA	Chattanooga, TN	03	77	5
STCC 49-26420	Radioactive Devices, N.O.S., Radioactive Articles				
	Charleston, SC	Chattanooga, TN	08	77	26
			09	77	22
	Charleston, SC	Tyner, TN	08	77	4
			09	77	2
STCC 49-26430	Radioactive Material, Low Specific Activity				
	Idaho Falls, ID	Charleston, SC	01	77	2
	Charleston, SC	Tyner, TN	04	77	6
	Charleston, SC	Chattanooga, TN	04	77	6
STCC 49-26440	Radioactive Material, N.O.S.				
	Charleston, SC	Tyner, TN	07	76	4
			10	76	3
			01	77	3
			02	77	4
			03	77	3
			07	77	2
	Charleston, SC	Chattanooga, TN	06	77	14
	Pascagoula, MS	Dunbarton, SC	10	77	2
	Charleston, SC	Chattanooga, TN	07	76	4
			10	76	3
			01	77	5
			02	77	2
			03	77	1
	Charleston, SC	Scoville, ID	10	76	2
			06	77	2
STCC 49-26490	Uranium Hexafluoride, low specific activity (containing 0.7% or less U-235) (uranium fluorides not irridated nor requiring protective shielding)				
	Paducah, KY	Portsmouth, VA	05	77	2
			06	77	4
			09	77	2
	Norfolk, VA	Paducah, KY	12	77	6
	Portsmouth, VA	Paducah, KY	12	77	6
	Portsmouth, VA	Knoxville, TN	12	77	11
	Pinpoint, VA	Knoxville, TN	12	77	11

	Origin	Destination	Month	Year	Loads
STCC 49-28410	Fissile Radioactive Material, Fissile Class I				
	Tampa, FL	Atlanta, GA	01	77	1
STCC 49-29420	Radioactive Device, N.O.S., Fissile Class I				
	Inness, SC	St. Francis, TX	07	77	7
			08	77	5
STCC 49-29480	Radioactive Material, N.O.S., Fissile Class I (watch enamel)				
	Pascagoula, MS	Dunbarton, SC	06	76	2

Notes:
1. Although the Standard Transportation Commodity Code indicates different categories, the first four items all appear to refer to monazite shipments.
2. N.O.S. = not otherwise stated
3. Information was provided by group of railroads

501 208

NRC FORM 335 (7.77) U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

1. REPORT NUMBER *(Assigned by DDC)*
NUREG/CR-0931

4. TITLE AND SUBTITLE *(Add Volume No., if appropriate)*
Transportation of Radioactive Material in Georgia
(August 1, 1977 - September 30, 1978)

2. *(Leave blank)*

3. RECIPIENT'S ACCESSION NO.

7. AUTHOR(S)
State of Georgia (Department of Human Resources)

DATE REPORT COMPLETED
MONTH: June YEAR: 1979

9. PERFORMING ORGANIZATION NAME AND MAILING ADDRESS *(Include Zip Code)*
Department of Human Resources
State of Georgia
47 Trinity Avenue
Atlanta, Georgia 30334

DATE REPORT ISSUED
MONTH: July YEAR: 1979

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-06-77-021

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

PERIOD COVERED *(Inclusive dates)*
August 1, 1977 to September 30, 1978

15. SUPPLEMENTARY NOTES

14. *(Leave blank)*

16. ABSTRACT *(200 words or less)*

Under contract with the U. S. Nuclear Regulatory Commission and the U. S. Department of Transportation, the Georgia Department of Human Resources (in cooperation with the Office of Interdisciplinary Programs, Georgia Institute of Technology) engaged in a cooperative program for the surveillance of radioactive material in transport within and through the State of Georgia. Shipments of radioactive material were surveyed to determine the types of material, 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) radiopharmaceutical packages, (2) packages for industrial, research or education use, (3) teletherapy and radiography sources, and (4) nuclear fuel cycle shipments. Radiopharmaceuticals constituted the most numerous shipments, but the highest curie amounts were in spent fuel elements. The transportation workers whose radiation dose rates were measured did not receive excessive increments from the radioactive materials; however, the report recommends practices be instituted to reduce the radiation doses even further.

17. KEY WORDS AND DOCUMENT ANALYSIS

17a. DESCRIPTORS

501 209

17b. IDENTIFIERS/OPEN-ENDED TERMS

18. AVAILABILITY STATEMENT
No restrictions

19. SECURITY CLASS *(This report)*
Unclassified

21. NO. OF PAGES

20. SECURITY CLASS *(This page)*
Unclassified

22. PRICE
$