
Transportation of Radioactive Material in South Carolina

October 1980 - September 1981

Department of Health and Environmental Control
State of South Carolina

Prepared for
U.S. Nuclear Regulatory
Commission
and
U.S. Department of Transportation

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ABSTRACT

During the fourth and final year of this contract, transportation of radioactive materials into and within South Carolina was studied. The majority of the presented data results from inspections of shipments containing low-level radioactive wastes. A small number of packages containing other radioactive materials was also inspected.

Although the study determined that violations of State and Federal regulations still exist, the results indicate a significant decrease in the number of violations over the study period from October 1978 through September 1981. This may be attributed to the enforcement of new legislation and increased efforts of field inspectors.

The following recommendations are offered:

1. The Department of Transportation should increase the emphasis on carrier equipment inspections.
2. Clarification and revision of Motor Carrier Safety regulations is needed. This should include provisions for required, frequent carrier inspections of equipment.
3. Carriers and drivers should be trained and knowledgeable as to their responsibilities and in applicable regulations.

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INTRODUCTION

The State of South Carolina continued a surveillance and inspection program for a fourth year under a contract with the U.S. Department of Transportation (DOT). This program was directed largely at the transport of radioactive waste material on public highways. Waste shipments constitute the largest volume of radioactive materials shipped in South Carolina. This study covered the period from October 1980 through September 1981.

The inspection program was conducted on a daily basis at the Chem-Nuclear Systems, Inc. (CNSI) waste burial facility located in Barnwell County, South Carolina. Personnel representing the South Carolina Department of Health and Environmental Control (DHEC) monitored daily site operations and ensured that incoming radioactive waste shipments were in compliance with all applicable State and Federal regulations. Surveillance and inspection activities were also conducted at carrier terminals located adjacent to the CNSI facility complex. The terminals are operated by Home Transportation, Inc. and Tri-State Motor Transit, Inc., that are major transporters of low-level radioactive waste.

As a routine part of the compliance program in South Carolina, package inspections were also conducted at academic institutions, hospitals, and other receiving locations throughout the State. Generally speaking, no significant transportation or packaging problems were observed during these inspections.

During this surveillance period, DHEC continued regulatory actions pertinent to "South Carolina Radioactive Waste Transportation and Disposal Act" which became effective July 1, 1980. A brief discussion of this Act is included in this report.

A complete listing of shipment origins and descriptions are included in Appendix I. Shipment inspection procedures are outlined in Appendix II.

Throughout this report comparisons are made between data collected during the second, third and fourth contract years.* Data from the first contract year were not included in these comparisons due to the incompatibility of the data collected.** The first year study centered on individual package inspections at carrier terminals as opposed to an emphasis on the study of low-level radioactive waste during the second, third and fourth years of the contract study.

* Second contract year: October 1978-September 1979, "Transportation of Low-Level Radioactive Waste Into South Carolina," Bureau of Radiological Health, Department of Health and Environmental Control, State of South Carolina, NUREG/CR-1434, April 1980.

Third contract year: October 1979-September 1980, "Transportation of Radioactive Material in South Carolina," Bureau of Radiological Health, Department of Health and Environmental Control, State of South Carolina, NUREG/CR-2195, November 1981.

** First contract year: January 31, 1977-February 1, 1978, "Transportation of Radioactive Material in South Carolina," Bureau of Radiological Health, Department of Health and Environmental Control, State of South Carolina, NUREG/CR-0266, April 1978.

RESULTS AND DISCUSSION

Shippers of radioactive waste in South Carolina currently must supply DHEC with certain advance notification information. As part of this information the shipper must designate a route to be used by the carrier. Analysis of data collected through shipper notifications indicates that, from the north, Interstate 95 is the most often designated route in the state. Radioactive waste shipments which originate in the midwest are generally routed via Interstate 26 or Interstate 77. Once the shipments leave the interstate system within the state, the most direct state routes are used for continuation to the burial site. Major routes used for carriage of radioactive wastes in South Carolina are listed in Table IX and shown in Figure 2.

The carriers of low-level radioactive waste shipments are classified into three categories:

1. Private and common carriers transporting radioactive waste in a vehicle designated "Exclusive Use" or "Sole Use", as defined by DOT regulations. Approximately 95% of the shipments transported fall within this category.
2. Common carriers transporting waste as part of a general cargo on the same truck.
3. Courier and freight forwarders, such as United Parcel Service (UPS) and private vehicles.

For the most part, radioactive waste received at the CNSI burial site during this period of study was classified by the shipper as Radioactive-Low Specific Activity.

A total of 4,742 shipments were inspected during the course of this study. Table I shows individual monthly totals for shipments and discrepancies. Discrepancies were found in only 160 shipments which is less than four (4) percent of the incoming shipments. Only ten (10) shipments or approximately 0.21 percent of those inspected had discrepancies which the Department felt warranted punitive action. (On July 1, 1980, the Department was given punitive action concerning discrepancies.) During the three (3) month period of 1980 from July 1 to September 30, equivalent to one quarter of the 1981 study period, DHEC took punitive action against seven (7) radioactive waste generators. By extrapolating these figures, it would appear that the number of discrepancies severe enough to warrant punitive actions in the 1981 study year were reduced by more than a factor of two compared to the 1980 study year. The most significant hazard during the 1981 study year continued to be the poor mechanical condition of some transport vehicles. This fact is reflected in Table II where roadworthiness discrepancies represent 55 percent of all discrepancies noted.

Direct gamma radiation levels in excess of regulatory limits were found in only three (3) shipments during this period. Radiation levels measured at the surface of non-compliant vehicles, casks, or packages average 230 mR/hr. The maximum radiation level found was 250 mR/hr measured at the surface and 15 mR/hr when measured at two meters. The regulatory limit set for radiation levels as measured in the driver's compartment was exceeded once during the year. In one case a leaking container caused release of spreadable contamination in excess of the regulatory limits. During the study periods for 1979 and 1980, 7 and 15 shipments

respectively were cited for direct gamma radiation levels exceeding regulatory limits. Although several leaking containers were noted during both the 1979 and 1980 studies none of these resulted in contamination levels in excess of the DOT regulatory limits.

Improper blocking and bracing of containers, or lack thereof, was observed in 11 shipments during the 1981 study. This number is approximately one-half that for previous reporting periods. Twenty-four (24) discrepancies of this type were noted during the 1979 study and twenty-seven (27) during the 1980 period. (See Table VIII).

Most of the low-level radioactive waste received at the CNSI site is contained in 55 gallon DOT specification drums. Of the drums received, only one was not properly sealed. This violation consisted of a loose rim lock band and lid. Damages to the drums were observed in 3 cases. The drums were either rusted with holes or had holes punched in them by handling equipment. In 1979, approximately 40 drums were found to be missing seals and 9 were found to be damaged. The 1980 study found 18 improperly sealed and 15 damaged drums. These figures reveal very significant improvements when comparing the percentage of all incoming shipments which they represent. During the 1981 study this type of violation represented only 0.08 percent of all inspected incoming shipments vs. 3.7 and 5.9 percent for the 1979 and 1980 periods respectively.

To a lesser degree, low-level radioactive waste was contained in large wooden or steel boxes. Four of the boxes did not qualify as strong, tight packages. Upon inspection, it was found that these boxes split open during transit and released a small portion of the contents onto the trailer floor. The materials that leaked from the packages contained trace amounts of radioactivity in the pico-curie per gram range and did not create contamination levels in excess of DOT regulatory limits.

Inspection of Type A and NRC certified "Greater than Type A" casks was an integral part of the study. In the previous two studies, it was evident that many of the casks were not being maintained in compliance with their certificates. A total of 7 discrepancies were uncovered during the current study. Missing lid bolts and damaged or worn tie-down assemblies contributed to the majority of these discrepancies. Even though tie-down assemblies are provided as part of the cask equipment, many drivers fail to check and tighten the tie-downs during transit. There was also one instance where a driver had removed package tie-down chains when the shipment was delivered to a terminal; subsequently, the shipment moved a short distance on public roads without the load being secured to the trailer.

Missing DOT hazardous material placards seemed to be a continuing problem, as observed in 17 cases. In most instances, however, it appeared as if the placards were lost during transit. In other instances, carriers were not aware that the shipments required placards. During the 1979 and 1980 studies 22 and 58 discrepancies of this type were noted. On a percent basis these numbers represent 1.7%, 10.4%, and 0.4% for each successive year.

Improper and incorrect package labeling was found in 20 shipments. As reported in the second year and third year studies (NUREG/CR-1434/CR-2195), incidents of mislabeling or no labeling still persist on the part of some shippers. The occurrence of this problem was reduced significantly from the second and third year studies where 75 and 67 violations of this sort were observed. During the 1981 study missing isotope content and quantity or transportation index on the labels accounted for seven (7) of these violations. In three (3) cases, wrong labels were applied to the packages. In two (2) cases the Transportation Index (TI) was in excess of that shown on the package label. Completely missing labels accounted for the remaining discrepancies.

Inspection of shipping documents accompanying waste shipments indicated two (2) instances where radioactive waste was improperly classified and described. This presents a problem for the disposal site operator in that he is not assured that he can receive the radioactive material as specified on the shipping papers. All shipments received during the study period were properly certified. Most of the paperwork discrepancies resulted from failure to include exclusive use instructions.

In general, smears taken on surfaces of casks, packages, and transport trailers indicated trace radioactivity in the form of removable contamination. Smear samples taken from one cask shipment indicated contamination in excess of regulatory limits. The regulatory limits were not exceeded during the previous reporting periods.

To determine the impact that direct radiation from the shipments of low-level radioactive waste had at and near the receiving area at the burial site and the adjacent transportation terminals operated by Home Transportation Company and Tri-State Motor Transit, thermoluminescent dosimeters (TLD) were placed at strategic locations. The locations of these TLD monitors are shown in Figures 3, 4, 5, and 6. It is important to mention that shipments arriving at the two terminals operated by these carriers are not off-loaded into a terminal warehouse. The shipments remain on the transport vehicles for delivery to the burial site.

Table V is a tabulation of the results of the TLD area monitors used as part of the survey. The control TLD was posted outside the DHEC office in Columbia, South Carolina, 70 miles away from the Barnwell area. The average exposure rate for the control TLD was 0.22 mrem per day. This exposure rate has not been subtracted from any of the results shown in Table V.

The information gathered indicated that direct radiation from the low-level radioactive waste shipments has not caused any significant increase in background radiation in the areas surveyed except in one location. TLD Number 80-0625, located across from the main office building at the burial facility, indicated an average daily exposure rate of a factor of thirty (30) above all other locations. At this location, the waste shipments are parked in lines awaiting inspection and off-loading. The transport vehicles remain at the location for a number of hours. During inclement weather, the vehicles may be parked there for days. Hence, increased radiation levels resulted.

A review of personnel exposure records for waste and handling personnel, equipment operators, and drivers employed by CNSI was made during the study. The whole body integrated exposures for individuals in these job classifications are summarized in Table VII. From these results, it has been determined that no individual received an exposure above the occupational exposure limits set forth in NRC regulations. However, it must be pointed out that the exposures listed in Table VII are the results of all handling operations at the burial site. These exposures are not representative of those expected from general handling at a carrier terminal, nor the exposures expected for drivers of transport vehicles.

All of the discrepancies and violations that have been discussed in this section are summarized by contract year in Table VIII and Figure I.

ENFORCEMENT ACTIONS

Act 429 of 1980, "The South Carolina Radioactive Waste Transportation and Disposal Act," authorizes DHEC to take appropriate enforcement action against persons who violate Federal and State regulations pertaining to the transportation and disposal of radioactive waste. In essence, this legislation requires shippers (waste generators) to show evidence of financial ability to protect the public from transportation accidents involving radioactive waste, to obtain an annual transport permit, and to notify DHEC, in writing, 72 hours in advance of shipments arriving in the State. This legislation also provides DHEC with the authority to levy civil penalties and suspend transport permits in the event of violations of Federal and/or State law.

During this study period, DHEC suspended ten (10) radioactive waste generators from transporting waste into the State, based on their noncompliance with applicable Federal regulations. A total of \$19,500 in civil penalties were levied. A summary of these enforcement actions is included as Table VI. Prior to resumption of waste shipments into South Carolina, the waste generators were required to submit to DHEC inspection procedures and corrective measures to ensure compliance with established regulations.

ACCIDENTS INVOLVING SHIPMENTS OF RADIOACTIVE MATERIAL

During the period from October, 1980 through September, 1981 three highway accidents occurred involving shipments of radioactive material. Two of these accidents were of a very minor nature and resulted in slight damage to the carrier's transport vehicle. Neither of these accidents caused any damage to the vehicles' radioactive waste payloads.

The third incident occurred on September 18, 1981, when a truck owned and operated by Southern Space, Inc., overturned in a ditch on U.S. 76-378 just west of Sumter, South Carolina. At the time of the wreck, the vehicle was carrying 23 steel 55-gallon drums filled with protective clothing contaminated with small amounts of radioactive material. The radioactive material consisted of mixed fission products. The shipper listed the total quantity as 11.10 mCi. The maximum radiation level on contact with any single drum was 7 mR/hr. Garments were contained in plastic bags, taped shut; the bags were inside DOT 17H steel drums.

In the wreck, which involved no other vehicles or persons, about half of the drums were dented. Of these, about 5 or 6 were bent badly enough so that the metal tops came off inside the truck. The plastic bags, however, remained essentially intact; only a few very small tears occurring with typical tear dimensions of one-half to one inch. No garment was close to coming out of any container. No drums were thrown out of the truck.

Direct radiation surveys of the truck and at the accident site indicated that no radioactive material was released. These survey results were confirmed by separate laboratory analyses of swipes and soil samples taken from the truck, inside and outside, and the accident scene.

CONCLUSIONS

The information gathered during the study periods represented by 1979, 1980, and 1981, indicates that violations of Federal and State regulations still occur. Based on the information obtained in successive years the actual percentage of these discrepancies has gone down. This may be attributed in large part to legislation allowing civil penalties and increased efforts of field inspectors.

The small number of shipments which were found to exceed regulatory limits for direct radiation or presented hazards due to leakage did not contribute to an increased exposure to the general public. Direct radiation from the shipments did not significantly increase background radiation at the terminals and delivery points, with the exception of the trailer parking area at the burial facility. The other violations and discrepancies observed do not represent a significant risk to the general public.

Through vigilant enforcement of State and Federal regulations, low-level radioactive waste transportation does not currently present undue risks to public health and safety. Inspection of shipments at the point of origin and destination, coupled with prompt enforcement action, provides an effective method for reducing risks and ensuring compliance with applicable regulations. These comprehensive efforts must continue in order to guarantee the health and safety of the handlers, drivers, and the general public.

The following recommendations are offered:

1. The Department of Transportation should increase the emphasis on carrier equipment inspections.
2. Clarification and revision of Motor Carrier Safety regulations is needed. This should include provisions for required, frequent carrier inspections of equipment.
3. Carriers and drivers should be trained and knowledgeable as to their responsibilities and in applicable regulations.

TABLE I
FOURTH YEAR TRUCK INSPECTIONS AT CHEM-NUCLEAR

<u>Month</u>	<u>Total # Insp.</u>	<u># with Discrepancies</u>	<u>% of Total</u>	<u>Total # of Discrepancies</u>
October	478	12	2.5	22
November	374	18	4.8	20
December	401	20	5.0	22
January	387	22	5.7	24
February	349	16	4.6	24
March	385	7	1.8	8
April	362	16	4.4	16
May	381	15	3.9	20
June	474	9	1.9	9
July	442	8	1.8	8
August	382	10	2.6	14
September	327	7	2.1	9
	<hr/> 4,742	<hr/> 160	<hr/> 3.37	<hr/> 196

TABLE II
TYPE OF DISCREPANCY

Month	Total #	Road ¹ Worthiness	Paperwork ²	Radiological ³	Placarding ⁴	Restrains ⁵
October	22	1	9	3	8	1
November	20	14	3	1	2	0
December	22	10	2	3	4	3
January	24	15	2	2	5	0
February	22	10	4	0	7	1
March	8	4	1	0	3	0
April	16	14	-	1	1	-
May	20	12	2	1	-	5
June	9	7	-	-	2	-
July	8	7	-	-	1	-
August	14	8	2	-	3	1
September	9	5	-	3	1	-
Totals	194	107	25	14	37	11
% Total	100	54.6	12.8	7.2	18.8	5.6

¹ROADWORTHINESS - Includes flat tires, leaking exhausts, fractured or broken frame members and springs, missing bolts, nuts, wheel wedges, etc. and damaged tire rims.

²PAPERWORK - Includes missing or inadequate exclusive use instructions, shippers' certification.

³RADIOLOGICAL - Includes excessive radiation fields, leaking containers, improperly closed containers.

⁴PLACARDING - Includes improper labels, lack of placards or labels.

⁵RESTRAINTS - Includes lack of proper blocking or braces, lack of tie downs and/or loose tie downs.

TABLE III
SMEAR* SAMPLE RESULTS

(Incoming Shipments)

* Dry 45mm "Nu-Con" wipes were used to take smears of sample areas approximating 100 square centimeters. Samples were analyzed using a gas flow proportional system. Counting times of two minutes per wipe were used.

Date(81)	# Shipments (smears/shipment)	Dpm/100cm ² (Beta, Gamma)	
		High	Average
12-02	15 (3)	42.7	5.4
12-04	2 (3)	9.4	3.2
12-05	2 (3)	868.9	226.3
12-16	2 (3)	288.6	50.5
12-18	2 (3)	203.6	60.7
12-30	4 (1)	8.3	3.9
12-31	1 (3)	93.5	71.9
01-12	2 (3)	112.8	34.1
01-13	1 (1)	1.3	1.3
01-14	2 (3)	79.8	17.2
01-15	1 (2)	3.6	3.2
01-19	2 (3)	3,000	1,051
02-12	1 (3)	37	16.6
02-19	1 (3)	27.6	17.7
03-19	1 (2)	4.0	3.5
04-09	1 (3)	170	103
04-29	1 (3)	480	278
05-13	1 (3)	3	2
06-30	1 (1)	990	990
07-17	3 (1)	36	21
09-08	3 (1)	825,280*	700,000*

* This is from a shipment of cobalt-60 from Neutron Products, Inc., Dickerson, Maryland, which was found to be spreadable contamination on the bottom exterior of a Type B cask. It represents the most significant violation in excess of DOT limits. See p. 16, Table VI for enforcement actions.

TABLE IV
FOURTH YEAR INDIVIDUAL PACKAGE INSPECTIONS

Date	Location	Package Type	Transport Group	Activity	Type Label	Package & Seal Condition	Transport Index	Beta Gamma DPM/100cm ² Removable Contamination
1-13-81	CNSI	Steel DOT 7A Type A	III	0.2 mCi	Yellow II	Good	0.2 (.8)*	-
1-15-81	CNSI	Steel DOT 7A Type A	III	1.0 mCi	Yellow II	Good	0.2	-
1-19-81	CNSI	Stainless Steel Cask/ Lead	III	277.7 Ci	Yellow III	Good	15	3,000
1-19-81	CNSI	Steel DOT 7A Type A	II, III, IV	602 mCi	Yellow III & LSA	Good	1.2	124
2-04-81	CNSI	Steel DOT 7A Type A	IV	1.726 mCi	White I	Good	.01 (.8)*	-
2-20-81	CNSI	Steel DOT 7A Type A	IV	4.0 mCi	Yellow III	Good	1.0	-
3-17-81	CNSI	Steel DOT 7A Type A	III, IV	.0279 mCi	Yellow III	Good	3.0	-
4-03-81	Columbia	Steel DOT 7A	Special Form	60 Ci	None	Good, No Seal	1	-
4-03-81	Columbia	Steel DOT 7A	Special Form	16 Ci	Yellow III	Rusty, No Seal	1	-
4-03-81	CNSI	Steel DOT 7A	VII	37.5 Ci	White I	Good	-	-
4-09-81	CNSI	Steel Liner	IV	280 Ci	Yellow III	Good	3	170
4-29-81	CNSI	Steel Liner	III	870.4 Ci	Yellow III	Good	4	480
5-13-81	CNSI	Steel DOT 7A	I	unlisted	White I	Good	.05	-
8-19-81	Catabaw Nuc. Station	Steel DOT 6717	Special Form	13.5 Ci	Yellow II	Good ring with bolt	0.5	-
9-17-81	Applied Eng. Orangeburg, SC	DOT Reg.	Special Form	64.0 Ci	Yellow II	Good	1.4	-
9-28-81	Daniel Int. Greenville, SC	DOT Reg.	Special Form	57.0 Ci	Yellow II	Good	1.2	-
9-28-81	Daniel Int. Greenville, SC	DOT Reg.	Special Form	42.0 Ci	Yellow II	Good	3.5	-

* Discrepancies

TABLE V

DIRECT RADIATION EXPOSURE MEASUREMENTS
USING LiF THERMOLUMINESCENT DOSIMETERS

October 1, 1980 to September 31, 1981

Station Number, Location	Total mrem For Period	Aveg mrem Per Day	Days Exposed
Chem-Nuclear Systems, Inc. Barnwell, S.C.			
80-6131 Drivers Lounge	106.8	0.37	289
80-6132 Security Office	93.4	0.32	289
80-6133 Lounge & Canteen	100.2	0.35	289
80-6134 Receptionist Desk	149.7	0.37	408
80-0644 Traffic Control Gate	121.4	0.42	289
80-0646 Fence, East Side	72.3	0.19	380
80-1409 On-site Picnic Area	118.9	0.31	380
80-1452 Jct. of Roads 585 & 586	106.1	0.28	380
80-0603 Osborn Rd., Front Entrance	65.5	0.17	380
80-0625 Fence Along Truck Inspection Lane	662.0	1.74	380
80-0645 Fence, North Side	67.4	0.18	380
Home Transportation Company Barnwell, S.C.			
80-6118 Inside Office	41.1	0.14	289
80-6119 Outside Office	79.9	0.20	408
80-6130 East Gate on Osborn Road	52.0	0.17	310
80-1451 East Side of Terminal Property	60.4	0.14	380
S.C. #64, Moore's Store Snelling, S.C.			
80-1453	55.70	0.15	380
S.C. #64 at Barnwell City Limits Barnwell, S.C.			
80-0617	67.70	0.18	380
AMOCO Station, U.S. #78 Williston, S.C.			
80-6120	83.20	0.22	380

DIRECT RADIATION EXPOSURE MEASUREMENTS
 USING LiF THERMOLUMINESCENT DOSIMETERS
 TABLE V
 Page 2

Station Number, Location	Total mrem For Period	Aveg mrem Per Day	Days Exposed **
Tri-State Motor Transport			
80-6139 Outside Office	13.3	0.13	99
Jct. of S.C. #19 & U.S. #278 New Ellington, S.C.			
80-0104	50.3	0.17	289
Truck Stop, Ft. Watson Motel * Santee, S.C.			
80-6151 Sewage Plant	46.6	0.25	190
80-6152 Fence, North	32.9	0.17	190
80-6153 Exxon Station	54.9	0.29	190
80-6154 Fence, Repair Shop	43.4	0.23	190
80-6155 Restaurant, South Side	30.0	0.31	98
80-6156 South Side of House Trailer	39.2	0.21	190
Truck Stop, Safe Haven Area * Manning, S.C.			
80-6157 Fence	40.8	0.21	190
80-6158 Warning Sign	42.3	0.22	190
Control Badge Bureau of Radiological Health Columbia, S.C.			
80-0001 2600 Bull Street	81.80	0.22	379

* Discontinued

** Number of days varies due to pick up schedules and theft of monitors

TABLE VI

SUMMARY OF ENFORCEMENT ACTIONS

<u>Date</u>	<u>Shipper</u>	<u>Waste Description and Classification</u>	<u>Transport Mode</u>	<u>Violation</u>	<u>Enforcement Action</u>
Nov. 20, 1980	RMI Company Ashtabula, OH	Contaminated trash, Radioactive-LSA	Closed van Exclusive Use	a. Large holes in 55 gallon drums, not STC. 49CFR 173.392(C)(1). b. Burial container not constructed to prevent corrosion from contained waste.	Fined \$2000.00
Dec. 9, 1980	Florida Power and Light Co. Turkey Point	Contaminated trash, Radioactive-LSA	Closed van Exclusive Use	Holes found in numerous 55 gallon drums. Not STC's 49CFR 173.392(C)(1).	Fined \$1000.00
Dec. 23, 1980	Carolina Power and Light Company Brunswick Station	Compacted trash contained in metal dumpsters, Radioactive -LSA	Flatbed trailer Exclusive Use	a. Container leaking contents, not STC's. 49CFR 173.392(C)(1). b. Liquids in excess * of allowable limits 10CFR 30.41.	Fined \$2000.00
Jan. 29, 1981	Olin Corporation Marion, IL	Depleted uranium contaminated soil contained in 55 gallon drums, Radioactive-LSA	Closed van Exclusive Use	a. Liquids in excess * of allowable limits 10CFR 30.41. b. Drums contained puncture holes, not STC's. 49CFR 173.392 (C)(1).	Fined \$2000.00 suspended trans- permit not to exceed 1 year.
Jan. 28, 1981	PASNY-Indian Pt. 3	Deminerallizer resins, dewatered, Radioactive- LSA	Greater than Type A cask Exclusive Use	Liquids in excess * of allowable limits 10CFR 30.41.	Fined \$1000.00

* Violation of burial facility license

<u>Date</u>	<u>Shipper</u>	<u>Waste Description and Classification</u>	<u>Transport Mode</u>	<u>Violation</u>	<u>Enforcement Action</u>
Feb. 10, 1981	Florida Power Corp. Crystal River	Compacted waste contained in 55 gallon drums, Radioactive-LSA	Greater than Type A cask, Exclusive Use	Radioactive levels in excess of DOT limits at surface of package (cask) 220mr/hr, and at 2 meters from vertical point of transport vehicle 15mr/hr. 49CFR 173.392(J)(2)(3).	Fined \$2500.00 and transport permit suspend. for 30 days.
March 12, 1981	VEPCO-Surry Station	Compacted waste contained in metal dumpsters, Radioactive-LSA	Flatbed trailer Exclusive Use	Holes in container, not STC's. 49CFR 173.392(C)(1).	Fined \$1000.00
Sept. 2, 1981	Rhone-Poulenc Chemical Company	Diatomaceous earth filter media, Radioactive-Low Specific Activity	17H drums in closed van, Exclusive Use	Leaking containers, not strong tight containers. 49CFR 173.392(C)(1).	Fined \$2000.00
Sept. 4, 1981	Interstate Uniform Service	Laundry waste and piping, Radioactive Material, NOS	17H drums in closed van, Nonexclusive Use	a. Drums not labeled 49CFR 172.402. b. Shipment not certified nor placarded properly. 49CFR 172.204.	Fined \$1000.00
Sept. 8, 1981	Neutron Products, Inc.	Aluminum crucibles and holders, Radioactive Material	1-13-G-1 Shipping Cask, Exclusive Use	Spreadable surface Contamination in excess of 49CFR 173.397.	Fined \$5000.00 suspension of trans. permit for 30 days.

TABLE VII

PERSONNEL EXPOSURE (TLD) FOR CHEM-NUCLEAR SYSTEMS, INC. EMPLOYEES
October 1980 - September 1981

Job Classification	Avg. No. Employees	Total Man-Rem	*Average Exposure per Individual in Rem
Health Physics Technicians	13	10.366	0.796
Off-Loaders	17	22.105	1.30
Equipment Operators	7	11.405	0.950
Drivers	15	1.685	0.112
Maintenance	23	0.437	0.190

* For the period October 1980 - September 1981.

TABLE VIII

COMPARATIVE YEARLY TABULATION OF DISCREPANCIES

Contract	Total Vehicle Inspections	Total Discrepancies	Road ¹ Worthiness	Paper Work ²	Radiological ³	Placarding ⁴	Restraints ⁵
1979	1,334	446 33.4%	No Data	No Data	143 10.7%	279 20.9%	24 1.8%
1980	558	229 41.0%	No Data	12 2.2%	52 9.3%	125 22.4%	40 7.2%
1981	4,742	196 4.1%*	107 2.3%	25 0.5%	16 0.3%	37 0.8%	11 0.2%

¹ ROADWORTHINESS - Includes flat tires, leaking exhausts, fractured or broken frame members and springs, missing bolts, nuts, wheel wedges, etc. and damaged tire rims.

² PAPERWORK - Includes missing or inadequate exclusive used instructions, shippers' certification.

³ RADIOLOGICAL - Includes excessive radiation fields, leaking containers, improperly closed containers.

⁴ PLACARDING - Includes improper labels, lack or placards or labels.

⁵ RESTRAINTS - Includes lack of proper blocking or braces, lack of tie downs and/or loose tie downs.

* Total discrepancies divided by total vehicle inspections.

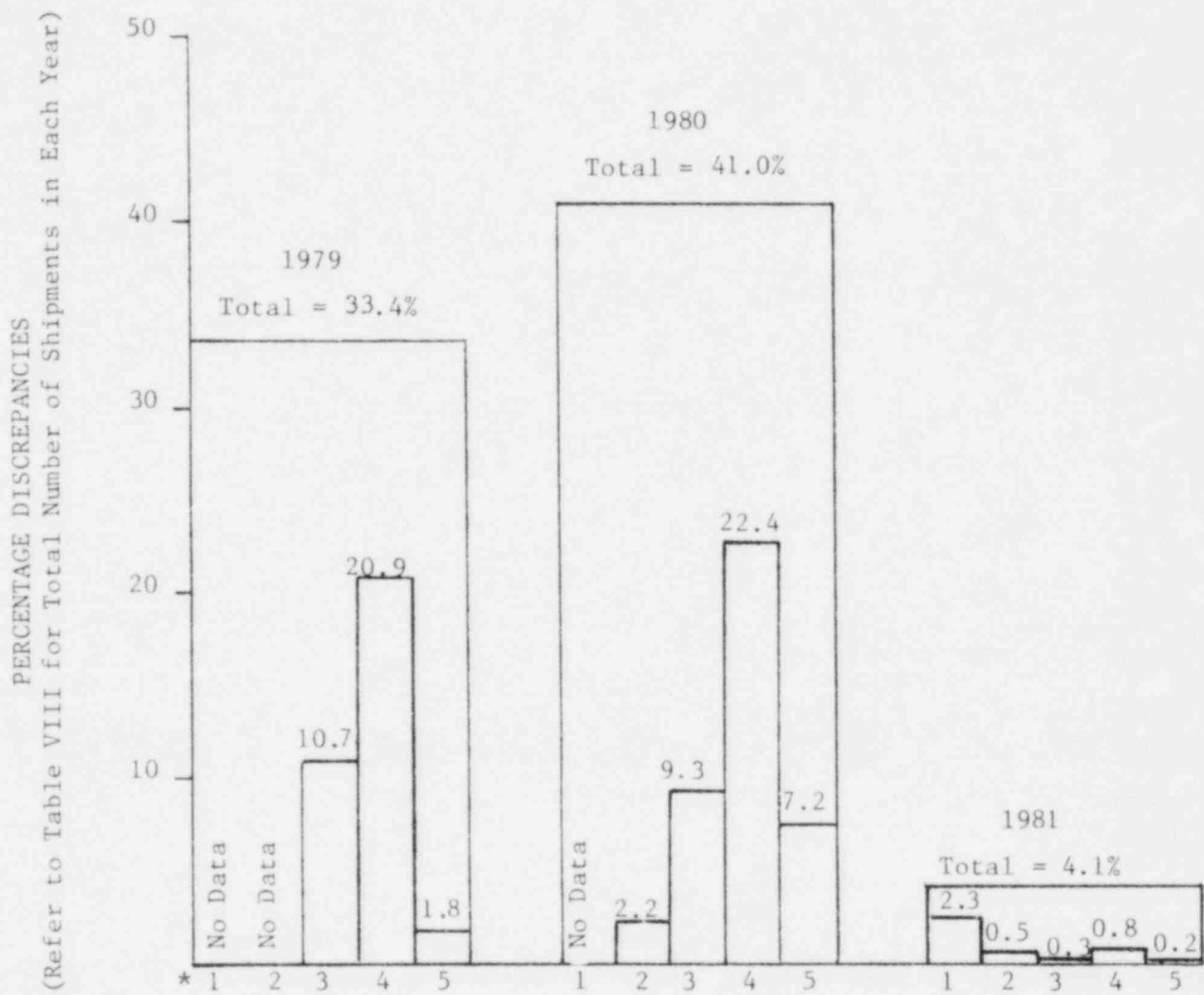
TABLE IX
MAJOR TRANSPORT ROUTES

- A - 48-321-3-64
- B - 130-76-178-25-19-78-39-64
- C - *I95-301-70-64
- D - 90-378-I95-301-70-64
- E - I95-321-278-64
- F - 151-15-I20-I26-3-64
- G - I77-72-321-I20-I26-321-3-64 OR I77-I20-I26-321-3-64
- H - 125-278-64
- I - I26-321-3-64 OR I26-321-3-70-64
- J - I26-85-153-123-130
- K - I26-121-19-278-64
- L - 301-278-64
- M - I26-301-70-64
- N - 17-64
- O - 76-I95-301-70-64

* I - denotes Interstate Highway

FIGURE I

Comparative Yearly Percentage for Discrepancies



* Numbers 1 - 5 correspond to Superscripts for Table VIII

FIGURE 2
Major Highway Routes

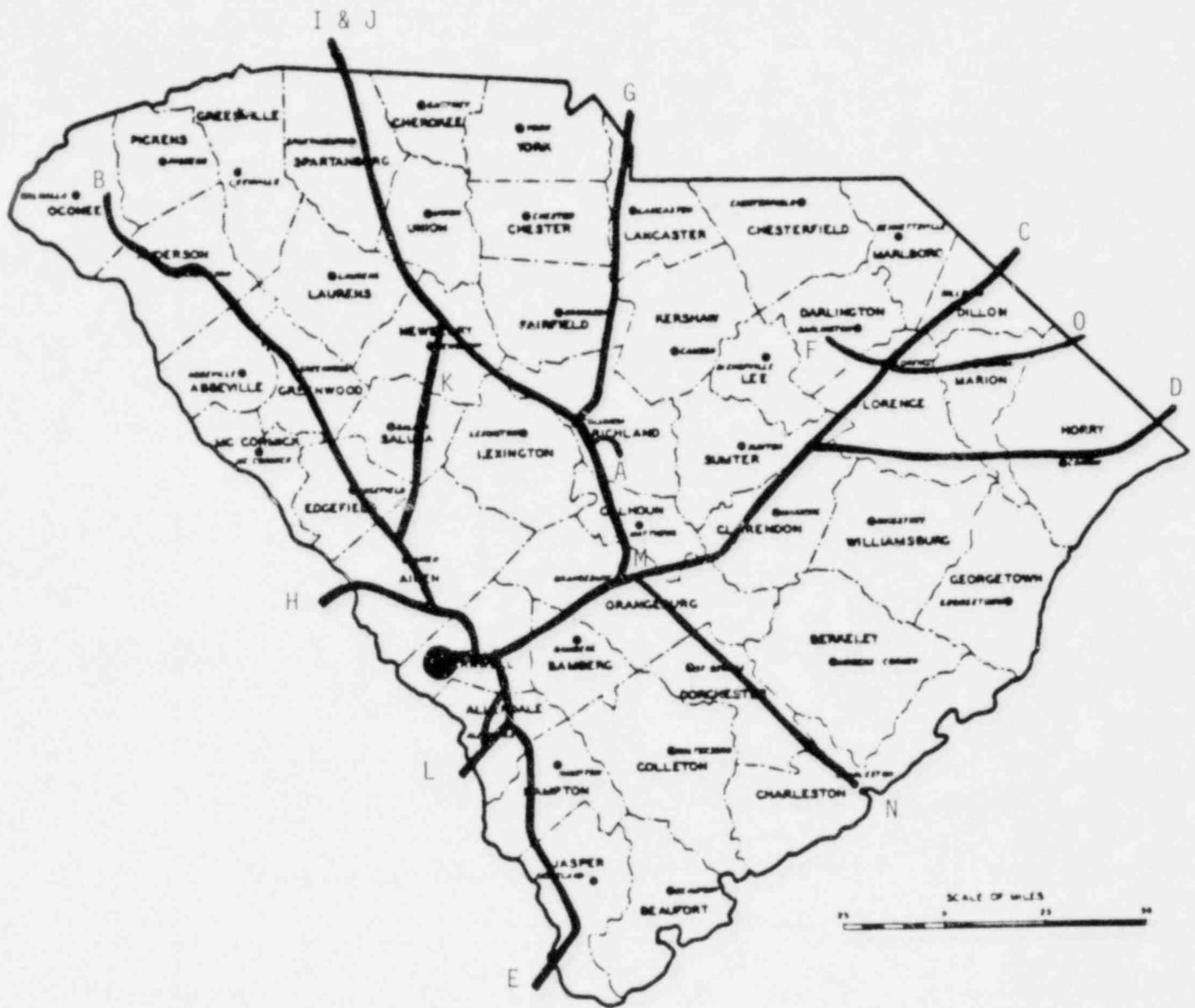


FIGURE 3

Location of TLD Area Monitors around Chem-Nuclear Facility and Adjacent Transportation Terminals

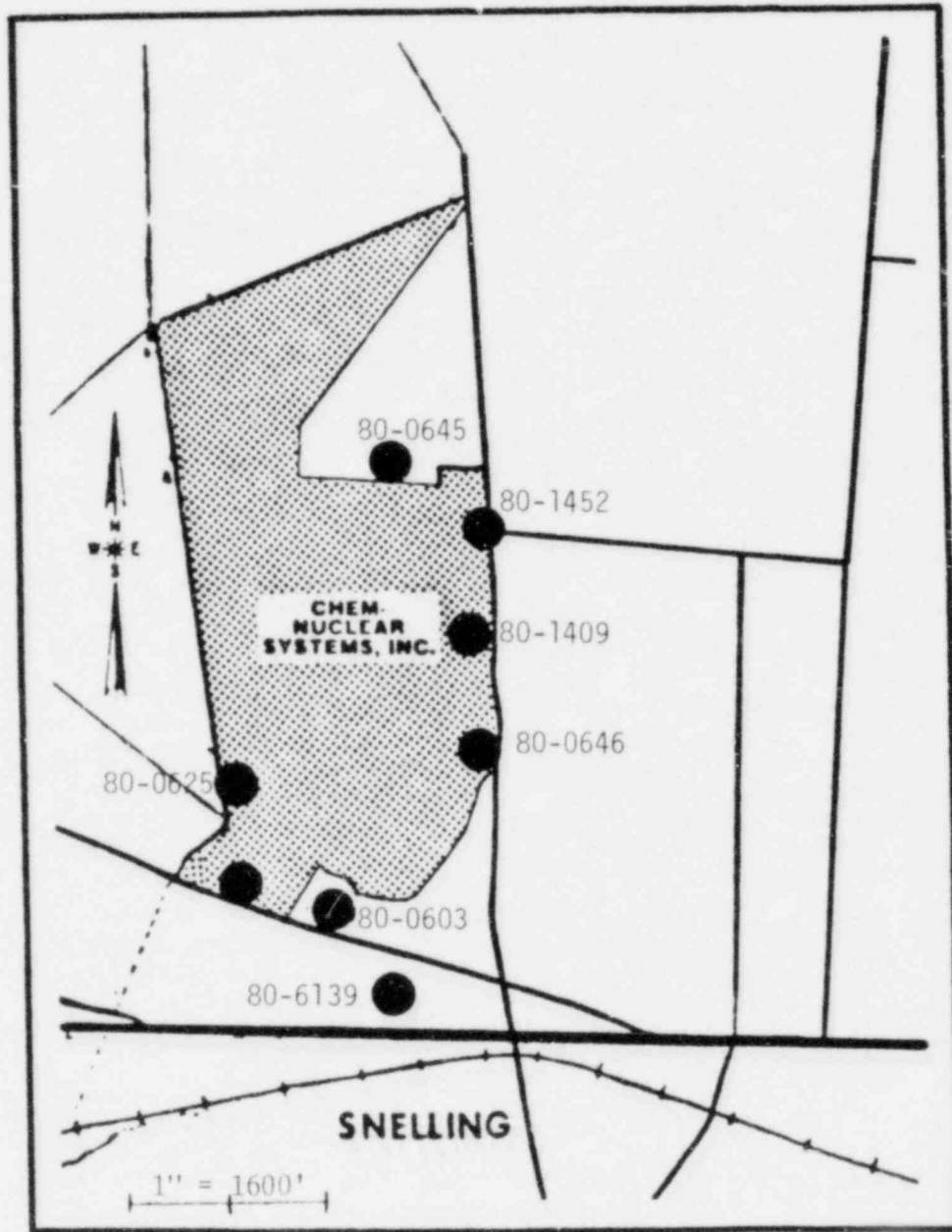


FIGURE 4

Location of TLD Area Monitors at Site Buildings
at Chem-Nuclear Systems, Inc.,
Barnwell, South Carolina

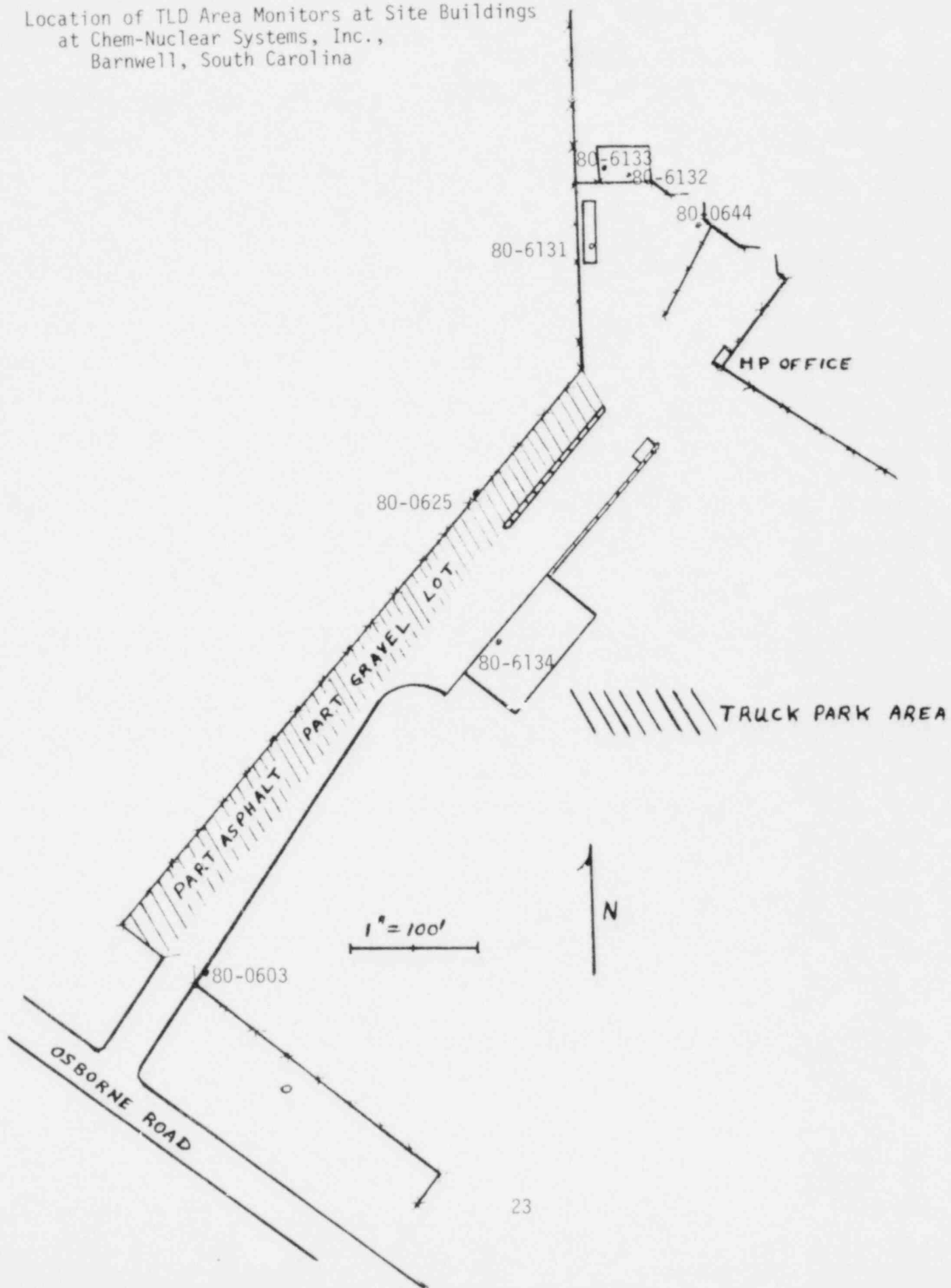


FIGURE 5

Location of TLD Area Monitors at
Home Transportation Co. Terminal
Barnwell, S.C.

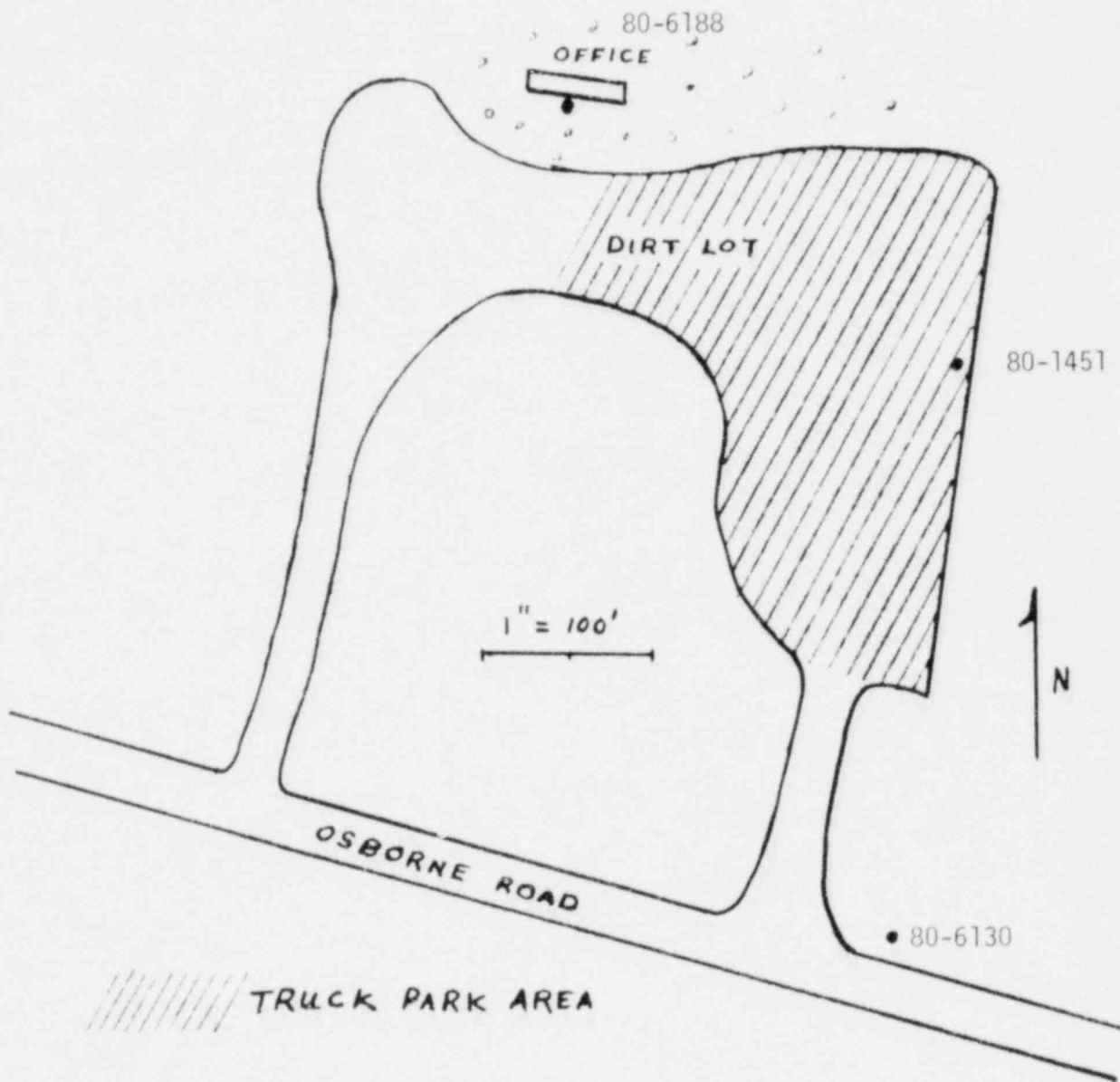
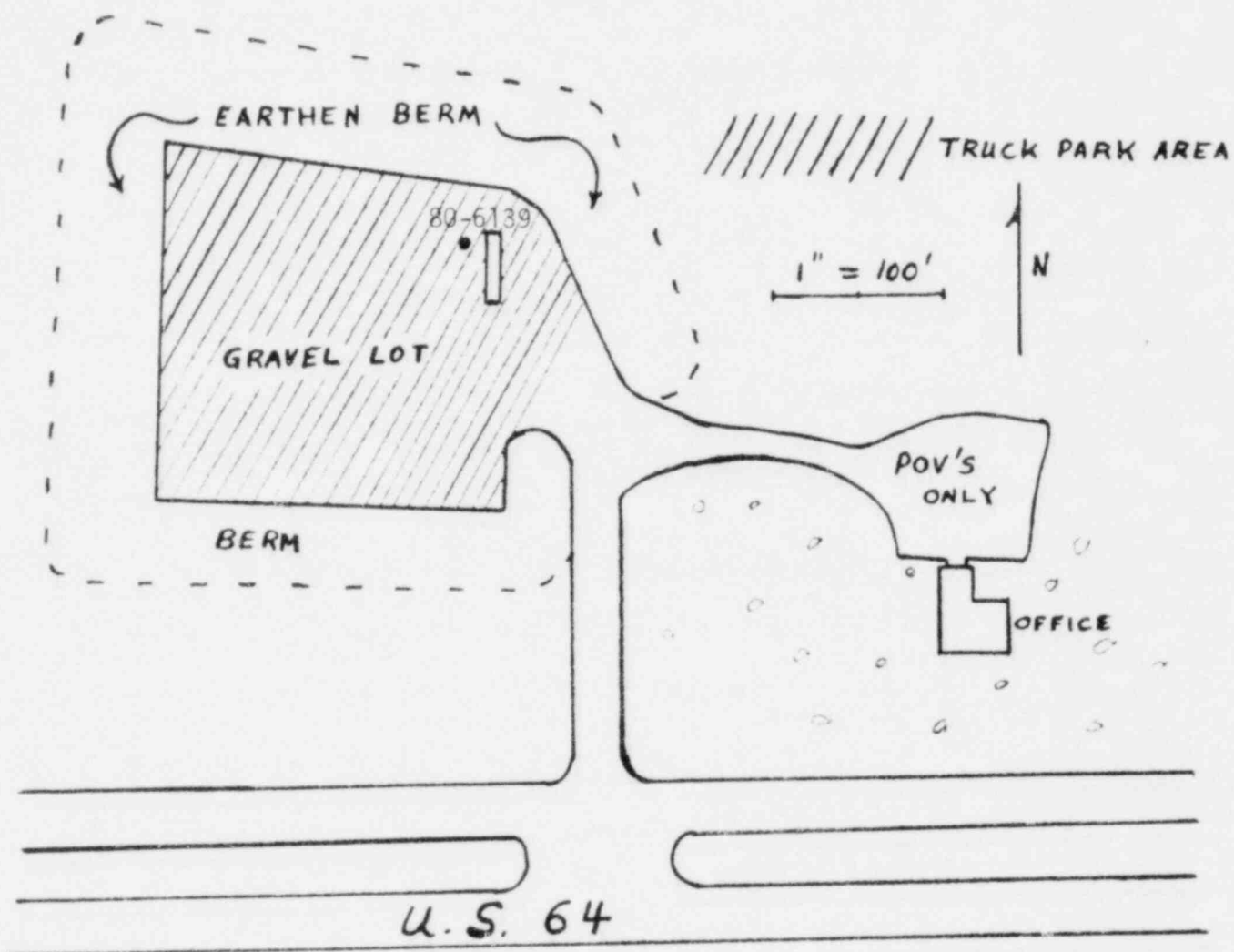


FIGURE 6

Location of TLD Area Monitor at
Tri-State Motor Terminal



APPENDIX I

SHIPMENT DESCRIPTIONS

A. Origin and types of radioactive shipments:

1. Commercial nuclear power plants, U.S. Navy nuclear powered vessels, and research reactors.
 - a. Spent resins and filters used to remove radioactive contaminants and corrosion products from primary cooling systems.
 - b. Concentrated solidified sludges.
 - c. Contaminated or irradiated metal components and equipment (pumps, fuel racks, piping, etc.).
 - d. Contaminated liquid in solidified form.
 - e. Contaminated paper, protective clothing, wood, building rubble, and other general trash.
2. Academic, commercial and government research laboratories and hospitals.
 - a. Contaminated general laboratory trash, such as glassware, paper, lab clothing, gloves, culture dishes, vials, syringes, etc.
 - b. Animal carcasses containing residual radioactive tracers.
 - c. Decayed sealed radioactive sources used in cancer therapy, instrument calibration and research.
 - d. Solidified aqueous solution containing radioactive contaminants.
3. General industrial, irradiator facilities, research laboratories, and nuclear fuel processing facilities.
 - a. Sealed radioactive sources from gauging devices.
 - b. Large radioactive sealed sources used in irradiators for sterilization of products or in industrial radiography.
 - c. Depleted uranium slag resulting from the manufacture of shielding devices and weapons projectiles.
 - d. Uranium slags and slurries generated as the result of nuclear fuel fabrication and processing.
 - e. Piping, wiring, metals, and other hardware with induced radioactivity from particle accelerators.

4. Department of Defense

- a. Aviation gauges, luminous dials, compasses, and electron tubes containing radioactive material.

B. Packages and containers used for shipping:

1. 5-gallon metal pails with crimp tops.
2. 30- and 55-gallon metal drums with rim lock bands.
3. Steel cask liners (100 - 300 cubic feet).
4. Large reinforced wooden crates.
5. Type A and Type B shipping casks.
6. Transfer "pigs" (various sizes and shapes).
7. Large metal tanks and steel containers.
8. Items wrapped in heavy polyethylene or Herculon.
9. Large concrete blocks.
10. Bulk material in covered dump truck (not requiring packages).

C. Motor vehicles used for transport purposes:

1. Tractor/trailer, enclosed vans (hard or canvas top).
2. Flat-bed trailers with large crates, metal tanks, with shipping cask.
3. Step-deck trailers with shipping casks permanently or temporarily mounted.
4. Low-boy trailers with shipping casks permanently or temporarily mounted.
5. Straight trucks and delivery vans.
6. Pickup trucks.

APPENDIX II

INSPECTION PROCEDURES

The inspections were performed at the Chem-Nuclear Systems, Inc. site near Barnwell, South Carolina, by inspectors of the South Carolina Department of Health and Environmental Control, Bureau of Radiological Health (DHEC). Arriving shipments were inspected prior to their moving into the trench site area for off-loading. A normal sequence for inspection by DHEC involved the following procedures:

1. Review and inspect shipping papers for proper classification, copies of notifications, certifications, and transport permits.
2. Survey vehicle and packages with portable survey instruments to determine radiation levels in accordance with DOT regulations.
3. Inspect vehicle for DOT placards.
4. Inspect tractor and trailer for defects in tires and lights, and for structural failure of trailer.
5. Inspect security seals on closed vans or casks.
6. Open transport trailer and inspect packages and containers for labels, markings, seals, specification packaging, damage, leakage, bracing and blocking.
7. Inspect shipping casks for labels, markings, seals, lid bolts, tie-downs, mounting bolts, damage or leakage.
8. Take smears on outside and floors of closed vehicles, flatbeds, low-boy, etc.
9. Take smears from casks, containers, and representative packages.
10. Note any discrepancies during, and following, off-loading of packages.
11. Record all information on appropriate inspection forms.

NRC FORM 335 (7-77)		U.S. NUCLEAR REGULATORY COMMISSION BIBLIOGRAPHIC DATA SHEET		1. REPORT NUMBER (Assigned by DDC) NUREG/CR-2842	
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7. AUTHOR(S) Richard Sappington and staff members of the Bureau of Radiological Health				3. RECIPIENT'S ACCESSION NO.	
9. PERFORMING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code) Bureau of Radiological Health Department of Health and Environmental Control State of South Carolina 2600 Bull Street Columbia, SC 29201				5. DATE REPORT COMPLETED MONTH January YEAR 1982	
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15. SUPPLEMENTARY NOTES First year-NUREG/CR-0255; Second year-NUREG/CR-1434; Third year-NUREG/CR-2195				6. (Leave blank)	
16. ABSTRACT (200 words or less) Transportation of radioactive materials into and within South Carolina was studied for the fourth and final year under the joint NRC/DOT contract. The majority of the data presented results from inspections of shipments containing low-level radioactive wastes. A small number of packages containing other radioactive materials was also inspected. The results indicate a significant decrease in the number of violations of State and federal regulations over the study period from October 1978 through September 1981. This may be attributed to the enforcement of new legislation and increased efforts of field inspectors. Major recommendations are: 1. The Department of Transportation should increase the emphasis on carrier equipment inspections. 2. Clarification and revision of Motor Carrier Safety regulations is needed. This should include provisions for required, frequent carrier inspections of equipment. 3. Carriers and drivers should be trained and knowledgeable as to their responsibilities and in applicable regulations.				8. (Leave blank)	
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18. AVAILABILITY STATEMENT Unlimited				13. TYPE OF REPORT Transportation Surveillance Study (Fourth year)	
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TRANSPORTATION OF RADIOACTIVE MATERIAL IN SOUTH CAROLINA