CHARACTERISTICS OF HAZARDOUS CARGO SHIPMENTS ON VIRGINIA HIGHWAYS

N. K. Hook, Jr.*, Virginia Department of Highways and Transportation, Arlington; and
John T. Hanna, Virginia Division of Highway Safety, Richmond

The movement of dangerous materials poses potential health and safety hazards to many citizens along routes of travel. The purpose of this paper is to identify the type and frequency of hazardous materials being transported over Virginia highways. Analyses of field interviews with 7,591 truckers to determine type of hazardous cargoes, their origins and destinations, and the compliance with federal and state placarding regulations are presented. Results of the study indicate that approximately 3.6 percent of all trucks on Virginia highways contain hazardous materials; most of them carry flammable liquids.

SPECIAL problems are inherent in the transportation of certain materials that pose extreme safety and health hazards. When one recognizes that nearly 40 percent of all manufactured freight is being shipped on our nation's highways (1) and is cognizant of the potential dangers involved in the transportation of hazardous materials, the need for determining the frequency and type of hazardous cargo shipment becomes apparent. This report summarizes the frequency of dangerous article shipments and potential dangers involved in these shipments and evaluates the movement of hazardous material on highways throughout Virginia.

DEFINITION OF HAZARDOUS MATERIALS

A hazardous or dangerous material is defined as any flammable liquid, flammable solid, oxidizing substance, corrosive liquid, compressed gas, poisonous substance, radioactive substance, explosive, or other substance defined by the Virginia State Corporation Commission, the U.S. Department of Transportation (2), or other authorized regulatory agency.

DATA COLLECTION

To determine the general magnitude of problems associated with the transportation of hazardous materials, field surveys were conducted at eight permanent weigh stations located throughout Virginia and operated by the Virginia Department of Highways and Transportation. The location of these survey points is shown in Figure 1. The primary purposes of these surveys were to determine what types and quantities of hazardous materials were being moved throughout Virginia and to what degree these shipments pose severe hazards to the health and welfare of other persons. Specifically, information was collected on each truck arriving at the weigh station to determine

Publication of this paper sponsored by Committee on Transportation of Hazardous Materials.

*Mr. Hook was with Wilbur Smith and Associates when this research was performed.

1. The origin and destination points for each hazardous material shipment as identified on trucker weigh bills,
2. The type of hazardous material being shipped and the quantity of each, and
3. The degree to which truck placarding requirements are met by trucking firms.

Each station was surveyed between 8:30 and 10:30 a.m. continuously for 8 hours in each direction. Data were maintained by direction of travel for a later analysis.

In addition to the trucker surveys, interviews were conducted with major manufacturers and users of hazardous materials and with several trucking firms. These field surveys provided the information required to identify problems associated with the transportation of dangerous materials.

ORIGIN-DESTINATION SURVEY

During the field interviews, 7,591 trucks were surveyed and were found to contain 334 shipments of hazardous materials. These 334 shipments were carried by 274 trucks. Twenty-seven percent of these shipments (91 shipments) had both origin and destinatior within Virginia, and 31 percent (102 shipments) had either an origin or destination within Virginia but not both. Forty-two percent (141 shipments) passed through Virgin with both an origin and destination outside of the state.

Since Virginia lies in the middle of the United States on the Atlantic seaboard and ha a natural barrier to the east, the Atlantic Ocean, and to the west, the Appalachian Mountains, it was anticipated that north-south shipments of hazardous materials would be frequently noted passing through Virginia. However, when the origins and destinations of hazardous cargo shipments were plotted, no significant trends were apparent. Trip desire patterns through and within Virginia are dispersed throughout the state. No major routes were identified as carrying significant volumes of hazardous materials This may be in part because manufacturers use rail or water transportation for large shipments of a hazardous nature between distant points. Table 1 gives a summary of hazardous cargo shipments by survey location and direction of travel. The weigh stations at Stephens City and Sandston, Virginia, had the highest percentage of dangerou article shipments (5.0 and 4.5 percent respectively). Dahlgren and Dumfries, Virginia, had the lowest percentage of hazardous material shipments (2.0 and 2.6 percent respectively). The overall average of hazardous cargo shipments was 3.6 percent.

TYPES OF HAZARDOUS CARGOES

Table 2 gives the types of hazardous cargoes traveling within Virginia (8-hour survey). Flammable liquids are the most frequent shipments (129 trucks). The second most frequent shipment is corrosive materials (70 trucks). Fourteen trucks surveyed were carrying explosives. No truckers were surveyed hauling radioactive materials, etiologic agents, or class C poisons.

Because of the wide variations in cargo quantities, it is not possible to indicate an average cargo shipment. However, there are two possible exceptions: Truckers hauling flammable liquids and compressed gases generally are restricted in quantities of materials hauled. Most truckers interviewed had either full or empty trucks; only a few trucks were only partially full. The average quantity of flammable liquid hauls was 5,470 gal (20 700 liters), and the average quantity of compressed gas was 6,401 lb (2900 kg) for flammable gases and 7,480 lb (3390 kg) for nonflammable gases. Average quantities were determined from trucks with hazardous materials on board and did not include empty trucks.

DIRECTION OF TRAVEL

An attempt was made to determine the percentage of hazardous cargo shipments by

Figure 1. Field survey locations.

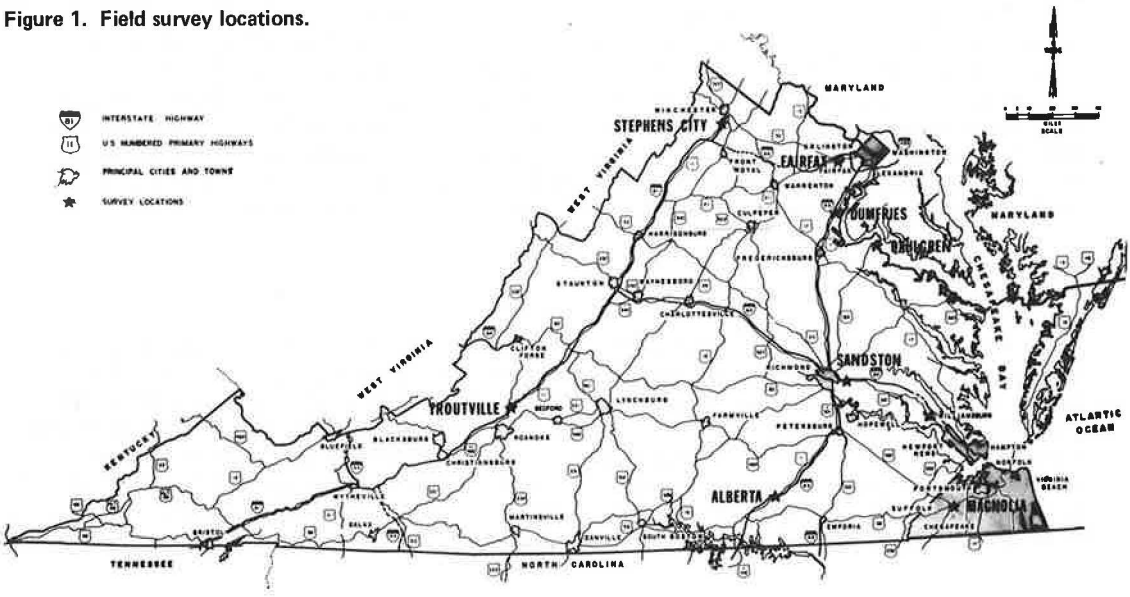


Table 1. Percentage of hazardous cargo shipments by station and direction of travel.

Virginia Location	Route	Day of Week	Total Trucks	Trucks With Hazardous Cargo	Total (percent)
Alberta	I-85				
Northbound		Tuesday	324	11	3.4
Southbound		Tuesday	435	15	3.4
Subtotal			759	26	3.4
Dahlgren	US-301				
Northbound		Monday	192	2	1.0
Southbound		Monday	164	5	3.0
Subtotal			356	7	2.0
Dumfries	I-95				
Northbound		Friday	903	20	2.2
Southbound		Friday	1,169	35	3.0
Subtotal			2,072	55	2.6
Fairfax	I-66				
Eastbound		Thursday	347	15	4.3
Westbound		Thursday	386	13	3.4
Subtotal			733	28	3.8
Magnolia	US-58				
Eastbound		Friday	362	6	1.6
Westbound		Friday	400	25	6.2
Subtotal			762	31	4.1
Sandston	I-64				
Eastbound		Monday	337	23	6.8
Westbound		Monday	390	10	2.6
Subtotal			727	33	4.5
Stephens City	I-81				
Northbound		Wednesday	397	20	5.0
Southbound		Wednesday	478	24	5.0
Subtotal			875	44	5.0
Troutville	I-81				
Northbound		Tuesday	649	19	2.9
Southbound		Tuesday	658	31	4.7
Subtotal			1,307	50	3.8
Total			7,591	274	3.6

direction of travel (Table 3, 64-hour survey). Hazardous article shipments ranged between 2.9 and 4.2 percent by direction of travel. However, the analysis does not indicate a significant hazardous material movement in a particular direction.

A statistical analysis was conducted to determine if the directional distribution of hazardous materials is a predictable occurrence. A chi-square test of independence was conducted to determine if hazardous cargo shipments depend on survey location and, thereby, are predictable on a statewide basis. Based on the results of the statistical analysis, no predictable frequency of hazardous material shipments existed.

PLACARDING

An inventory of dangerous shipments that are not placarded as specified by state and federal rules and regulations was made. As shown in Figure 2, approximately 33.9 percent of all trucks carrying hazardous cargoes did not have placards as required by regulations. However, when compared with the total number of trucks traveling on the highways, only 1.2 percent of hazardous cargo shipments were in violation of federal and state rules and regulations. Truckers gave varying reasons for not having placards properly affixed to the vehicles: Placards were not issued by the dispatcher, and weather conditions prohibited the placards from being affixed.

IMPLICATIONS

Special consideration must be given to any highway incident involving dangerous articles. Because of the nature of the materials, severe hazards that can affect public health and safety are inherent in any dangerous article shipment. It is not possible to generalize about the type of hazard involved by classifying of material (i.e., explosive, flammable, or corrosive) since each class of material will exhibit a wide range of potential dangers. Unless the actual cargo is known, it is advisable to anticipate that the cargo is flammable and explosive and extremely dangerous to health.

Current federal and state regulations that pertain to the transportation of dangerous articles do not require placards that will not burn. Considering the relative dangers of materials being transported, it would be beneficial if placards were required to be nonflammable and legible for a period of time when exposed to fire. This would result in potentially significant benefits to emergency crews responding to an incident involving dangerous materials.

Some cargoes moving over Virginia's highways pose severe dangers to health and welfare of many citizens (i.e., truck load shipments of explosives, certain poisons, and other materials). Further research is needed to determine the needs for specific routing for these materials. It might also be advantageous to have certain materials that are shipped in bulk quantities escorted on the highway and through urban areas.

It was found that hazardous cargo shipments averaged 3.6 percent of all trucks on Virginia highways. This is considerably lower than was initially anticipated before this study was conducted. Some states might, however, have a higher percentage of hazardous material shipments because of manufacturing and industrial facilities and military and aerospace complexes. Therefore, the percentage of hazardous material shipments within Virginia may not be typical of other states because situations will vary between survey points.

Further research might be beneficial to determine

1. The primary mode of hazardous cargo shipments (i.e., water, rail, or highways),
2. The quantities in which hazardous materials are generally transported in other states,
3. The relative dangers of hazardous materials by classification, and
4. Additional precautionary measures and regulations that should be instituted to ensure the safety and welfare of all citizens along routes of hazardous material shipments.

Table 2. Types of hazardous cargoes.

Classification	Number of Shipments	Quantity (lb)	Average Shipment (lb)
Explosive, unclassified[a]	1	240	240
Explosive, class A	7	113,289	16,184
Explosive, class B	1	6,948	6,948
Explosive, class C	5	3,770	754
Flammable liquid	129	705,702[b]	5,470[b]
Flammable solid	19	496,471	26,130
Oxidizing material	7	106,459	15,208
Corrosive material	70	1,044,112	14,916
Flammable compressed gas	48	307,233	6,401
Nonflammable compressed gas	28	209,446	7,480
Poisons, unclassified[a]	6	116,895	19,483
Poisons, class A	3	82,795	27,598
Poisons, class B	9	131,384	14,598
Poisons, class C	0	0	0
Etiologic agents	0	0	0
Radioactive materials	0	0	0
Cryogenic materials	1	35,000	35,000
Total, lb[c]	205	2,654,042	12,947

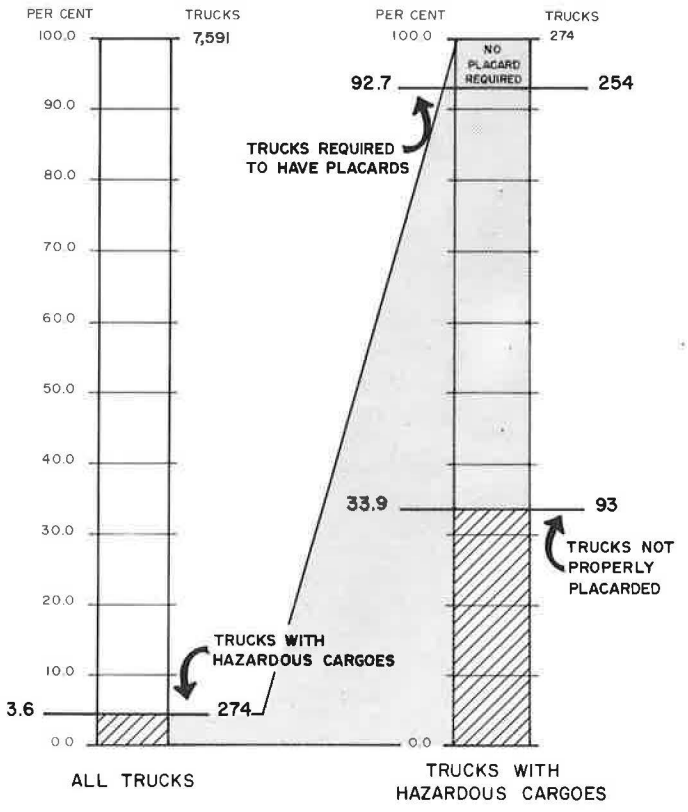
Note: 1 lb = 0.45 kg. 1 gal = 3.8 liters.

[a]Indicates that the shipping document did not indicate product by name or class such as A, B, or C explosive or poison.
[b]Gallons.
[c]Represents split classification shipments and, therefore, will not compare with other tables.

Table 3. Percentage of hazardous cargo shipments by direction of travel.

Direction	Total Trucks	Trucks With Hazardous Cargo	Percent
Northbound	2,465	72	2.9
Southbound	2,904	110	3.8
Eastbound	1,046	44	4.2
Westbound	1,176	48	4.0
Total	7,591	274	3.6

Figure 2. Placarding regulation compliance.



ACKNOWLEDGMENT

We wish to express our appreciation to the National Highway Traffic Safety Administration and to the Virginia Division of Highway Safety for providing funds for the study. The Virginia Department of Highways and Transportation provided invaluable assistance in permitting the use of weigh stations during the data collection phases of the study. In addition, the assistance of the Federal Highway Administration and the Office of the Secretary of Transportation provided valuable input in the initial research of this report.

REFERENCES

1. Changes in Legal Vehicle Weights and Dimensions. NCHRP Rept. 141, 1973, p. 21.
2. Title 49, Code of Federal Regulations. U.S. Government Printing Office, Washington, D.C.
3. Highway Transportation of Hazardous Materials in Virginia. Virginia Division of Highway Safety and National Highway Traffic Safety Administration, 1974.