Hazardous Materials Commodity Flow Survey

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Abstract

The US Department of Energy, Office of Packaging and Transportation, has conducted a number of highway Commodity Flow Surveys along the major shipping corridors it uses for shipment of hazardous (radioactive and chemical) materials, in response to requests from its transportation stakeholders.

The objective of a Commodity Flow Survey is to collect data which can be analyzed to provide clear images, over time, of the types and amounts of hazardous materials shipments moving past a point along a transportation corridor. The information produced by such a survey can be an indispensible tool in helping emergency planners understand and identify the planning, training, and resource requirements needed to effectively respond to a transportation incident involving hazardous materials.

This paper discusses requisites for conducting a useful Commodity Flow Survey and presents lessons learned on how results are developed and how insights on hazardous materials movements are gained through use of a survey. A key issue in the process is the care that must be exercised in planning and executing the survey, such that high data quality is achieved, with the result that the survey findings are clear and useful to transportation emergency planners. Among the activities described and discussed are: establishing survey location and objectives cooperatively with local emergency planners; establishing and training an effective survey team; survey data interpretation and analysis; and presentation of results as clear and persuasive images.

Preface

In the United States, hazardous (radioactive and chemical) materials are generally distributed by highway or shipped in bulk by rail. Detailed information on rail shipments is maintained by the railways and is available to qualified emergency managers. This paper focuses on highway transport of hazardous materials and illustrates the processes involved in collecting information beneficial to emergency response planners along the highways.

Hazardous materials are shipped along preferred highways, i.e., highways determined by federal and state transportation officials to present minimum risk. For long haul operations, this generally results in the use of the United States Interstate and Defense Highway System, to the maximum extent practical.

To date, the United States Department of Energy has conducted seven 24-Hour Commodity Flow Surveys along Interstate Highways and surveyed over 55,000 commercial vehicles, of which

2,900 were carrying hazardous material loads totaling over 50 million pounds (22.7 million kilograms).

I. The Planning Process

Planning for a Commodity Flow Survey (CFS) begins with an expression of interest from state or local emergency planners in having a better understanding of the types and quantities of hazardous materials (Hazmat) moving through a particular locale.

The first planning challenge is to find a time and place suitable for conducting a highway survey, while maximizing the safety of survey personnel and the vehicles being surveyed and minimizing the impact of the survey on the flow of traffic. For limited access or Interstate highways, selection of a highway rest area or inspection station is the usual result. Accordingly, the cooperation of the authorities (commercial vehicle enforcement) who operate and maintain these facilities is essential, and these parties become key partners in planning and conducting a successful CFS.

The second challenge is planning for and staffing the survey. This includes reaching agreement among all participants on the times and dates of the survey, the roles and responsibilities of the participating organizations, the development of estimated manpower resources including an integrated shift schedule for the participating organizations, and agreement that each person participating in the survey has the training and tools required to safely and successfully conduct the survey.

The first step in the planning process is the development of a survey plan. The plan may be brief but, at a minimum, should contain information relating to: 1) the survey location; 2) dates, times, and duration of the survey; 3) human resources needed to conduct the survey; 4) a description of the place where, within the facilities chosen, survey data can be safely collected and the rules of site safety effectively applied; and 5) a description of how data is to be collected for accuracy and efficiency.

Safety and logistical considerations should be thoroughly developed in the planning process to assure that the survey is organized such that it can be executed harmoniously while being able to respond to unforeseen developments during the survey. Needs of the survey personnel should not be overlooked. Provisions should be made for shelter from inclement weather and sun protection, water and snack foods, and restroom facilities. For the evening hours of the survey, consideration should be given for survey area lighting, the use of reflective clothing by the survey team, and illuminated highway signage that clearly indicates that all Hazmat vehicles must enter the facilities for the survey.

Training is essential to conduct of the survey. When the survey team has been identified and the roster (shift schedule) developed, a team meeting should be scheduled about a week before the survey to instruct the team members on the techniques and rules of the survey. This training should include: the objectives of the survey; the rules of safety; how to identify motor vehicle

and trailer types; how to quickly find key information from the shipping papers (e.g., the UN number, the specific name of the load and its weight or volume, the origin and destination of the shipment); and how to enter data clearly and correctly on the survey forms provided.

II. Execution of the Survey (Lessons Learned)

The survey should begin on the appointed date only after all logistical details have been resolved and training for the survey has been conducted.

We have enjoyed excellent cooperation from the facility operators in identifying and directing Hazmat traffic to the safe area where the data is being collected. Typically, only about 5% of the commercial vehicles passing through the facilities need be diverted to the survey area. As a usual practice, surveys are usually begun at 9:00am on a mid-week day and continue for a 24-hour period. The data taking process begins when the first vehicle of the day stops at survey point. The survey team should consist of two or more persons on each side of the highway, depending on the time of day and expected traffic flow. It is desirable to have additional personnel who can relieve the survey team or provide a second survey team capability during periods of peak traffic activity. Normally, one team member is responsible for querying the vehicle driver for information and clearly transmitting it to the second team member who records the information on the survey data sheet. For vehicles carrying a single commodity, this transaction usually requires less than half a minute. For mixed loads with multiple commodities, discretion must be exercised by the survey team in recording only significant quantities of materials in order to avoid unnecessary delay of shipments.

An example data sheet from a survey logbook is included as Attachment 1. For this example, there are six data fields to be logged, they are: vehicle sequence; time of data entry; type of commercial vehicle; Hazmat placard number; hazardous material number (UN Number); origin and destination of the shipment; and proper name of the material along with its weight or volume. For mixed load shipments, more than one line on the data sheet may be utilized to record all the significant hazmat data.

As data sheets are completed, they are entered into loose-leaf logbooks and, at the conclusion of the survey, the remaining forms are entered the logbooks and a count of all commercial vehicles passing through the facilities (obtained from the station commander) during the 24-hour period is recorded.

III. The Commodity Flow Survey Report

The purpose of the CFS Report is to document the information collected during the survey and to present conclusions drawn from analysis of the data, supported by a clear presentation of the data as graphical images and summary tables. At a minimum, the CFS Report should consist of an executive summary, the survey data table, supporting tables and charts, and conclusions and findings.

IV. Parameters Examined in the CFS Survey Report

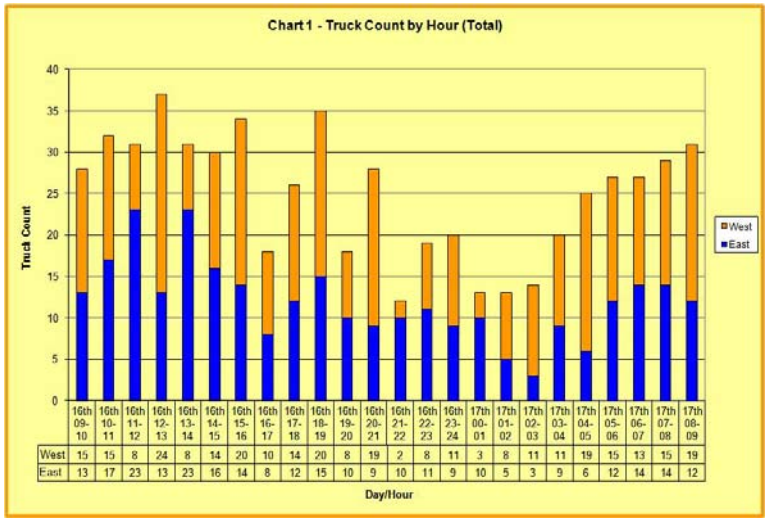
For the CFS Studies we have prepared, the following parameters have been examined:

A. Data Table

Data from the survey forms (Appendix 1) is entered into a spreadsheet and displayed in a table as shown in the example table (Appendix 2).

B. Vehicle Count by Hour of the Day

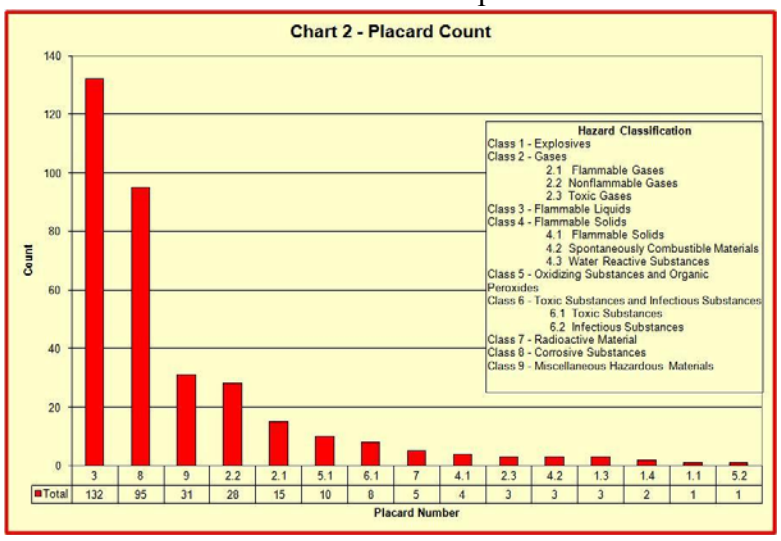
Chart 1 illustrates the flow of hazardous material traffic as a function of the time of day, and is useful to emergency planners in showing the ebb and flow of traffic during the day. Additional charts for each direction as a function of time are also useful. Periods of peak activity at that point along the highway can be identified. These periods are an indicator of increased probability of risk as a function of the time of day.



	16th 09-10	16th 10-11	16th 11-12	16th 12-13	16th 13-14	16th 14-15	16th 15-16	16th 16-17	16th 17-18	16th 18-19	16th 19-20	16th 20-21	16th 21-22	16th 22-23	16th 23-24	17th 00-01	17th 01-02	17th 02-03	17th 03-04	17th 04-05	17th 05-06	17th 06-07	17th 07-08	17th 08-09
West	15	15	8	24	8	14	20	10	14	20	8	19	2	8	11	3	8	11	11	19	15	13	15	19
East	13	17	23	13	23	16	14	8	12	15	10	9	10	11	9	10	5	3	9	6	12	14	14	12

C. Placard ID Count

Chart 2 illustrates the numbers of shipments for each hazard class (or division) identified during the 24-hour period of the survey. The hazard classification system established by the United States Department of Transportation employs placard identification which can be used by emergency responders to quickly gain an understanding of the types of materials and the threats they present. This example shows the relative distribution of the threats which can be expected to be

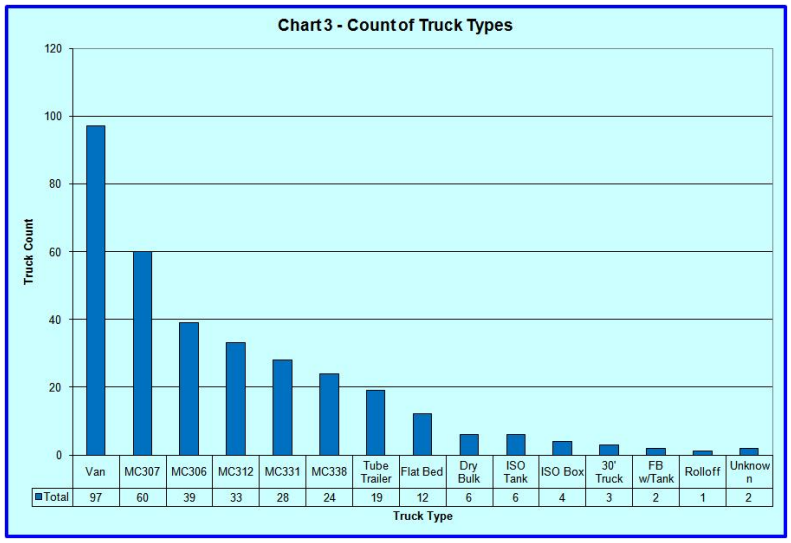


	3	8	9	2.2	2.1	5.1	6.1	7	4.1	2.3	4.2	1.3	1.4	1.1	5.2
Total	132	95	31	28	15	10	8	5	4	3	3	3	2	1	1

encountered along this particular stretch of highway.

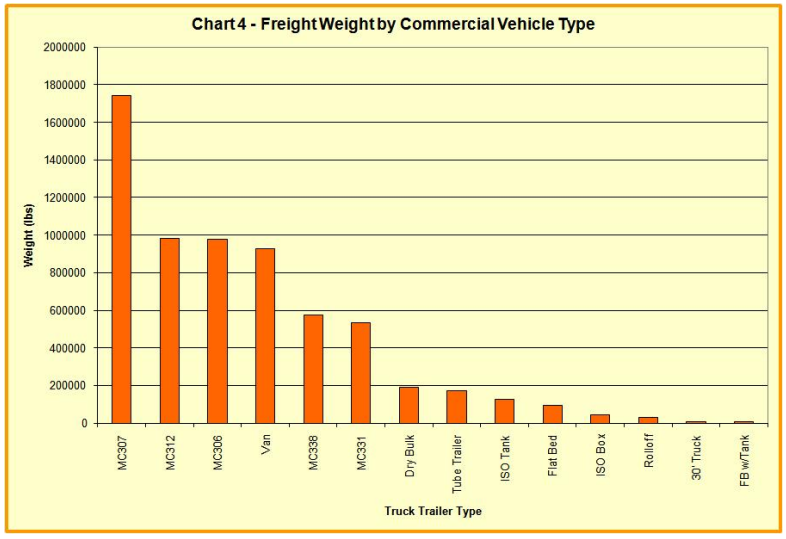
D. Commercial Vehicle Types

Chart 3 presents a count the types of commercial vehicles most commonly encountered on this particular highway. Knowledge of equipment types is useful to emergency response teams in securing the necessary training to cope with incidents related to equipment failure (e.g. leaking valves on tankers, pressure relief systems, load securement, etc.) for a particular type of vehicle. An identification chart for common road trailers is given in the Emergency Response Guidebook[1] at page 19. Many other types of custom trailers are used for specific Hazmat loads. They are identified using expert knowledge or from the identification tag bolted to the trailer frame.



E. Freight Weight by Commercial Vehicle Type

Chart 4 illustrates the total weight of cargo by truck type on a particular highway. As can be seen in this example, tanker trucks generally represent the truck types carrying the heaviest loads. Typically, tankers carry full loads of over 50,000 pounds whereas the average van has been found to carry less than 20,000 pounds. The information in this example shows that about 80% of the freight weight carried on this highway is carried in tank trucks. Incidents resulting from these vehicles could result in major releases of hazardous materials.

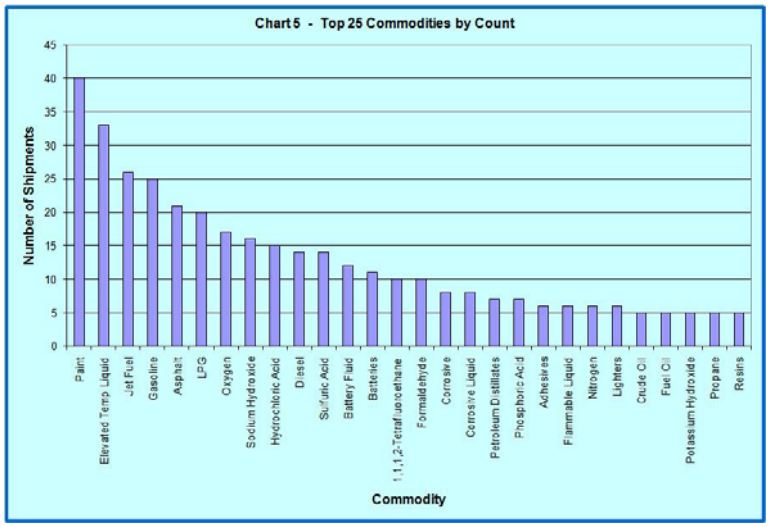


[1] The Emergency Response Guidebook was developed jointly by Transport Canada, The U. S. Department of Transportation, the Secretariat of Transport and Communications of Mexico and with the collaboration of CIQUIME (Argentina) for use by fire fighters, police, and other emergency service personnel who may be first to arrive at the scene of a transportation incident

involving dangerous goods. It is normally revised and reissued every four years. An electronic copy may be found at: http//hazmat.dot.gov/pubs/erg/guidebook/htm in English and Spanish.

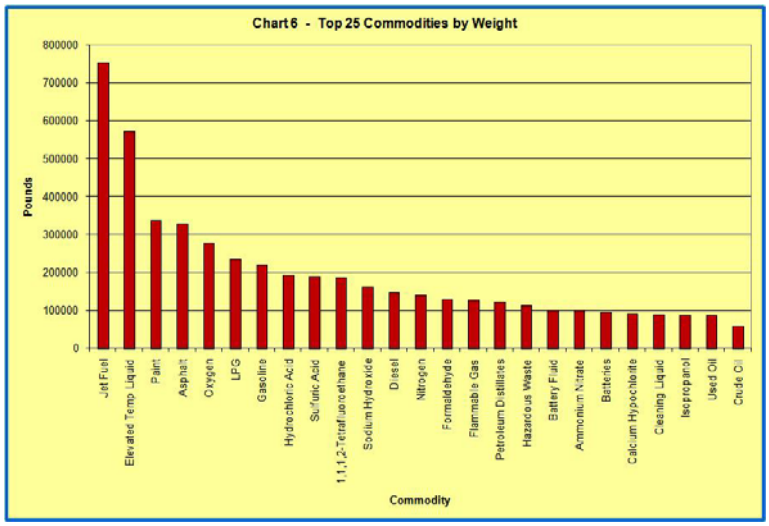
F. Top Commodities by Count

Chart 5 illustrates the 25 most commonly encountered hazardous materials and the numbers of shipments of each that were counted during the survey. This information addresses the probabilities of emergency responders encountering an incident involving one of these materials. These are the materials most likely to be involved in an incident on this highway; however, the consequences of the incident are the product of the probability and quantity of material involved. The next chart speaks to the issue of quantity at this point along the highway.



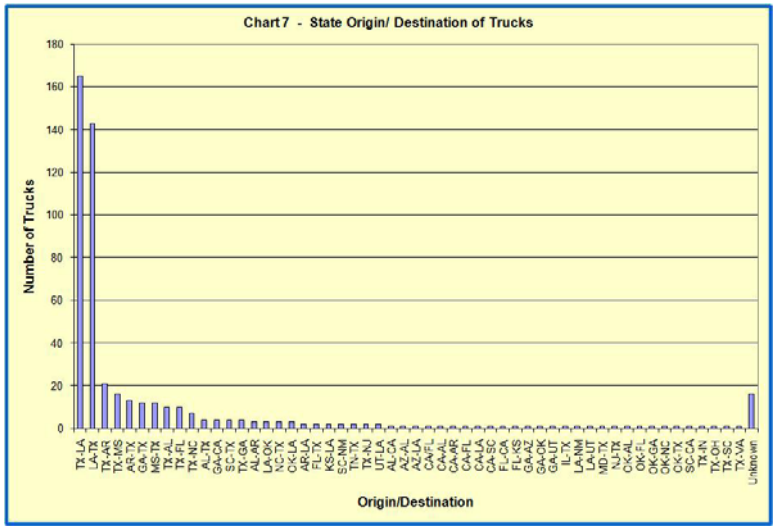
G. Top Commodities by Weight

Chart 6 addresses the 25 hazardous materials being shipped in the greatest total quantity along the highway during the survey. This chart, when taken with the previous chart which addresses probability, can give emergency planners an improved perspective on risks which could lead to serious consequences. This knowledge may be invaluable in planning for a transportation emergency.



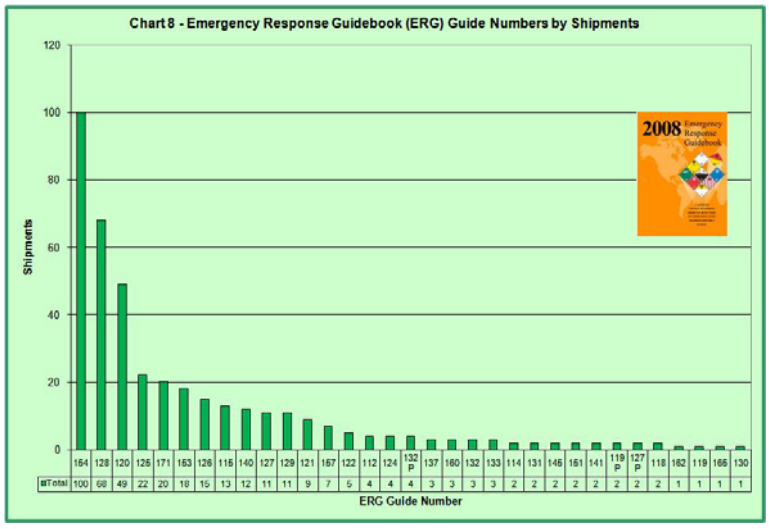
H. Origin and Destination of Commercial Vehicles

Chart 7 illustrates the origin and destination of each commercial vehicle. This information can be used to determine the distribution of local, regional, and national traffic. In this example regional traffic dominates. It may also be useful to summarize this information in pie charts showing local, regional and national contributions to traffic flow. This information is also useful for planning future highway improvements.



I. Emergency Response Guide

Chart 8 illustrates how each shipment relates to the Emergency Response Guidebook[1] and the appropriate response for an incident related to that particular hazardous material. As an example, for the radioactive shipments shown in this chart, the Response Guide Numbers 162 and 165 are given for Radioactive Materials (Low to Moderate Level Radiation) and Radioactive Materials (Fissile/Low to High Level Radiation), respectively. The materials were shown of the manifest as LSA II and Nuclear Fuel Rods, respectively. This information may be useful in identifying gaps that may exist in response training and for prioritizing emergency response training needs.



IV. Conclusion

This paper provides useful planning information that can be developed from the data taken during a Commodity Flow Survey. It may answer some questions for local emergency planners on what, how much, and at when certain hazardous materials are moving along a highway. Charts are provided to answer some of these questions. However, the heart of the survey is the entirety of the data contained on the spreadsheet and displayed as the data table.

The information in the data table can be manipulated in many ways to examine particular questions that arise from the survey. For example, in one survey it was found that petroleum products constituted more than half of the hazardous materials being shipped. This was addressed by preparing separate charts for petroleum products and for other hazardous materials. For another survey involving intersecting highways, surveys were conducted concurrently on both highways. Analysis of that data provided insight on the traffic flow interaction between the two highways, i.e. percent of hazardous material traffic exiting to the other highway versus percent of traffic remaining on the highway.

Although the survey data is quantitative, all conclusions drawn are qualitative. This is due to the limitation of survey duration. A 24-hour survey provides only a picture in time of one particular day. Other follow-up surveys could provide a clearer understanding of how distribution patterns for each hazardous material may change seasonally, e.g. greater volume of home heating oil in the winter. Nevertheless, it is believed that the information provided by the survey remains an invaluable emergency planning tool.

ATTACHMENT 1

Commodity Flow Survey
September 9-10, 2009

EXAMPLE

☐ Eastbound
☐ Westbound

J. L. Smith
Observer

#	Time	Trailer Type	Placard Number	Material ID#	Origin/ Destination	Hazmat Load e.g. Specific Material, Weight/Volume	
1	09:00	Van	8	1791	Rock Hill, SC Sylva, NC	Hypochlorite Solution, 18%	2,000 lbs
2	09:02	Double Van	3	1133	Richmond, VA Tempe, AZ	Adhesives	1418 lbs
		"	3	1193	"	Methyl ethyl ketone	1505 lbs
		"	8	2794	"	Wet Batteries	1900 lbs
3	09:05	Van	3	1263	Raleigh, NC Searcy, AR	Paint	248 lbs
		"	8	3066	"	Paint	742 lbs
4	09:09	MC 306	3	1203	Charlotte, NC Enka, NC	Diesel	6700 gal
5	09:16	MC 338	2	1073	Hickory, NC Knoxville, TN	Oxygen	42,980 lbs
6	14:22	MC 307	9	3082	Greer, SC Santa Ana, CA	Methylene diphenyl diisocyanate	44,020 lbs
7	15:56	MC 312	3	1219	Hopewell, VA Tulsa, OK	Isopropanol	19,980 lbs
8	15:58	MC307	9	3257	Asheville, NC Canton, NC	Asphalt	Empty

Commodity Flow Survey
September 12-13, 2007
Survey Data Table

Time	Dir.	Trailer Type	Orig/ Dest	Trailer Placard	Material Hazard Class	Mat'l ID	Material PSN	Material Name	ERG Guide Number	Quantity (lbs)	Other
12:18	East	MC306	MD-MD	3	Flammable Liquid	1993	Combustible liquid, NOS	Heating Oil	128	0	Empty
12:19	East	MC306	MD-MD	3	Flammable Liquid	1993	Combustible liquid, NOS	Diesel	128	0	Empty
12:20	West	MC407	WV-NJ	3	Flammable Liquid	1247	Methyl methacrylate monomer	Methyl Methacrylate	129P	0	Residue-Empty
12:24	West	MC306	MD-MD	9	Miscellaneous	3257	Elevated temperature liquid, NOS	Asphalt	128	21,262	
12:25	West	Van	MD-OH	8	Corrosive	2794	Batteries, wet, filled with acid	Batteries	154		
12:33	East	MC312	MD-MD	9	Miscellaneous	3257	Elevated temperature liquid, NOS	Asphalt	128	0	Coating
12:36	East	MC306	MD-MD	3	Flammable Liquid	1993	Combustible liquid, NOS	Diesel	128	0	Empty
12:39	East	MC312	TX-NJ	3	Flammable Liquid	1993	Combustible liquid, NOS	Toluene & Aliphatic Waste	128		4751 gal
12:40	West	MC312	MD-IN	3	Flammable Liquid	1206	Heptanes	Heptanes	128	74,600	7554 gal
12:44	East	MC306	MD-MD	3	Flammable Liquid	1993	Combustible liquid, NOS	Heating Oil	128	0	Empty
12:49	East	MC306	MD-MD	3	Flammable Liquid	1993	Combustible liquid, NOS	Diesel	128	0	Empty
12:56	West	Van	MD-OH	8	Corrosive	2794	Batteries, wet, filled with acid	Batteries	154	1,600	
13:05	East	Tube Trailer	MD-DE	2.2	Nonflammable Gas	1046	Helium, compressed	Helium	121		12 Tubes - partial load -half
13:13	West	MC306	PA-OH	3	Flammable Liquid	1203	Gasoline	Gasoline	128	71,980	
13:16	East	MC312	PA-MD	8	Corrosive	3267	Corrosive liquid, basic, organic, NOS	Organic Waste	153		4500 gal
13:22	East	MC306	MD-MD	3	Flammable Liquid	1203	Gasoline	Gasoline	128	0	Empty
13:25	West	MC307	MD-MD	3	Flammable Liquid	1202	Diesel fuel	Diesel	128	52,521	7503 gal
13:27	East	MC306	MD-MD	3	Flammable Liquid	1203	Gasoline	Gasoline	128	0	Empty
13:33	East	Van	WV-MD	8	Corrosive	1751	Corrosive solid, NOS	Corrosive Solids	154		672 Cases
13:35	East	MC312	MD-MD	9	Miscellaneous	3257	Elevated temperature liquid, NOS	Asphalt	128	0	Coating
13:35	West	Van	MD-MI	9	Miscellaneous	3077	Hazardous waste, solid, NOS	Arsenic Trioxide waste	171	44,489	
13:35	West	Van	CT-TN	7	Radioactive	2982	Radioactive material, NOS	Radioactive Material	163	10,000	