S. Clark and R. Pitt

Module 5: Analysis of Transportation-Related Chemical Spill Data for Alabama

This module summarizes the information collected and analyzed from the National Response Center involving transportation-related accidents occurring in Alabama. The purpose of this task was to identify the most common hazardous materials lost, where the accidents occurred, and which medium (land, air water) was affected. This module is mostly excerpted from the following report:

Becker, S., R. Pitt, and S. Clark. *Environmental Health, Public Safety, and Social Impacts Associated with Transportation Accidents Involving Hazardous Substances*. University Transportation Center of Alabama and US Dept. of Transportation. UTCA Project No. 00214. Tuscaloosa, AL. July 2001.

This information was used to identify substances for inclusion in the later modules which describes methodologies that can be used to predict the movement and dispersion of lost materials. The National Response Center database includes all spills and accidents reported to local authorities and to the Coast Guard. It therefore incorporates many accidents that are of no direct interest for these modules (such as sewage overflows and offshore marine operations). This information was collected using the following procedures: separating the Alabama records from those of the rest of the nation, purging reports of non-applicable events, sorting by transportation mode and location, sorting by material type, and sorting by volume of material lost.

Major features of Alabama's transportation network include the following:

- five major interstate highways and an extensive network of surface highways (almost 95,000 miles of roadways with motorists traveling approximately 50 billion miles on them every year),
- the second longest inland waterway system in the nation and a deep-water port that is the nation's 12th busiest (the Port of Mobile serves 1,100 vessels annually, generating 66,000 truck movements and 119,000 train movements to and from the facility),
- five Class I railroads (over 5,200 miles of railroad track mileage in Alabama, with Birmingham being a major Southeastern hub), and
- eight commercial airports and 91 general aviation facilities,

With the large amount of transportation activity in the state, it is not surprising that more than 1,700 transportation-related accidents involving hazardous materials occurred in Alabama during the past ten years. These accidents have involved a large number of different materials, with petroleum hydrocarbon compounds being the most frequently lost hazardous material.

Methodology

This activity consisted of collecting information on hazardous-materials-related transportation accidents in Alabama from the databases available from the National Response Center (NRC). The NRC's "primary function is to serve as the national point of contact for reporting all oil, chemical, radiological, biological, and etiological discharges into the environment anywhere in the United States and its territories" (http://www.nrc.uscg.mil/nrcback.html, December 20, 2000). The NRC forwards these reports to the appropriate federal agencies, including the Department of Transportation, the Department of the Interior, the Department of Defense, the Department of Health and Human Services, the Federal Emergency Management Agency, the Environmental Protection Agency, the Nuclear Regulatory Commission, and the Federal Railroad Administration. The NRC is operated by the

U.S. Coast Guard as part of the National Oil and Hazardous Substances Pollution Contingency Plan. Although the main intention of this database is to record losses of hazardous materials, many other materials have also been reported and included in the database by local law enforcement officials, environmental regulators, and shipping companies.

The database maintained by the NRC is accessible through the website http://www.nrc.uscg.mil/. At the time of the this data collection effort, the databases covered the years 1990 through 1999. The NRC makes the information available in four files per calendar year. The first file describes the incident itself; the second, a description of the material(s) involved; the third, information on any trains involved in the incident; and the fourth, information on any derailed railroad cars. For this data collection activity, the four files for each year were combined, using the NRC Incident Report Number, into a single spreadsheet for all accidents that occurred in the state of Alabama during the years of interest. These spreadsheets were then culled for transportation-related incidents, and finally combined into one spreadsheet that describes the incidents reported for the decade of interest. This spreadsheet is presented as Appendix B of this module.

Results

Table 5-1 shows some of the hazardous materials that have been lost during transportation-related accidents in Alabama from 1990 – 1999. By far, the most common (and the largest) materials spilled are petroleum oils and fuels (fuel oil, crude oil, kerosene, gasoline and diesel fuel). Ammonia spills were also common. Spills of numerous other toxicants and hazardous materials were also reported. Table 5-2 lists the locations of the 226 reported 1998 Alabama transportation-related accidents and the media directly affected, as an example of the spill locations for the complete period. Of course, many of the land-based accidents affected other media through evaporation (to air) and runoff (to water). In the 10 year data period, more than 1,700 transportation-related accidents have occurred in Alabama involving hazardous materials.

Table 5-1. Partial List of Materials Reported Spilled During Recent Alabama Transportation-Related Accidents

Ammonium Hydroxide	Ammonia, Anhydrous	Ammonium Nitrate Solution	Arsenic	Butadiene	Chlorine	Caustic Soda Solution	Ethylene Glycol
Gasoline	Hydrogen Peroxide	Kerosene	Methyl Mercaptan	Yellow Paint	Asbestos	Mercury	Lindane
Sewage	Oil: Diesel	Oil, Fuel: No. 5	Hydraulic Oil	Oil: Crude	Oil, Fuel: No. 2-D	Oil, Transformer	Refrigerant Gases
Sulfuric Acid	Sulfur Dioxide	Sodium Hydroxide	Sulfur Oxide	Triethylene Glycol	Toluene	Turpentine	P-Xylene

Table 5-2. Locations of Reported 1998 Alabama Transportation-Related Accidents (226 accidents)

Location and Media Directly Affected	Percentage of 1998 Alabama Transportation-Related Accidents
Highways	27
Railroads	30
Pipelines	1
Marine terminals	43
Land	33
Water	52
Air	2
Unknown	14

The reported 1998 Alabama transportation-related accidents also resulted in immediate problems to people and property, and disruptions to the transportation systems. Of the 226 reported accidents in 1998, there were 20 deaths and 27 injuries. In addition, four accidents caused property damage, two accidents resulted in evacuations, and nine accidents resulted in road closures. However, longer-term problems are not addressed by these accident statistics.

Of special interest is the frequency of accidents, the quantity of the different materials spilled, the hazards of the spilled chemicals, and the accident locations. The spreadsheets included in Appendix B are organized according to the format of the NRC reports. This information includes the following:

- date and time of the accident,
- the location of the incident,
- the suspected responsible party (including contact information),
- the cause of the accident,
- a description of the accident
- a description of the environmental medium affected,
- numbers of deaths, injuries and evacuation,
- a description (including volumes) of the chemicals spilled, and
- information on any train cars that derailed in the accident.

In some cases, the volume of chemical spilled was not known at the time of the report. The NRC information lists this lack of information as a “0” volume under the “Quantity Spilled” column. When conducting the additional analyses of the database, these ‘potentially-unknown’ quantities were retained, as these accidents, especially those involving petroleum products, are a

significant fraction of the number of transportation-related accidents in Alabama. The information that was not retained in the additional analyses were the oil-sheen entries because the volume of oil spilled was obviously small.

Table 5-3 is a summary of the largest quantities of hazardous materials lost for each mode of transportation considered. The accidents listed as occurring at "fixed" locations are generally loading operations and are not associated with building or storage tank disasters. The marine operations include shipping accidents and leaks, and underwater pipeline leaks and breaks that occurred on inland waterways. The off-shore locations are mostly associated with accidents at drilling and well platforms. These data clearly show that the most frequently spilled chemicals in Alabama are the petroleum products. In addition to these, ethylene glycol (antifreeze) is also commonly lost to the environment. This would be expected in an accident in which the radiator and/or engine of a vehicle is damaged. These data also emphasize the variety of transportation modes (marine, highway, etc.) where these spills occur. Many different hazardous substances can be lost during transportation accidents, in addition to the most common oil and fuel spills. Fortunately, many of the most hazardous substances were associated with only one or a very few incidents in the ten years of study, and only relatively small quantities of material were lost. Highly-hazardous ammonium nitrate, ammonia, molten aluminum, sodium hydroxide, and different acids were all released to the environment in Alabama during their transport during the period of study.

Table 5-3. Largest Spill Quantities Lost for each Major Transportation Mode Examined (1990 – 1999 Alabama Transportation Accidents)

Transportation Mode	Most Common (by volume lost)	2nd Ranked	3rd Ranked	4th Ranked
Aircraft accidents	Jet fuel (1330 gals/13 incidents)	Malathion (404 gals/13 incidents)		
Fixed locations	Hydrocarbons (fuel oil, gasoline, crude oil, diesel oil, hydraulic oil, kerosene, asphalt, transformer oil, and creosote) (82,901 gals/250 incidents)	Chromic acid/phosphoric acid (24,000 gal/1 incident)	Coal (12,000 lbs/1 incident)	Sodium hydroxide (5,000 lbs/2 incidents)
Highway accidents	Hydrocarbons (diesel oil, road tar, gasoline, fuel oil, asphalt, LPG, jet fuel, hydraulic oil, and creosote) (184,281 gals/225 incidents)	Poultry fat (49,720 lbs/2 incidents)	Ammonium nitrate and fuel oil (30,000 lbs/1 incident)	Molten aluminum (20,000 lbs/1 incident)
Marine operations	Hydrocarbons (crude oil, diesel oil, fuel oil, asphalt, motor oil, lubricating oil, waste oil, hydraulic oil, gasoline, jet fuel, and lubricating mud) (2,024,569 gals/584 incidents)	Sodium hydroxide (1,000 lbs/1 incident)	Bromine (900 lbs/1 incident)	Adiponitrile (640 lbs/1 incident)
Off-shore locations	Hydrocarbons (lubricating mud, drilling mud, diesel oil, hydraulic oil, crude oil, motor oil, fuel oil) (1188 gals/62 incidents)			
Pipelines	Hydrocarbons (fuel oil, crude oil, diesel oil, and gasoline) (14,166 gals/26 incidents)	Paraxylene (1,000 gals/1 incident)	Salt water (60 gals/1 incident)	Triethylene glycol (35 gals/1 incident)
Railroad and highway crossings	Hydrocarbons (diesel oil, fuel oil, and motor oil) (8,558 gals/13 incidents)	Formaldehyde solution (1 gal/1 incident)		
Railroad accidents	Coal (934,800 lbs/10 incidents)	Plastic pellets (262,500 lbs/2 incidents)	Hydrocarbons (petroleum oil, asphalt, diesel oil, creosote, lubricating oil, and hydraulic oil) (72,959 gals/108 incidents)	Limestone (3,000 lbs/2 incidents)
Unknown locations	Hydrocarbons (gasoline, fuel oil, diesel oil, hydraulic oil, and asphalt) (2,861 gals/191 incidents)	Sodium hydroxide (5 gals/1 incident)	Ethylene glycol (5 gals/1 incident)	

Tables 5-4 through 5-12 (Appendix A) are separated by location of the accidents (highways, railroads, pipelines, etc.) and also includes information, where available, from the National Fire Protection Association (NFPA) regarding the hazards associated with the particular chemical. The hazard information is primarily available for organic chemicals. The mode of transport with the fewest overall number of accidents is the air, i.e., airplane crashes. However, large quantities of pesticides (especially malathion) was lost to the environment during 13 crashes of crop-dusting planes during this ten-year period. The largest single accident was a crude oil spill at a marine terminal (the *T/V R. Hal Dean* ran aground in the Pensagoula Ship Channel on Jan 2, 1991, releasing about 2,000,000 gallons of crude oil). The largest spills are associated with marine operations (ship casualties by far being the largest), followed by highway and railroad accidents, and then pipeline accidents. For many substances, just a few accidents accounted for the majority of the spill volume.

The tables in Appendix C show the locations of the most frequent accidents. The locations with the most frequent spills are the historical *USS Alabama* Battleship museum and the hazardous waste landfill at Emelle, likely because of diligent reporting by the site operators. Additional locations of frequent spills include several sites where chemicals are transferred from marine craft to land vehicles such as trains and trucks. At many of these sites, the quantities spilled per incident are small. However, it may be anticipated that frequent spills in one area may cause longer-lasting environmental impacts.

Total Nationwide Transportation Accidents Involving Hazardous Materials

Table 5-4 lists transportation-related accidents involving hazardous materials that have occurred throughout the US from 1987 through 1996. During this ten year period, almost 100,000 accidents have taken place. The states with the largest number of

accidents were: California, Illinois, Pennsylvania, Texas, and Ohio. These states also had the largest damages, plus deaths and major injuries associated with these accidents. Alabama had about 1.4% of the total number of accidents, and about 2% of the total nation-wide damages.

Table 5-4. Hazardous Material Releases Due To Transportation Related Accidents (Total Incidents from 1987 through 1996)

State	Incidents *	% of Total Incidents	Minor Injuries	Major Injuries	Deaths	% of Total Major Injuries and Deaths	Monetary Damages	% of Total Monetary Damages
Alabama	1407	1.4	56	5	4	1.91	$6,130,333	1.93
Alaska	75	0.1	0	0	0	0.00	$4,336,448	1.37
Arizona	1035	1.0	53	3	0	0.64	$4,886,599	1.54
Arkansas	1495	1.5	47	3	6	1.91	$4,794,981	1.51
California	7986	8.0	393	32	12	9.36	$29,507,788	9.29
Colorado	2223	2.2	67	5	3	1.70	$4,904,738	1.54
Connecticut	855	0.9	30	5	1	1.28	$1,148,000	0.36
Delaware	164	0.2	13	2	0	0.43	$2,787,459	0.88
Washington DC	95	0.1	0	0	0	0.00	$105,125	0.03
Florida	3358	3.4	154	20	10	6.38	$10,174,434	3.20
Georgia	3029	3.0	104	12	1	2.77	$8,033,769	2.53
Hawaii	33	0.0	12	2	0	0.43	$116,147	0.04
Idaho	318	0.3	7	2	0	0.43	$1,971,481	0.62
Illinois	7034	7.1	186	13	1	2.98	$12,912,353	4.07
Indiana	2604	2.6	105	12	1	2.77	$5,665,407	1.78
Iowa	1436	1.4	62	7	1	1.70	$3,531,360	1.11
Kansas	2072	2.1	117	7	3	2.13	$4,276,598	1.35
Kentucky	1479	1.5	78	6	1	1.49	$4,272,881	1.35
Louisiana	1972	2.0	224	16	0	3.40	$9,578,683	3.02
Maine	379	0.4	5	2	1	0.64	$1,635,088	0.51
Maryland	1607	1.6	33	9	4	2.77	$3,829,070	1.21
Massachusetts	2209	2.2	48	4	0	0.85	$5,298,080	1.67
Michigan	2668	2.7	83	6	3	1.91	$3,649,846	1.15
Minnesota	2172	2.2	38	4	0	0.85	$6,397,663	2.01
Mississippi	1077	1.1	33	5	4	1.91	$5,537,637	1.74
Missouri	2913	2.9	87	5	1	1.28	$8,707,391	2.74
Montana	204	0.2	794	2	1	0.64	$19,330,794	6.09
Nebraska	607	0.6	20	1	0	0.21	$2,268,460	0.71
Nevada	394	0.4	6	2	0	0.43	$1,273,272	0.40
New Hampshire	221	0.2	7	2	0	0.43	$465,710	0.15
New Jersey	2444	2.5	120	9	2	2.34	$5,362,612	1.69
New Mexico	886	0.9	34	3	2	1.06	$2,005,724	0.63
New York	4342	4.4	96	32	7	8.30	$9,476,116	2.98
North Carolina	3721	3.7	65	14	4	3.83	$9,369,221	2.95
North Dakota	147	0.1	9	4	0	0.85	$1,636,376	0.52
Ohio	7190	7.2	168	4	0	0.85	$10,698,598	3.37
Oklahoma	854	0.9	32	3	1	0.85	$2,908,048	0.92
Oregon	1374	1.4	55	2	0	0.43	$2,548,988	0.80
Pennsylvania	7480	7.5	126	18	4	4.68	$19,777,213	6.23
Rhode Island	121	0.1	2	0	0	0.00	$214,045	0.07
South Carolina	1063	1.1	16	2	0	0.43	$4,276,052	1.35
South Dakota	139	0.1	2	1	0	0.21	$616,558	0.19
Tennessee	2935	3.0	56	10	13	4.89	$15,708,941	4.95
Texas	6883	6.9	353	36	10	9.79	$24,981,453	7.87
Utah	1346	1.4	18	4	0	0.85	$2,363,545	0.74
Vermont	143	0.1	2	0	0	0.00	$1,290,592	0.41
Virginia	1406	1.4	51	2	5	1.49	$6,440,824	2.03
Washington	1273	1.3	44	6	0	1.28	$1,984,268	0.62
West Virginia	476	0.5	44	2	3	1.06	$3,983,108	1.25
Wisconsin	1569	1.6	123	8	2	2.13	$9,451,305	2.98
Wyoming	479	0.5	25	2	3	1.06	$3,742,200	1.18
U.S. Territories	98	0.1	2	0	0	0.00	$1,160,615	0.37
Total	99490	100	4305	356	114	100	$317,523,997	100

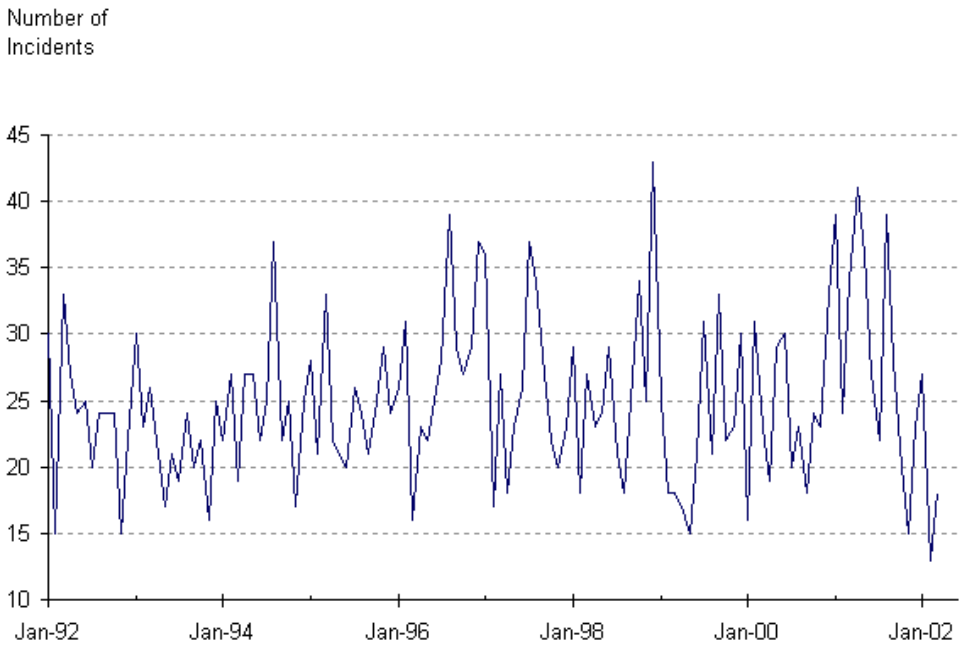
* Incidents can be defined as transportation related accidents that have resulted in the release of a hazardous material.

Source: U.S. Department of Transportation Hazardous Materials Information System

Hazardous Materials Incidents Involving Motor Vehicles or Train Derailments

Motor vehicle accidents or train derailments account for only a small portion of the total number of hazardous materials incidents. However, their consequences are often the most severe. Figure 5-1 shows that in the ten year period from January 1992 through January 2002, about 15 to 40 of these accidents occur in the US every month.

Figure 5-1. Hazardous materials incidents involving vehicular accidents or train derailments (monthly data, not seasonally adjusted).



Source: http://www.bts.gov/transtu/indicators/Safety/html/Hazardous_Materials_Incidents_Involving_Crashes_or_Train_Derailments.html Data from the U.S. Department of Transportation, Research and Special Programs Administration, Office of Hazardous Materials, Planning and Analysis.

Accidents Involving Railroads and Hazardous Materials

In 1981, the National Transportation Safety Board (1981) published a report based on the investigation of accidents involving train collisions with trucks transporting hazardous materials. An average of 62 accidents of this type occurred annually during their study period, resulting in an average of more than $1.6 million in property damage, 41 injuries, and 7 fatalities. Some individual accidents have involved fatalities and property damage in excess of prior yearly averages. One railroad's data, when extrapolated, suggest that there may be as many as 750 near-collisions between trains and trucks transporting bulk hazardous materials each year. The accidents tend to involve trucks transporting petroleum products and to occur close to distribution/storage terminals.

References and Links

U.S. Bureau of Transportation Statistics:

http://www.bts.gov/transtu/indicators/Safety/html/Hazardous_Materials_Incidents_Involving_Crashes_or_Train_Derailments.html

U.S. National Response Center:

http://www.nrc.uscg.mil/nrcback.html,

U.S. National Transportation Safety Board. *Safety Study: Railroad/Highway Grade Crossing Accidents Involving Trucks Transporting Bulk Hazardous Materials*. U.S. National Transportation Safety Board Report No: NTSB-HZM-81-2. 50 pgs. September 1981.