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Hazardous Materials Highlights – 2007 Commodity Flow Survey

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Hazardous materials movement through the Nation's transportation network in 2007 remained relatively unchanged from 2002 measures, according to data from the 2007 Commodity Flow Survey (CFS), released in 2010. The estimated 2.2 billion tons of hazardous materials carried by all modes of transportation is about the same as the estimated tonnage from the prior CFS in 2002. However, the value of those shipments more than doubled, from \$660 billion to \$1,448 billion, driven primarily by the increase in the price of refined petroleum products and other basic commodities.

Slightly more than half (54 percent) of hazardous material tonnage is moved via trucks over the Nation's highways. Pipeline is the next most used carrier of hazardous materials, handling 28 percent of the tonnage, while the other modes each accounted for 7 percent or less of total hazardous material tonnage.

Hazardous Material Classes

There are nine classes of hazardous materials. Flammable Liquids (Hazard Class 3) represented the bulk of hazardous materials transported. Of the 2.2 billion tons of hazardous

materials shipped, 1.8 billion tons were Flammable Liquids, primarily consisting of refined petroleum products. Shipments of Hazard Class 3 materials accounted for 182 billion (56.1 percent) of the total 323 billion hazardous materials ton-miles generated in 2007. Shipments of Hazard Class 2 (Gases) comprised 251 million tons, and their transport amounted to 55 billion ton-miles. Corrosive Materials (Hazard Class 8) shipments totaled 114 million tons, generating 44 billion ton-miles. Table 1 shows shipments by hazardous material class.

Some hazardous materials are additionally designated as "Toxic by Inhalation" (TIH), which includes gases and volatile liquids that are toxic when inhaled and pose additional risk when transported. In 2007, shippers sent 27 million tons of TIH materials that accounted for 10 billion ton-miles.

Most hazardous materials are designated in the Code of Federal Regulations (CFR) as requiring shipment in Packing Groups I, II, or III. Packing Group I requires, by regulation, the most rigorous packaging for transport. In 2007, shippers sent 586 million tons of Packing Group I materials, generating 72 billion ton-miles.

About the Commodity Flow Survey

Survey data cited in this report are from the *2007 Economic Census* released in July 2010. The Commodity Flow Survey (CFS) is the primary source of national and State-level data on domestic freight shipments by American establishments in mining, manufacturing, wholesale, auxiliaries, and selected retail industries. Data are provided on the types, origins and destinations, values, weights, modes of transport, distance shipped, and ton-miles of commodities shipped. The CFS is a shipper-based survey and is conducted every 5 years as part of the Economic Census. It provides a modal picture of national freight flows and represents the only publicly available source of commodity flow data for the highway mode. Prior to 2007, the CFS was conducted in 1993, 1997, and 2002. CFS data and publications can be found at http://www.bts.gov/publications/commodity_flow_survey/.

Shipments by Mode

Trucks transported the largest volume of hazardous materials through the Nation's transportation system, moving 1.2 out of 2.2 billion tons of hazardous materials. These shipments accounted for 104 billion highway ton-miles, out of the total 323 billion ton-miles moved by all modes. CFS data for the highway mode is particularly important because it represents the sole source of national data for hazardous materials transported by truck.

Overall, the truck mode moved 53.9 percent of hazardous materials tonnage in 2007. Private trucking carried 31.7 percent, and for-hire trucking carried 22.2 percent. Hazardous materials shipments transported solely by truck represented 50 percent or more of the tonnage in every hazard class

Table 1: Hazardous Materials Shipment Characteristics by Hazard Class in 2007

| Hazard class and description | Value (million \$) | Tons (thousands) | Ton-miles (millions) | Average miles per shipment |
|--|-----------------------|---------------------|-------------------------|-------------------------------|
| Total | 1,448,218 | 2,231,133 | 323,457 | 96 |
| Class 1, Explosives | 11,754 | 3,047 | 911 | 738 |
| Class 2, Gases | 131,810 | 250,506 | 55,260 | 51 |
| Class 3, Flammable liquids | 1,170,455 | 1,752,814 | 181,615 | 91 |
| Class 4, Flammable solids | 4,067 | 20,408 | 5,547 | 309 |
| Class 5, Oxidizers and organic peroxides | 6,695 | 14,959 | 7,024 | 361 |
| Class 6, Toxic (poison) | 21,198 | 11,270 | 5,667 | 467 |
| Class 7, Radioactive materials | 20,633 | 515 | 37 | S |
| Class 8, Corrosive materials | 51,475 | 114,441 | 44,395 | 208 |
| Class 9, Miscellaneous dangerous goods | 30,131 | 63,173 | 23,002 | 484 |

KEY: S = Estimate does not meet publication standards because of high sampling variability or poor response quality.

SOURCE: Research and Innovative Technology Administration and U.S. Census Bureau, *2007 Commodity Flow Survey, Hazardous Materials*, Table 2a, available at http://www.bts.gov/publications/commodity_flow_survey/.

Table 2: Hazardous Materials Shipment Tonnage Shares by Mode in 2007

| Mode of transportation | Percentage of Tons |
|-------------------------|--------------------|
| All modes | 100.0 |
| Truck | 53.9 |
| Pipeline | 28.2 |
| Water | 6.7 |
| Rail | 5.8 |
| Multiple modes | 5.0 |
| Other and unknown modes | 0.4 |

NOTES: The total includes shipments via the air mode. However, an individual estimate for the air mode cannot be published because it does not meet the standard for release due to variability.

SOURCE: Research and Innovative Technology Administration and U.S. Census Bureau, *2007 Commodity Flow Survey, Hazardous Materials*, Table 1c, available at http://www.bts.gov/publications/commodity_flow_survey/.

except Class 6 (Toxic Materials and Infectious Substances), which had roughly half of its tonnage transported by rail. (See table 1 for a list of classes.) The remaining hazardous materials tonnage recorded in the 2007 CFS was transported by pipeline—28.2 percent; water—6.7 percent; rail—5.8 percent; and multiple, other, and unknown modes—5.4 percent (table 2).

The 2007 CFS shows that 32.2 percent of all hazardous materials ton-miles are attributed to truck, 28.5 percent to rail, and 11.5 percent to water, with other modes handling the remainder (table 3).

Hazardous Materials Shippers

Industry subsectors and groups under the North American Industry Classification System (NAICS) that are major hazardous materials shippers include the Petroleum and

Coal Products Manufacturing industry (NAICS 324), which transported 56.0 percent of its hazardous materials tonnage via pipeline and 21.3 percent by truck, and the Petroleum and Petroleum Products Merchant Wholesalers industry (NAICS 4247), which transported 90.5 percent of its hazardous materials tonnage by truck. The Chemical Manufacturing industry (NAICS 325) moved 39.5 percent of its hazardous materials tonnage by truck, 25.3 percent by rail, and 19.7 percent via pipeline (table 4).

Other Hazardous Materials Shipment Characteristics

The movement of hazardous materials through the U.S. transportation system represents almost 18 percent of total tonnage for all freight shipments as measured by the CFS. Hazardous materials ton-mileage represents about 10 percent of the CFS national total (table 5).

The majority of hazardous materials transportation originates in a limited number of States. There are 10 States responsible for initiating the transportation of approximately two-thirds of both the tonnage and ton-miles associated with hazardous materials transportation across our Nation. Texas was the State that had the greatest amount of hazardous materials shipments by tonnage as both an origin and destination in the 2007 and 2002 CFS, due in large part to the concentration of the petro-chemical industry located there. Louisiana and California represented the next two States with the greatest amount of hazardous materials shipments by tonnage.

Comparisons With Prior Surveys

The estimated total of 2.23 billion tons of hazardous materials shipments reported in the 2007 CFS is not significantly different from the estimated 2.19 billion tons reported in the

Table 3: Hazardous Materials Shipments by Mode in 2007

| Mode of transportation | Value (million \$) | Tons (thousands) | Ton-miles (millions) | Average miles per shipment |
|------------------------------|-----------------------|---------------------|-------------------------|-------------------------------|
| All modes | 1,448,218 | 2,231,133 | 323,457 | 96 |
| Truck | 837,074 | 1,202,825 | 103,997 | 59 |
| For-hire truck | 358,792 | 495,077 | 63,288 | 214 |
| Private truck | 478,282 | 707,748 | 40,709 | 32 |
| Rail | 69,213 | 129,743 | 92,169 | 578 |
| Water | 69,186 | 149,794 | 37,064 | 383 |
| Air (includes truck and air) | 1,735 | S | S | 1,095 |
| Pipeline | 393,408 | 628,905 | S | S |
| Multiple modes | 71,069 | 111,022 | 42,886 | 834 |
| Parcel, U.S.P.S. or courier | 7,675 | 236 | 151 | 836 |
| Other multiple modes | 27,739 | 56,750 | 17,297 | 233 |
| Other and unknown modes | 6,534 | 8,489 | 1,466 | 58 |

KEY: S = Estimate does not meet publication standards because of high sampling variability or poor response quality.

SOURCE: Research and Innovative Technology Administration and U.S. Census Bureau, *2007 Commodity Flow Survey, Hazardous Materials*, Table 1a, available at http://www.bts.gov/publications/commodity_flow_survey/.

Table 4: Hazardous Materials Shipment Characteristics for Selected NAICS Codes in 2007

| NAICS Code | NAICS Code Description | Tons | | | Ton-Miles | | |
|------------|---|----------------------|--------------------------|-----------------------------------|----------------------|--------------------------|-----------------------------------|
| | | Total (thousands) | Hazardous (thousands) | Hazard- ous share (percent) | Total (thousands) | Hazardous (thousands) | Hazard- ous share (percent) |
| | Total | 12,543,425 | 2,231,133 | 17.8 | 3,344,658 | 323,457 | 9.7 |
| 324 | Petroleum and coal products manufacturing | 1,415,099 | 930,698 | 65.8 | 207,148 | 128,090 | 61.8 |
| 325 | Chemical manufacturing | 594,262 | 248,941 | 41.9 | 279,917 | 101,050 | 36.1 |
| 4246 | Chemical and allied products merchant wholesalers | 119,971 | 64,533 | 53.8 | 31,344 | 12,813 | 40.9 |
| 4247 | Petroleum and petroleum products merchant wholesalers | 846,636 | 803,894 | 95.0 | 52,112 | 39,482 | 75.8 |
| 45431 | Fuel dealers | 48,438 | 47,817 | 98.7 | 1,784 | 1,761 | 98.7 |
| 551114 | Corporate, subsidiary, and regional managing offices | 250,262 | 72,893 | 29.1 | 80,199 | 17,764 | 22.1 |
| -- | All other surveyed industries | 9,268,757 | 62,357 | 0.7 | 2,692,154 | 22,497 | 0.8 |

NOTE: NAICS codes shown had the highest estimated weight without considering the sampling variability.

SOURCE: Research and Innovative Technology Administration and U.S. Census Bureau, *2007 Commodity Flow Survey, Hazardous Materials*, Table 17; and *2007 Commodity Flow Survey, U.S. Report*, table 10, available at http://www.bts.gov/publications/commodity_flow_survey/.

Table 5: Hazardous Versus Nonhazardous Materials Shipment Characteristics by Mode of Transportation in 2007

| Mode of transportation | Tons | | | Ton-miles | | |
|------------------------------|-------------------|----------------------|-------------------------|------------------|----------------------|-------------------------|
| | Total (thousands) | Hazardous Percentage | Nonhazardous Percentage | Total (millions) | Hazardous Percentage | Nonhazardous Percentage |
| All modes | 12,543,425 | 17.8 | 82.2 | 3,344,658 | 9.7 | 90.3 |
| Truck | 8,778,713 | 13.7 | 86.3 | 1,342,104 | 7.7 | 92.3 |
| For-hire truck | 4,075,136 | 12.1 | 87.9 | 1,055,646 | 6.0 | 94.0 |
| Private truck | 4,703,576 | 15.0 | 85.0 | 286,457 | 14.2 | 85.8 |
| Rail | 1,861,307 | 7.0 | 93.0 | 1,344,040 | 6.9 | 93.1 |
| Water | 403,639 | 37.1 | 62.9 | 157,314 | 23.6 | 76.4 |
| Air (includes truck and air) | 3,611 | S | 90.2 | 4,510 | S | 96.1 |
| Pipeline | 650,859 | 96.6 | 3.4 | S | S | S |
| Multiple modes | 573,729 | 19.4 | 80.6 | 416,642 | 10.3 | 89.7 |
| Parcel, U.S.P.S. or courier | 33,900 | 0.7 | 99.3 | 27,961 | 0.5 | 99.5 |
| Other multiple modes | 113,841 | 49.8 | 50.2 | 46,402 | 37.3 | 62.7 |
| Other and unknown modes | 271,567 | 3.1 | 96.9 | 33,764 | 4.3 | 95.7 |

KEY: S = Estimate does not meet publication standards because of high sampling variability or poor response quality.

SOURCE: Research and Innovative Technology Administration and U.S. Census Bureau, *2007 Commodity Flow Survey, Hazardous Materials*, Table 4, available at http://www.bts.gov/publications/commodity_flow_survey/.

2002 CFS. However, the estimated value of hazardous materials shipped more than doubled from \$660 billion in 2002 to \$1,448 billion in 2007, principally due to an increase in the price of refined petroleum products and basic commodities classified as hazardous materials.

The usage of modes of transportation for shipments of hazardous materials in 2007 was similar to that in 2002. In 2007, 53.9 percent of hazardous materials tonnage was carried by truck, compared to 52.9 percent in 2002. Similarly pipeline, the mode that transported the second-largest volume of hazardous materials in 2007, had a share of 28.2 percent in 2007, compared to a share of 30.2 percent in 2002. Due to methodological changes in mileage calculations, much of the tonnage previously identified as moving solely by the water mode has shifted to multiple mode classifications, in which water is part of the modal combination.

The same States that accounted for the most hazardous material shipments tonnage and ton-miles in 2002 were also the leading States in 2007 (see figure 1).

Efforts were undertaken with the 2007 CFS to improve the reliability of the estimates for hazardous materials through the targeting and oversampling of hazardous materials shippers. This “oversampling” of hazardous materials shippers, together with a 2007 CFS sample size of 102,369 establishments, resulted in 5.6 percent of the 4.9 million 2007 CFS shipment records being classified as a hazardous materials shipment, compared to 4.9 percent of 2.6 million shipment records from a sample of 51,005 establishments in the 2002 CFS being designated as a hazardous materials shipment.

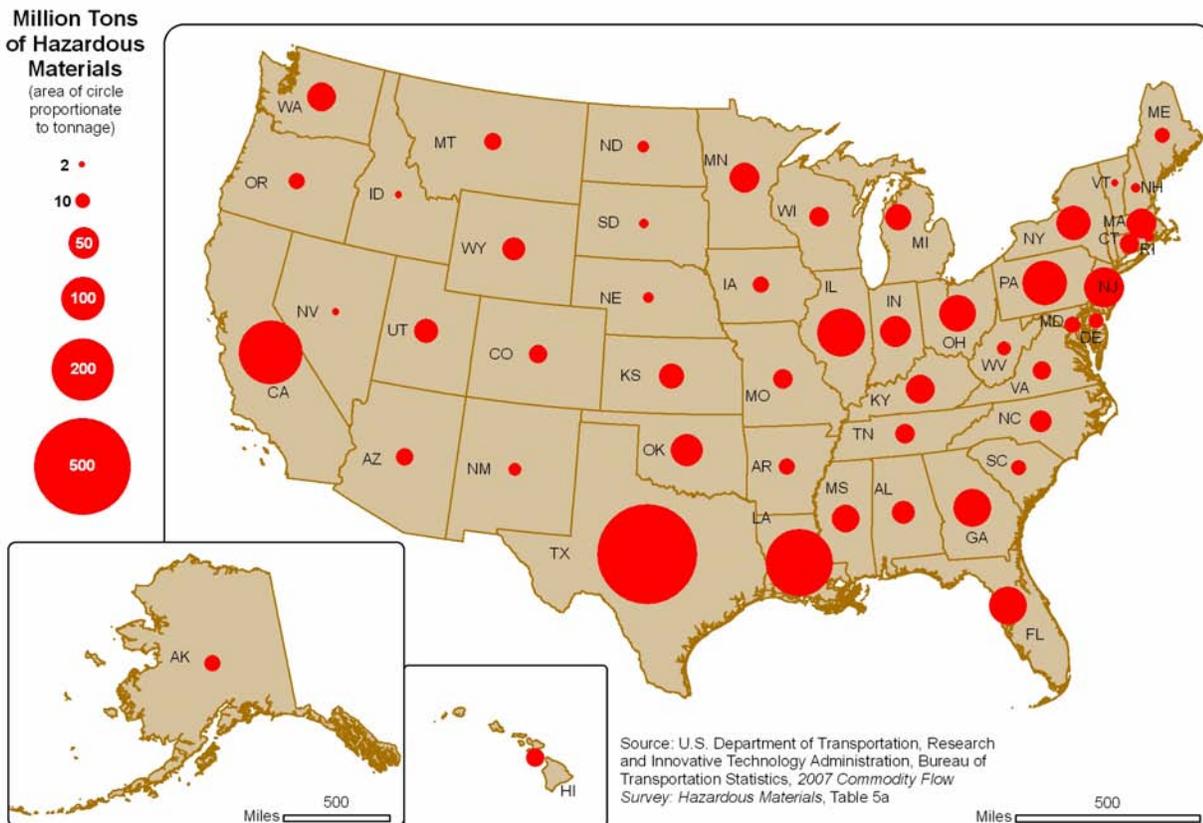
Application of CFS Hazardous Materials Data

Hazardous materials shipment data collected in the CFS allow for the identification of hazardous material flows by mode over our Nation’s transportation network. These data provide information that is critical for conducting hazardous materials transportation safety risk analyses and security assessments. Hazardous materials data produced from the CFS represent national benchmarks of the type, quantity, and distance of hazardous materials transported by mode in the United States. These data are used in policy development, the rule making process, program planning and identifying emergency response and preparedness needs, and can also be used to establish national estimates of daily hazardous material shipments.

Hazardous materials data from the CFS are used to assess the safety of hazardous materials transportation. CFS data employed as denominator values when joined together with the numerator values of hazardous materials accidents and incidents can be used to quantify the level of risk associated with transporting hazardous materials.

CFS hazardous materials data fill a need for benchmark national hazardous material transportation flow data. Data on the flows of hazardous materials in the rail and water modes are collected in other data sets, but are not necessarily publicly available and do not provide a complete nationwide assessment of hazardous materials transportation. CFS hazardous materials data provide national estimates of hazardous materials transportation flows across all modes and combinations of modes. 

Figure 1: Hazardous Materials Tonnage by Originating State, 2007



Hazardous Materials Transportation Regulation

The safety of transporting hazardous materials has long been an area of concern to the Federal Government. Legislation regulating the transportation of explosives and flammable materials was first enacted in the mid-nineteenth century. In 1908, Congress passed the Explosives and Combustibles Act, authorizing the Interstate Commerce Commission to issue regulations covering the packing, marking, loading, and handling of explosives and other dangerous substances in transit.

The Federal statute known as the Hazardous Materials Transportation Act (HMTA) of 1974, signed into law in 1975, expanded the role of the U.S. Department of Transportation in regulating the safety of hazardous material transportation. The HMTA states that when the Secretary of Transportation finds that transportation of a commodity of a particular quantity and form poses an unreasonable risk to the health and safety or property of the public, the commodity is to be designated as a hazardous material.

The regulations identifying various commodities as hazardous materials and specifying the requirements for their transport are codified in the Code of Federal Regulations (CFR) Title 49 Parts 100 to 185. A table listing over 3,000 proper shipping names and corresponding hazmat identification numbers along with specific transportation requirements is shown in 49 CFR 101.

The hazmat identification number is a four-digit number (also known as the United Nations/ North American, or UN/NA number) and is assigned to each listed hazardous material in the hazardous materials table. The four-digit hazmat ID numbers are grouped into 21 divisions that are categorized by 9 distinctive Hazard Classes. This regulatory structure is now universal, having been developed and implemented by international committees organized under the authority of the United Nations.

Building on this existing detailed and hierarchical regulatory scheme—while at the same time collecting shipment data by the Standard Classification of Transported Goods (SCTG) codes—the CFS compiles a robust dataset of hazardous materials estimates by asking hazardous materials shippers to enter a four-digit UN/NA identification number on the CFS questionnaire. These data allow for the production of separate CFS analyses including a Hazardous Materials Report that displays hazardous material data sorted by hazard class, division, and selected hazmat ID numbers by the standard CFS characteristics of mode, value, tons, ton-miles, and distance shipped.

Although there are alternative data sources for obtaining data on hazardous materials shipments in the rail and water modes, CFS hazardous materials data is the only publicly available source of hazardous materials flow data for the highway and air modes, as well as multiple-mode combinations.

About This Report

This report was prepared by Ron Duych, a Senior Transportation Specialist in the Bureau of Transportation Statistics (BTS), Chester Ford, a Transportation Industry Analyst in BTS, and Hossain Sanjani, a Survey Statistician in BTS. BTS is a component of the U.S. Department of Transportation's Research and Innovative Technology Administration (RITA).

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2007 CFS Publications

- *2007 Commodity Flow Survey, U.S. Report*
- *2007 Commodity Flow Survey, Hazardous Materials Report*
- *2007 Commodity Flow Survey, Export Report*
- *2007 Commodity Flow Survey, State Summaries*

CFS data and publications can be found at http://www.bts.gov/publications/commodity_flow_survey.