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# Madison County, Kentucky Hazardous Materials Commodity Flow Analysis

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***FINAL REPORT***

***August 2011***


**Prepared by:**

**This project was completed by**

**Western Kentucky University in partnership with**

**Madison County Local Emergency Planning Committee**

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# Table of Contents

# List of Figures

## Chapter 1



## Chapter 2



## Chapter 3

**Chapter 4**

# List of Tables

## Chapter 2



## Chapter 3



## Chapter 4



## Chapter 5



## Chapter 7

# Chapter 1: Introduction

This report presents the results of a Commodity Flow Analysis of Hazardous Materials for Interstate-75 (I-75) (North and South Bound lanes) conducted by Western Kentucky University in partnership with the Madison County (Kentucky) Local Emergency Planning Committee (LEPC). The only Kentucky County within the study area is Madison County as shown in Figure 1.1.

The purpose of report is to give information on patterns of hazardous materials being transported along I-75 as observed from July 25th 2011 to August 5th 2011. A secondary purpose is to summarize incidents involving hazardous materials over the previous 6 years (January 2006 – June 2011). Finally, this report assesses survey information collected from fixed facilities that ship and receive hazardous materials in the I-75 highway.

Commodity flow analysis is necessary in order for the LEPC to prepare for future hazardous material releases that may occur along this section of I-75. Data collected from this study will aid the emergency planning process for specific hazardous materials that were observed to frequent the study area during the study period.

## 1.1 Background

Commodity flow studies have a primary goal of identifying the transport of specific goods through the transportation system of a specific area (Taylor et al., 2010). Commodity, as defined by the EPA, is any physical good moving or any good being transported (U.S. EPA, 2010). In this particular study, hazardous materials are the commodities of interest. Hazardous materials are defined in the following ways:

- US Dept of Transportation: "Any substance or material in any form or quantity which poses an unreasonable risk to safety and health and to property when transported in commerce," (US DOT, 1991).

- US EPA: "Any material, which when discharged into the environment, may be harmful to the public health or welfare of the United States," (U.S. EPA, 2010).

As well, according to the EPA, a material is considered hazardous if it displays one or more of the following characteristics (U.S. EPA, 2010):

- Ignitability: Can create fires under certain conditions. e.g. fuels which catch fire, and friction-sensitive substances.
- Corrosivity: Is acidic and capable of corroding metal.
- Reactivity: Can create explosions or toxic fumes, gases, or vapors when exposed or mixed with water.

- Toxicity: Is harmful or fatal when ingested, breathed, or absorbed by the skin.

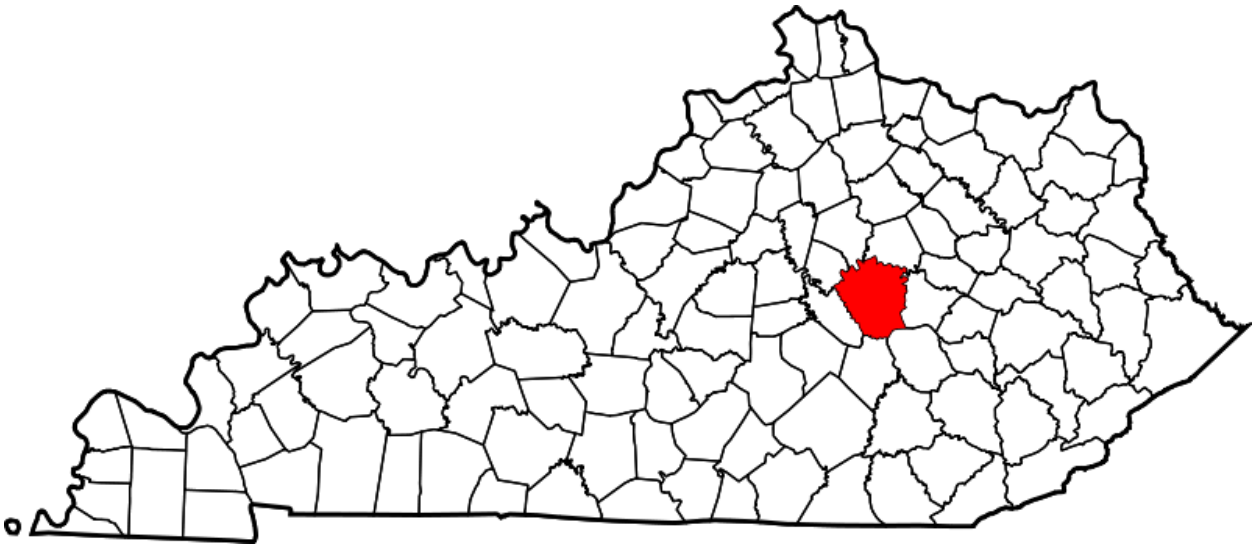

Figure 1.1. Location of Madison County, Kentucky

Hazardous material categories include (Transportation):

- Explosive Substances: will release pressure, gas, and heat when exposed to sudden shock, heat, or high pressure. e.g. Explosives, fuel, ammonium nitrate.
- Flammable and Combustible Substances: either liquid or solid, that can be easily ignited. e.g. petroleum substances.
- Toxic Materials (Poisons): can cause injury or death when they enter the bodies of living organisms. Can be classified by chemical nature or toxic action. e.g. heavy metals, cyanides, irritants.
- Oxidizers: supply oxygen to support normally non-flammable materials. e.g. fertilizers (oxides).
- Radioactive Materials: emit harmful rays and particles with their decay. e.g. plutonium, cobalt.
- Etiological Materials: cause disease or infection. e.g. germs which cause rabies, botulism, tetanus.

## 1.2 I-75 in Kentucky

I-75 is a part of the Interstate Highway System, which runs through the state of Kentucky from north to south for about 191.78 miles, in Kentucky. The main Kentucky cities that the highway passes through are Corbin, Richmond, Lexington, and Covington (Figure 1.2). In Kentucky, the speed limit on this highway is 70 miles per hour.

I-75 is a major north–south Interstate Highway in the Great Lakes and Southeastern regions of the United States. It travels from State Road 826 (Palmetto Expressway) and State Road 924 (Gratigny Parkway) in Hialeah, Florida (northwest of Miami) to Sault Ste. Marie, Michigan, at the Ontario, Canada, border. I-75 passes through six different states: Florida, Georgia, Tennessee, Kentucky, Ohio and Michigan. The highway continues northbound through the hilly and rugged terrain of the Cumberland Plateau region of Kentucky, passing through the cities of London, Richmond, and eventually reaching Lexington. The entirety of this highway measures about 1,786 miles. Large amounts of traffic are present on I-75, including commodity transport traffic. Intersections with other interstates occur along the I-75 corridor, these include I-4, I-10, I-20/I-85, I-24, I-40, I-64, I-71/I-74, I-70, I-80/I-90, I-94, and I-69.


Figure 1.2. I-75 Corridor from Northern KY-Cincinnati south thru Richmond, KY and continuing into Tennessee (Google Maps 2011).

A similar study entitled the Warren County, Kentucky: Hazardous Materials Commodity Flow Analysis was used as a basis for this study (Taylor et al., 2010). The primary sources for data collection were a placard survey, transportation incidence reports, and a fixed facility survey. Data were used to assess hazardous materials that are being transported by trucks via I-75 (North and South bound lanes). Each of the three primary sources is summarized below.

## 1.3 Data Collection Methods:

***ROADWAY PLACARD SURVEY***

Two Monitoring stations were established (as identified by WKU faculty, Madison County Emergency Management (MCEM) and Local Emergency Planning Commission (LEPC)) near I-75 North and South bound lanes passing through Madison County. A monitoring station was set up at Kentucky Artisan Center which served to monitor northbound lanes on I-75. The second monitoring station was set up at exit 95 which served to monitor southbound lanes on I-75.

With all necessary safety precautions, a team of two observers monitored each site for five days. A monitoring day consisted of a 12-hour observation period. From July 25th thru July 29th, monitoring occurred at the Kentucky Artisan Center from 7:30 AM – 7:30 PM, northbound I-75. Monitoring for southbound I-75 occurred From August 1st thru August 5th at exit 95 from 7:00 AM – 7:00 PM. This created a total of 120 monitoring hours. (60+60 = 120 hours)

During the observation hours the observers recorded the following variables: time of day, date, number of trucks, day of the week, location, Hazmat ID number, the hazardous material being transported, and the state listed on the license plate of each truck, if possible.

***TRANSPORTATION INCIDENCE REPORT***

A complete history from the previous 6 years (January 2006 – June 2011) of transportation incidents involving trucks carrying hazardous material on I-75 was gathered by the Madison County LEPC, from the Department of Transportation. This information was used in the report to document the recent history of recorded incidents involving hazardous materials.

***FIXED FACILITY SURVEY***

The fixed facility survey will consist of 35 response items designed to collect data from facilities that ship and receive hazardous materials. General information on the facility, trends in the hazardous materials shipped and received by the facility, and the frequency of the specific hazardous materials shipped through the facility is the specific data of interest. Madison County LEPC would request these data from the fixed facilities. The years 2006-2010 will be covered in this survey.

## 1.4 Organization of the Report

The first section of the report provides an introduction to the study, a description of methods, and other pertinent information. A second section of the report provides a detailed summary of the transportation incidence reports along I-75. These were incidents involving hazardous materials that were reported to the LEPC. The third section of this report details the results from the placard survey conducted along I-75. A fourth section illustrates the results of the fixed facility survey. Common hazardous materials observed are reviewed in the fifth section, which also

describes appropriate responses needed for these materials. Chapter five summarizes the results, and gives some recommendations.

In the appendices, we have included a copy of the survey that was sent to the facilities, a list of placard IDs observed, and a list of the most common roads used by facilities to reach/leave I-75.

# Chapter 2: Incident Report Analysis for I-75 from January 2006 to June 2011

Incident analysis indicates the history of accidents that took place in the past, indicates patterns of occurrence, and identifies weaknesses in incident preparedness. Assessment of incidents involving hazardous materials can give emergency responders information regarding hazardous materials types in previous accidents, precautions that are material specific and steps that should be taken in case a similar incident occurs in the future.

Incident report data was obtained from the LEPC database. Information consisted of incidents that had been reported from January 2006-June 2011. We received a total of 119 incident reports where the LEPC had responded. These included cases of accidents on I-75, air release leaks, and oil spills.

## 2.1 Comparison of Total Incidents from 2006-2011 to Hazmat Incidents from January 2006- June 2011.

The following section compares the total number of incidents that were reported to the LEPC and the hazardous materials incidents that took place from January 2006-June 2011. Table 2.1 provides overview of the total incidents reported to LEPC from 2006-2011. A trend of increasing incidents occurred through 2007 with a decrease to 19 and 15 reported in 2008 and 2009, respectively (Figure 2.1). Again the trend had increased to 19 in 2010 with a decrease to 16 in 2011. It must be noted that the reporting period for 2011 was from January to June. Based on the rate of incidents thus far in 2011, the 2010 total is expected to be exceeded in 2011.

| Year | No of Incidents Reported |
|---|---|
| 2006 | 17 |
| 2007 | 33 |
| 2008 | 19 |
| 2009 | 15 |
| 2010 | 19 |
| 2011* | 16 |

* Data from January-June 2011

Table 2.1. Vehicle incidents reported to LEPC, 2006-2011, in the I-75 in Madison County, KY

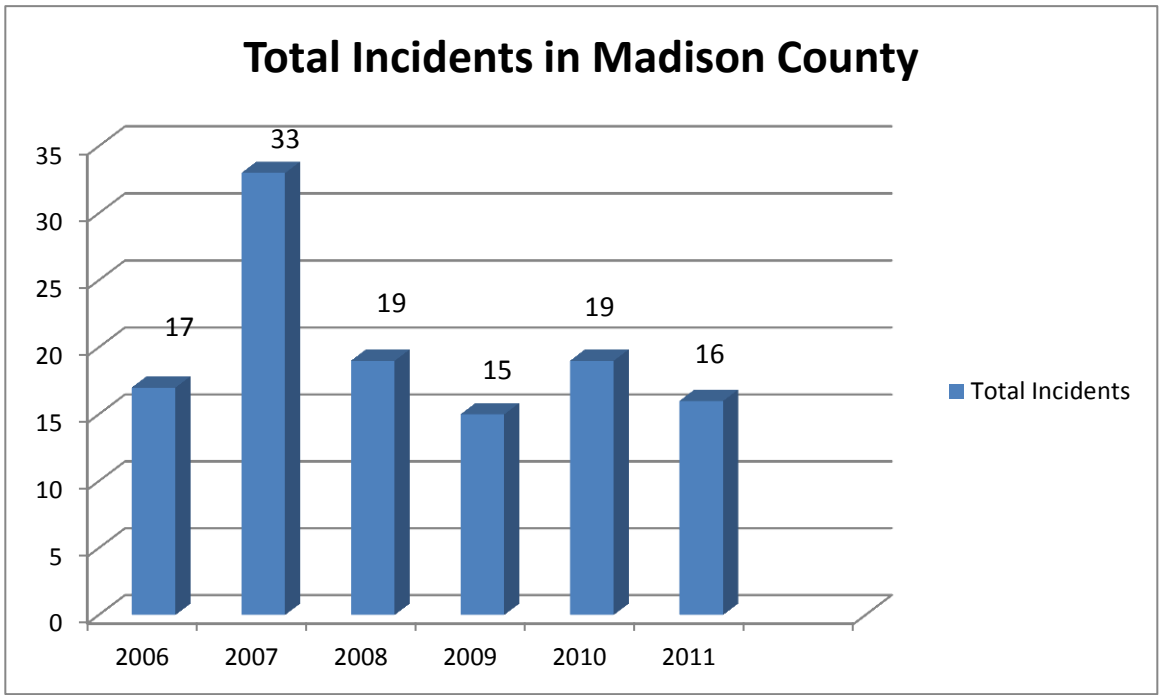


Figure 2.1. Total incidents reported in Madison County from 2006-2011* (Data from January 2006-June 2011)

To fully assess the risk of hazardous materials, it is essential to identify the most common region or locations of incidents. The distribution of incidents by county through the period of 2006-2011 shows that all the 119 incidents were reported in Madison County only.

The situation and type of emergency determines the emergency response. Several types of emergencies have been recorded in the incident reports from 2006-2011 (Figure 2.2). Spills made up 66% of all emergency cases reported to LEPC, followed by leakage (18%) and vehicle accidents (4%). Other emergencies included air release, suspicious package, fires, contamination etc.

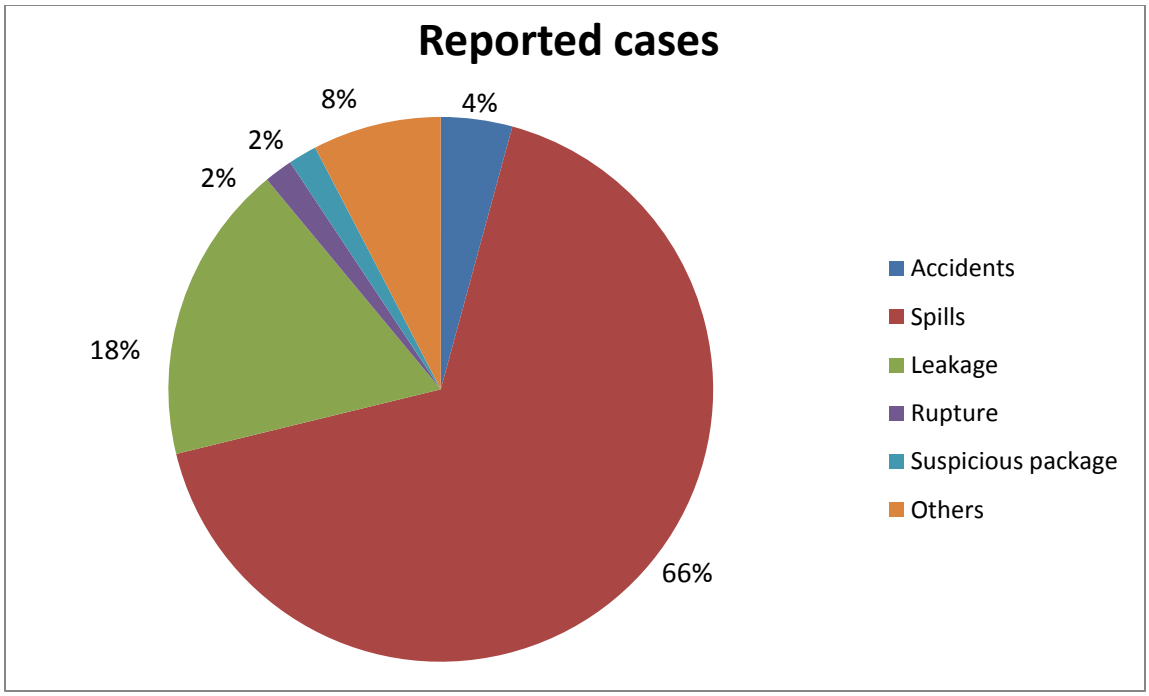


Figure 2.2. Types of emergencies reported as a percentage of the total emergencies, January 2006-June 2011.

Various classes of materials have been identified in the incident reports of the LEPC (Figure 2.3). These substances originated from the emergency types shown in Figure 2.2. Figure 2.3 indicates that flammable products like Crude Oil/Fuel/Diesel were the most common substances involved, and spills are a major reason for these. Other substances observed were, mercury, hydrochloric acid, sodium hydroxide solution, calcium chloride (solid), asphalt, and muriatic acid. However, oil, diesel and gas made up the majority, 69%, of all substances reported from emergency incidents.

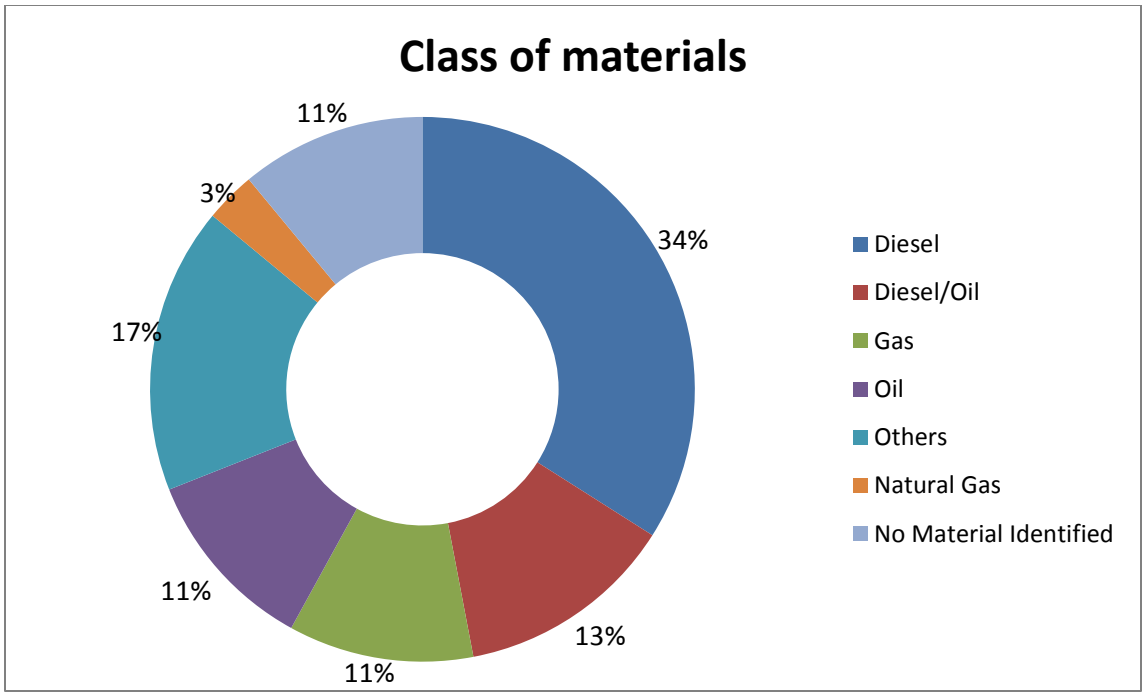


Figure 2.3. Class of materials reported to LEPS in emergency incidents.

## 2.2 Hazmat Cases in the I-75

Out of the total 119 emergency cases that LEPC responded to, 105 cases involved hazmat incidents that took place on I-75. This makes approximately 88% of the 119 total cases reported

Madison County is a populated area that I-75 passes through as it extends south in the direction of Knoxville, TN and north towards Richmond, KY. The analysis of the incidents on I-75 showed that all the 105 Hazmat incidents had occurred in Madison County only. Figure 2.4 following chart shows the distribution of incidents on I-75 from January 2006-June 2011.

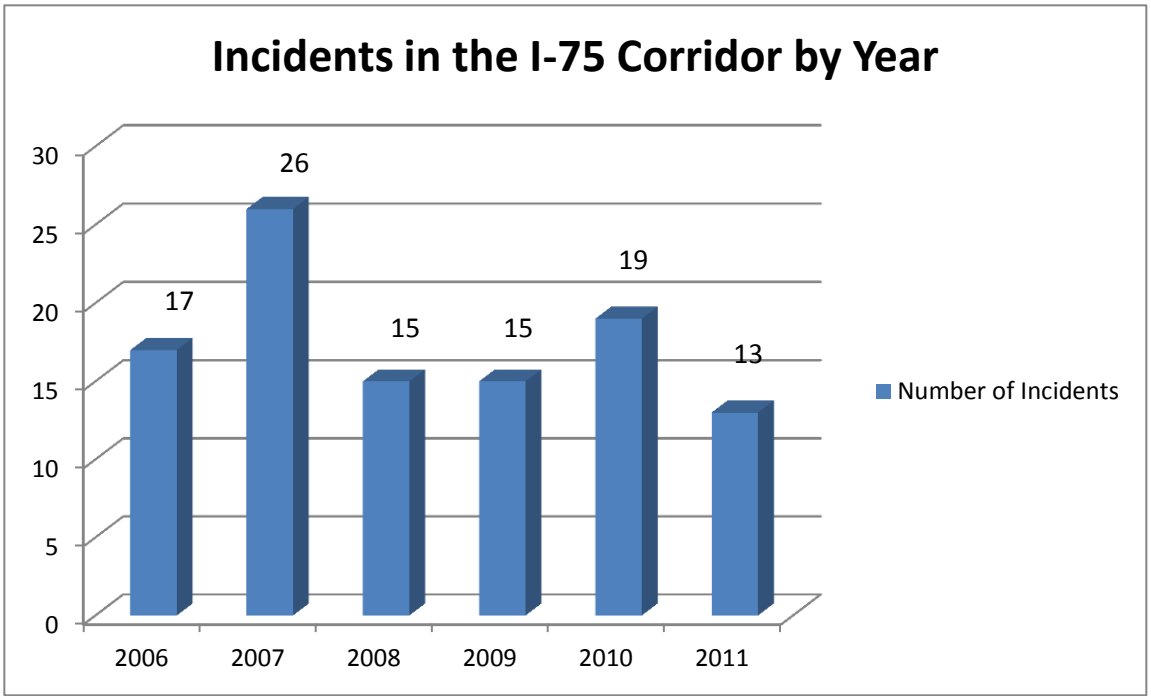


Figure 2.4. Incidents in the I-75 corridor, January 2006-June 2011

The type of accident reported that resulted in a hazmat release was assessed (Figure 2.5). The majority of releases that occurred on I-75 resulted from spills and leakage. Based on the amount of substance released, accidents are classified as major and minor. Major incidents are release of more than 100 gallons of hazardous material and minor is less than 100 gallons. A total of 12 major incidents have been reported on I-75 in the study corridor from January 2006- June 2011.

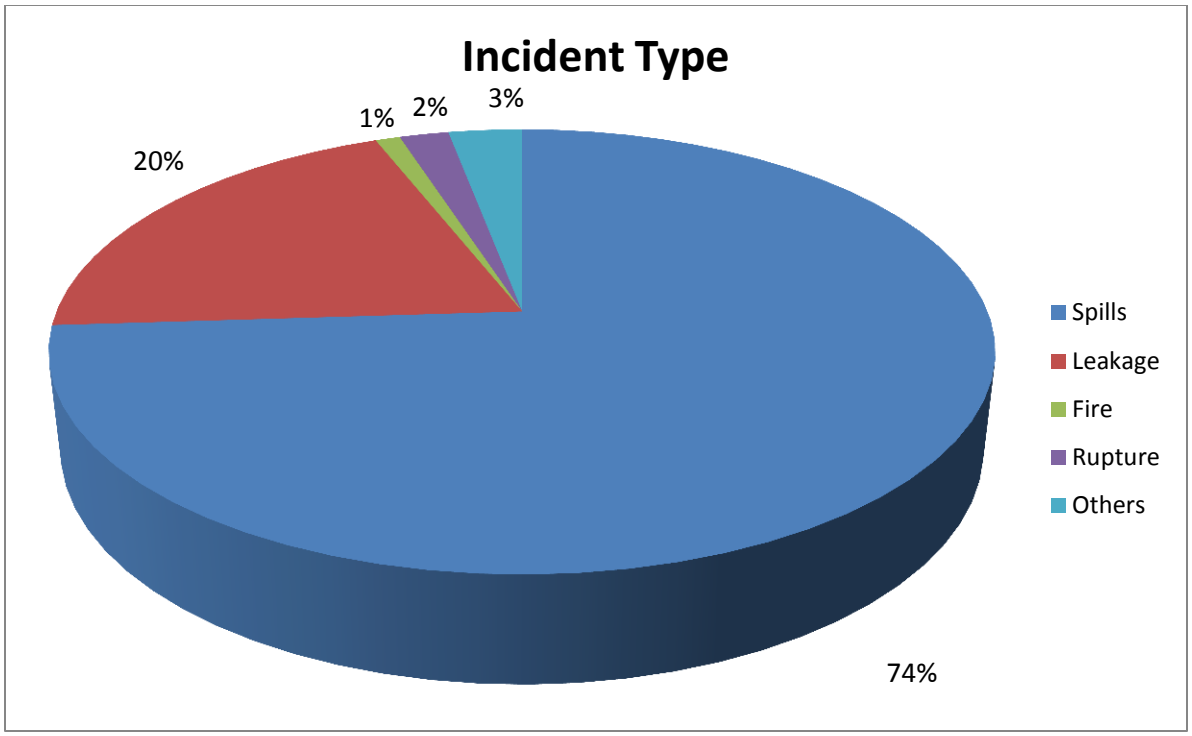


Figure 2.5. Types of Incidents on I-75

The following chart (Figure 2.6) presents the most common hazardous materials which were released in incidents on I-75 from 2006-2011. Each hazardous material being transported is identified by a unique number that appears on a USDOT hazardous materials transportation placard that should be posted on the front, rear, and sides of the vehicle. As stated by the USDOT, "Title 49 of the United States Code of Federal Regulations (49CFR) also known as the Federal Motor Carriers Safety Regulations (FMCSR) requires they use hazardous materials placards when shipping hazardous materials cargo and dangerous goods in the United States (USDOT, 2010, http://environmentalchemistry.com/yogi/hazmat/placards/)." The four digit numbers that appear on the placards, the UN/NA numbers, refer to specific chemicals or groups of chemicals.

As can be seen in Figure 2.6, Diesel is the most common substance reported in incidents from I-75 whose UN is 1993. Other hazardous materials reported from incidents in the study corridor were Oil/Diesel (UN 1202), Gas (UN 1203), Oil (UN 1270), Asphalt (UN 1999).

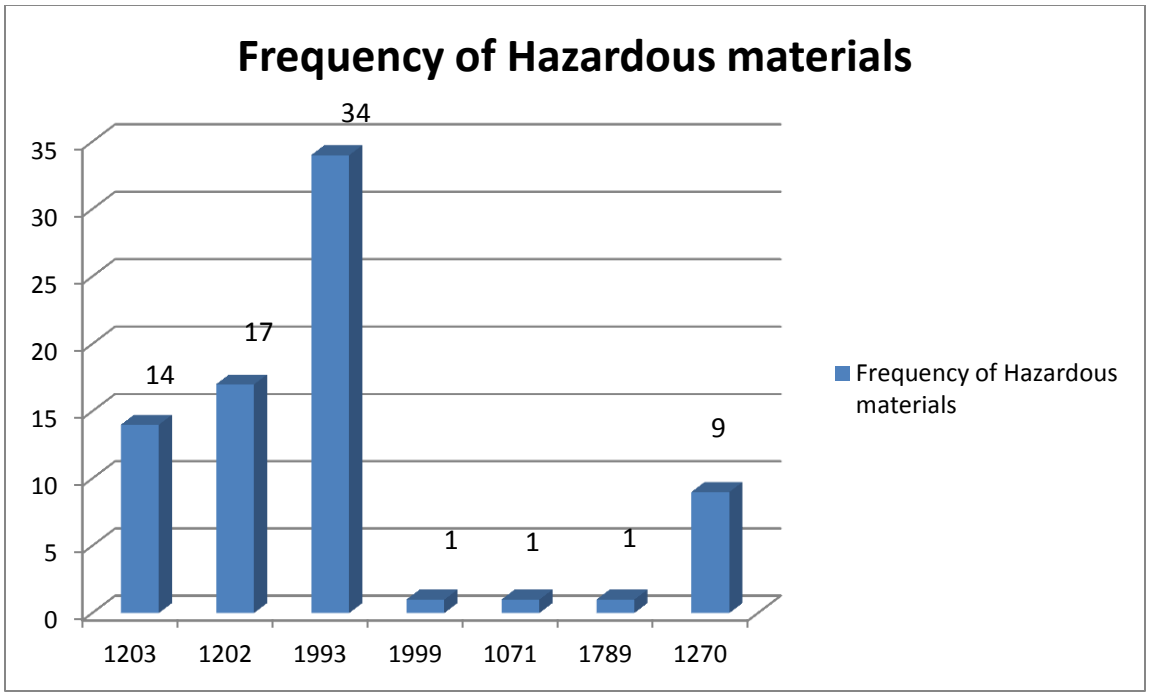


Figure 2.6. Most common hazardous materials reported in incidents from 2006-2011* on I-75. (*2011 data reported from January 2011 to June 2011.)

## 2.3 Analysis of Response Guides Based on the Incident History

The United States Department of Transportation published a guidebook which describes action on the part of the responders during the initial phase of a hazardous material incident, "The 2008 Emergency Response Guidebook (Guidebook)" (USDOT, 2008). The 2008 printing is used in this report to highlight the frequency of recommended response guides based on frequency of hazardous materials involved in hazmat incidents within the study corridor from 2006-2011. Please note there are a total of 62 different response guides numbered 111 to 172 in the Guidebook. The appropriate response to accidental release of each hazardous material is assigned a guide number, which is also associated with a brief description of the sorts of dangers that the material presents and the appropriate actions when accidentally released. By directly relating the six year history of incidents in the study corridor to the Guidebook, a practical utility of the current study is achieved for local emergency planning committee use. Professionals in this field should be able to expand on this usefulness (policy recommendations, training materials) through time.

The Guidebook is the most popular set of standards currently being used by the Emergency Response Community. However, there are other appropriate response standards that also exist in the community. Individuals interested in these other standards should direct inquiries to the LEPC. Readers should be cautioned that although one response might be deemed as "more important" than the others because it is associated with materials more frequently involved in

transportation incidents, this does not imply that training and preparedness should focus on one, or just a few, response guides. Training should be inclusive and systematically designed to provide wider knowledge of responses along with frequent review of those response types that are known to be frequently required within the jurisdiction.

Guide No. 128 is of great importance as it represents approximately 90% of the appropriate responses that should have had occurred during the past six years (Figure 2.7). Within the I -75 highway, this type of response, Number 128, would be invoked approximately 13 times a year on an average, if the emergency response teams actually responded by the book. Guide numbers 115, 119, 130, and 157 are other response guides that were used in the incidents on I-75.
It is apparent from this analysis that emergency responders within the study corridor, especially within Madison County, need to be well versed and highly practiced in a number of required response guides e.g.; 128, 115, 119, 130 and, 157.

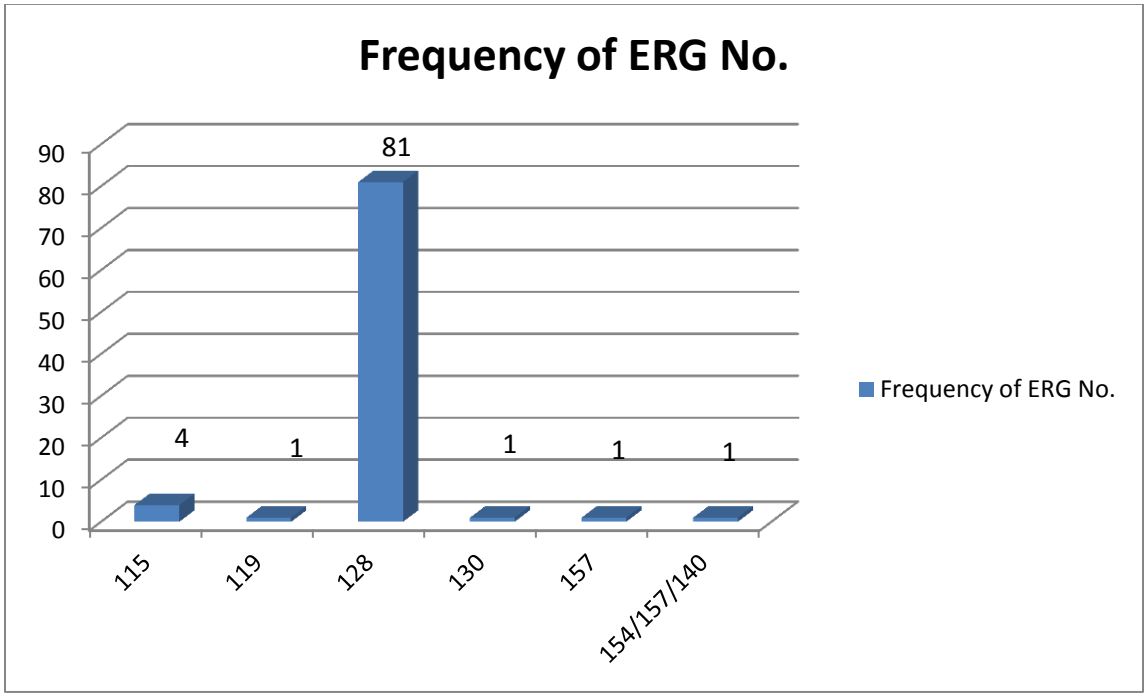


Figure 2.7. Emergency Response Guide frequency required

# Chapter 3: Analysis of the I-75 Placard Survey

The placard survey in the I-75 corridor involved 117.6 hours (approx. ~120 hours) of observation during the months of July and August 2011. These hours of observations were scheduled in order to note the daily and temporal differences in the transport of hazardous materials through the I-75 corridor. The observations were done in separate shifts by graduate students of the Western Kentucky University, Department Public Health, Environmental Health Science program. All placard survey hours followed pre-decided schedules. These schedules were pre-approved by the LEPC. Schedules were made in a manner so as to discourage repetition of the same students for two consecutive shifts. Also, in cases where repetition could not be avoided, appropriate breaks were provided between the hours of observation. This was done in order to avoid lack of concentration on the part of the students. For every shift, care was taken to schedule two students in order to avoid personal bias.

As mentioned previously, pre-approved schedules were made and observation of the trucks carrying hazardous materials through the I-75 corridor was made. The observation points were set up for monitoring the trucks passing both north and south. The monitoring station northbound trucks on I-75 was located at the Kentucky Artisan Center, near Richmond, KY. The monitoring point for southbound trucks was located at the Exit-95 of I-75.

At each monitoring point, and for each placard observation, the date, day, time, placard ID number, any other number on the placard (class number), and the state on the license plate was noted by the students. As mentioned above, the total number of observation hours was 120, of which the number of observation hours at Kentucky Artisan Center, Exit-77 of I-75 was 60 hours. The only deviation to this schedule was at the monitoring station at Exit-95 of I-75, which shut down for 2 hours 20 minutes (i.e. between 09:55am and 12:15 pm) on August 3rd 2011 due to severe thunder storm, thereby reducing the total hours of data collection at Exit-95 to 57 hours 40 minutes i.e. 57.6 hours. Thus, the total hours of observation in the I-75 corridor (as a part of placard survey) involved 117.6 hours (approx. ~120 hours) of observation.

## 3.1 Aggregate truck frequencies in the I-75 corridor

Since monitoring did not involve a direct count of the total number of trucks on I-75, this data was collected from the Division of Traffic Operations in the Kentucky Transportation Cabinet (KYTC). Monitoring of total trucks numbers and placards in the same survey would have been difficult at the monitoring stations. During times of high use, noting placards and counting trucks passing the stations may have hampered accuracy of the placard survey. Therefore, it was decided that student effort would focus on placarded trucks.

During the study period, the total number of placarded trucks observed that transported hazardous materials through the I-75 corridor, both northbound and southbound, was 834 (Figure 3.1). The average number of trucks observed on both northbound and southbound I-75 per hour was about 7 (7.14). The total number of placarded trucks per day can be extrapolated to be 168 (7x24) for I-75 per day. When comparing the difference in the average number of hazmat trucks

northbound and southbound on I-75, the total number of trucks observed were greater for southbound (574) as compared to the northbound (260). The average number of placarded trucks per hour (Figure 3.2) was greater for southbound trucks (9.95) as compared to northbound trucks (4.33). Thus, there was only a 56.5% difference in the average number of placarded trucks passing northbound and southbound per hour.

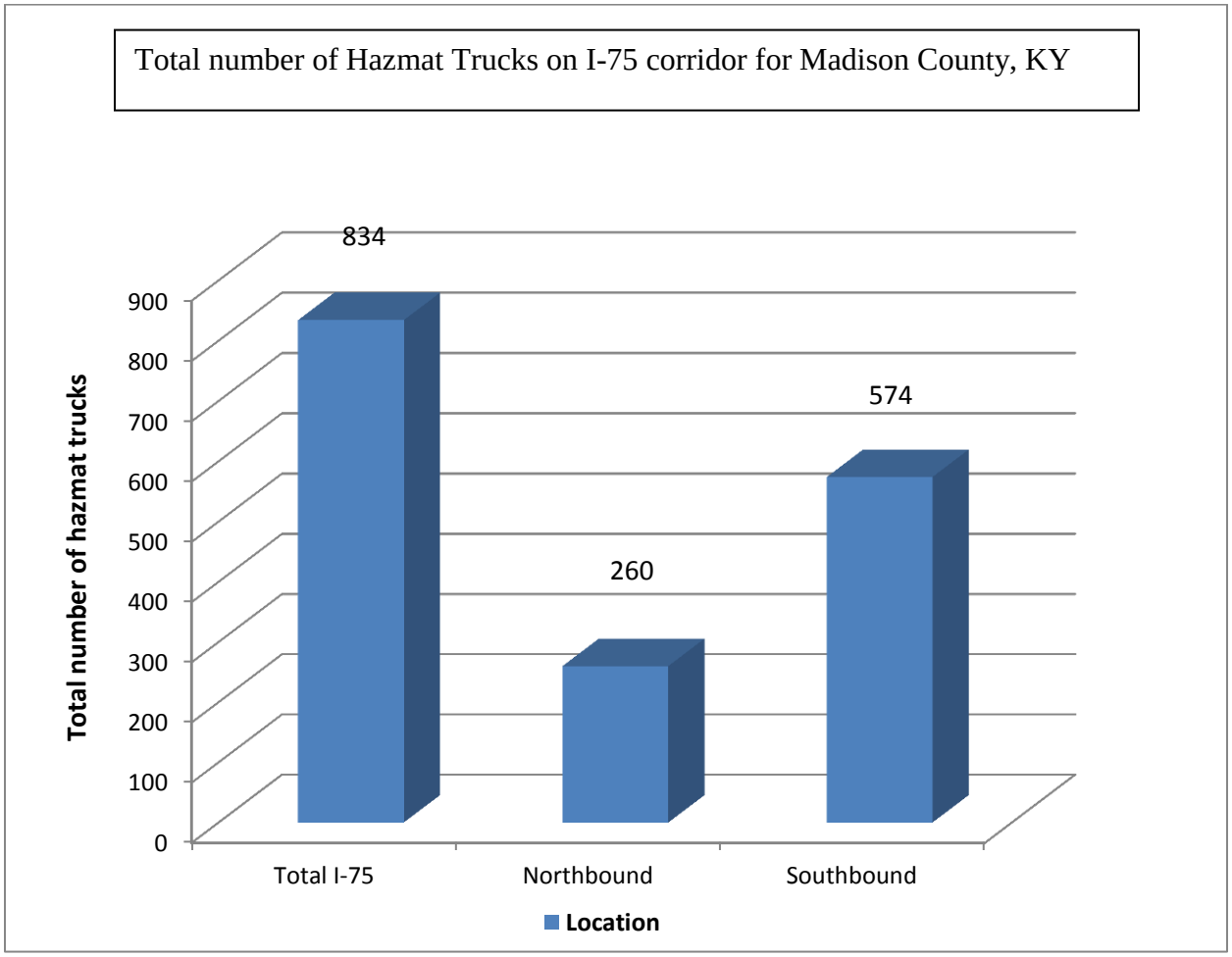


Figure 3.1. Placarded commercial trucks observed on I-75

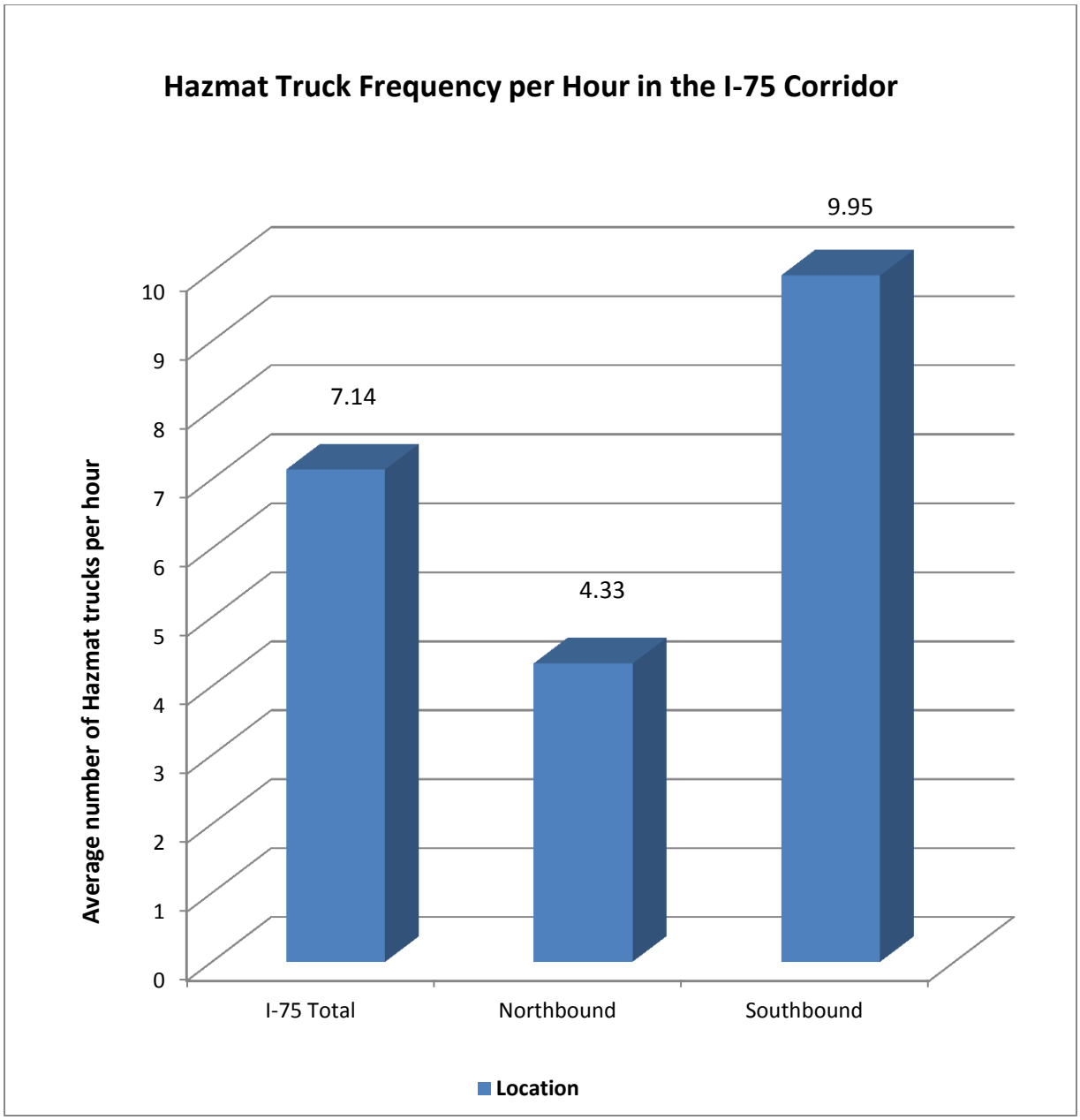


Figure 3.2. Placarded trucks per hour observed on I-75

## 3.2 Truck Frequencies by Day of the week

Observation hours at the monitoring points on I-75 were scheduled in a manner as to note the differences in the frequency of hazmat traffic during the various days of the week. Students made observations at the monitoring points near Kentucky Artisan Center, Richmond, KY and Exit-95 of I-75, Richmond, KY during weekdays.

Hazmat transportation by commercial trucks demonstrated notable differences across days of the week (Figure 3.3). Total hazmat transport across I-75 peaked on Thursday with the average number of trucks being 17.08 per hour. The least rate of hazmat transport was recorded on Monday with an average of 10.33 per hour. Of the other three days, the average was greatest for Wednesday, 15.89 per hour, while the traffic was approximately the same on Tuesday and Friday, 14.41 and 14.75 per hour, respectively.

Parallel variations were noted for the southbound hazmat transport on I-75. Figure 3.4 shows the number of commercial trucks transporting hazardous materials per hour for each lane for I-75. Observations peaked on Thursday, with an average of 11.16 vehicles per hour, and the least truck movement was recorded on Monday, with an average of 8.75 vehicles per hour. Among the other observation days for southbound I-75, Wednesday showed the highest hazmat truck movement (10.97 per hour) while Tuesdays and Fridays had approximately the same traffic (9.25 and 9.75 per hour respectively).

For the northbound commercial trucks, the trend was almost identical with reference to the day with the highest hazmat transport. For northbound commercial trucks transporting hazmat, the peak was on Thursday (5.91 per hour) and the least was on Monday (1.5 per hour). Among the other days, Friday had a higher transport rate (5.00 per hour) as compared to Tuesday (4.33 per hour) or Wednesday (4.91 per hour).

## Truck Frequencies by Day of the week:

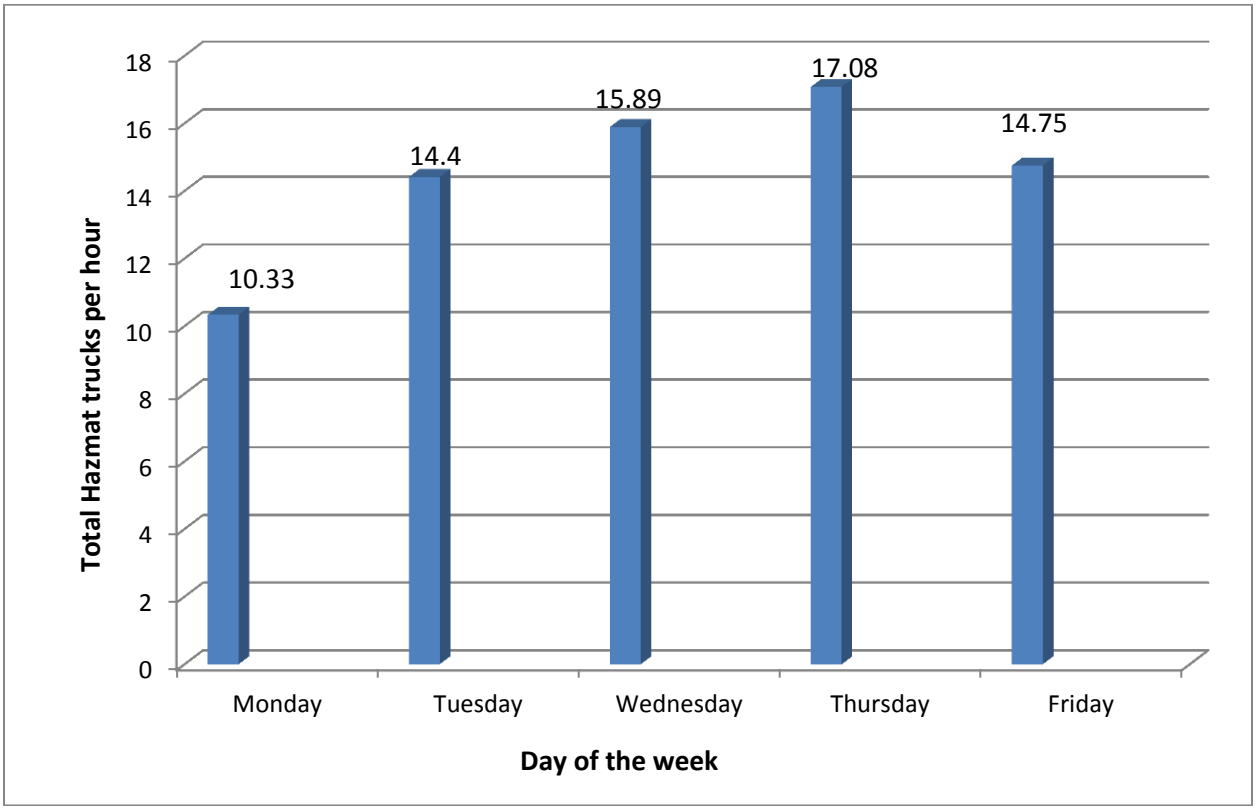


Figure 3.3. Placarded trucks observed on I-75 by day of the week

## Hazmat Frequencies According To Direction on I-75

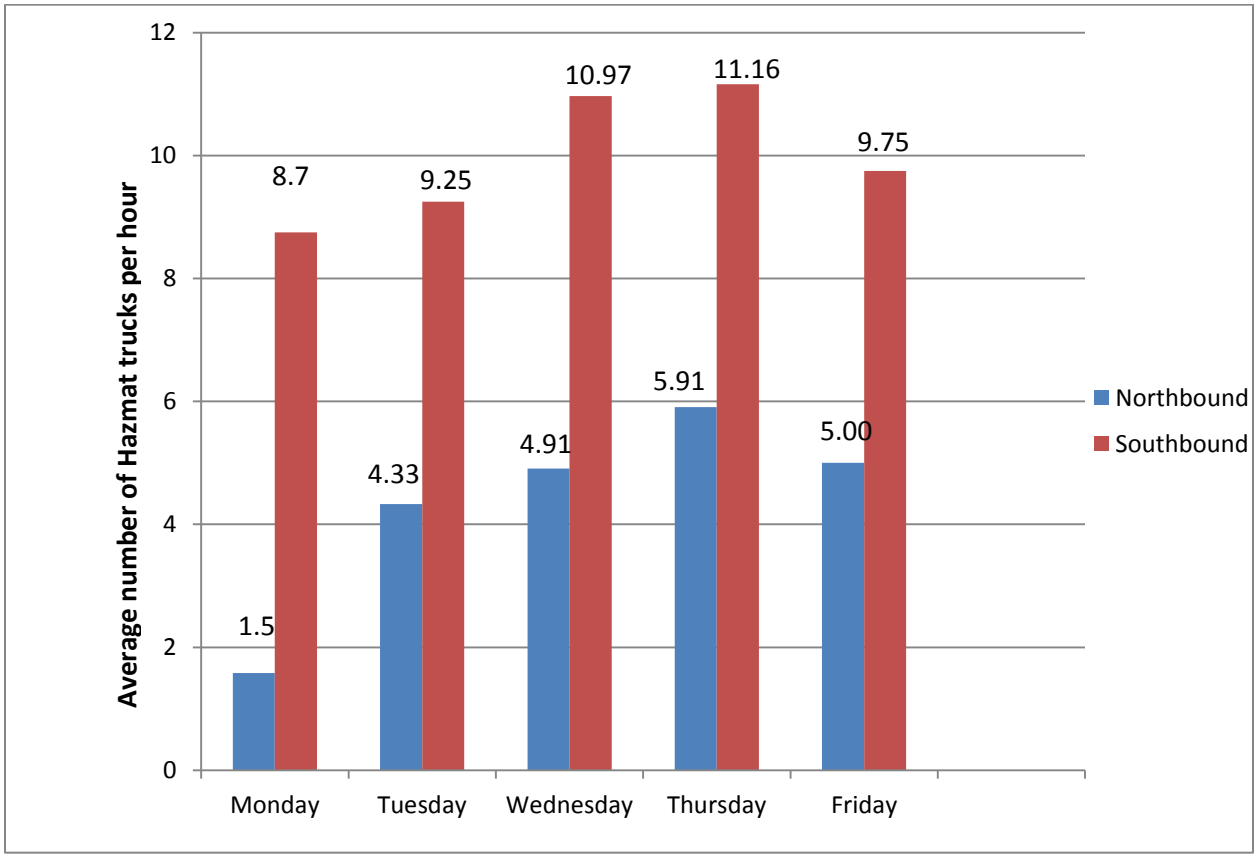


Figure 3.4. Placarded trucks observed on the North bound and South bound lanes of I-75 by day of the week

## 3.3 Truck frequencies by time of Day

Variations in the frequency of hazmat transport were determined with reference to time of day. The time of day is important in order to correlate hazmat movement with the expected times of traffic congestion. In this manner, risk profiles for hazardous materials transport can be projected by time of day.

In order to analyze the hourly frequency of hazmat transport, the monitoring hours at each observation point was divided into 3 periods. The divisions of observation hours for both North bound (Kentucky Artisan Center, Richmond, KY) and South bound lanes (Exit-95, Richmond, KY) of I-75 are as follows:

Period 1 (Morning): 7 am to 11 am
Period2 (Midday): 11 am to 3 pm
Period 3 (Evening): 3 pm to 7 pm

As shown in Figure 3.5, the maximum frequency of hazmat trucks were observed during the midday for both north and south bound lanes (25 per hour for north bound and 55.25 per hour for south bound). For the northbound lanes, the frequency was higher during the morning hours (9.3 per hour) and was diminished towards evening (6.9 per hour) and night (6.5 per hour). However, for the southbound lane, the hourly frequency was approximately equal for both morning and evening

# HAZMAT TRANSPORT FOR NORTH AND SOUTHBOUND LANES ON I-75 BY THE TIME OF DAY:

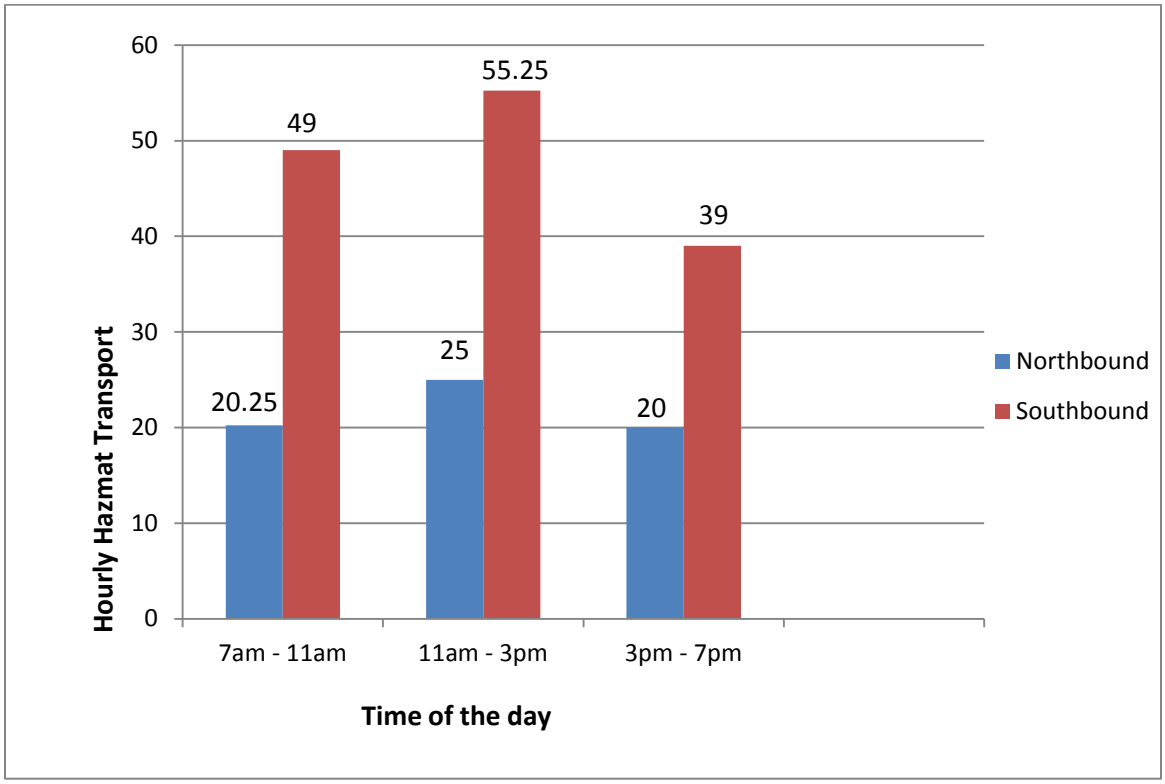


Figure 3.5. Placarded trucks observed on I-75 by time of the Day for North and South bound lanes.

## 3.4 Composition of Hazardous Materials Being Transported

Analysis of placard data was used to assess materials being transported along the northbound I-75. Based on Figure 3.6. Petrol/ Gasoline (ID no. 1203) was the most frequently transported hazmat with a frequency of 22% of the total hazardous materials observed for commercial trucks. Other frequently observed materials included Corrosive (Class:8 = 14%), Flammable (5%), ID No: 1993 (5%) and so on. Figure 3.7 shows the top 10 hazardous materials transported along with the top 10 materials transported in the "Others" category.

Southbound I-75 observations of hazmat transport were similar to northbound (Figure 3.6). The most frequent hazmat transported was Petrol/ Gasoline (ID No: 1203) with the frequency being 17% of the total hazardous materials transported southbound. The other most frequently observed hazardous materials, in terms of percentages, were Flammable (16%), Corrosive (10%), Combustible Liquid (6%) (ID No: 1993).

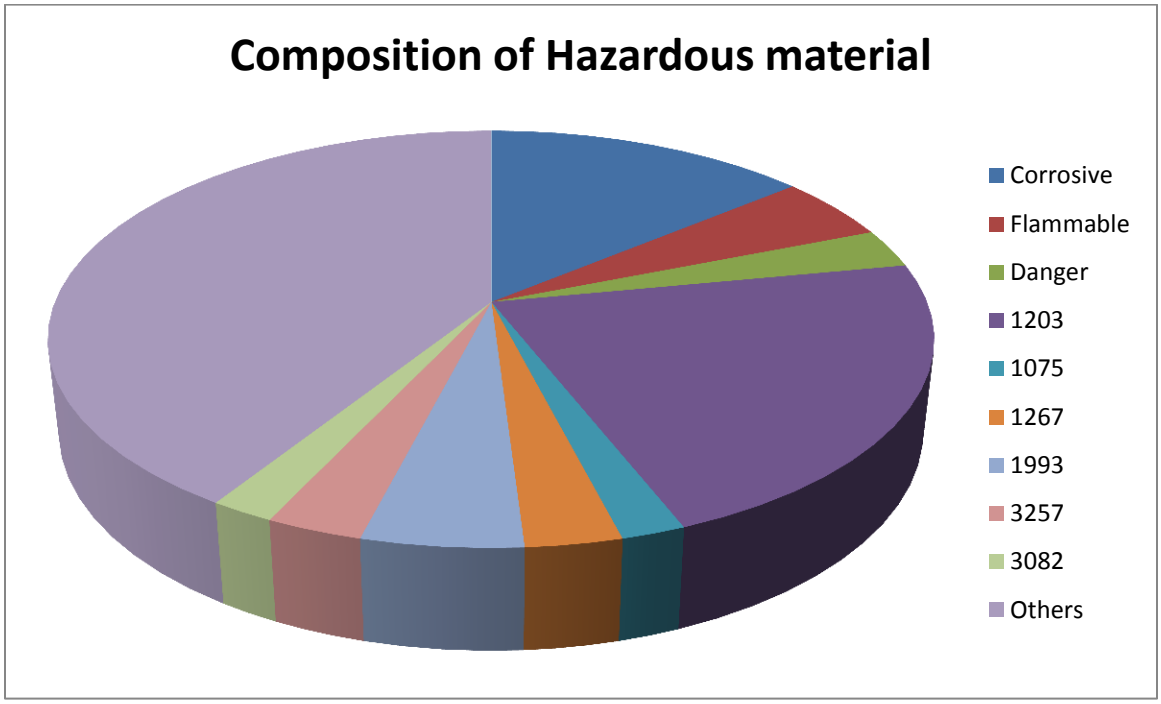


Figure 3.6. Top 10 Hazardous materials transported along Northbound 1-75 corridor

Table 3.1. Types of hazardous materials transported (%), Northbound I-75

| Type | Type of Hazardous material (%) |
|---|---|
| Corrosive | 14 |
| Flammable | 5 |
| Danger | 3 |
| 1203 | 22 |
| 1075 | 2 |
| 1267 | 3 |
| 1993 | 5 |
| 3257 | 3 |
| 3082 | 2 |
| Others | 41 |

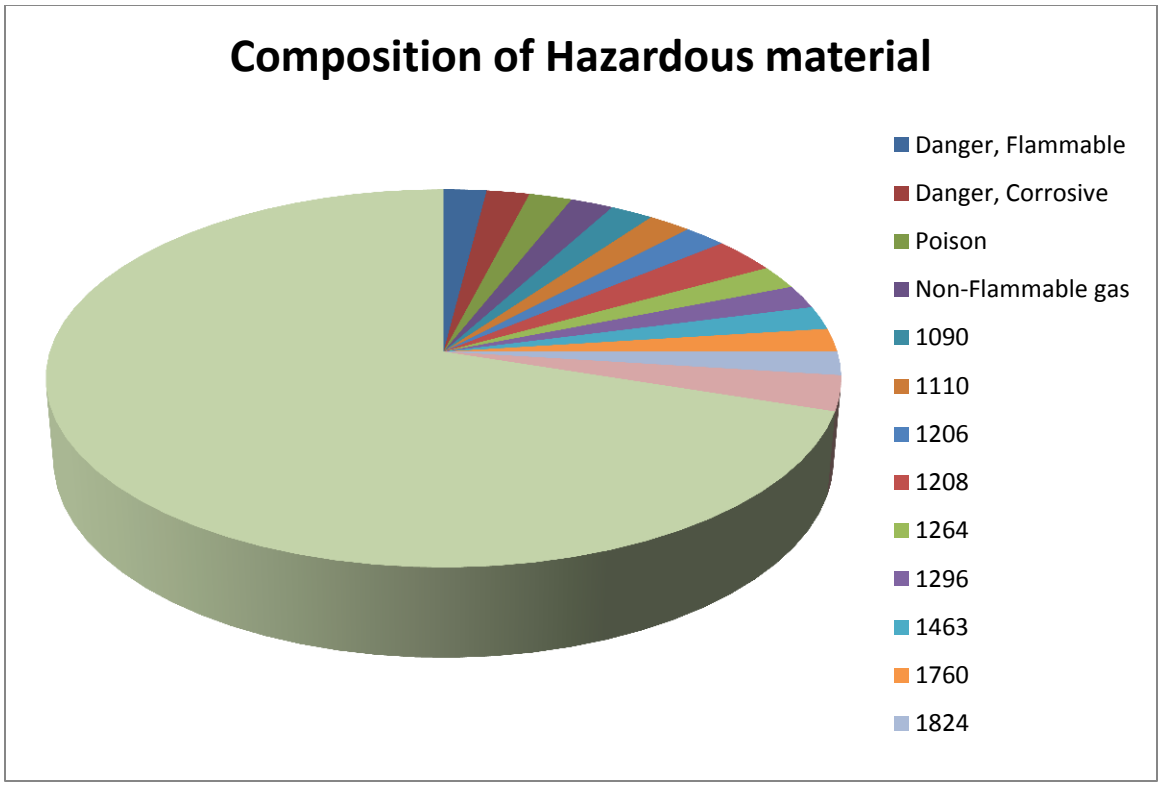


Figure: 3.7. Hazardous materials (%) reported in the others category, Northbound 1-75 corridor

Table 3.2. Composition of hazardous materials reported, Northbound I-75

| Type | Composition of Hazardous material (%) |
|---|---|
| Danger, Flammable | 2 |
| Danger, Corrosive | 2 |
| Poison | 2 |
| Non-Flammable gas | 2 |
| 1090 | 2 |
| 1110 | 2 |
| 1206 | 2 |
| 1208 | 3 |
| 1264 | 2 |
| 1296 | 2 |
| 1463 | 2 |
| 1760 | 2 |
| 1824 | 2 |
| 2187 | 3 |
| Others | 70 |

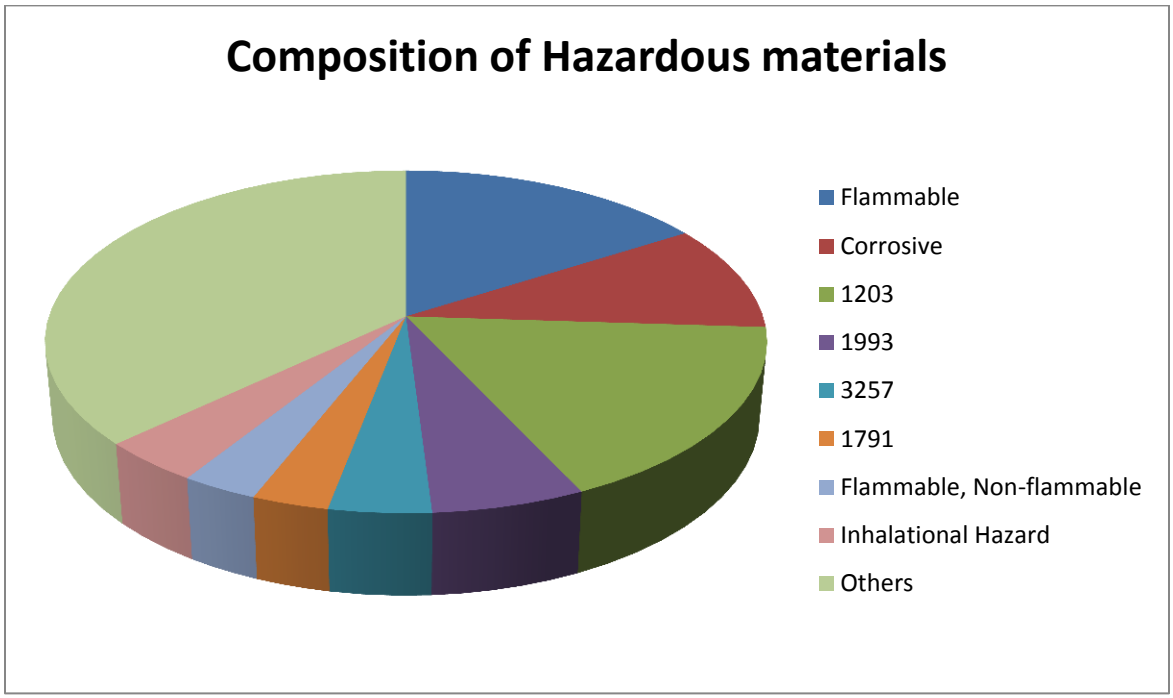


Figure: 3.8. Top 10 hazardous materials transported along the Southbound I-75 corridor

Table 3.3. Most common hazardous materials observed, Southbound I-75 Corridor

| Type | Composition of Hazardous materials in (%) percentages |
|---|---|
| Flammable | 16 |
| Corrosive | 10 |
| 1203 | 17 |
| 1993 | 6 |
| 3257 | 4 |
| 1791 | 3 |
| Flammable, Non-flammable | 3 |
| Inhalational Hazard | 4 |
| Others | 37 |

## 3.5 Recommended Responses to the Frequently Transported Hazardous Materials

According to the frequency of recurring hazardous materials in the I-75 corridor, a recommendation is made based on the most frequently recurring guide number. There were a significant number of trucks that did not have a 4 digit placard number; they rather did have labels which indicate the 'nature' or 'Class' of the hazardous material they were transporting. We considered only the placard numbers (thereby eliminated the labels) to get the respective Guide No. This guide number in the Emergency Response Guide will help in preparing for hazmat incidents and training the emergency response team.

As per the frequencies, the most frequent guide no. in the Northbound and Southbound combined corridor is 128 (Flammable Liquids, Water Immiscible) comprising almost 27% of the total hazardous materials transported. The other most frequent guide nos. include 154 (Flammable Liquids, Water Miscible). Thus, this exhibits an exaggerated need for development of emergency response for the flammable liquids. Please refer Figure 3.9 for further information.

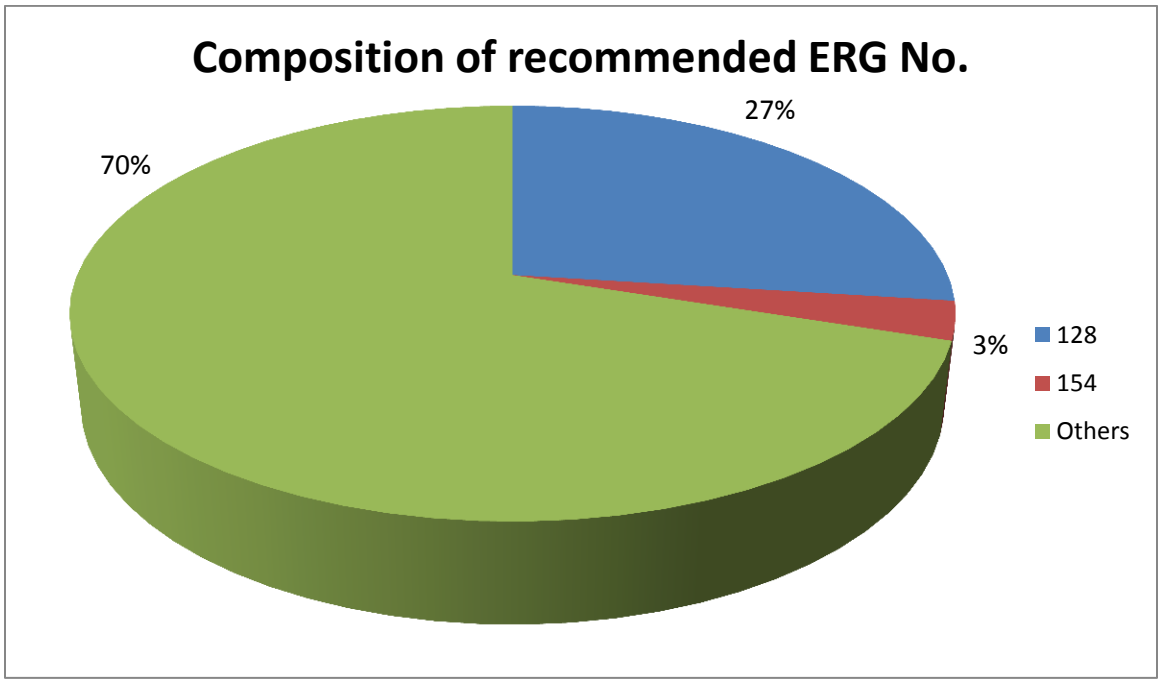


Figure 3.9. Composition of most frequently used ERG's

# Chapter 4: Fixed Facilities along the I-75 Corridor

There are 6 fixed facilities within the Madison County of the study corridor in South Central Kentucky. The Kentucky Emergency Response Commission monitors these facilities because they store large amounts of hazardous materials, and in some cases in excess of the threshold planning capacity of one or more of the EPA's "Extremely Hazardous Materials" (Agency, 2010). In order to maintain inventories of these materials, fixed facilities such as manufacturing plants, regional terminals and distributors, municipal water plants, and retail operations that serve agriculture, receive shipments into and, in some cases, send hazardous materials outbound. Proper plans for anticipating the timing and placement of transportation incidents involving hazardous materials should be based upon the knowledge of fixed facilities uses of trucking, although other modes of transportation such as rail and barge may be used.

In order to investigate the use of local roads, highways, and streets in moving hazardous materials to and from fixed facilities in the study corridor, voluntary questionnaires were mailed to environmental health and safety managers at these facilities during July 2011. The questionnaire was designed to document the origins and destinations of hazmats interacting with fixed facilities within the corridor. Information requested in the questionnaire included:

- Frequency of Hazmat shipments
- Routine of hazmat shipments
- Total quantities of hazardous materials
- Origins/Destinations of shipments
- Timing of Hazmat shipments
- Composition of Hazmat shipments
- Recent trends

A total of six usable questionnaires were returned to LEPC. Questionnaires were assessed to portray the types of hazmat transport taking place at the local scale. Inspection of the questionnaires returned indicated a wide variety of firms in terms of size and function, which adds further support to the assumption of a representative sample.

## 4.1 Fixed facilities and hazardous materials

There are six industrial facilities, large and small, located in the study area and around I-75 which use these roadways for transportation of materials. Most of them ship and receive hazardous materials. It is essential to know the type of hazardous material transported as well as their regular periods of shipment. This knowledge will elucidate the most common substances transported, their origins and destinations, as well as trend of transportation over the last five years (i.e. 2006-2010). LEPC is in need of fixed facility information to plan for necessary steps they should take for the most common hazardous materials transported. An important part of this survey was to assess if the facilities transport hazardous materials on legal holidays as well

as based on climatic conditions. Facilities which responded that they do not carry hazardous materials have been discarded from the results.

## 4.2 Fixed Facility Locations

Survey questions regarding the location of facilities based on city, state and county were provided to local industry and fixed facilities. This data was used to assess hazardous materials transport in and out of the Madison County area. All the 6 facilities that responded were based in Kentucky, and some had corporate offices in other states. Kentucky cities where fixed facilities are located are presented in Figure 4.1. Most facilities (4 facilities) were located in Richmond followed by Berea (2). All the 6 facilities were located in Madison County.

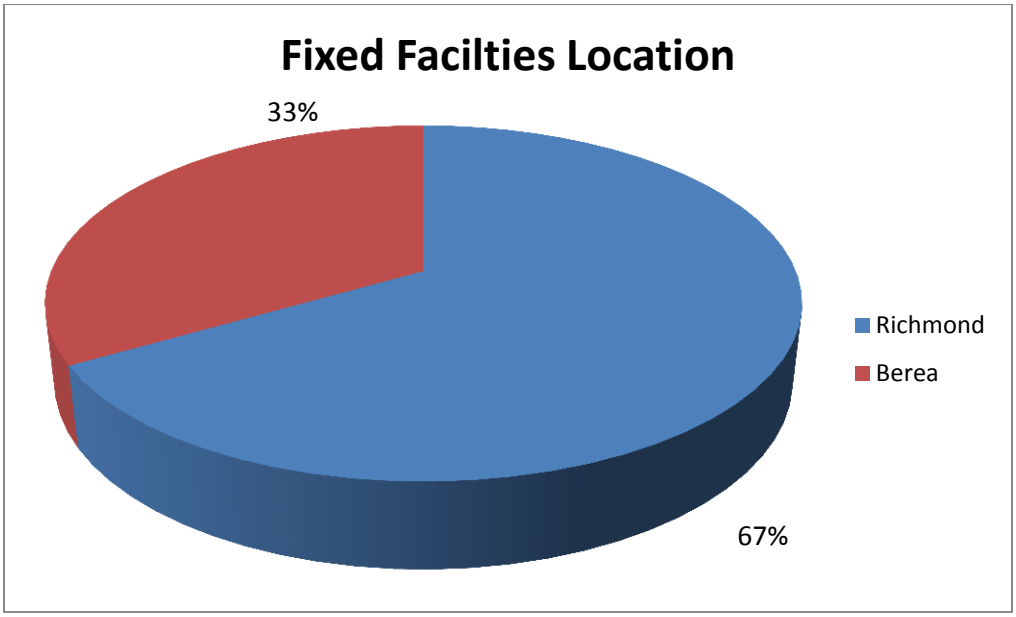


Figure 4.1. No of fixed facilities in Madison County, Kentucky, by city

The facilities were asked about the most common mode of *transportation* of materials through their facilities. All the facilities reported using trucks as a major source of transporting their materials. None of the facilities reported using railroad, as means of transportation.
The survey consisted of questions requiring the facilities to give information about the number of placarded trucks that leave or come to their facilities. They were also asked to give the routes they use for their movement, and to get to I-75, as this can be vital information to trace accidents or leaks.

One of the questions in the survey asked the facilities to give information regarding the number of placarded trucks that entered and left their facilities. Table 4.1 gives an overview of the movement of trucks by each facility for shipping and receiving. When we compare the tonnage of materials shipped or received over the past five years, we observe the following trend shown in Figure 4.3.

Table 4.1. No of Placarded Trucks-Shipped and Received by each facility

| S.NO | Facility Name | Trucks Received (1-1-2006 to 12-31-2010) | Trucks Shipped (1-1-2006 to 12-31-2010) |
|---|---|---|---|
| 1 | Enersys | 3600 | 147 |
| 2 | Hitachi Automotive systems | NA | 131 |
| 3 | Pittsburg Glass Works | 120 | 8 |
| 4 | Tri County Fertilizers | 178 | 1055 |
| 5 | Richmond Utilities | 6 | NA |
| 6 | Sherwin Williams | 8926 | 31955 |

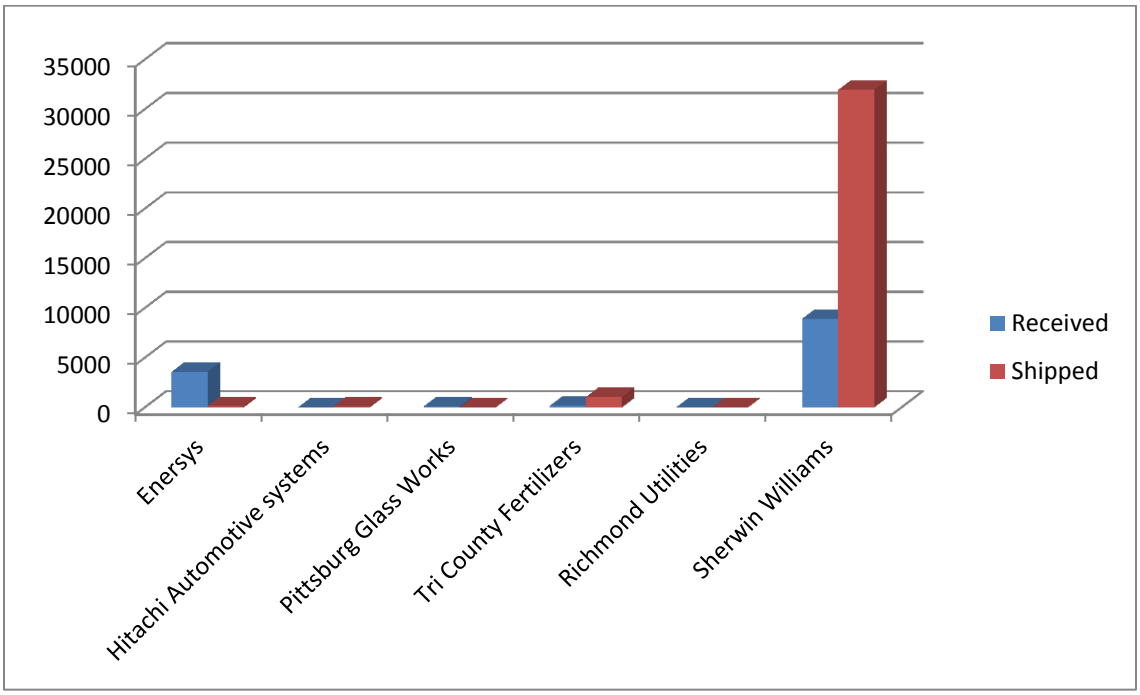


Figure 4.2. Distribution of Placarded trucks based on Shipping/Receiving by facility

Hazardous materials shipment decreased from 328955.7 tons to 260913 tons from 2006 to 2009 and again it increased to 315472.6 tons in 2010 (Figure 4.3). The reduction in tonnage mirrors the economic downturn that the United States and the region have experienced. At the level of individual facilities there are few systemic patterns of hazmat truck movements detected through analysis of these survey results.

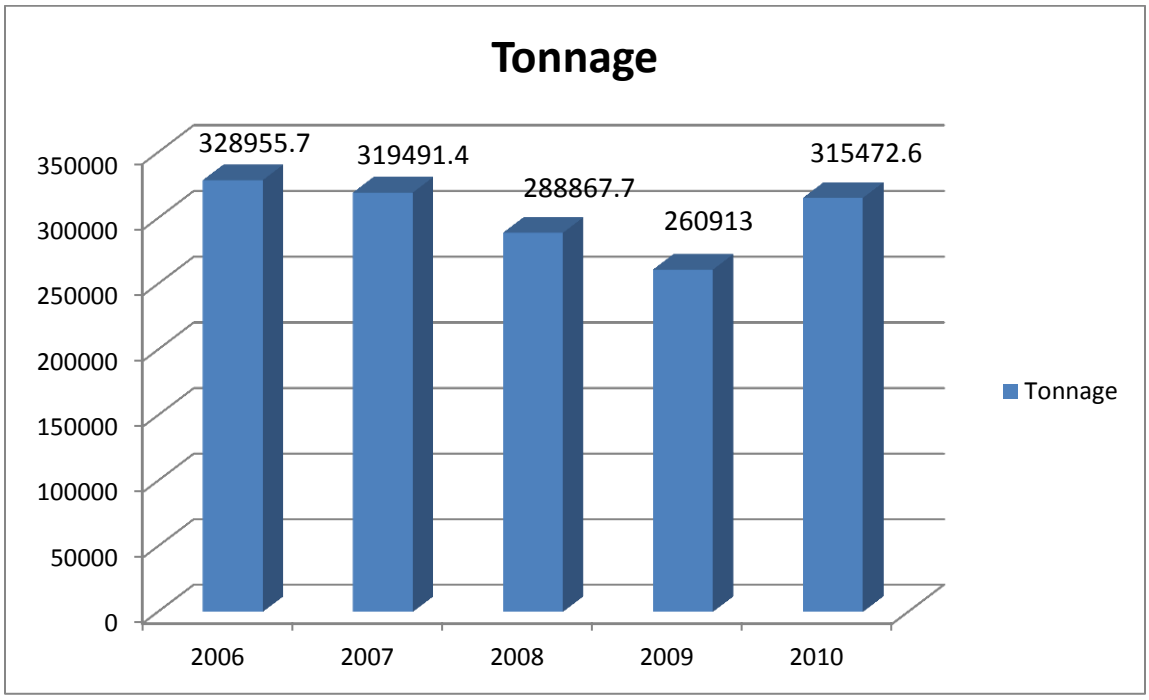


Figure 4.3. Tonnage of materials shipped and received for the calendar years 2006-2010

## 4.3 Time and Space Pattern for shipments out of the facilities

Facilities were asked to report on days of shipment. Three facilities reported Saturday and one facility reported Sunday as the routine days of shipment. Two of the facilities reported that they had no routine period of shipment. Basically, shipment was based on their requirements. Table 4.2 shows the facilities that reported that they did not have a routine of shipment of materials out of the facilities. A list of days and the number of facilities that ship on each day is shown in Table 4.3. As evidenced from the data, shipments primarily occur Monday through Friday (Figure 4.4).

Table. 4.2. Facilities with no routine days of shipment.

| | |
|---|---|
| 1. | Pittsburgh Glass Works |
| 2. | Richmond Utilities |

Table 4.3. Distribution of facilities shipping based on day of week

| Day | No of Facilities shipping on that day |
|---|---|
| Monday | 3 |
| Tuesday | 4 |
| Wednesday | 3 |
| Thursday | 4 |
| Friday | 3 |
| Saturday | 3 |
| Sunday | 1 |

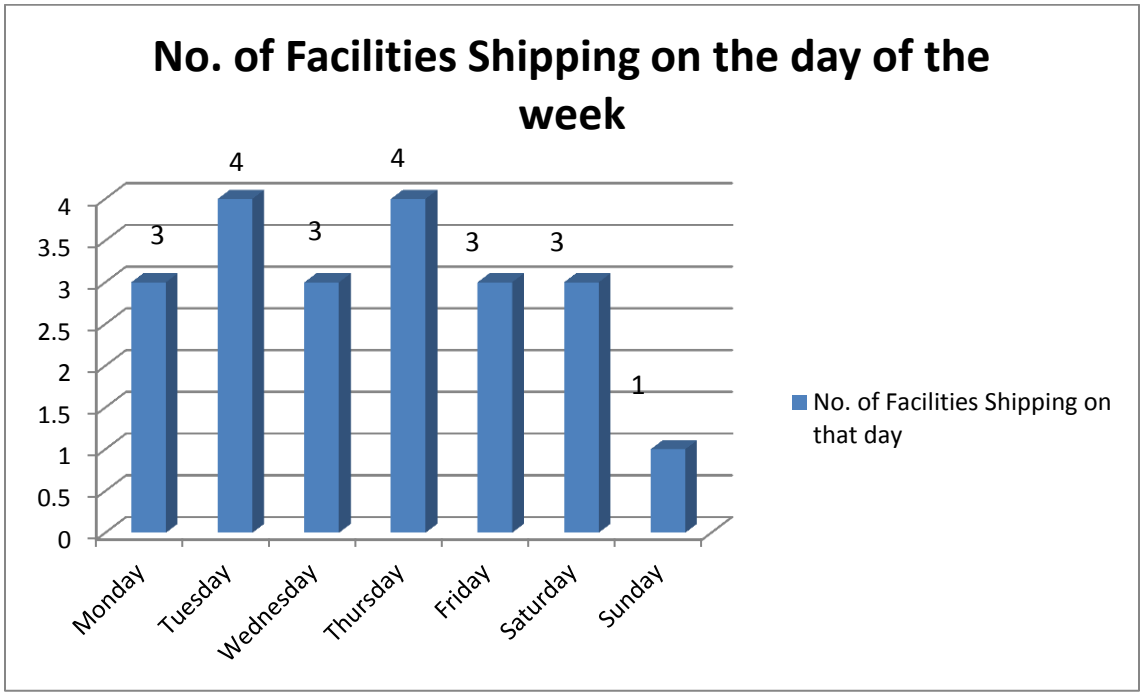


Figure 4.4. Distribution of facilities shipping based on day of the week

Fixed facilities were also asked to give information on the most common shipment times. Results are shown in Table 4.4 and Figure 4.5. Three facilities had no routine time of shipment. The most common time of day of shipments was during normal working hours, between 6 am – 4 pm. No facility ship after 4pm.

Table 4.4. Time of day that facilities shipped most often

| **Time of Day** | **No of Facilities shipping at that time** |
|---|---|
| 6 am-9 am | 2 |
| 9 am -12 pm | 3 |
| 12 pm-4pm | 2 |
| 4pm-6pm | 0 |
| 6pm-12 am | 0 |
| 12am-6am | 0 |
| No Routine | 3 |

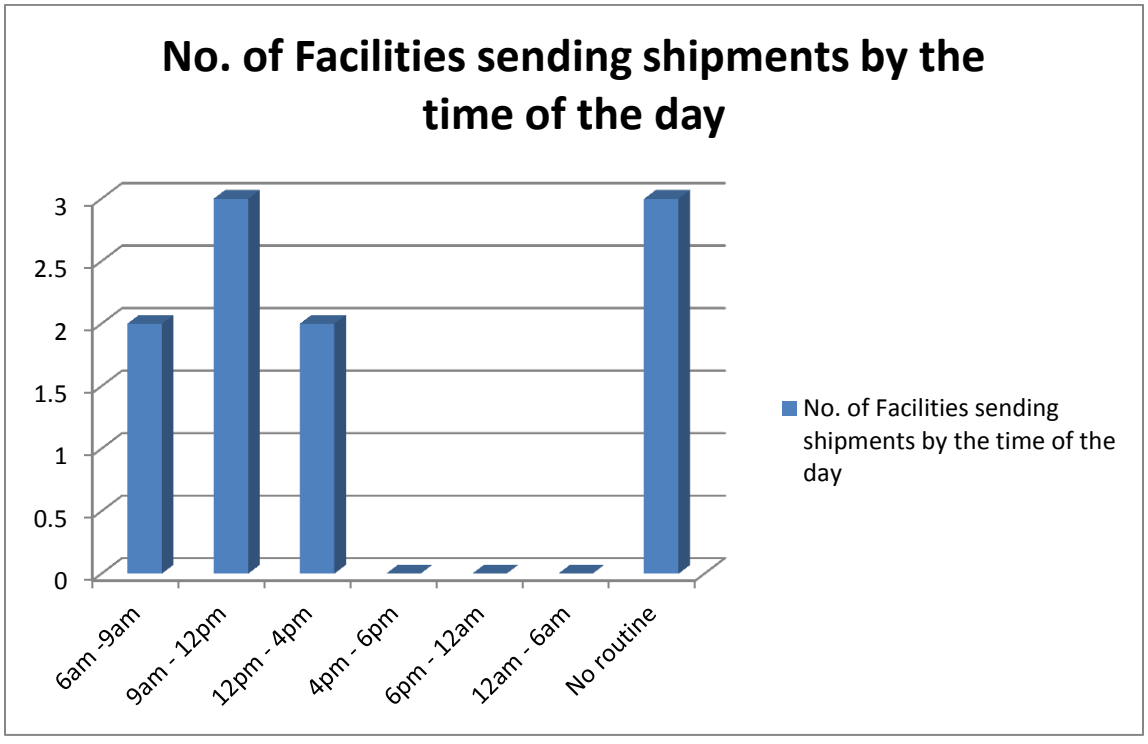

Figure 4.5. Time of day of shipping from facilities

## 4.4 Space and time pattern for receiving into the facilities

Information reported by facilities was analyzed to determine time patterns associated with receiving. Table 4.5 and Figure 4.6 gives information about the days of the week during which the facilities receive shipments. Most of the facilities received shipments on weekdays. Five facilities received shipments on Saturdays and Three facilities received on Sundays. However, it is clear that work days are when shipments are normally received.

Table 4.5. Distribution of facilities receiving materials based on days of week

| Day | No of Facilities receiving on that day |
|---|---|
| Monday | 5 |
| Tuesday | 6 |
| Wednesday | 5 |
| Thursday | 6 |
| Friday | 5 |
| Saturday | 5 |
| Sunday | 3 |

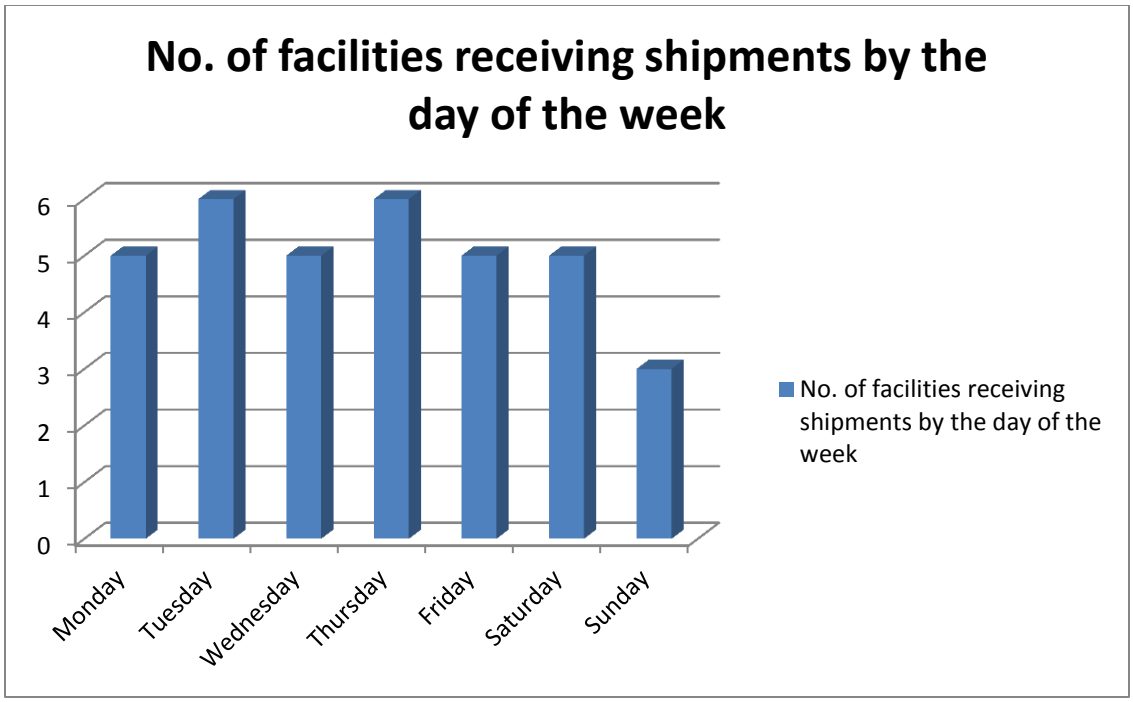


Figure 4.6. Distribution of facilities receiving materials based on days of week

Analysis of times when shipments are received indicates that most occur between 6 am – 4 pm, standard work hours. Three facilities had no routine time (of the day) for receiving the shipments. Figure 4.7 shows the distribution based on the surveys. The facilities were asked if they received or shipped hazardous materials on legal holidays. Five out of 6 facilities, which make up 83% of all the facilities, ship or receive hazardous materials on legal holidays. This may be a cause of concern as with low traffic, trucks can drive at higher rates of speed, thus increasing the chances of incidents.

Table 4.6. Time shipment of receiving reported by facilities

| **Time of Day** | **No of Facilities receiving at that time** |
|---|---|
| 6 am-9 am | 2 |
| 9 am -12 pm | 3 |
| 12 pm-4pm | 2 |
| 4pm-6pm | 1 |
| 6pm-12 am | 0 |
| 12am-6am | 0 |
| No Routine | 3 |

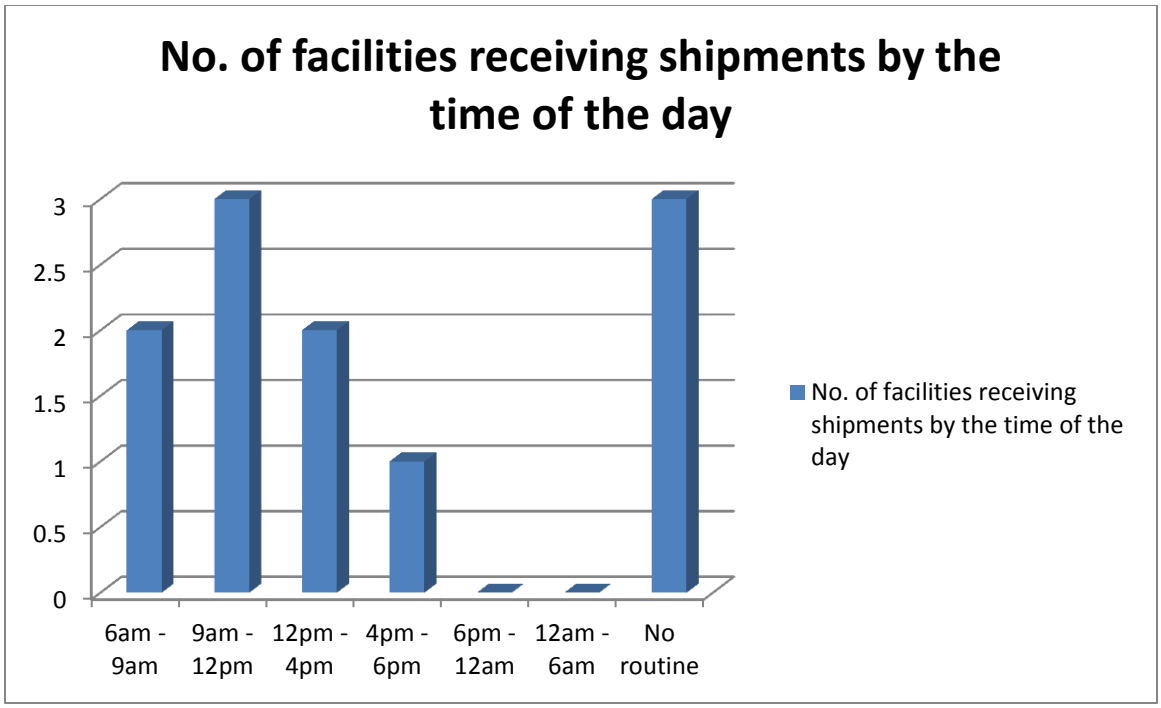


Figure 4.7. Figure showing time of receiving of shipments into facilities

## 4.5 Material Data Analysis

The questionnaire was designed to elicit information about five most frequently shipped hazardous materials to and from fixed facilities, within the study corridor. The 6 respondents listed a total of 18 hazardous materials that were transported during the five year period from January 2006 through December 2010. The survey had questions regarding the most common cities and states the materials are received from or shipped to, as well as the season of the year.

Out of the 18 hazardous materials listed, Lead debris, LP gas, Ceramic paint, Acids (which include Bulk acid, Waste acid, Hydrochloric acid) formed approximately 50% of the composition of hazardous materials reported by the fixed facilities (Figure 4.8). Other materials that were shipped or received included Ammonium nitrate, Broken fluorescent lamps, caustic sodium hydroxide, chlorine gas, flammable solids&liquids and others together formed the 50% of the total of hazardous materials. The other hazardous materials, consisted of the substances having the following Placard numbers: 3077, 2796, 1075, 1110, 1263, 1268, 1755, 1825, 1866, 2055, 2072, 3175, 3264.

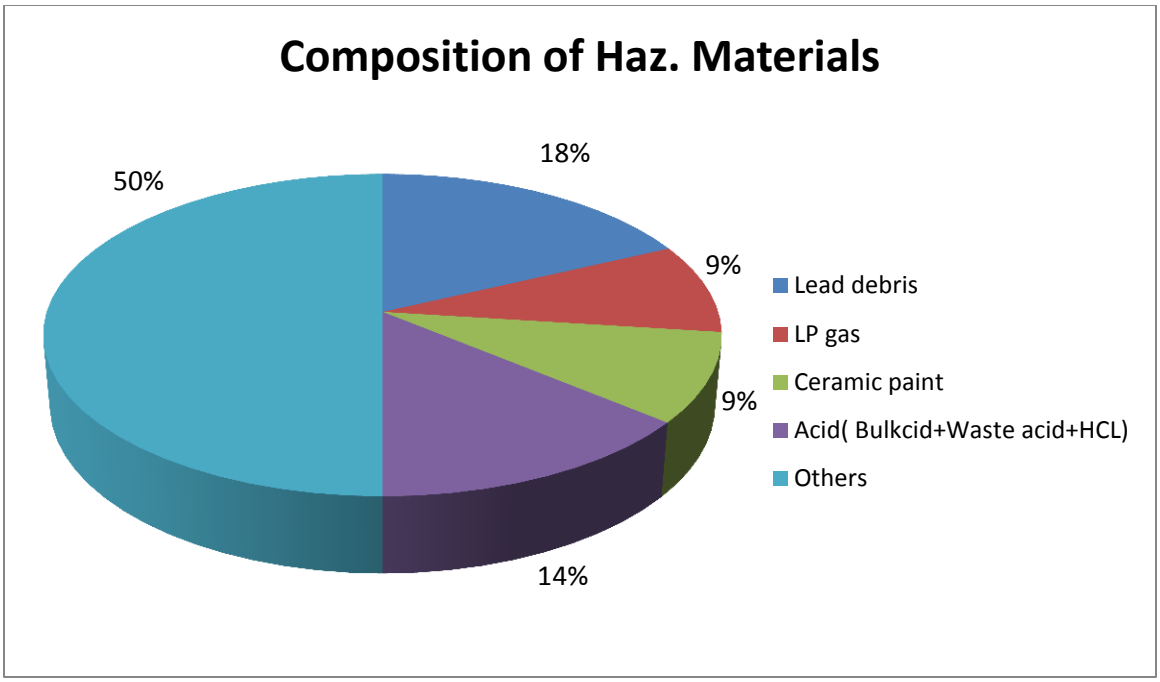


Figure 4.8. Hazardous Material most commonly shipped/Received

The survey also asked the facilities to fill out information about the origin city and state of materials received. This information provides guidance on the routes that commercial trucks may take to the fixed facilities, As such, this will add in emergency preparedness. Figure 4.9 shows that Texas & Kentucky are the major states of origin for hazardous materials in the I-75 corridor of the study area; they are followed by Ohio, Missouri and others. Other states include AL, PA, UT, MI, AR, KS, NC, LA, WI, WV, IL, IN.

Boss, Mo.; Canton and Columbus, OH are the most common cities of origin of hazardous materials into the study corridor (Figure 4.10). They are followed by Houston, Indianapolis, Plano and others. Survey results show that local transport is a primary source of materials. Table 4.7 gives an overview of the different states and cities from which commodity flow originates in the study corridor. A map of states that fixed facilities received shipments from is shown in Figure 4.11.

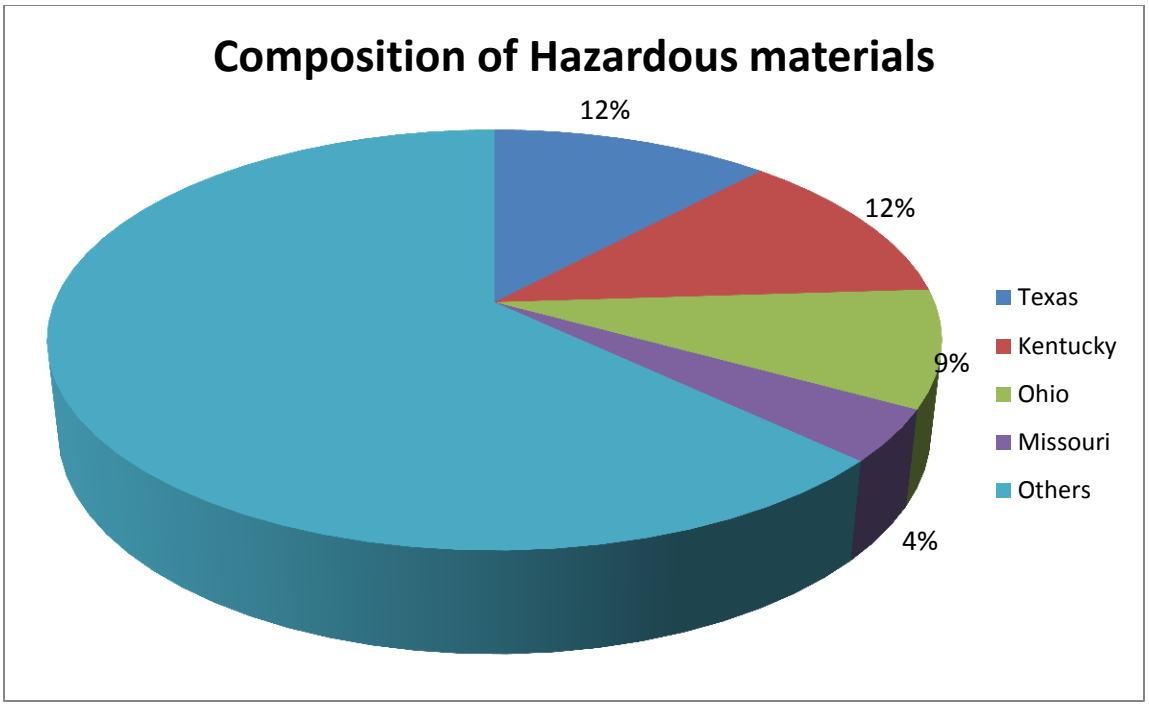


Figure 4.9. States of Origins of Hazardous materials shipment

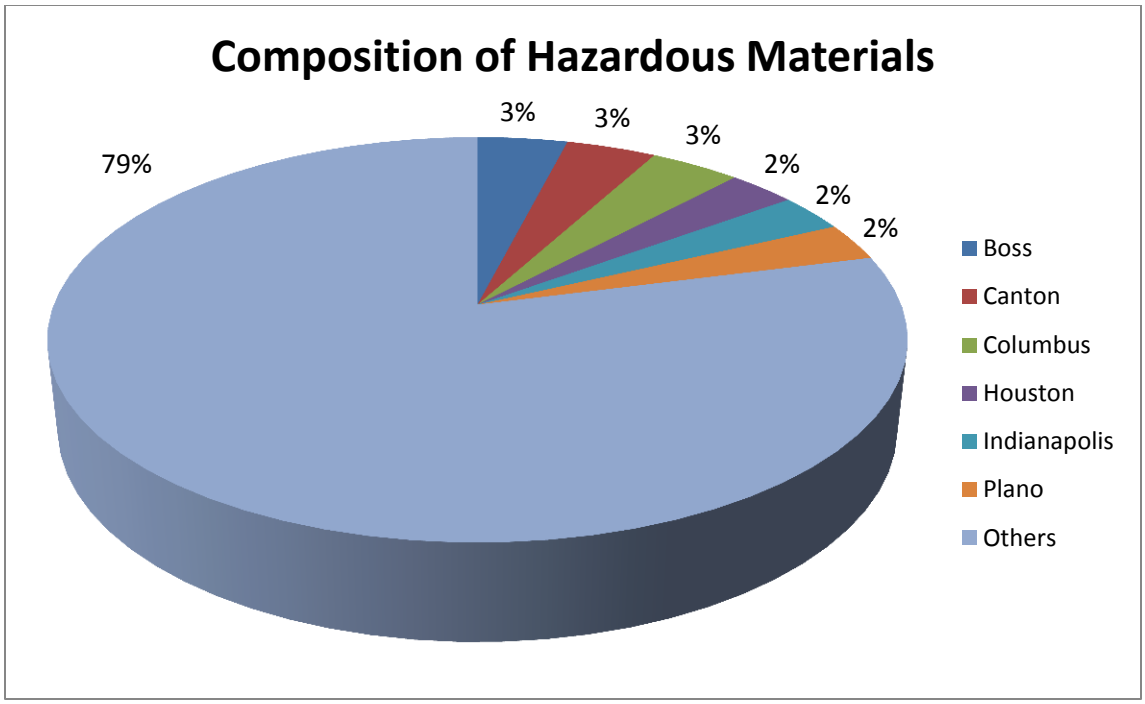


Figure 4.10. Most common cities of origin of Hazardous materials

| States | Cities |
|---|---|
| MO | Boss |
| AL | Emelle |
| PA | Downington |
| UT | Salt Lake City |
| MI | Grand Rapids |
| AR | Benton |
| KS | Andover |
| NC | Greensboro |
| LA | Shrevport |
| WI | Port Washington |
| OH | Columbus, Canton, Monroe |
| WV | Institute |
| KY | Louisville, Lancaster, Winchester, Richmond, Berea, Somerset, Smithfield, Henderson, Ashland |
| IL | Channahon, Willow springs |
| IN | Indianapolis |
| TX | Deer park, Fort Worth, Houston, Texas city, Kingsport, Plano, Garland, Dallas |

Table 4.7. States and Cities of Origin for commodity flow on I-75, Madison County, KY

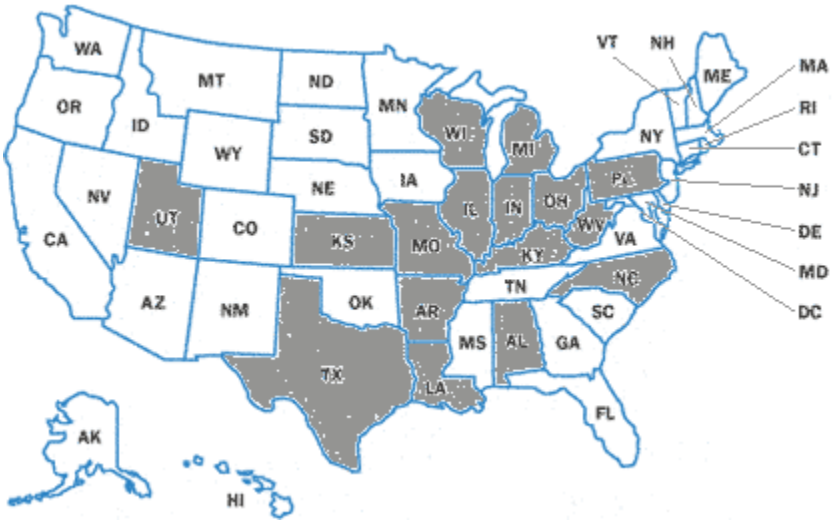


Figure 4.11. States of origin of hazardous materials

Facilities provided the most common seasons of the year during which they transport hazardous materials (Figure 4.12). For the facilities that responded, 52% reported that they had no particular season for transportation of hazardous materials. Basically, the supply period is based upon demand for their produced materials. The distribution of supply was equivalent throughout the year, with a slightly decreased rate from October to December

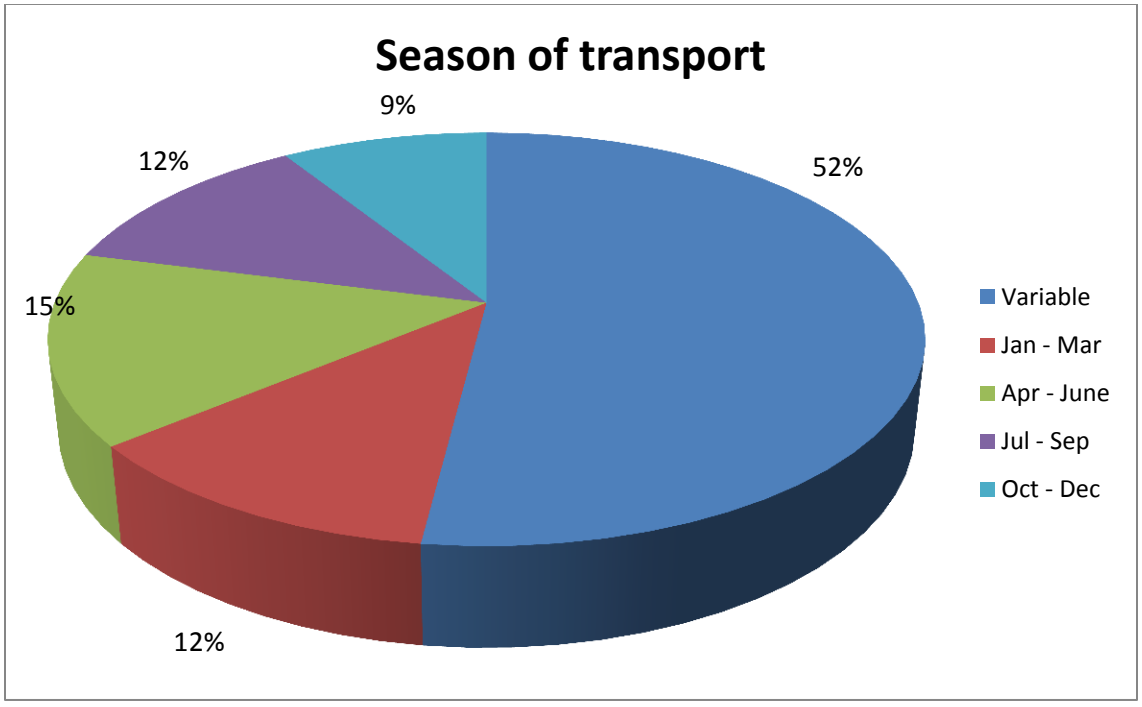


Figure 4.12. Seasons of shipments on I-75

# Chapter 5: Discussion - Most Common Hazardous Materials Transported through I-75 Corridor

The following points regarding the most common hazardous materials are provided in a bulleted list for ease of review. Below, placard numbers are provided to improve the ease of "Guidebook" use.

- The Placard Ids of the first five most commonly reported hazardous materials transported through the I-75 study corridor were 1203, Flammable, 3257, Corrosive and 1993.

- The following table (Table shows the most common Placard numbers with their respective guide numbers used from the Emergency response guidebook:

Table 5.1. Placard numbers for the most commonly received commodities.

| *Placard No.* | *Respective Guide No.* |
|---|---|
| 1203 | 128 |
| Flammable | 127 |
| 3257 | 128 |
| Corrosive | 153 |
| 1993 | 128 |

- Placard Id 1203 is used for materials like Gasohol, Gasoline, Motor Spirit and Petrol, while Id 3257 is used for the materials that are environmentally hazardous Liquid materials, Hazardous waste materials and other regulated liquid substances. The Placard Id 1993 is used for Combustible Liquids, Compound cleaning liquids, Compound tree or week cleaning liquids, Diesel fluids, Flammable Liquids, Fuel Oil, Medicines, and

materials used in refrigeration. Apart from these the common toxic materials transported through this route included Flammable and Corrosive hazardous materials.

- Now we shall discuss the immediate response in case of emergency, for the materials using the common Placard Id numbers and the respective PPE (Personal Protective Equipment / Response) required.

Reported Emergency Response from the "Guidebook":

1. **Materials with Placard Id. 1203: Gasohol, Gasoline, Motor Spirit and Petrol.**

- **Emergency Response:** These are usually the non- Polar or Water Immiscible liquids. According to the Emergency Response Guidebook, in case of small fire involving these materials, dry chemical or Co2 is suggested to be used. Water spray, fog or regular foam can be used in case of large fires. In case of massive fire involving large Tanks or Trailer Loads, it is suggested to fight the fire from maximum distance or use unmanned hose holders; and if this is not possible, withdraw from area letting the fire burn. Withdraw immediately in case of a rising sound or discoloration of tank. It is advised to always stay away from the Tanks engulfed in fire. In case of Spill or Leak, first step is to eliminate all ignition sources (e.g. No Smoking).Do not step on the spilled material, and if possible stop the leak. A vapor suppressing foam may be used to reduce the vapors. In case of the large spills, it is suggested to dike far ahead of liquid spill for later disposal.

- **PPE required:** Positive Pressure Self-contained breathing apparatus (SCBA)

2. **Flammable Materials**: These are the Polar or water miscible liquids. But the emergency Response and PPE required for this section of materials is same as mentioned above.

3. **Materials with Placard Id. 3257:** This involves the materials that are environmentally hazardous Liquid materials, Hazardous waste materials and other regulated liquid substances. These are the moderate hazard materials.

- **Emergency Response and PPE:** Emergency Response in case of a Fire is same as mentioned in the section 1 with Placard 1203. In case of Spill or Leak involving these materials, apart from the response mentioned in section 1, it is advised to prevent dust cloud and avoid inhalation of asbestos dust. In case of a Small Dry spill, it is advised to use a clean shovel to place the material into clean, dry container and cover loosely and remove containers from the spill area. In case of a Small spill, take up the material with

the sand or other non-combustible absorbent material and place into containers for later disposal. In case of large spill, cover the powder spill with plastic sheet or tarp to minimize the spreading. It is also advised to try and avoid entry into waterways, sewers, basements or confined areas. A Self-contained breathing apparatus (SCBA) is advised as a PPE.

4. **Corrosive Materials:** These are also Combustible Materials.

- **Emergency Response:** The emergency response for these materials is same as mentioned in the 1 above. In addition to that, it is advised to not get water inside the containers. Elimination of the ignition sources is highly recommended.

- **PPE:** Apart from the commonly used SCBA, it is advised to wear chemical protective clothing that is specifically recommended by the manufacturer.

5. **Materials with Placard Id. 1993:** It involves Combustible Liquids, Compound cleaning liquids, Compound tree or week cleaning liquids, Diesel fluids, Flammable Liquids, Fuel Oil, Medicines, and materials used in refrigeration. Since the placard Id, for the materials under this section also refers to the Guide No. 128, the Emergency response and PPE required remains the same as mentioned in Section 1.

# Chapter 6: Summary

Hazardous materials are an important part of contemporary American society. As with other commodities, hazardous materials are produced, transported, stored, used and discarded. A threat to environment and human health is posed by hazardous materials that are released due to highway, railway, and other incidents. Incidents with hazardous materials can take place at any time, from their production to their disposition. This study clarifies the quantities and types of hazardous materials that are transported on I-75 highway in the Madison County area of Kentucky. Likewise, information is provided on the timing of transport, which is critical for emergency preparedness by LEPC.

It is essential to educate communities, both large and small, about the care to be taken with hazardous materials. Hence, it is important to initiate construction of a knowledge base that concerns types of hazardous materials being transported into, out of, and through a respective jurisdiction. In addition to their relative frequencies, the timings and routes of hazardous materials increase emergency response. The Emergency Response Planning committee must be predicated on an adequate portrayal of these elements of hazmat movements. The adequacy of emergency response organizational schemes, equipment inventories and purchases, and personal training can only be assessed in the light of this type of information.

This report creates an accurate starting point, and begins the development of the necessary knowledge of transportation of hazardous materials through the I-75 corridor in Madison County. Communicating this information to emergency responders will generate an initial line of incident response before such an event occurs. Coordination of emergency response will be critical to adequately protect human health and environment from the potential impacts of the hazardous materials documented. It is hopeful that results and recommendations of this report will be a useful guide in preparing emergency responders.

This study provides focus on highway transportation. The empirical results that are summarized below are based on the following:

- A six year hazmat incident history from 2006-June 2011 which was reported to the Madison County Local emergency Planning commission.
- A fixed facility survey sent out to all the facilities in Madison County and the surrounding region.
- Commodity flow data were collected by placard surveys on I-75. Monitoring was conducted by Western Kentucky University students from the Department of Public Health, Environmental Health Science program. Student work was supervised by Dr. Vijay Golla and Dr. Ritchie Taylor of Western Kentucky University and by Mr. Bryan Makinen with Madison County LEPC.

The following section summarizes the results obtained in chapters 2, 3, 4 and 5 and gives recommendations which can be used as a guidance tool for emergency preparedness:

**Result 1**:
During the period of January 2006 - June 2011 a total of 119 incidents were reported to the Madison County Local Emergency Planning Commission. Out of the total of 119 incidents, 105 occurred in the I-75 study corridor. A great variation is found in the number of incidents reported during the data period, with greater incidents being reported in 2007. USDOT placard ID number 1993 (Diesel/Oil) was the most common hazardous material involved in incidents, accounting for 47% of total emergency incidents. Current data for 2011 indicates a greater rate of incidents than in 2010, with only incident data available through June 2011. Hazmat transport reported by fixed facilities, both shipping and receiving, indicates that transport volume follows economic activity.

**Recommendation 1.1:**
The emergency response committee should index general economic activity as a predictor of commodity transport. Data shows that transport volume corresponds to the number of incidents. Periods of recovery after a sustained economic lull may be particularly dangerous periods in the study corridor.

**Recommendation 1.2**:
LEPC should inform local emergency responders as to the most detected placard ID numbers in surveys, incidents, and from other data sources. This would ensure that responders are prepared for hazardous materials incidents that are likely to occur. Also, LEPC planning should take all hazardous materials observed in to account in planning.

**Result 2:**
Majority of incidents include spill and vehicular accidents along the I-75 corridor.

**Recommendation 2:**
It is important to update the drivers about the current rules and regulations and safety norms. Strict rules should be implemented for speed control in this corridor, especially in the Richmond area. Log books should be thoroughly checked to make sure the drivers do not overwork, and speed limits for trucks should be restricted to 60 mph. Also trucks overtaking on highways should be fined. A system of automated signage may improve safety.

**Result 3:**
Diesel, placard ID 1993, is the most common hazardous material released hazmat incidents. The Response guide that should be used for this substance is 128.

**Recommendation 3:**
It is important for Local Emergency responders to be properly trained for response Guide no 128. They should be updated with any changes that are made to this guide. Annual training for emergency responders should include a refresher on application of response guide 128 under various scenarios.

**Result 4:**
The overall frequency of hazardous material demonstrated an increase in the southbound transport. This shows that a greater amount of hazardous materials pass through the state of Kentucky even if the destination for the hazardous materials are southern states.

**Recommendation 4:**
This warrants an increased need for the emergency responders to be vigilant around the southbound I-75 corridor since it is a popular route for hazardous materials. Additional emergency crossover points should be provided along I-75 that allows emergency vehicles increased access for incidents.

**Result 5:**
The frequency of hazardous materials was recorded to be highest on Thursday as compared to any other day of the week. Also, it was noted that the traffic lull with regards to the hazardous material was highest from 10 am to 3 pm. Fixed facility data indicate that Monday through Friday are the busiest days for transport, and 6 am – 4 pm is when the majority of shipping and receiving occurs.

**Recommendation 5:**
It is extremely important for the emergency responders to be familiar with the peak days and times with reference to the transportation of hazardous materials. This will ensure better alertness and preparedness in case an incident occurs during these time periods. Extra emergency responders should be on call during the aforementioned peak timing in order to ensure efficient response. One potential problem in areas with volunteer emergency responders is that these responders are usually working other jobs during these peak times for hazardous materials transport. A system needs to be devised to improve incident response in these areas.

**Result 6:**
The most common hazardous material that was transported across the I-75 corridor was placard ID 1203 which was petrol. This demonstrates the increased transportation of motor fuels between states.

**Recommendation 6:**
This explains the increased need of developing emergency response for these fuel related products in case of an incident. It is also important to train the emergency responders with reference to these motor fuels. Annual training should be established for incidents involving ID 1203.

**Result 7:**
From chapter 4, Fixed Facilities, it is clear that the greatest numbers of facilities are located in the city of Richmond. It is the seventh largest city in Kentucky and second largest in Bluegrass region (after Lexington).

**Recommendation 7:**
It is very important for Local responders in the city of Richmond to be trained to deal with any kind of hazmat incidents. Proper training equipments and PPE should be kept in place. Each responder should review the hazmats that have been observed in this report and be trained to respond to each one. Additionally, scenarios with multiple hazmats should be practiced.

**Result 8:** Transportation of the majority of hazardous materials takes place during weekdays, and between working hours of 6 am -4 pm. This corresponds to the morning and evening rush hours of public traffic. Additionally, this corresponds to school bus transport.

**Recommendation 8:** Facilities should be requested to change their hours of shipments to mid day, early morning or early evening. This will limit the risk to the public during traffic rush hour.

**Result 9:** On reviewing the data, it is clear that Texas and Kentucky are the most common states of origin of hazardous materials. But based on the cities of Boss, Canton and Columbus, these are at the top of the chart of most common cities of origin/destination of hazardous materials.

**Recommendation 9:** From this, we can conclude that the part of I-75 corridor between the cities of Boss, Canton, Columbus and city of Richmond should be considered important, and emergency response stations should be established at regular intervals along this corridor.

# Chapter 7: Comparison of Commodity Flows on I-75 (2011) and I-65 (2010) and I-65 (1998)

Table 7.1 shows that traffic flow of hazardous materials has increased by approximately 55% over the past 12 years. Placard ID 1203 is transported on a lesser scale on I-75, as compared to 2010 and 1998. However due to limited information we cannot comment on the incidents reported on I-75 in 2011.

Table 7.1 Summary of the Comparison of Commodity Flows on I-75 and I-65 (2010) and I-65 (1998)

| Characteristics | I-65 (1998) | I-65 (2010) | I-75 (2011) |
|---|---|---|---|
| **Traffic** | | | |
| Hazmats/hr | 5.61 | 8.7 | 7.14 |
| Peak Hazmat Day | Wednesday | Friday | Thursday |
| Peak Hazmat Hours | 10- 4 pm | 10 am to 2 pm | 11am – 3pm |
| Max. Hazmat Direction | South | South | South |
| **Hazmat Composition** | | | |
| Placard 1203 (% of hazmats) | 21 | 38.7 | 18% (14/77) |
| Max. Response Guide (%) | 128 (33%) | 128 (44.6%) | 128 (91%) |

# Chapter 8: References

Agency, E. P. (2010, March 10). *Wastes-Hazardous Wastes*. Retrieved July 20, 2010, from U.S.Environmental Protection Agency: http://www.epa.gov/osw/hazard/

Mitchelson, R., Calhoun, K. (1998). *The Kentucky I-24 Corridor Hazardous Materials, Commodity Flow Analysis.* Kentucky.

Transport Canada (TC), U.S. Department of Transportation (DOT) (2008). *ERG2008, Emergency Response Guidebook.*

Transportation, D. o. (n.d.). *U.S Department of Transportation Federal Motor Carrier Safety Administration*. Retrieved July 20, 2010, from DOT: http://www.fmcsa.dot.gov/safety-security/hazmat/complyhmregs.htm#hm

Taylor, R. (2010). Warren County, Kentucky Hazardous materials commodity flow analysis. Retrieved August 12, 2010, from digitalcommons.wku.edu/public_hlth_fac_pub/1/