U.S. Department of Transportation

Pipeline and Hazardous Materials Safety Administration

Building Safe Communities: Pipeline Risk and its Application to Local Development Decisions

Office of Pipeline Safety

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Building Safe Communities:

Pipeline Risk and its Application to Local Development Decisions

I. Purpose

Developing and applying recommended practices for land use and development in areas near pipelines is one means of addressing pipeline risks to communities. The U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA), Office of Pipeline Safety (OPS), is sponsoring the Pipelines and Informed Planning Alliance (PIPA) to develop these recommended practices. A balanced view of the risks involved with pipelines and their relation to land use planning and development decisions by local governments, landowners, and property developers is important for effective application of the recommended practices.

The purpose of this report is to assist local governments and developers in better understanding pipeline risks and to provide a context for the use of recommended practices for development near hazardous liquid and gas transmission pipelines. This report aims to provide a context for local governments and developers to better understand pipeline risks through discussion of the following areas:

- Risks that transmission pipelines pose to the community and mitigation of those risks;
- Transmission pipeline historical safety performance;
- Comparison between pipeline historical risk and historical risk from the release of hazardous materials from other modes of transportation;
- Specific regulations covering pipeline operations that could affect populated areas, drinking water sources, and ecologically sensitive areas.

II. Background

A vast network of hazardous liquid and gas transmission pipelines[1] traverses the United States (see Figure 1 below). Approximately 294,000 miles of onshore gas transmission pipelines and 164,000 miles of onshore hazardous liquid pipelines move natural gas, crude oil, and petroleum products throughout the U.S. every day[2]. These pipelines transport commodities from producers, refiners, and processors to industrial and commercial end users, as well as to terminals and distribution companies. Transmission pipelines transport a high volume of commodities over long distances, with approximately two-thirds of

[1] Hazardous liquid and gas transmission pipelines will be collectively referred to as "transmission pipelines" throughout this study. Transmission pipelines, which are the subject of this report and the PIPA Final Report, are distinct from "gathering" and "distribution" pipelines. Gathering pipelines transport gas or liquids from production facilities to transmission pipelines. Distribution pipelines are used to supply natural gas to the consumer and are located downstream of a natural gas transmission pipelines. See 49CFR192.3 for definitions of gas "transmission," "gathering," and "distribution" pipelines. See 49CFR195.2 for the definition of a hazardous liquid "gathering" pipeline.

[2] This is average mileage from annual reports for hazardous liquid and gas transmission onshore pipelines during 2004-2008. Mileage data may be found here on the OPS website.

the ton-miles of the nation's oil and petroleum products transported by pipelines[3] and nearly all natural gas used in the U.S. transported by transmission pipelines.

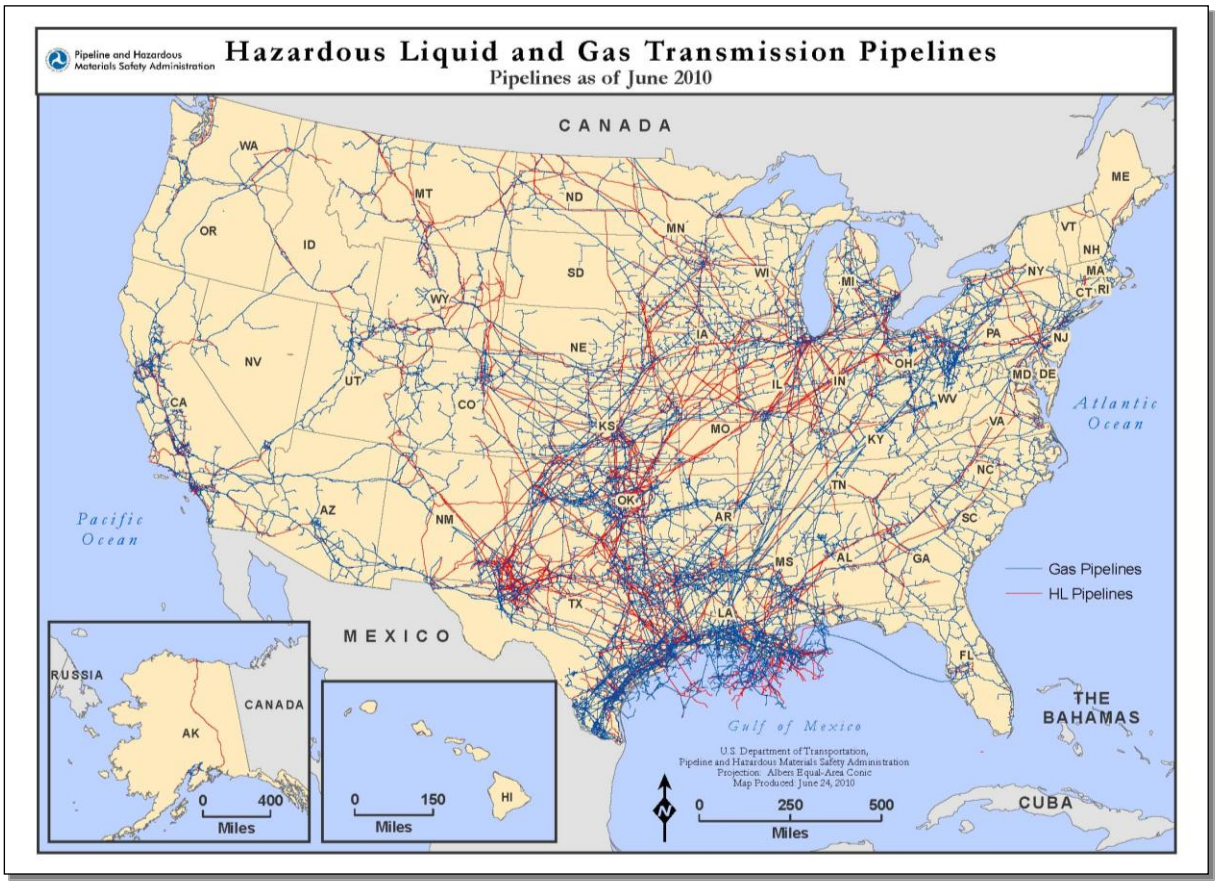

Figure 1: U. S. Network of Hazardous Liquid and Natural Gas Transmission Pipelines[4]

Across the U.S., transmission pipelines are often located in rights-of-way adjacent to and across land used for other purposes, such as residences, businesses, farms and industrial facilities. In these locations, people may spend extended periods of time in close proximity to pipelines. Many of these transmission pipelines have been in place for decades and often pre-date the surrounding development. Many portions of existing transmission pipelines were originally constructed in sparsely populated areas, but subsequent population growth over time transformed some of these areas into more populated and developed areas, with increasing development of housing subdivisions, schools, shopping centers, industrial/business parks, etc. Simultaneously, economic growth over time has generated demand for construction of more pipelines to meet growing needs for energy.

[3] http://aopl.org/aboutPipelines/. Operators of hazardous liquid pipelines reported transporting 3.9 trillion barrel-miles of crude oil, refined products, and highly volatile liquids in 2009 annual reports to PHMSA.
[4] Source: National Pipeline Mapping System (NPMS) maintained by OPS.

According to infrastructure information collected by OPS, at least 55% of currently operating hazardous liquid pipelines was installed before 1970 and at least 71% was installed before 1980. Figure 2 below shows the breakdown of hazardous liquid pipeline mileage by decade of installation.

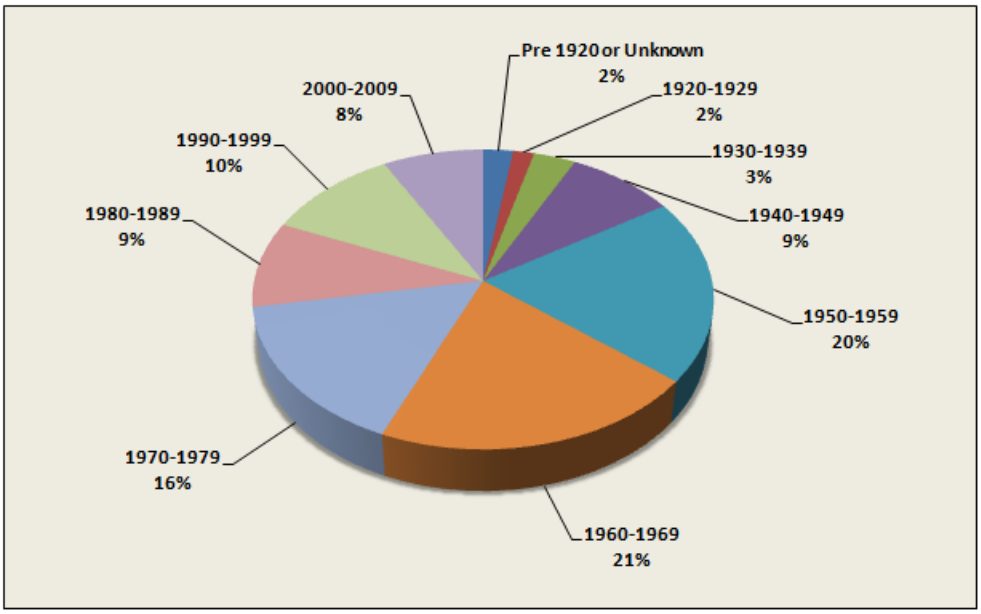

Figure 2: Hazardous Liquid Pipeline Mileage by Decade of Installation[5]

This breakdown is similar for onshore natural gas transmission pipelines. As shown on Figure 3 below, at least 59% of onshore gas transmission pipeline mileage was installed before 1970 and at least 69% was installed before 1980.

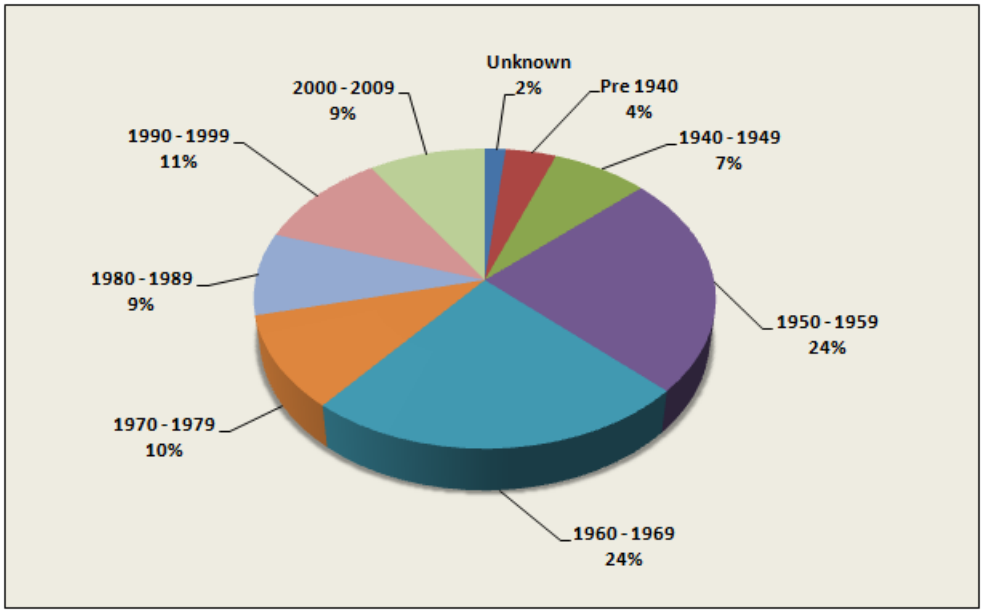

Figure 3: Onshore Natural Gas Transmission Pipeline Mileage by Decade of Installation

[5] Includes both onshore and offshore pipelines. Data on decade of installation is not recorded separately for onshore and offshore hazardous liquid pipelines.

As additional homes, businesses, and schools are constructed and other development occurs, more people will be living, working, and shopping in the vicinity of transmission pipelines. Similarly, with increasing demand for energy, it is likely that new transmission pipelines will be constructed in areas of existing development. Because of these expected trends, local governments are increasingly required to make decisions concerning land use planning and development in the vicinity of transmission pipelines.

The federal government, along with its state partner agencies, regulates the safe construction, testing, operation, and maintenance of the nation's transmission pipelines. In addition, federal pipeline safety regulations include targeted regulations for inspecting and managing the integrity of pipeline segments that have the potential to impact populated and developed areas[6].

Permitting and routing of interstate natural gas pipelines are approved by the Federal Energy Regulatory Commission (FERC). State agencies (e.g. Public Utility Commissions) approve the permitting and routing of intrastate natural gas pipelines and hazardous liquid transmission pipelines

Local governments (and in some cases state governments), rather than the federal government, are the most common regulators of land use and property development, including land use and development near pipelines. Some local governments have enacted or are developing ordinances to regulate land use and development near transmission pipelines. Examples include St. Peters, Missouri; Edison Township, New Jersey; Austin, Texas; Olathe, Kansas; Redmond and Whatcom County, Washington; and Brookings County, South Dakota. In 2004, a study[7] was conducted to examine how local governments, property owners, and developers should approach such development. The study concluded that recommended practices should be developed for decision-makers to apply when addressing proposed land use and property development near transmission pipelines.

Recommended practices for land use and development in areas near transmission pipelines is one means of addressing pipeline risks to communities. The Pipelines and Informed Planning Alliance (PIPA) was initiated to develop such recommended practices. PIPA is a collaboration of pipeline safety stakeholders, including representatives of: local, state and federal governments; the pipeline industry; property development organizations; home builder associations; fire marshals; and pipeline safety advocacy organizations. PIPA's work to develop recommended practices raised the question of how risks posed by transmission pipelines – to residential, commercial, and other development in populated areas – should be considered in land use planning and decision making.

Each community faces a variety of risks from many causes, including, motor vehicle accidents, household accidents, natural hazards, and industrial accidents. Control and mitigation of these risks involves a combination of measures employed by the sources of the risks, regulatory bodies, community groups and individual efforts. For example, motor vehicle risks are reduced by measures taken by the motor vehicle manufacturer, road designer and builder, local government (through the placement of road signs and traffic signals and enforcement of road safety laws), and by individual initiatives (through safe driving habits and seat belt use, etc).

[6] See the appendix to this report for more detail on these regulations, called "Pipeline Integrity Management" regulations.

[7] Special Report 281, *Transmission Pipelines and Land Use*, Transportation Research Board of the National Academies. 2004.

III. Pipeline Risks and Risk Mitigation

Pipeline Risks

Risks to the public from hazardous liquid and gas transmission pipelines result from the potential unintentional release of products transported through the pipelines. Releases of products carried by pipelines can impact surrounding populations, property, and the environment, and may result in injuries or fatalities as well as property and environmental damage.

These consequences may result from fires or explosions caused by ignition of the released product, as well as possible toxicity and asphyxiation effects. Some releases can cause environmental damage, impact wildlife, or contaminate drinking water supplies. Releases can also have significant economic effects, such as business interruptions, damaged infrastructure, or loss of supplies of fuel such as natural gas, gasoline, and home heating oil.

The potential consequences of transmission pipeline releases vary according to the commodity that is released as well as characteristics of the surrounding area. Gas transmission pipelines transport natural gas almost exclusively[8]. Natural gas releases pose a primarily acute hazard. If an ignition source exists, a release of gas can result in an immediate fire or explosion near the point of the release. This hazard is reduced over a relatively short period after the release ends as the gas disperses. If the vapors accumulate inside a building, then the hazard may remain longer[9]. There is also a possibility that the size or movement of the vapor cloud could result in consequences away from the initial point of the release, but because natural gas is lighter than air, this situation is not common. Structures and topographic features in the vicinity of a release can serve as barriers and mitigate the consequences of the release for other nearby areas.

Hazardous liquid pipelines transport a greater variety of products (including petroleum, petroleum products, natural gas liquids, anhydrous ammonia, and carbon dioxide), so the risks of hazardous liquid pipeline releases vary according to the commodity involved. Releases of some commodities transported in hazardous liquid pipelines, such as propane, pose primarily an acute hazard of fire or explosion, similar to natural gas. These commodities have a high vapor pressure and are in liquid form while transported under pressure in a pipeline. However, if they are released from the pipeline, they will convert to gas as the pressure is reduced. Some of these commodities have densities greater than air, so they have a stronger propensity to remain near the ground than natural gas, which disperses more readily. The behavior of these commodities when released presents some different challenges for mitigation, compared to other hazardous liquids or natural gas.

Releases of other hazardous liquids, such as gasoline and crude oil, have both acute and more long-term potential consequences, as the released product can spread over land and water, flowing into valleys, ravines, and waterways. This can result in harmful consequences to people and to the environment, including human injuries or fatalities from fire or explosion, as well as potential ecological damage and contamination of drinking water supplies occurring some distance from the point of initial release.

[8] A very small percentage of gas transmission pipelines transport other commodities such as hydrogen and chlorine, as well as other gases that are the result of oil refinery operations.
[9] Muhlbauer, W. Kent, *Pipeline Risk Management Manual*, 1992.

Assessing the potential consequences of releases from specific pipelines in specific locations should be based on a pipeline- and location-specific evaluation of the following four elements:

1. *Which commodity or commodities might be released?* A list of commodities potentially transported in a specific pipeline may be obtained from the pipeline operator.
2. *How much of the transported commodity might be released?* The answer to this differs at different locations along a pipeline and can be derived from pipeline flow rates, spill detection time, pipeline shutdown time, drain down volume, and other technical factors. These factors may be discussed with the pipeline operator.
3. *Where might the released substance go?* The answer to this is derived by considering the released commodity, release volume, and potential flow paths over land and water, as well as potential air dispersion. Overland flow can be affected by factors such as gas or liquid properties, topography at and near the spill location, soil type, nearby drainage systems, and flow barriers. Similarly, flow in water can be affected by the water flow rate and direction and properties of the spilled fluids. Air dispersion can be affected by the properties of released vapors and wind direction and speed.
4. *What locations might be impacted?* This question is answered by considering how potential impacts, including thermal impacts from fire, blast overpressure from explosion, toxic and asphyxiation effects, and environmental contamination, could affect locations where the released commodity travels. Planned evacuation routes should be considered when performing these assessments.

Various commercially available models have been developed and are available to communities to help predict the impacts of pipeline releases on nearby areas. These models support analysis of such elements as spill volumes, release paths along land or water, air dispersion patterns, and spill impacts on human health, property, and the environment.

Transmission pipeline releases result from a variety of causes, including internal and external corrosion, excavation damage, mechanical failure, operator error, and natural force damage. Pipelines with different characteristics and operating environments have different susceptibilities to these failure causes. This results in different failure probabilities from different causes at different points along the pipeline.

In addition to the lengths of pipe that make up transmission pipeline segments on a right-of-way (sometimes referred to as “line pipe”), transmission pipeline systems include ancillary facilities, such as pump stations and tank facilities (for liquid pipelines) and compressor and regulator/metering stations (for gas pipelines). These facilities are often adjacent or beyond the right-of-way and on operator-owned property, frequently protected by security fencing.

Most communities in the vicinity of transmission pipelines are near rights-of-way with line pipe and not near ancillary facilities. However, some communities may be near these facilities. The predominant failure causes and failure modes are different for these ancillary pipeline facilities than the predominant failure causes and failure modes for line pipe. Consequently, local governments should be aware of what

parts of a transmission pipeline system are in the vicinity of their communities in order to better understand which pipeline risk factors should be addressed in their communities.

Risk Mitigation

Transmission pipeline operators seek to reduce the risk of releases by taking measures to minimize the probability and consequences of such releases. These measures include proper pipeline route selection, design, construction, operation, and maintenance, as well as the use of automated monitoring and control systems, public awareness programs, and excavation damage prevention programs.

Transmission pipeline operators also conduct emergency response drills and exercises – both on their own and in cooperation with local emergency responders – to ensure that emergency preparedness and response planning is adequate should a pipeline incident occur. Also, gas transmission pipeline operators are required by regulation to reduce the operating pressure of their pipelines and make other adjustments to operations and maintenance based on criteria related to increasing populations near their pipelines. These requirements could come into effect if additional residences or places of public assembly (schools, hospitals, nursing homes, parks, etc.) are constructed near a gas transmission pipeline.

Federal pipeline safety regulations govern the construction, operation, and maintenance of pipelines. These regulations govern significant risk factors that affect the probability and consequences of releases. PHMSA and its partnering state regulatory agencies inspect transmission pipelines and enforce the regulations to better assure safety and reduce risk. In addition to federal government regulatory requirements, standards and recommended practices developed by standards development organizations provide further guidance on the safe construction, operation, and maintenance of pipelines in important areas[10].

Safety can also be promoted through proper, risk-informed land use planning, design**,** and construction practices for industrial, commercial and residential developments near transmission pipelines. There are a number of opportunities for stakeholders (including landowners, local governments, emergency responders, developers, and state and federal pipeline regulators) to participate in transmission pipeline safety discussions and support safety initiatives. These activities include following safe excavation practices, including use of the one-call process (e.g., call 811 before digging); monitoring and reporting suspicious activity on transmission pipeline rights-of-way; keeping rights-of-way free from obstructions and encroachments; and following PIPA recommended practices on land use near transmission pipelines. Together, transmission pipeline operators and other stakeholder groups can significantly reduce risks to people, communities, and the environment.

Resources are available to easily identify transmission pipelines within or near a given community. PHMSA maintains the National Pipeline Mapping System (NPMS), a geographic information system (GIS)

[10] One example is Standard B31.8S, *Managing Integrity of Gas Pipelines*, developed by the American Society of Mechanical Engineers. Additionally, the American Petroleum Institute's Recommended Practices, such as RP1162, *Public Awareness Programs for Pipeline Operators*, focus on transmission pipeline operations and maintenance, as well as public outreach to help prevent damage to pipelines.

database that contains the locations and attributes of hazardous liquid and gas transmission pipelines operating in the United States. The NPMS is updated and maintained with mandatory annual submissions of pipeline geospatial data by pipeline operators. One important function of the NPMS is to support queries by members of the public to identify which hazardous liquid and gas transmission pipeline companies operate pipelines in a specific county or zip code. This allows local governments to locate transmission pipelines within or near their communities and to determine areas that could be impacted by releases from these pipelines. PHMSA will provide raw NPMS geospatial data to county and state officials upon request[11].

The NPMS is useful to local governments in understanding the general location of transmission pipelines in their area, and in determining who operates those facilities, but the NPMS data accuracy may not be sufficient for some purposes. More accurate data may have to be obtained directly from the pipeline operator. The target accuracy of NPMS data is currently ±500 feet, although much of the NPMS data is much more accurate than ±500 feet. The NPMS does not include information on the location of distribution pipelines or non-regulated pipelines.

IV. Historical Safety Performance of Onshore Gas Transmission & Hazardous Liquid Pipelines

The historical record of onshore[12] hazardous liquid and gas transmission pipeline incidents provides an overview of the safety performance of these pipelines over time at the national level[13]. Figures 4 through 7 below show trends in the number of pipeline incidents and in the resulting number of fatalities and injuries. Graphs are shown for subsets of total reported incidents known as "significant incidents" [14] and "serious incidents"[15]. The graphs depict data for onshore transmission pipelines over the years 1990-2009 and were chosen in order to depict trends over a 20 year time period. Hazardous liquid and gas transmission pipelines are shown on separate graphs. The separate graphs demonstrate somewhat different trends over time.

[11] NPMS may be accessed at http://www.npms.phmsa.dot.gov/. Information on requesting geospatial data may be found at https://www.npms.phmsa.dot.gov/application.asp?tact=Data&page=subapp.asp?app=data&act=data_req.

[12] Pipeline incident data used throughout this study includes onshore pipelines only, as these are the pipelines of immediate concern to local governments. Incident data from offshore pipelines, which often face different risks and predominant incident causes than onshore pipelines, are not included.

[13] Records on transmission pipeline incidents are maintained by PHMSA and are available here and at http://primis.phmsa.dot.gov/comm/reports/safety/PSI.html.

[14] PHMSA defines significant incidents as those incidents reported by pipeline operators when any of the following conditions are met:

1. fatality or injury requiring in-patient hospitalization
2. $50,000 or more in total costs, measured in 1984 dollars
3. highly volatile liquid releases of 5 barrels or more or other liquid releases of 50 barrels or more
4. liquid releases resulting in an unintentional fire or explosion

[15] PHMSA defines a serious pipeline incident as an event involving a fatality or injury requiring in-patient hospitalization. Note that serious incidents are a subset of significant incidents, including only incidents with consequences to human health and safety (fatalities and injuries only).

Hazardous Liquid Pipelines

The incident history of hazardous liquid pipelines for the past 20 years is shown in Figures 4 and 5 below[16]. Figure 4 shows:

- A general downward trend in the annual number of significant hazardous liquid pipeline incidents;
- On average, about 3% of significant hazardous liquid incidents included death or injury and are classified as "serious" incidents. Fatalities and injuries in these data were experienced by both the general public and by pipeline operator personnel. The breakdown of fatality and injury statistics for these groups is discussed in Section V below.

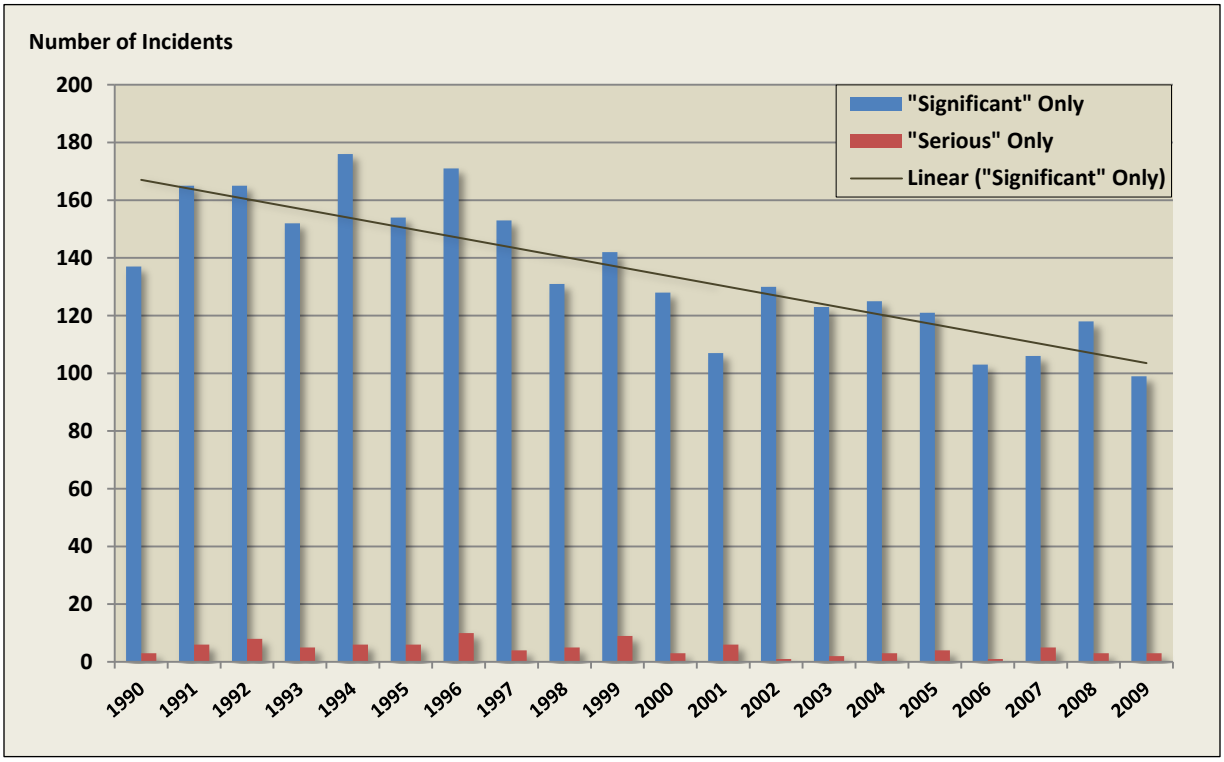

Figure 4: Trends in Hazardous Liquid Onshore Incidents: 1990-2009

[16] Note that the vertical scales of Figures 4 and 5, showing hazardous liquid pipelines incidents, are different from the vertical scales of Figures 6 and 7, showing gas transmission pipeline incidents. More incidents are reported for hazardous liquid pipelines, primarily because the incident reporting criteria for hazardous liquid pipelines require more incidents to be reported.

Figure 5 shows that the annual number of fatalities and injuries from hazardous liquid pipeline incidents fluctuated over the time period:

- In six years out of the 20 year period, no fatalities occurred.
- Incidents resulting in multiple injuries or fatalities are not frequent. However, they did occur during this time period. For example, the spike shown in the number of injuries from hazardous liquid pipeline incidents in 1992 was caused by a single incident in Washington County, Texas, with 3 fatalities and 22 injuries[17]. Other incidents with higher numbers of fatalities or injuries include incidents in the following years:
  - 1999 (Whatcom County, Washington, 3 fatalities and 8 injuries);
  - 2004 (Floyd County, Kentucky, 12 injuries);
  - 2004 (Contra Costa County, California, 5 fatalities and 3 injuries);
  - 2007 (Clarke County, Mississippi, 2 fatalities and 7 injuries).

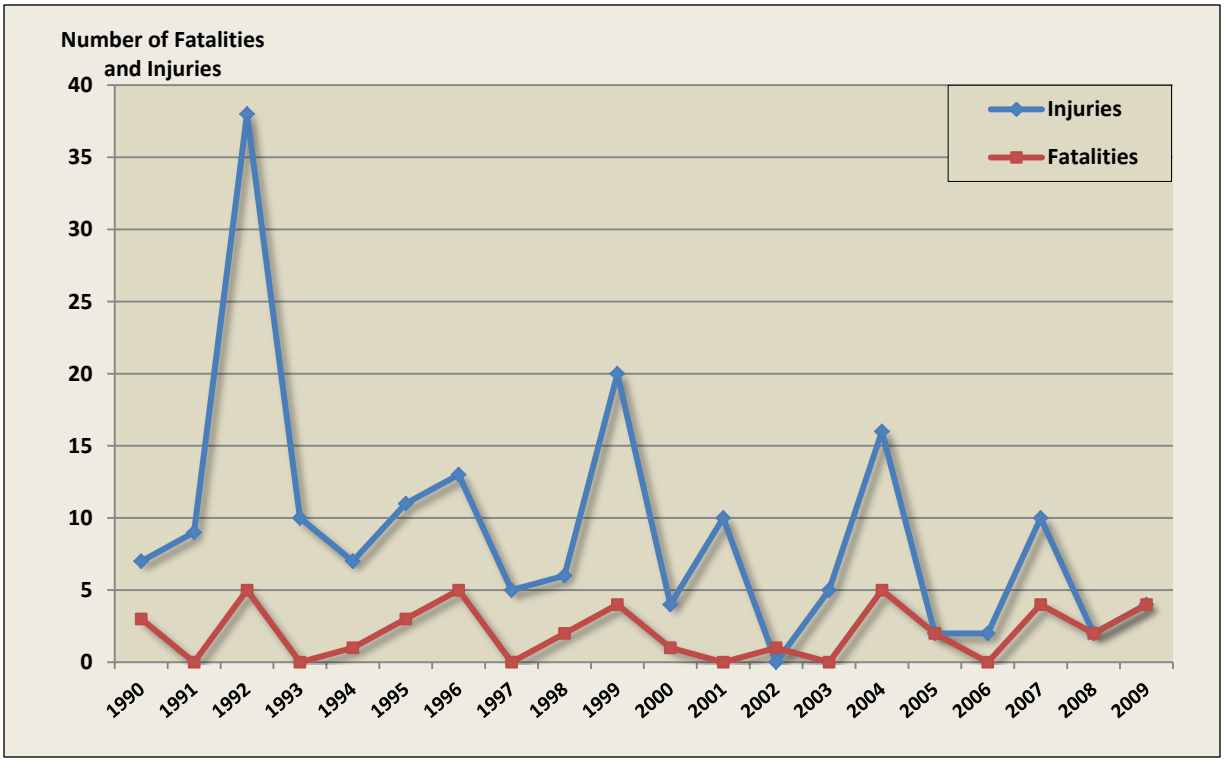

Figure 5: Trends in Fatalities and Injuries in Hazardous Liquid Onshore Incidents: 1990-2009

[17]The number of injuries associated with this event as reported in the accident report from the operator. An NTSB investigation of this event reported a slightly different injury total.

Gas Transmission Pipelines

The incident history for gas transmission pipelines for the most recent twenty years is shown in Figures 6 and 7 below[18]. Figure 6 shows:

- An overall increasing trend in the annual number of natural gas transmission pipeline significant incidents over the time period;
- A major reason for this trend is a relatively high number of gas transmission pipeline significant incidents in 2003, 2005, 2006, and 2009:
  - In 2003 and 2006, the higher number of incidents is primarily due to a higher number of incidents caused by materials and weld failures (15 in 2003 and 16 in 2006 due to this cause vs. an average of 8 per year over 1990-2009);
  - In 2005, the relatively high number of incidents reflects the natural force damages to pipelines from the effects of hurricanes Katrina and Rita (11 incidents due to this cause vs. an average of 4 per year over 1990-2009);
  - In 2009, the higher number of incidents is spread among several cause categories, including materials and weld failures and equipment failures.
- On average, about 16% of significant gas transmission incidents included death or injury and are classified as "serious" incidents. Fatalities and injuries in these data were experienced by both the general public and by pipeline operator personnel. The breakdown of fatality and injury statistics for these groups is discussed in Section V below.

[18] Note that the vertical scales of Figures 6 and 7, showing gas transmission pipeline incidents, are different from the vertical scales of Figures 4 and 5, showing hazardous liquid pipelines incidents. More incidents are reported for hazardous liquid pipelines, primarily because the incident reporting criteria for hazardous liquid pipelines require more incidents to be reported.

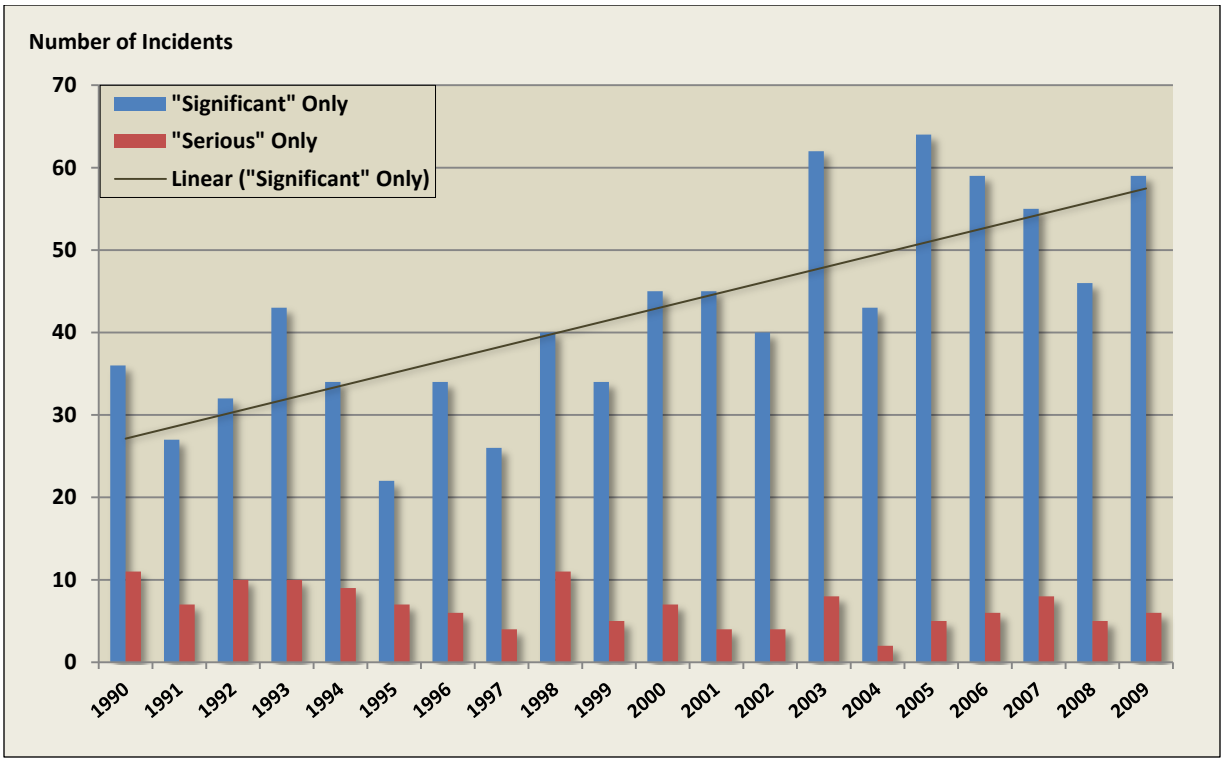

Figure 6: Trends in Natural Gas Transmission Onshore Incidents: 1990-2009

Figure 7 shows that the number of fatalities and injuries has fluctuated over 1990-2009:

- While incidents resulting in multiple fatalities and injuries were not common, they did occur during this time period:
  - A spike in fatalities in 2000 was due to a single incident in a remote area near Carlsbad, New Mexico that claimed 12 lives.
  - A spike in injuries in 2000 is due to two incidents in Louisiana and Mississippi that caused 11 out of the year's 16 injuries.
- No fatalities were experienced in eight out of the 20 years over 1990-2009.

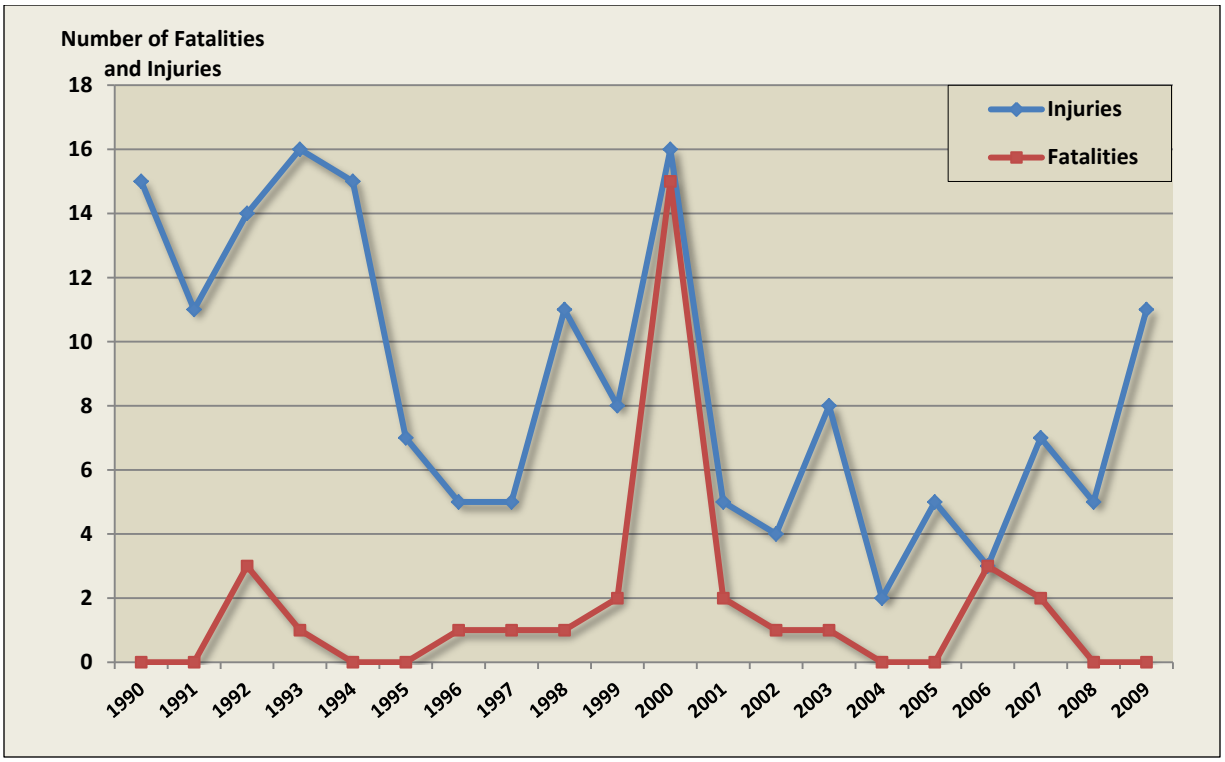

Figure 7: Trends in Fatalities and Injuries in Natural Gas Onshore Transmission Incidents: 1990-2009

Incident Causes

Pipeline incident causes fall into several broad categories based on how PHMSA collects incident data from pipeline operators. Figures 8 through 11 below show the number and percentage of significant onshore transmission pipeline incidents attributable to different cause categories during 2005-2009[19].

Separate graphs are shown for line pipe (i.e., portions of pipelines *not* including ancillary facilities such as tank facilities, pump stations, compressor and regulator/metering stations) and for ancillary facilities (pump stations, compressor stations, tank facilities etc.). Separate graphs are shown to illustrate how different incident causes predominate, depending on the part of the pipeline system involved. Local governments should be aware of the specific parts of a transmission pipeline system within their communities in order to determine which risk factors are most important.

[19] This time period is the most recent five complete years of data available. The period was chosen in order to give a relevant "snapshot" of the relative frequency of different causes. Data on the cause categories used here are not available before 2002.

Figures 8 and 9 show the breakdown of incidents by cause for line pipe. For both hazardous liquid and gas transmission pipelines, the predominant failure causes for line pipe are corrosion, material/weld failures, and excavation damage.

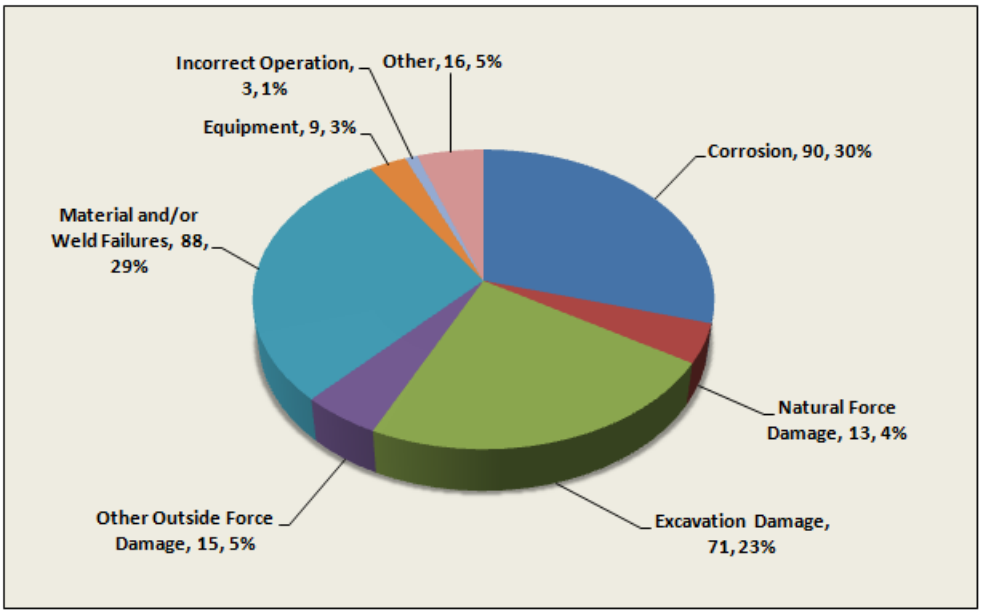

Figure 8: Causes[20] of Significant Onshore Hazardous Liquid Pipeline Incidents (Right-of-Way Line Pipe Only 2005-2009)

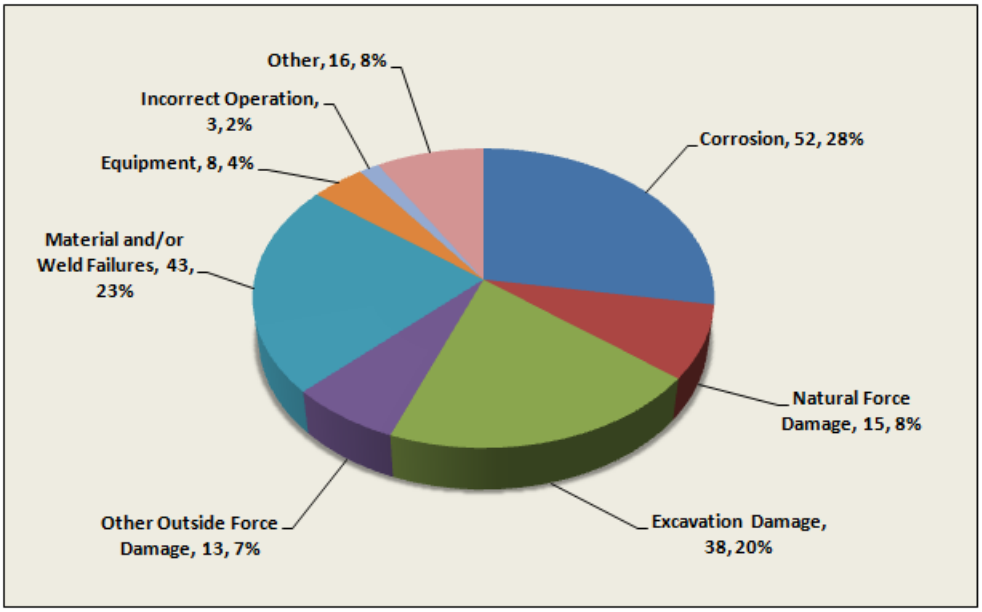

Figure 9: Causes of Gas Transmission Pipeline Significant Onshore Incidents (Right-of-Way Line Pipe Only 2005-2009)

[20] In Figures 8 through 13, which show incident breakdowns by cause, the number of incidents for each cause is given, followed by the percentage of incidents for each cause.

Figures 10 and 11 show the breakdown of incidents by cause for ancillary facilities. For hazardous liquid pipeline facilities (pump stations, tank facilities, etc.), the highest-percentage failure causes are equipment failures, incorrect operation, and corrosion (see Figure 10).

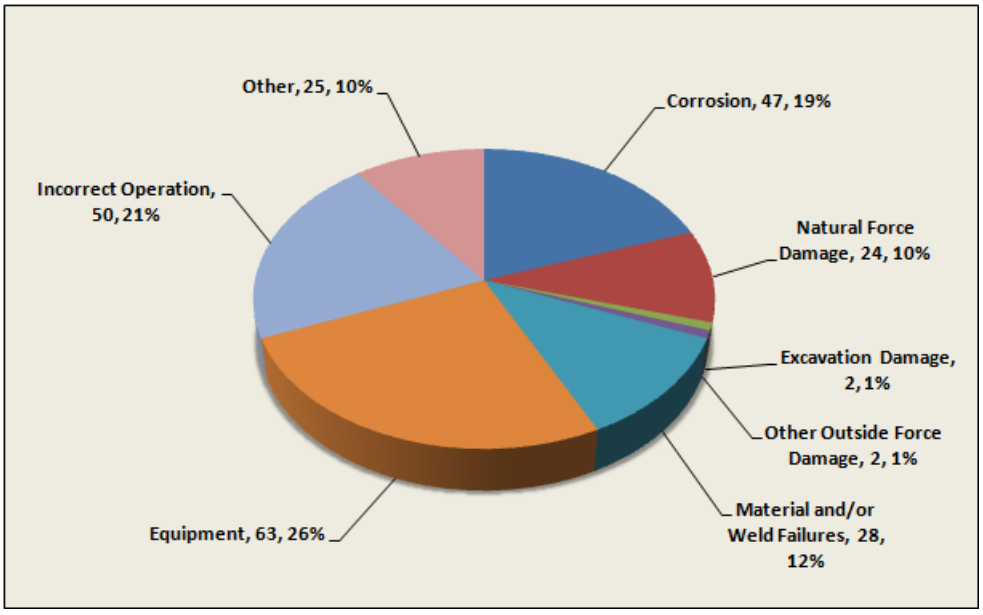

Figure 10: Causes of Significant Onshore Hazardous Liquid Pipeline Incidents Facilities Only (e.g., Pump Stations, Tank Facilities) 2005-2009

For gas transmission pipeline facilities (compressor stations, regulator/metering stations), a high percentage of incidents are caused by equipment failures, other outside force damage[21], and natural force damage, but the highest percentage of incidents are classified as being due to "other" causes (see Figure 11). Incidents are assigned to this category if the cause of the incident was unknown or was not tied to one of the other defined failure cause categories. The gas transmission incidents assigned to the "other" cause category included several releases due to equipment malfunctions at compressor stations.

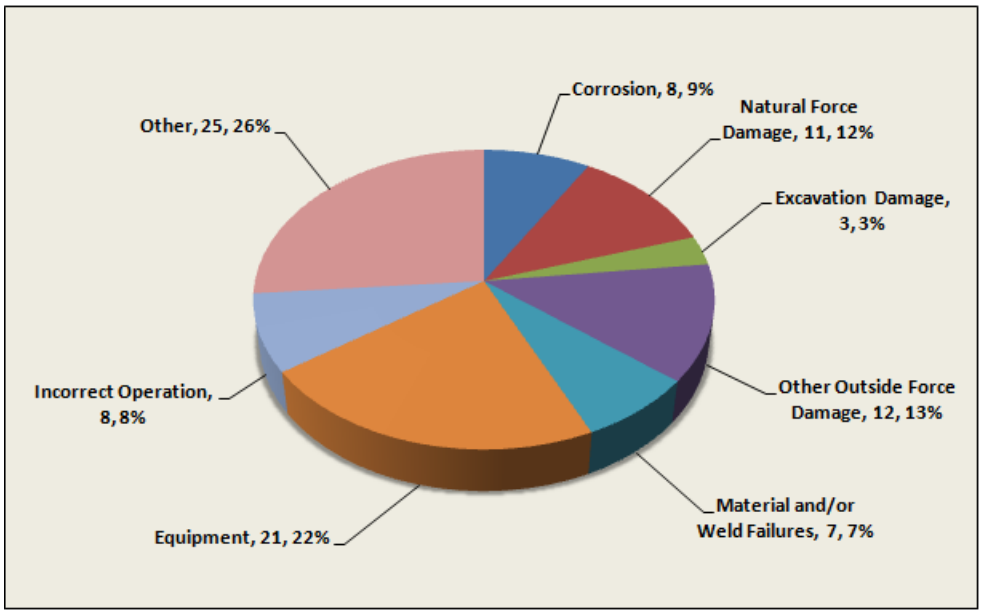

Figure 11: Causes of Gas Transmission Pipeline Significant Onshore Incidents Facilities Only (e.g., Compressor Stations, Regulator/Metering Stations) 2005-2009

[21] An example of this cause category is a non-excavating vehicle striking an aboveground pipeline facility.

Figures 12 and 13 below show the cause breakdown for serious incidents (i.e., those which include a fatality or an injury requiring hospitalization), which are a subset of significant incidents. For both hazardous liquid and gas transmission pipelines, excavation damage, incorrect operation, other outside force damage, and "other" causes are the causes of the highest percentage of serious incidents (although the number of incidents in any category is small). Corrosion, material/weld failures, and equipment failures are the cause of a lower percentage of serious incidents than they are for the larger population of significant incidents.

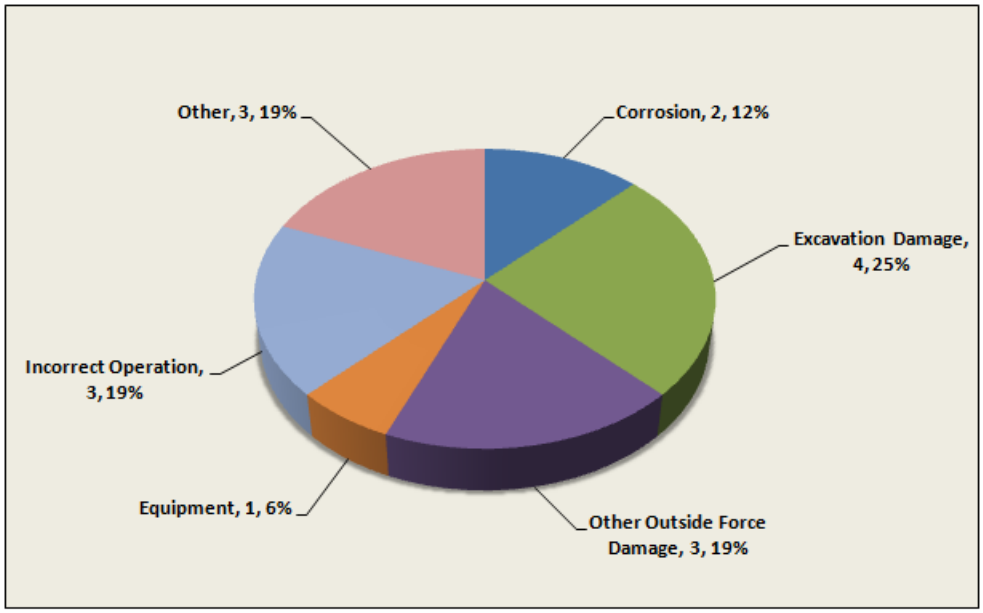

Figure 12: Causes of Onshore Hazardous Liquid Pipeline Serious Incidents 2005-2009

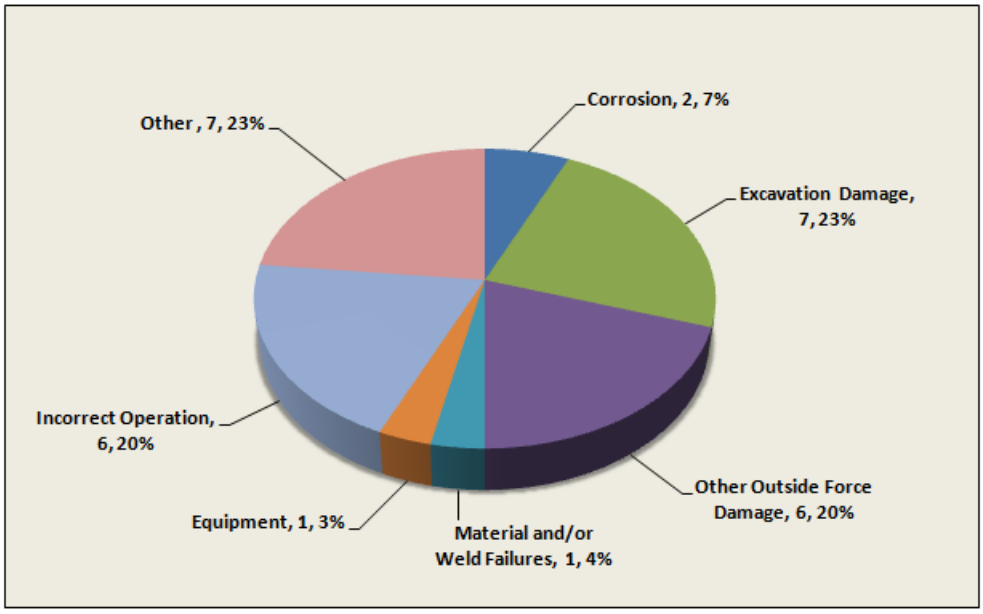

Figure 13: Causes of Onshore Gas Transmission Pipeline Serious Incidents 2005-2009

V. Relative Risk of Transmission Pipelines

Stakeholders should be aware of the relative risks of transmission pipelines when considering land use and development decisions near transmission pipelines. Consideration should be given to the characteristics of the specific pipeline involved, the size of the pipeline right-of-way, and the surrounding environment and terrain.

One illustration of transmission pipeline relative risk is a comparison of the incident history of transmission pipelines versus other modes of hazardous materials transportation that may pose risks to communities. This section draws on U.S. Department of Transportation incident data for transportation of hazardous materials by road and railway for comparison with incident data for onshore hazardous liquid and gas transmission pipelines. These comparisons may be useful to local governments for land use planning, because railways and roads, like pipelines, are transportation pathways interspersed within the public domain and present the risk to communities of a potential hazardous materials release.

Presenting the relative frequency of incidents involving release of hazardous materials from different modes and the relative frequency of fatalities and injuries resulting from the release of hazardous materials from different modes provides information on the relative risks of releases from the transportation pathways that a local government may have within its jurisdiction. Tables 1 through 4 below provide incident statistics for the different transportation modes as a framework for this comparison. The road and railway statistics in the tables are based on reported incidents for these modes when hazardous materials were released. The transmission pipeline statistics in the tables are based on significant incidents. The tables also include statistics based on serious[22] incidents for all modes[23].

[22] The definition of "serious" incidents used by PHMSA's Office of Hazardous Materials Safety (OHMS) for hazardous materials releases from road and railway transportation includes additional criteria. Since 2002, PHMSA/OHMS has defined "serious incidents" as incidents that involve either:

- a fatality or major injury caused by the release of a hazardous material,
- the evacuation of 25 or more persons as a result of release of a hazardous material or exposure to fire,
- a release or exposure to fire which results in the closure of a major transportation artery,
- the alteration of an aircraft flight plan or operation,
- the release of radioactive materials from Type B packaging,
- the release of over 11.9 gallons or 88.2 pounds of a severe marine pollutant, or
- the release of a bulk quantity (over 119 gallons or 882 pounds) of a hazardous material.

The number of "serious" incidents presented in the tables of this section for road and railway includes only incidents meeting the first of these criteria (incidents with fatality or injury caused by the release of a hazardous material), and no other incidents meeting the other criteria. For transmission pipelines, all serious incidents are included.

[23] To capture a current snapshot of relative risks for the different modes, comparisons are made based on the most recent five complete years of incident data (2005-2009). Other reasons for using this time period for the data include:

- The current reporting criteria for hazardous materials release data went into effect in 2002.
- The breakdown of fatalities and injuries by public vs. operator employee or contractor was only recorded beginning in 2002.
- Hazardous liquid pipeline operator annual reports of mileage began in 2004.

It is recognized that the comparisons presented here do not include a complete picture of the risks of different transportation modes, nor are the statistics that are compared here based on perfectly identical data. Caveats on interpretation of the statistics presented in this section include:

1. Because the scope of PIPA is limited to transmission pipelines, there is no presentation of gas distribution pipeline incident data and no attempt to characterize risk to communities of distribution pipelines[24].

2. The focus of this study is providing information to support planning and land use decisions for areas near transmission pipelines. These pipelines transport hazardous materials and risks to the public result from the accidental release of these materials. Consequently, the comparative incident statistics presented for roads and railways are based strictly on releases of hazardous materials. It is recognized that this is a fraction of the total risk from vehicles transporting hazardous materials[25] and an even smaller fraction of the total risk from all vehicles on roads and railways[26].

3. The specific functions in the transportation system of roads, railways, and pipelines and the types of commodities transported by these modes are not uniform. Hazardous liquid pipelines primarily transport oil and oil products, which, can also be transported by truck and railway. Gas transmission pipelines almost exclusively transport natural gas, which is not transported by road or railway. A variety of other hazardous materials are transported by road and railway, including both bulk and packaged shipments. Release of these materials can have significantly different effects than releases of oil, refined products, or natural gas.

4. Questions were raised in 2009 Congressional hearings[27] about the completeness of reporting of (non-pipeline) hazardous materials incidents. One estimate quoted was that 60-90% of all such incidents were unreported. If these estimates apply equally to serious incidents, then the number of serious road and railway hazardous material incidents presented in this section could be too low by a factor of 10 (some cases were cited of non-pipeline incidents involving fatalities or injuries that went unreported).

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[24] Gas distribution pipeline incident data may be found here: http://primis.phmsa.dot.gov/comm/reports/safety/SigPSI.html?nocache=3825#_ngdistrib.

[25] For example, see a 2004 study [Craft, *Crashes Involving Trucks Carrying Hazardous Materials*, FMCSA-RI-04-024] of accidents involving trucks with hazardous materials cargo, which estimates that most fatalities from such accidents did not result from release of hazardous materials. Fatalities from these accidents that were not caused by hazardous materials releases are part of the total risk presented by transport of hazardous materials, but are not included in the statistics in this section, because they are not directly relevant to the planning and land use decisions faced by local governments that are the subject of the PIPA recommended practices.

[26] For example, 37,423 total fatalities occurred in 2008 motor vehicle traffic crashes (source: National Traffic Safety Administration (NTSA) Fatality Analysis Reporting System (FARS)). In 2009, 704 total fatalities resulted from accidents involving trains (source: U.S. DOT Federal Railroad Administration, *Railroad Safety Statistics 2009 Preliminary Annual Report*).

[27] Congressional Committee on Transportation and Infrastructure hearings on "Concerns with Hazardous Materials Safety in the U.S.: Is PHMSA performing its mission" (written report submitted by Majority Staff to the Members of the Committee), September 9, 2009.

5. Table 1 presents serious incident counts for roads and railways that include both injuries requiring hospitalization and those *not* requiring hospitalization. The counts given for pipeline serious incidents include only incidents involving fatalities or injuries requiring hospitalization. To make the serious incident data for roads, railways, and pipelines more comparable, Table 1 also gives serious incident counts for roads and railways that include only injuries requiring hospitalization. These counts are shown in the table in parentheses. Both sets of injury counts include only injuries where the hazardous materials release was the cause of the injury.

Tables 1 through 4 present separate statistics for hazardous liquid and gas transmission pipelines. This approach is taken because of the different commodity properties and different risk characteristics for these two classes of transmission pipeline. Natural gas is not typically transported by road or rail, so gas transmission pipelines constitute a distinct transportation mode. The statistics presented for transmission pipelines include incidents involving both line pipe and facilities.

Table 1 shows that the total number of hazardous materials incidents from 2005-2009 for road and railway transportation is greater than the number of transmission pipeline significant incidents[28] (almost 15,000 for road and around 700 for railway versus 109 for hazardous liquid pipelines and 57 for gas transmission pipelines). However, a lower percentage of road and railway incidents result in fatality or injury requiring hospitalization: (less than 1% for both road and railway versus around 3% for hazardous liquid pipelines and 11% for gas transmission pipelines)[29].

[28] Table 1 gives significant incident counts for transmission pipelines for consistency with the historical data presented in the previous section. The magnitude of difference between road and railway incidents and transmission pipeline incidents remains the same even if all transmission pipeline incident reports were considered here.

[29] These percentages are obtained by calculating the proportion of incidents in Table 1 involving fatality or injury *requiring hospitalization*. The relevant figures are 26 out of 14,963 incidents for road, 5 out of 718 for railway, 3 out of 109 for hazardous liquid pipelines, and 6 out of 57 for gas transmission pipelines.

Table 1 - Hazardous Materials Transportation Incident Statistics[30] Compared to Onshore Hazardous Liquid and Natural Gas Transmission Incident Pipeline Statistics: 2005-2009

Mode		2005	2006	2007	2008	2009	Total 05-09	Average per Year
Road	All HazMat Incidents	13,460	17,156	16,905	14,787	12,507	74,815	14,963
	HazMat Incidents with Death or Injury[31]	118 (43)[32]	102 (25)	96 (31)	81 (15)	60 (14)	457 (128)	*91 (26)*
Railway	All HazMat Incidents	745	704	750	751	638	3,588	718
	HazMat Incidents with Death or Injury	23 (4)	21 (7)	28 (4)	29 (7)	19 (5)	120 (27)	*24 (5)*
Hazardous Liquid Pipeline (Onshore only)	Significant Incidents	121	103	106	118	99	547	109
	Incidents with Death or Injury	4	1	5	3	3	16	*3*
Gas Transmission Pipeline (Onshore only)	Significant Incidents	64	59	55	46	59	283	57
	Incidents with Death or Injury	5	6	8	5	6	30	*6*

Table 2 shows incident rates for each hazardous materials transportation mode, based on the number of serious incidents (i.e., incidents with fatality or injury as a direct result of the release of hazardous materials) per 1,000 miles of road, railway, or pipeline in the U.S. This comparison shows:

- Transmission pipelines have lower rates of serious incidents per mile than other transportation modes, if road and railway serious incident counts include injuries not requiring hospitalization. In this case, rates of serious incidents per mile are slightly lower for pipelines than for roads, while the rate of serious incidents per mile for railways is approximately 10 times greater.
- If only hospitalization injuries are included in the serious incident counts for roads and railways, then transmission pipelines have lower rates of serious incidents per mile than railway transportation, but higher rates (by about a factor of 3) of serious incidents per mile than road transportation. (Injury counts that include hospitalization injuries only for road and railway are shown in Table 2 in parentheses; the figures represent injuries as a direct result of a hazardous materials release).

[30] Source: Hazardous Materials Information System (HMIS) database (data as of 2/22/2010) for road and railway hazardous materials incidents and from PHMSA OPS accident/incident reports for transmission pipeline incidents. Hazardous materials incidents are reported (per 49 CFR 171.15 & 171.16) for unintentional release of a hazardous material during transportation (including loading, unloading and temporary storage related to transportation). Fatalities and injuries reported here are those that are a direct result of a hazardous materials release.

[31] In Table 1, road and railway hazmat incidents with death or injury are hazardous materials releases when injuries or fatalities directly result from the release. Transmission pipeline incidents with death or injury include all incidents when a fatality or injury occurs that is associated with a pipeline release.

[32] Numbers shown in parentheses for roads and railways are for serious incidents involving fatalities and injuries requiring hospitalization only as a direct result of a hazardous material release.

- Hazardous liquid pipelines and gas transmission pipelines have nearly equal rates of serious incidents per mile.
- As was noted previously, it is possible that the number of non-pipeline hazardous materials incidents is significantly undercounted, so that the road and railway serious incident rates per mile could be higher than the rates shown in the table and, consequently, higher relative to transmission pipeline serious incident rates per mile.

Table 2: Comparative Statistics for Serious Incident Rates
Onshore Transmission Pipelines vs. Road and Railway (2005-2009 Incidents)

Mode	Average Miles[33]	Average HazMat Serious Incidents per Year	Average HazMat Serious Incidents per 1,000 Miles per Year
Road	4,013,758	91 (26)[34]	0.023 (0.0065)
Railway	95,304	24 (5)	0.25 (0.052)
Hazardous Liquid Pipeline (Onshore)	164,234	3	0.018
Gas Transmission Pipeline (Onshore)	294,562	6	0.020

The rates in Table 2 are averages using nationwide incident data from 2005-2009. The rate of serious incidents per mile in a specific location in any specific community may vary considerably, based on the specific characteristics of the transportation infrastructure at the location (pipeline, roadway, and railway) and characteristics of the surrounding community. The expected rate of incidents involving different hazardous material transportation modes in a specific community will depend on the degree of exposure to each mode, namely, the number of miles of road, railway, and pipeline. The higher the pipeline, road, and railway mileage in a community, the higher is the community's level of exposure to potential incidents. However, the characteristics of the area (e.g., rural versus urban; density, pattern, and type of structures; topography) could decrease or increase the risk to the area surrounding the transportation infrastructure.

In serious transmission pipeline incidents, those killed or injured can be pipeline operator employees or contractors working in the pipeline right-of-way or on pipeline operator property (ancillary facilities) or members of the general public. Thus, the rate of incidents that resulted in death or injury to the general public is less than the rates in Tables 1 and 2 for all incidents resulting in deaths and injuries.

[33] Road mileage consists of miles of public roads and streets in the U.S. Railway mileage consists of miles of track in the U.S. (Source: http://www.bts.gov/publications/national_transportation_statistics/#chapter_1). Mileage data are the average mileages during 2004-2008, as the latest mileage figures for road, railway and transmission pipelines are for 2008 at the time of this report. Mileage for hazardous liquid and gas transmission onshore pipelines may be found at this link.

[34] Numbers shown in parentheses for roads and railway are for serious incidents involving fatalities and injuries *requiring hospitalization* as a direct result of a hazardous material release.

For example, of the 17 pipeline-related fatalities during 2005-2009, five (29%) were fatalities among the general public. Because of the relatively small number of incidents that result in fatalities, this percentage would be expected to vary if data from a different time period were considered. Fatalities to members of the public in these data include:

- A natural gas transmission pipeline failed because of excavation damage, killing an excavator working on the pipeline right-of-way. Pipeline incident reports submitted to PHMSA count third-party excavators as part of the "general public" if the excavator is not a contractor (second-party) or employee of the transmission pipeline operator (first-party). PHMSA recognizes that the nature of the risk faced by a third-party excavator working on the transmission pipeline right-of-way is similar to the risk faced by an operator's employee or contractor performing similar work.
- A natural gas transmission pipeline failed because of corrosion in a pipeline casing under a roadway crossing, leading to an explosion, fire, and fatal injury to the driver of a passing vehicle.
- A transmission pipeline failed at a weld and released propane, which ignited, resulting in the deaths of two occupants of nearby homes.
- A car left a roadway, crashed through barriers, and struck a gasoline pipeline facility. The incident resulted in a fire. The driver of the car died, but the cause of the fatality is uncertain.

Similarly, Tables 1 and 2 include road or railway incidents resulting in deaths and injuries from hazardous materials releases involving both operator personnel (drivers, etc.) and members of the general public (including first responders).

Table 3 includes the number of fatalities of operator employees (including contractor) and the general public for road, railway, and transmission pipeline transportation. These data show for 2005-2009:

- Road transportation had the highest rate of fatalities (10.2 per year).
- Railways and hazardous liquid pipelines had a lower rate of fatalities (2.4 per year).
- Gas transmission pipelines had the lowest rate of fatalities (1 per year).
- Road transportation had the lowest percentage of general public fatalities:
  - 14% (7 of 51) of fatalities due to road hazardous materials incidents were to the general public;
  - 86% (44 of 51) of fatalities were to employees of the operator.
- Railway transportation had the highest percentage of general public fatalities:
  - 83% (10 of 12) of fatalities due to railway hazardous materials incidents were to the general public;
  - 17% (2 of 12) were to operator employees.
- Relatively low percentages of transmission pipeline incident fatalities were suffered by the general public:
  - 25% (3 of 12) of hazardous liquid pipeline incident fatalities were to members of the general public.
  - 40% (2 of 5) of gas transmission pipeline incident fatalities were to members of the general public[35].

[35] One general public fatality was a fatality of a third-party excavator working on the pipeline right-of-way.

Table 3: Comparison of HazMat Fatality Statistics (2005-2009)
Operator Personnel vs. General Public for all Transportation Modes

	2005	2006	2007	2008	2009	Total	Average per Yr.
Road	24	6	10	8	3	51	10.2
Operator Employee	*19*	*5*	*10*	*8*	*2*	*44*	*8.8*
General Public	*5*	*1*	*0*	*0*	*1*	*7*	*1.4*
Railway	10	0	0	1	1	12	2.4
Operator Employee	*1*	*0*	*0*	*1*	*0*	*2*	*0.4*
General Public	*9*	*0*	*0*	*0*	*1*	*10*	*2.0*
Hazardous Liquid Onshore Only	2	0	4	2	4	12	2.4
Operator Employee and Contractor Employee	*2*	*0*	*2*	*1*	*4*	*9*	*1.8*
General Public	*0*	*0*	*2*	*1*	*0*	*3*	*0.60*
Gas Transmission Onshore only	0	3	2	0	0	5	1.0
Operator Employee and Contractor Employee	*0*	*2*	*1*	*0*	*0*	*3*	*0.60*
General Public	*0*	*1*	*1*	*0*	*0*	*2*	*0.40*

It should be noted that because of the relative infrequency of fatalities due to releases from transmission pipelines (as well as railways and, to a lesser extent, trucks), the figures shown in Table 3 could vary significantly from comparable statistics covering a different 5-year period. For example, releases from onshore gas transmission pipelines in 2010 (through September) resulted in at least 9 fatalities. Based on these incomplete totals for 2010, the 5-year period including 2006 through 2010 would have an average rate of at least 2.8 fatalities per year (compared to 1.0 per year for 2005-2009). The reason for this magnitude of fluctuation is that incidents resulting in multiple fatalities are infrequent, such that one may not occur at all during a given five year period, resulting in a low yearly rate of fatality for the period.

Table 4 includes the number of operator employee and general public injuries requiring hospitalization[36] due to road, railway, and transmission pipeline incidents for 2005-2009. These data show:

- The yearly rate of injuries incurred during 2005-2009 was higher for railway (25.6 per year) and road (21.8 per year) transportation than for gas (6.2 per year) and hazardous liquid (4 per year) transmission pipelines.
- The highest percentage of injuries incurred by the general public during 2005-2009 was due to railway incidents:
  - 78% (100 of 128) of injuries due to railway hazardous materials incidents were to the public;
  - 96% (96 of 100) of the general public hospitalization injuries in these data were due to two specific incidents in 2005 in Miller County, Arkansas and Aiken County, South Carolina.
  - 22% (28 of 128) of injuries from 2005-2009 were to railway employees.
- A somewhat lower percentage of injuries to the general public was due to hazardous liquid pipeline incidents:
  - 70% (14 of 20) of injuries due to hazardous liquid pipeline incidents were to the public.
  - 50% (7 of 14) of injuries to the public in these data were the result of one specific incident in 2007.
  - 30% (6 of 20) of the injuries due to hazardous liquid pipeline incidents were to pipeline operator employees or operator contractors.
- A significantly lower percentage of injuries to the public were due to gas transmission pipeline incidents. Most injuries due to gas transmission pipeline incidents were to pipeline operator employees or operator contractors:
  - 42% (13 of 31) of injuries due to gas transmission incidents were to the general public;
  - 58% (18 of 31) were to pipeline operator employees and operator contractors.
- The lowest percentage of injuries incurred by the general public was due to road transportation hazardous materials incidents:
  - 22% (24 of 109) of these injuries were to the general public;
  - 78% (85 of 109) of these injuries were to operator employees.

[36] Pipeline incident reports from transmission pipeline operators are required to report injuries if "inpatient hospitalization" is involved. An injury involving hospital treatment may not be reported if the injured individual is released without an overnight hospital stay.

Table 4: Comparison of HazMat Injury Statistics (2005-2009)
Operator Personnel vs. General Public for all Transportation Modes

	2005	2006	2007	2008	2009	Total	Average per Yr.
Road	33	21	34	10	11	109	21.8
Number of Operator Employees HOSPITALIZED	*25*	*20*	*22*	*10*	*8*	*85*	*17*
General Public HOSPITALIZED	*8*	*1*	*12*	*0*	*3*	*24*	*4.8*
Railway	99	9	5	7	8	128	25.6
Number of Operator Employees HOSPITALIZED	*3*	*7*	*5*	*7*	*6*	*28*	*5.6*
General Public HOSPITALIZED	*96*	*2*	*0*	*0*	*2*	*100*	*20*
Hazardous Liquid Onshore Only (HOSPITALIZATION only)	2	2	10	2	4	20	4
Number of Operator Employees and Contractor Employees	*0*	*0*	*1*	*2*	*3*	*6*	*1.2*
General Public	*2*	*2*	*9*	*0*	*1*	*14*	*2.8*
Gas Transmission Onshore Only (HOSPITALIZATION only)	5	3	7	5	11	31	6.2
Number of Operator Employees and Contractor Employees	*3*	*2*	*6*	*3*	*4*	*18*	*3.6*
General Public	*2*	*1*	*1*	*2*	*7*	*13*	*2.6*

VI. Summary and Conclusions

- It is important for local governments to make risk-informed decisions regarding land use planning and development in locations where residences and businesses are increasingly in proximity to transmission pipelines. PIPA has developed recommended practices to guide local land use and development decisions. Local governments should apply these recommended practices as appropriate, based on local conditions and the relative risk tolerance of their communities. The degree of risk tolerance is expected to vary across different communities in different parts of the country. Consequently, the application of specific PIPA recommended practices is expected to vary among different communities.
- Although transmission pipeline incidents are infrequent, they do have potentially serious consequences that may significantly impact the general public. Consequently, local governments should consider the risks, including both likelihood and consequences, of transmission pipeline incidents when making decisions related to land use planning and development. They should make full use of available resources and communicate with the transmission pipeline operators

in their communities to better understand the characteristics of the specific line pipe and/or ancillary facilities and the characteristics of the surrounding area that may affect risk. Local government decisions might include:

- Constraints on activities on or near transmission pipeline rights-of-way;
- Restrictions on the types of land use and development that is allowed along transmission pipeline rights-of-way;
- Specific design or construction features of the development;
- Measures to facilitate emergency response and evacuation in the event of a transmission pipeline incident.

- When weighing the potential risks of hazardous materials releases in areas proposed for development, local governments should base their decisions on a balanced consideration of all risks. A balanced view includes consideration of all modes of hazardous materials transportation in the area, including roads and railway transportation, as well as transmission pipelines. Local governments should obtain all available information to allow a better understanding of hazardous material risks in their community.
- A comparison of the frequency of incidents involving death or injury resulting from hazardous materials releases from different transportation modes over 2005-2009 shows:
  - The rate per mile of such incidents was substantially lower for transmission pipelines than for railways.
  - The rate per mile of such incidents is approximately equal for transmission pipelines and road transportation, counting incidents where hazardous materials directly caused the death or injury.
  - If only injuries requiring hospitalization are counted, then the incident rate per mile was higher for transmission pipelines than for roads, but lower than for railroads.
  - The average number of fatalities per year was highest for road transportation incidents where hazardous materials releases caused the fatality, compared to lower averages for railway transportation and transmission pipelines.
  - The average number of injuries requiring hospitalization per year was substantially lower for transmission pipelines than for road or railway transportation.
  - A minority of fatalities involved the general public for road transportation and transmission pipelines. The majority of fatalities from railway incidents involved the general public.
  - A minority of hospitalization injuries involved the general public for road transportation and gas transmission pipelines. The majority of injuries from railway and hazardous liquid pipelines involved the general public.
  - Incidents involving road and railway transportation may have been under-reported, possibly significantly. Since the numbers of incidents are the basis for these comparisons between road and railway transportation and transmission pipelines, the relative risk of road and railway transportation may be higher than indicated here by these comparisons.

Appendix: Pipeline Integrity Management Programs

Federal pipeline safety regulations governing the operation of hazardous liquid and gas transmission pipelines include targeted requirements for inspecting and managing the integrity of pipeline segments that have the potential to impact "high consequence areas" (HCAs). Under these requirements, transmission pipeline operators must develop "integrity management programs" that provide additional protection to HCAs. The extra safety precautions and preventive measures taken by transmission pipeline operators on pipeline segments that could potentially impact HCAs are intended to reduce the likelihood and the consequences of a pipeline release in those areas, which would include many of the populated areas involved in land use and development decisions.

HCAs are defined differently for hazardous liquid and gas transmission pipelines, because of the commodities' different properties for these two types of pipelines. For gas transmission pipelines, HCAs include more densely populated areas, areas with buildings that are difficult to evacuate, and areas where larger groups of people might assemble. This is because the risks from potential natural gas releases are concentrated in the area immediately around the release, and natural gas releases have little potential for more long-term environmental damage. Based on reports from transmission pipeline operators for 2008, only 7% of gas transmission pipeline mileage in the U. S. has the potential to impact HCAs.

Hazardous liquid pipeline HCAs include populated areas, ecologically sensitive areas, drinking water sources, and waterways used for commercial navigation. These criteria for HCAs recognize the potential long-term consequences of releases from hazardous liquid pipelines to the environment, as well as the potential immediate impacts in the vicinity of the release location[37]. Consequently, a higher percentage of hazardous liquid pipeline mileage is counted as having the potential to impact HCAs. Based on reports from hazardous liquid pipeline operators for 2008, 43% of hazardous liquid pipeline mileage in the U. S. has the potential to impact HCAs.

Operators of transmission pipeline segments that could affect HCAs are subject to additional requirements for periodically testing, inspecting, and assessing the integrity of these segments and repairing defects that could compromise pipe integrity. These operators are also subject to reporting requirements for these pipeline segments that are greater than the reporting requirements for other segments of their pipelines. These and other requirements for pipeline segments with the potential to affect HCAs are found in PHMSA's Integrity Management regulations[38].

Transmission pipeline operators are required to revise their integrity management programs to reflect additional development around the pipeline, if the new development creates additional HCAs as defined in the regulations. For example, if a new facility that is difficult to evacuate, such as a hospital or nursing home, is constructed close to a gas transmission pipeline, then a new HCA could result and the pipeline operator would be required to revise the integrity management program to cover that pipeline segment.

[37] More information on HCAs for hazardous liquid and gas transmission pipelines may be found at http://primis.phmsa.dot.gov/comm/FactSheets/FSHCA.htm.

[38] Integrity management regulations are found in Title 49 of the Code of Federal Regulations (CFR), Part 195.452 (for hazardous liquid pipelines) and Parts 192.901- 192.951 (for gas transmission pipelines).