



Vulnerabilities in the Oil and Gas Sector Pipeline Networks: Analysis of Office of Pipeline Safety (OPS) Data¹

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Executive Summary

This research brief includes summary information about incidents and accidents involving spills or releases of products related to petroleum and natural gas for three pipeline networks: hazardous liquid pipelines (which transport oil and other petroleum products), natural gas transmission pipelines and natural gas distribution pipelines. The data are maintained by the Office of Pipeline Safety (OPS) and provide information on the consequences associated with disruptions to these vital networks. The figures provide an idea of the potential consequences of a terrorist attack against these infrastructures. Some of the most important results of the analysis presented here are:

- Hazardous liquid accidents, which include spills of oil and other petroleum products, are more common than natural gas transmission and distribution accidents.
- Natural gas distribution incidents are associated with higher numbers of fatalities and injuries. In the last few years, however, a natural gas transmission incident had the highest number of fatalities.
- For hazardous liquid pipeline accidents operator property damage and other costs associated with the spills were the highest cost categories with the highest incidents having costs of \$13.4 million and \$24 million respectively for these categories.
- Over the last few years the incident with the highest property damages was a natural gas transmission incident (\$87 million).
- Natural gas distribution incidents tend to be associated with lower property damages. During 2004-05 the maximum property damages associated with a single incident was \$5 million.

The transport of oil and gas products and their delivery to final consumers relies on three primary pipeline networks in the United States. These are the natural gas transmission pipelines, the natural gas distribution pipelines and the hazardous liquid pipelines. The latter refers to pipelines that transport petroleum products such as crude oil, diesel,

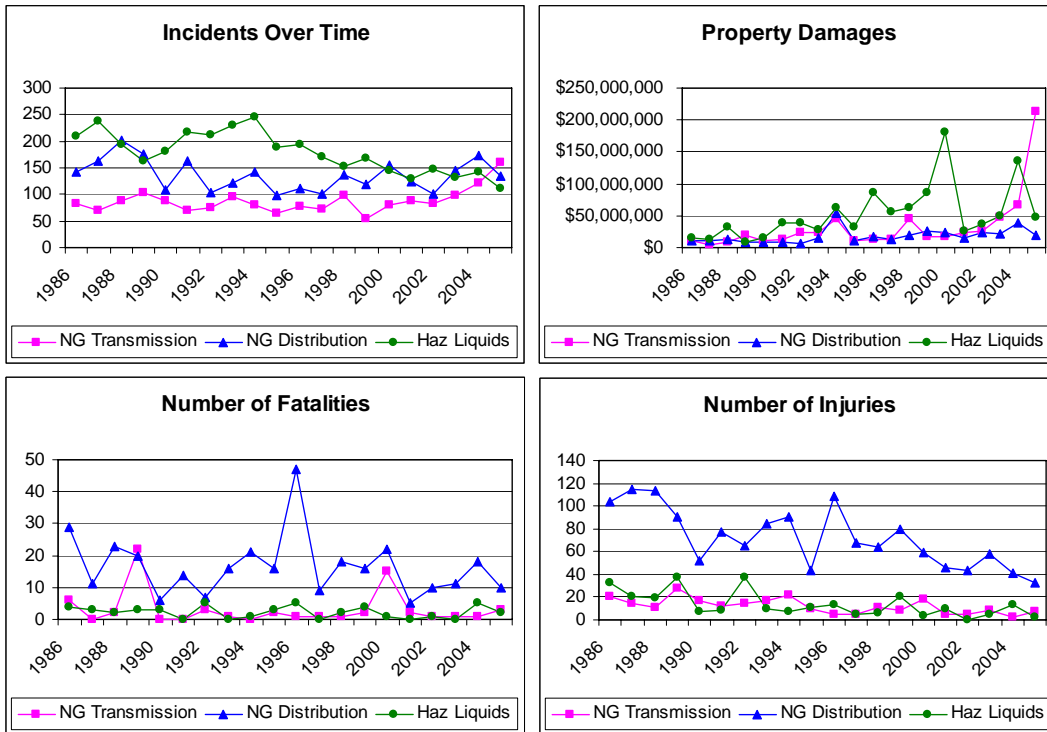
¹ This research brief is based on ongoing work of the NYU-Wagner School ICIS group as part of the I3P SCADA project.

kerosene, fuel oil and various others. Given the nature of these products information about spills or releases related to them and their consequences is carefully monitored. In the United States the Office of Pipeline Safety (OPS), which is part of the U.S. Department of Transportation, maintains detailed databases on incidents and accidents that affect each of these pipeline networks. The information is made available to the public through the OPS web page.²

The information included in these databases allows for an examination of geographical location of the incidents, type of incident and cause, and consequences of the incident. An analysis of this information provides information on the kinds of consequences that could be expected if the pipeline networks were attacked by terrorist groups. This background document summarizes the OPS data for these three pipeline networks.

Figure 1 summarizes some of the consequence measures for these three sets of OPS data. It includes annual summaries for the number of incidents, property damages, number of fatalities and number of injuries. Over the last few years included in the figures the number of incidents is similar for the three sets of data. Natural gas distribution incidents tend to have lower property damages but they also have the largest number of injuries and fatalities. Moreover, natural gas distribution incidents appear to be increasing.

Figure 1. Measures of Pipeline Incidents and their Consequences



² See: <http://ops.dot.gov/stats/stats.htm>

The information gathered by OPS has become much more detailed in the last few years. As a result, the data summaries presented throughout the rest of this document refer to the years 2002-05 for the hazardous liquid accidents and the natural gas transmission incidents, and to 2004-05 for the natural gas distribution incidents.

Hazardous Liquid Accidents

The Office of Pipeline Safety defines hazardous liquids as those that are dangerous to human health or safety or to the environment when used incorrectly or when not properly stored or contained. The hazardous liquids for this purpose include petroleum, petroleum products and anhydrous ammonia. Accidents are defined as unplanned occurrences that result in the release of product from a hazardous liquid pipeline (<http://primis.phmsa.dot.gov/comm/Glossary.htm>).

During the period 2002-05, most of the hazardous liquid pipeline accidents (97.9%) took place on-shore. Incidents took place in many states, with the ones having the highest number of accidents being Texas (431) Oklahoma (145), California (123), Kansas (112) and Louisiana (100). About 15% of the accidents occurred in high consequence areas, which include densely populated areas, sources of drinking water, and sensitive ecological areas.

About 15% of the hazardous liquid pipeline accidents involved pipeline leaks and 3% were ruptures. The most common accident causes for this period were equipment failure (34.7%), corrosion (21%), material and/or weld failures (11.3%), incorrect operation (8.8%), excavation damage (6.3%), and natural forces (5.4%).

During 2002-05, four accidents involved fatalities and 19 involved injuries. The highest number of fatalities for a single incident was 5 and the highest number of injuries was 9. About 98.9% of the hazardous liquid pipeline accidents during the period 2002-05 involved a spill of crude oil, fuel oil, ammonia, diesel, gasoline, jet fuel, kerosene and related products. The most commonly spilled products were crude oil (35%), gasoline (10.6%), propane (3.5%), and diesel fuel (3.4%). Only 49 out of 1582 incidents required an evacuation.

The maximum dollar damages recorded during this three year period for the hazardous liquid pipeline accidents were as follows: public/private property damages (\$1.75 million), cost of emergency response phase (\$12.22 million), cost of environmental remediation (\$6.6 million), other public costs (\$3.2 million), value of product lost (\$0.54 million), value of operator property damage (\$13.4 million), and other operator costs (\$24 million).

In terms of environmental impacts, roughly 37% resulted in soil contamination, 2.5% involved spills in ocean waters, about 6% involved spills in surface waters and about 4% resulted in damage to ground waters.

Natural Gas Transmission Pipeline Incidents

Natural gas transmission incidents refer to large-diameter pipelines that transport natural gas from gathering, processing or storage facilities to other processing or storage facilities and to large-volume customers and natural gas distribution systems (<http://primis.phmsa.dot.gov/comm/Glossary.htm>). The natural gas transmission pipelines can be inter-state or intra-state.

Natural gas transmission incidents occurred in all regions of the country. For the period 2002-2005 most of the incidents took place in the southwest region of the country (36.9%). States with the highest number of incidents during this period were Louisiana (74), Texas (67) and California (20). These states also have some of the largest pipeline networks in term of pipeline mileage. Most of the incidents (72.6%) took place onshore, but a large number took place offshore (27.4%). The majority of incidents took place in interstate pipelines (67.7%). The most common area of incidence occurrence was under ground (40.6%) followed by under water (26.7%). Incidents occurring above ground accounted for 19.4% of the total.

During the period 2002-2005, the most common causes of natural gas transmission incidents were internal corrosion (14.1%), third party excavation damage (13.8%), external corrosion (10.6%) and heavy rains and floods (10.4%). Most of the incidents refer to leaks in the pipelines (34.6%). Ruptures account for 20.5% of the incidents. The type of component that failed most often was body of pipe, which accounted for almost half of the incidents (47.5%). Joints and pipe seams accounted for 6.5% and 3.5% of incidents respectively.

During the period 2002-05 the number of fatalities associated with the incidents was small, with a total of 5 fatalities. Almost 99% of the incidents were not associated with any fatalities. There were 20 injuries associated with the incidents and 95.6% of the incidents had zero injuries.

The maximum costs associated with these incidents for 2002-05 were: total dollar amount of property damages (\$87.5 million), total dollar amount of gas loss (\$2.35 million), and total dollar amount of operator damage (\$25.9 million). Mean total dollar amount of property damages for the incidents during this period was about \$758,407.

During the period 2002-2005, in most of the incidents (91.7%) gas did not ignite and was not accompanied by an explosion (94.2%). In most of the incidents (88.9%) there was no need for an evacuation.

Natural Gas Distribution Pipeline Incidents

The natural gas distribution pipelines are small-diameter pipelines that supply natural gas to the final consumer (<http://primis.phmsa.dot.gov/comm/Glossary.htm>). During the period 2004-05, the natural gas distribution pipeline incidents are pretty evenly distributed around the country with the central, eastern and southwest regions of the

country having about 25.7% of incidents. The states with the highest number of incidents were Louisiana (13.6%), Arizona (3.3%), Indiana (3.3%), Minnesota (3.3%) and New Jersey (2.6%).

About 29% of the natural gas distribution pipeline incidents were caused by ruptures and about 17% by leaks. The most common cause was third party excavation damage (36.4%). Other common causes were fires and explosions and cars, trucks and other vehicles not related to excavation activity. The body of pipe was the most common component that failed in these incidents, accounting for about 38% of the total. Joints accounted for 7% of the incidents.

During the period 2004-05 there were 23 fatalities associated with the natural gas distribution pipeline incidents. The highest number of fatalities in any one incident was three. There were 66 injuries associated with these events. The highest number of injuries for any one event was four. There were 40 incidents with one injury.

The total dollar amounts associated with the natural gas distribution pipeline incidents is divided into four types: total dollar amount of property damages (\$5 million), total dollar amount of gas loss (\$0.39 million), total dollar amount of operator damage (\$2.5 million). The mean of the total dollar amount of property damages was \$188,021 which is significantly less than the mean value described for the natural gas transmission pipeline incidents.

About 57% of the natural gas distribution pipeline incidents were accompanied by gas ignition. Approximately 22% were accompanied by a gas explosion and about 29% of these incidents required an evacuation. These figures are significantly higher than the comparable figures for the natural gas transmission pipeline incidents.

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