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Pipelines Are Safest for Transportation of Oil and Gas

Diana Furchtgott-Roth, Senior Fellow, Manhattan Institute

MANHATTAN INSTITUTE FOR POLICY RESEARCH

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The Obama administration's decision to delay approval for the construction of TransCanada Inc.'s proposed Keystone XL pipeline was based, in part, on concerns over the safety and reliability of oil and natural gas pipelines. The pipeline is intended to transport oil from Canada to U.S. refiners on the Gulf of Mexico. In announcing his decision, the president called for a full assessment of "the pipeline's impact, especially on the health and safety of the American people."

Pipelines have been used to transport American natural gas or oil, including from Canada to the United States, for three quarters of a century. Almost 500,000 miles of interstate pipeline crisscross America, carrying crude oil, petroleum products, and natural gas. This extensive and operational infrastructure network is heavily regulated by the Department of Transportation, which monitors the very issues central to the Keystone controversy: safety and reliability.

Thus it is possible to answer, based on experience, the question of whether pipeline transport of oil and gas is safe. It is, moreover, possible to compare the record of oil and gas pipelines to that of transport via rail and road. As the major alternative means of fuel shipment, transport by rail and road has been increasing as limitations on pipeline capacity have become manifest (the underlying reason for the Keystone proposal).

A review of safety and accident statistics provided by the U.S. Department of Transportation for the extensive network of existing U.S. pipelines—including many linked to Canada—clearly show that, in addition to enjoying a substantial cost advantage, pipelines result in fewer fatalities, injuries, and environmental damage than road and rail. Americans are more likely to get struck by lightning than to be killed in a pipeline accident.[1]

The question of how to transport oil and gas safely and reliably is not a transitory one linked only to the Keystone controversy. Petroleum production in North America is now over 16 million barrels a day,[2] and could climb to 27 million barrels a day by 2020. Natural gas production in Canada and the United States could rise by a third over the same period, climbing to 22 billion cubic feet per day. This oil and gas will have to travel to where it is needed. Whether it is produced in Canada, Alaska, North Dakota, or the Gulf of Mexico, it will be used all over the country, especially since new environmental regulations are resulting in the rapid closures of coal-fired power plants, increasing the demand for natural gas as a substitute. Similarly, large fleets of buses and trucks are switching to natural gas, and General Motors and Chrysler are making dual-fuel pickup trucks.

This paper compares the record of transport via pipeline to that of road and rail and finds that pipelines are the environmentally safer option.

The first large-diameter long-distance pipelines were constructed during the Second World War, and they proliferated across the country over the ensuing two decades. Now America has 175,000 miles of onshore and offshore petroleum pipeline and 321,000 miles of natural gas transmission and gathering pipeline. In addition, over 2 million miles of natural gas distribution pipeline send natural gas to businesses and consumers.[3] This is expected to increase as households and businesses shift to natural gas to take advantage of low prices that are expected to last into the foreseeable future.

Pipelines are the primary mode of transportation for crude oil, petroleum products, and natural gas. As shown in Table 1, approximately 71 percent of crude oil and petroleum products are shipped by pipeline on a ton-mile basis. Tanker and barge traffic accounts for 22 percent of oil shipments. Trucking accounts for 4 percent of shipments, and rail for the

remaining 3 percent. Essentially all dry natural gas is shipped by pipeline to end users.

Table I: Crude Oil and Petroleum Products Transported in the United States by Mode (billions of ton-miles)

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008
Crude oil, total	**376.0**	**376.6**	**384.0**	**380.4**	**374.1**	**376.3**	**366.0**	**335.5**	**396.4**
Pipelines	283.4	277.0	286.6	284.5	283.7	293.5	300.5	266.6	330.7
Water carriers	91.0	98.1	95.7	94.1	88.7	81.1	63.8	66.9	63.2
Motor carriers	1.2	1.1	1.2	1.3	1.2	1.4	1.4	1.6	1.7
Railroads	0.4	0.4	0.5	0.5	0.5	0.4	0.4	0.4	0.7
Refined petroleum products, total	**497.3**	**493.2**	**480.6**	**502.9**	**528.4**	**529.7**	**489.4**	**499.9**	**485.7**
Pipelines	293.9	299.1	299.6	305.7	315.9	314.0	280.9	291.1	299.2
Water carriers	153.4	145.9	131.9	146.0	158.2	159.4	149.3	149.1	130.8
Motor carriers	30.1	29.7	29.4	31.9	33.2	33.4	33.8	33.5	33.4
Railroads	19.9	18.5	19.7	19.3	21.1	22.8	25.4	26.2	22.3
Combined crude and petroleum products, total	**873.3**	**869.8**	**864.6**	**883.3**	**902.5**	**906.0**	**855.4**	**835.4**	**882.2**
Pipelines	577.3	576.1	586.2	590.2	599.6	607.5	581.3	557.7	629.9
Water carriers	244.4	244.0	227.6	240.1	246.9	240.5	213.1	216.0	194.0
Motor carriers	31.3	30.8	30.6	33.2	34.4	34.8	35.2	35.2	35.1
Railroads	20.3	18.9	20.2	19.8	21.6	23.2	25.8	26.6	23.0

Source: "Table 1-61: Crude Oil and Petroleum Products Transported in the United States by Mode," U.S. Department of Transportation, Research and Innovative Technology Administration (RITA), Bureau of Transportation Statistics (BTS), accessed May 8, 2012, http://www.bts.gov/publications/national_transportation_statistics/html/table_01_61.html

If safety and environmental damages in the transportation of oil and gas were proportionate to the volume of shipments, one would expect the vast majority of damages to occur on pipelines. This paper finds the exact opposite. The majority of incidents occur on road and rail.

Data on pipeline safety are available from the United States Department of Transportation Pipeline and Hazardous Materials Safety Administration Office of Pipeline Safety (PHMSA).[4] Operators report to PHMSA any incident that crosses a certain safety threshold. These reports enable the public to compare the safety of pipelines to that of road and rail.

Table 2: Pipeline Incidents and Related Injuries and Fatalities (1992-2011)

	Number	Property Damage as Reported* (in millions)	Net Barrels of Liquids Lost	Injuries	Fatalities
1992	389	$70.5	68,810	118	15
1993	445	$67.3	57,559	111	17
1994	467	$160.6	114,002	120	22
1995	349	$53.4	53,113	64	21
1996	381	$114.5	100,949	127	53
1997	346	$79.6	103,129	77	10
1998	389	$126.9	60,791	81	21
1999	339	$130.1	104,487	108	22
2000	380	$191.8	56,953	81	38
2001	341	$63.1	77,456	61	7
2002	644	$102.1	77,953	49	12
2003	673	$139.0	50,889	71	12
2004	673	$271.9	69,003	60	23
2005	721	$1,246.7	46,246	48	14
2006	641	$151.1	53,905	36	21

A pipeline incident must be reported if any of the following occur: (1) Explosion or fire not intentionally set by the operator; (2) Release of five gallons or more of a hazardous liquid (any petroleum or petroleum product) or carbon dioxide; (3) Fatality; (4) Personal injury necessitating hospitalization; and (5) Property damage, including cleanup costs, and the value of lost product, and the damage to the property of the operator or others, or both, estimated to exceed $50,000.[5]

One way to look at the safety record of petroleum, petroleum products, and natural gas pipeline operators is to examine PHMSA's aggregated data from individual reports. Table 2 shows

2007	616	$154.9	68,941	53	15
2008	664	$555.8	69,815	59	9
2009	627	$178.0	32,258	66	13
2010	586	$1,336.4	123,419	109	22
2011	599	$336.3	108,663	65	17
Totals	10,270	$5,530.0	1,498,344	1,564	384

Source: "All Reported Pipeline Incidents," The United States Department of Transportation Pipeline and Hazardous Materials Safety Administration Office of Pipeline Safety, accessed April 24, 2012, http://primis.phmsa.dot.gov/comm/reports/safety/Allpsi.html?nocache=8953

a summary of all reported incidents and damage between 1992 and 2011. Property damage costs are reported by PHMSA in 2011, with lost product accounted for at benchmark prices at the time of the incident.

To the untutored eye, it can appear that pipelines are prone to significant accidents. For instance, there were 721 incidents in 2005, and 53 fatalities in 1996, many caused by a propane explosion in San Juan. However, as the tables make clear, safety-related incidents, as measured by volume, are actually minor. More importantly, it is crucial to keep in mind that there is no way, in an advanced industrial economy, to avoid shipment of fuels to provide power. Crucially, by comparison with other means of such transport, pipelines emerge as relatively safe and reliable.

Table 2 shows that the number of incidents is relatively low. It has ranged from 339 in 1999 to 721 in 2005. Property damage has ranged from $53 million in 1995 to $1.3 billion in 2010. Lost barrels of liquids reached a low of 32,258 barrels in 2009 to a high of 123,419 the following year. Injuries ranged from 36 in 2006 to 127 in 1996, and fatalities ranged from 7 in 2001 to 53 in 1996.

The unusual increases in gross property damage in 2005 and 2010 were largely attributable to Hurricane Katrina in 2005 and the Kalamazoo River oil spill in 2010. Higher market prices for petroleum over the period has led to an increased valuation of spillage. Throughout the 1990s, apart from a brief price spike associated with the Persian Gulf War, the West Texas Intermediate wholesale price of oil stayed below $25 dollars per barrel. Prices continued to increase between 2000 and 2008, and averaged $100 in 2008. Prices eased in 2009 and 2010, but averaged around $95 in 2011.[6]

A major criterion for determining if an incident had to be reported to PHMSA was significantly revised in 2002. Between 1992 and 2002 a spill only had to be reported if it was greater than 50 barrels of liquids or CO2 (after 1991). However, beginning in 2002, the limit was dropped to five gallons, with an exception for maintenance-related spills of five barrels or less confined to company sites.[7] Hence, minor spills that were not reported prior to 2002 were reported afterwards. From 1992 through 2001 an annual average of 383 incident reports were filed with PHMSA. Then, from 2002 through 2011, companies filed an annual average of 644 incident reports.

Gross barrels spilled do not take into account the number of barrels that were recovered during cleanup. The volume of liquids spilled that is ultimately recovered varies widely from year to year, and is likely heavily influenced by the nature of the spill. Between 1992 and 2011 about 40 percent of spilled liquids were recovered (Table 3). Over the entire 20-year period a total of less than 1.5 million net barrels were spilled.

Table 3: Percent of Liquids Recovered from Pipeline Incidents, All Reported Incidents (1992-2011)

Year	Gross Barrels Spilled	Net Barrels Spilled	Percentage Recovered
1992	137,065	68,810	50
1993	116,802	57,559	51
1994	164,387	114,002	31
1995	110,237	53,113	52
1996	160,316	100,949	37
1997	195,549	103,129	47
1998	149,500	60,791	59
1999	167,230	104,487	38
2000	108,652	56,953	48
2001	98,348	77,456	21
2002	97,255	77,953	20
2003	81,308	50,889	37
2004	89,311	69,003	23
2005	138,094	46,246	67
2006	137,693	53,905	61
2007	94,981	68,941	27
2008	102,076	69,815	32

Volumes that are spilled are miniscule when compared to the volumes of petroleum that are used in the United States. To provide some prospective, U.S. refineries produce near 9 million barrels of gasoline every single day. Considering

the vast network, 175,000 miles of petroleum pipeline and over 2 million miles of natural gas pipelines (about 321,000 of transmission and gathering lines, over 2 million of local distribution main and service lines), incidents are exceedingly rare.[8]

2009	54,964	32,258	41
2010	174,921	123,419	29
2011	137,932	108,663	21
Totals	2,516,625	1,498,341	40

Source: "All Reported Pipeline Incidents," The United States Department of Transportation Pipeline and Hazardous Materials Safety Administration Office of Pipeline Safety, accessed April 24, 2012, http://primis.phmsa.dot.gov/comm/reports/safety/Allpsi.html?nocache=8953 and Manhattan Institute calculations.

To draw another comparison, according to the National Weather Service there was an average of 39 reported deaths annually caused by lightning from 2001 to 2010.[9] From 1992 to 2011 fatalities related to pipeline incidents were about 20 per year. An individual had about twice the chance of getting killed by lightning as being killed in a pipeline incident.

Data are also provided by PHMSA that make it possible to determine in what type of pipeline system a particular incident occurred. There are four basic categories of pipeline systems, namely hazardous liquids, natural gas gathering, natural gas transmission, and natural gas distribution. Natural gas gathering pipelines bring raw natural gas from the wellhead to the gas processing plant. The natural gas transmission system is made up of pipelines that bring processed (dry) gas from the plants and carry it across the country to city gates or to large customers (e.g., heavy industry or electrical power plants). The natural gas distribution system is operated by local distribution companies which transport gas from the city gate to local households and local businesses. Table 4 displays what percentage of incidents, fatalities, injuries, and property damage from 1992 through 2011 occurred in each pipeline system.

Although fatalities and injuries are relatively low, the majority of those that do occur have been associated with pipelines that are part of a natural gas distribution system. The U.S. natural gas distribution pipeline network spans over 2 million miles, and the federal government does not regulate intrastate pipelines (local distribution and production gathering lines), except for gathering lines that are located on federal lands. Local distribution companies, where both the vast majority of pipeline miles exist and accidents occur, are regulated by states and municipalities.

Table 4: Percentage of Incidents, Fatalities, Injuries, and Property Damage by Pipeline System (1992-2011)

	Incidents	Fatalities	Injuries	Property Damage
Natural Gas Gathering	2	0	1	7
Natural Gas Transmission	18	12	14	28
Natural Gas Distribution	26	78	75	17
Hazardous Liquid	54	11	11	49

Note: Not all columns sum to 100 due to rounding.

Source: "All Reported Incidents," The United States Department of Transportation Pipeline and Hazardous Materials Safety Administration Office of Pipeline Safety, accessed May 1, 2012, http://primis.phmsa.dot.gov/comm/reports/safety/Allpsi.html?nocache=3087#_all and Manhattan Institute calculations.

The proportion of property damage from incidents originating at hazardous liquids pipelines is largely the result of the inclusion of lost product as part of the damage, and that cleanup of oil spills is costly. From an operational standpoint, incidents associated with natural gas transmission and hazardous liquid systems (large diameter interstate pipelines) have resulted in 86 deaths and 372 injuries from 1992 through 2011, as can be shown in Table 5.

Table 5: Incidents, Fatalities, Injuries, and Property Damage by Pipeline System (1992-2011)

	Incidents	Fatalities	Injuries	Property Damage as Reported
Natural Gas Gathering	212	0	12	$357,080,128
Natural Gas Transmission	1845	45	216	$1,534,724,575
Natural Gas Distribution	2644	298	1165	$942,404,551
Hazardous Liquid	5569	41	171	$2,695,828,774

Source: "All Reported Incidents," The United States Department of Transportation Pipeline and Hazardous Materials Safety Administration Office of Pipeline Safety, accessed May 1, 2012, http://primis.phmsa.dot.gov/comm/reports/safety/Allpsi.html?nocache=3087#_all and Manhattan Institute calculations.

How does this compare with road and rail? The U.S. Department of Transportation has compared the incident, injury, and fatality rates for oil and gas pipelines with transportation by road and rail for the period 2005 through 2009.[10] Road and rail have higher rates of serious incidents, injuries, and fatalities than pipelines, even though more road and rail incidents go unreported.

Table 6 compares incident rates for road, rail, oil and petroleum products, and natural gas transmission. Rail had the highest rate of incidents, with 651 per billion ton miles per year. This was followed by road, with 20 per billion ton miles per year. Natural gas transmission came next, with 0.89 per billion ton miles. Oil products were the safest, with 0.61 serious incidents per billion ton miles.

Table 6: Comparative Statistics for Incident Rates Onshore Transmission Pipelines vs. Road and Railway (2005-2009)

Mode	Billions Ton Miles of Shipment	Average Hazmat Incidents per Year	Average Hazmat Incidents per Billion Ton Mile
Road[1]	23	14,963	650.6
Railway[1]	35.1	718	20.5
Hazardous Liquid Pipeline (Onshore)[2]	584.1	354	0.61
Gas Transmission Pipeline (Onshore)[2]	338.5	300	0.89

1: Reproduced from U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, Office of Pipeline Safety, *Building Safe Communities: Pipeline Risk and its Application to Local Development Decisions*, October, 2010, Table 1, p. 23, http://www.pstrust.org/library/docs/PIPA-PipelineRiskReport-Final-20101021.pdf.

2: "All Reported Incidents," The United States Department of Transportation Pipeline and Hazardous Materials Safety Administration Office of Pipeline Safety, accessed May 1, 2012, http://primis.phmsa.dot.gov/comm/reports/safety/Allpsi.html?nocache=3087#_all and Manhattan Institute calculations.

Source: "Table 1-50: U.S. Ton-Miles of Freight (BTS Special Tabulation)," U.S. Department of Transportation, Research and Innovative Technology Administration (RITA), Bureau of Transportation Statistics (BTS), accessed May 8, 2012, http://www.bts.gov/publications/national_transportation_statistics/html/table_01_50.html

With respect to pipeline systems, natural gas transmission lines had the lowest average fatality rate for operator personnel and the general public between 2005 and 2009, as can be seen from Table 7, with a rate of one person killed per year. This was followed by oil and rail, with an average of 2.4 people per year. The highest is road, with an average of 10.2 people a year. This is not because members of the public are killed due to road accidents with oil trucks. Only 1.4 members of the public, on average, were killed annually, but an average of 8.8 operators died per year.

As shown in Table 8, injury rates, defined as numbers of people hospitalized, show a similar pattern. On average, annual injuries for 2005 through 2009 were lowest for oil, at 4 people per year, and natural gas, at 6.2 people per year. The rate was highest for rail, at 25.6 people per year; although this number was heavily biased by the 2005 observation. Road accidents were 21.8 people per year, on average.

Table 7: Comparison of Hazmat Fatality Statistics, Operator Personnel and General Public for Road, Rail, and Pipeline (2005-2009)

	2005	2006	2007	2008	2009	Total	Average per Year
Road	24	6	10	8	3	51	10.2
Railway	10	0	0	1	1	12	2.4
Hazardous Onshore Only	2	0	4	2	4	12	2.4
Gas Transmission Onshore Only	0	3	2	0	0	5	1.0

Source: Reproduced from U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, Office of Pipeline Safety, *Building Safe Communities: Pipeline Risk and its Application to Local Development Decisions*, October, 2010, Table 3, p. 26, http://www.pstrust.org/library/docs/PIPA-PipelineRiskReport-Final-20101021.pdf.

Table 8: Comparison of Hazmat Injury Statistics Operator Personnel and General Public for Road, Rail, and Pipeline (2005-2009)

	2005	2006	2007	2008	2009	Total	Average per Year
Road	33	21	34	10	11	109	21.8
Railway	99	9	5	7	8	128	25.6
Hazardous Onshore Only	2	2	10	2	2	20	4.0
Gas Transmission Onshore Only	5	3	7	5	11	31	6.2

Source: Reproduced from U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, Office of Pipeline Safety, *Building Safe Communities: Pipeline Risk and its Application to Local Development Decisions*, October, 2010, Table 4, p. 28, http://www.pstrust.org/library/docs/PIPA-PipelineRiskReport-Final-20101021.pdf.

Some claim that pipelines carrying Canadian oil sands crude, known as diluted bitumen, have more internal corrosion, and are subject to more incidents.[11] However, PHMSA data show no incidents of oil releases from corrosion from Canadian diluted bitumen between 2002 and 2010.[12] Oil sands crude has been transported in American pipelines for the past decade.

The evidence is clear: transporting oil and natural gas by pipeline is safe and environmentally friendly. Furthermore, pipeline transportation is safer than transportation by road, rail, or barge, as measured by incidents, injuries, and fatalities—even though more road and rail incidents go unreported.[13]

Yet, increasing oil and natural gas production is outpacing the transportation capacity of our inadequate national pipeline infrastructure. The Association of American Railroads reports that over the past three years the total share of oil and gas rail shipments has grown dramatically, from 2 percent of all carloads in 2008 to 11 percent in 2011.[14] In 2011 alone, rail capacity in the Bakken area—stretching from southern Alberta to the northern U.S. Great Plains—tripled to almost 300,000 barrels per day.[15]

As America continues to ramp up production of oil and natural gas, our pipeline infrastructure becomes more important. We need better pipelines to get oil from North Dakota to the refineries in the Gulf, and natural gas from the Marcellus Shale in Pennsylvania (and New York, should the Empire State allow production to move forward) and the Utica Shale in Ohio to the rest of the country.

In the next few years, the Obama administration may allow more states to explore for oil offshore. In addition, Congress might vote to give coastal areas a share of oil drilling revenue, providing a powerful incentive for more drilling. Congress could also form a liability risk pool to allow independent drillers to expand into the Gulf of Mexico. In order for these resources to get where they are needed, America needs more pipelines—the safest way to move fuel.

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ENDNOTES

1. Reliable data on water borne spills, which fall under the jurisdiction of the Coast Guard, are not readily available and so will not be included in this Issue Brief.
2. "International Energy Statistics, Production of Crude Oil, NGPL, and Other Liquids," United States Energy Information Agency, accessed May 29, 2012, http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=50&pid=55&aid=1&cid=&syid=2008&eyid=2012&

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6. "Petroleum and Other Liquids, Spot Prices," United States Energy Information Agency, accessed May 29, 2012 http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=50&pid=55&aid=1&cid=&syid=2008&eyid=2012&freq=M&unit=TBPD.
7. "Reporting Criteria Changes 1990-Current," The United States Department of Transportation Pipeline and Hazardous Materials Safety Administration Office of Pipeline Safety, last updated March 2011, http://primis.phmsa.dot.gov/comm/reports/safety/docs/IncidentReportingCriteriaHistory1990-2011.pdf
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11. See, for example, Lara Skinner and Sean Sweeney, "The Impact of Tar Sands Pipeline Spills on Employment and the Economy," Cornell University Global Labor Institute, March, 2012.
12. U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, data from form PHMSA F 7000-1.
13. 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.
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15. "Buffet's Burlington Northern Among Pipeline Winners," Bloomberg News, accessed June 05, 2012, http://www.bloomberg.com/news/2012-01-23/buffett-s-burlington-northern-among-winners-in-obama-rejection-of-pipeline.html

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