

Pipelines Safety And Security: Is It No More Than A Pipe Dream?

Methane leaks and explodes, Canadian tar sands crude sinks, and computerized control systems are being hacked. Is publicly-acceptable safety and security a realistic prospect?

By **Trudy E. Bell** (Copyright 2014 Trudy E. Bell)

THIS PAST JULY 4, Bank of America Merrill Lynch Global Research sent up fireworks throughout the petroleum industry. In a note titled “The United Petrostates of America” in *Global Energy Weekly*, the firm announced that because of hydraulic fracturing and unconventional recovery technologies, the United States had just become the biggest crude oil producer in the world—surpassing both Saudi Arabia and Russia. That milestone was achieved far faster than the International Energy Agency’s 2012 projection of around 2020.²⁶ Oh, and FYI: the U.S. has already been the world’s biggest producer of dry natural gas (consumer-ready methane) for years.¹⁷

The shale boom translates directly into transportation infrastructure: pipelines for gathering the hydrocarbons from wells, transporting them to gas processing plants and oil refineries, and distributing refined products to customers. The Interstate Natural Gas Association of America (INGAA) calculates that half a million miles—542,500 to be exact, greater than a round trip to the moon—more pipeline must be installed between now and 2035 to convey hydrocarbons from a projected 1.2 million new wells (307,000 gas and 914,000 oil). Three quarters of that mileage would be laid in the next five years.²⁹

Dramatic to anyone who drives through the “flyover country” of the Great Plains and Midwest is the tangible result: mile after mile of trenches being excavated and pipelines being laid through ranchlands, farm fields, and suburbs—some quite close to private homes.

Stay with me while we zoom through some essentials.

Pipeline primer

In separate systems, energy pipelines transport three classes of fluids: crude oil, hazardous liquids, and natural gas. Crude oil really should be crude *oils*, plural, as crudes differ significantly in their specific gravity, acidity, and other characteristics—more on this in a bit. Hazardous liquids include products refined from crude oil (such as gasoline, diesel, or petrochemicals used to make plastics) and highly volatile natural gas liquids (NGL) such as ethane, butane, and propane. They also include liquefied carbon dioxide (used to enhance oil recovery), and the highly saline wastewater infused with residual proprietary chemicals and naturally occurring radioactive materials and that returns from hydraulic fracturing of horizontal oil and gas wells (see “Shale Gas Extraction 101” in *The Bent*, Summer 2013).

Energy pipeline networks have a three-part anatomy. *Gathering* pipelines are often smaller-diameter pipe—2 to 12 inches^{5,24}—in the production (drilling) field that convey fluids commonly at lower pressures from individual wellheads to transmission pipelines.

Transmission pipelines usually range from 16 to 48 inches in diameter, most being somewhere between.^{7,27} These big pipes are the high-volume “interstate highways” transporting crude oil to refineries and natural gas to gas processing plants or underground storage. They also carry refined petroleum products or natural gas liquids to product terminals (large collections of tanks) near consumers. Some transmission pipelines also transport crude oil directly to tanker ships in deep-water ports for exporting to other nations or hydraulic fracturing wastewater from a drilling field to Class II injection wells for disposal of toxic waste.

Distribution pipelines range from big to small-diameter pipe—down to 4–6 inches for distribution mains and 1 inch or smaller for service lines—that



Enbridge 36-inch pipeline being installed only 7 to 15 feet from homes in Ceresco, MI, in January 2014. Replacing Line 6B that ruptured in July 2010, this new pipeline will also carry diluted bitumen (oil sands heavy crude). Made of high-strength carbon steel, its turquoise color is a fusion bond epoxy coating to resist external corrosion. Photo: David Gallagher

deliver natural gas through city streets directly to hot water heaters, stoves, and furnaces of individual home and business customers. There is no equivalent distribution network for refined petroleum liquids: a product may be pipelined to specific big customers (e.g., jet fuel to airports) but gasoline, diesel, home heating oil, and the like are transported to customers by truck.

Currently, the U.S. network of pipelines is north of 2.6 million miles—yes, mileage exceeding 100 trips around Earth's equator or 5 round trips to the moon. About three-quarters of that mileage—more than 2 million miles—is the block-by-block house-by-house distribution network for natural gas throughout virtually every American city and town. Some 320,000 miles comprise transmission pipelines for natural gas and another 185,000 miles for petroleum: crude oil (55,000 miles), refined products (95,000 miles), and other hazardous liquids.⁵ And counting.⁶

Maximum allowable

Product is moved through transmission pipelines either by compressors (for natural gas) or by pumps (for liquids). Most transmission pipelines operate at pressures of 600 to 1000 pounds per square inch (psi), with some rated to have a maximum allowable operating pressure up to 1,400 psi gauge (psi above atmospheric pressure).^{7,27} For comparison, the pressure inside the solid-fuel rocket boosters of NASA's space shuttle (R.I.P.) reached a peak of 1,000 psi at ignition.⁸ Shutoff valves are spaced along the pipeline every 5 to 20 miles for use during maintenance or emergencies.^{12, 27, 28}

Before a new pipeline starts carrying hazardous fluids, it undergoes hydrostatic testing: it is filled with water at pressures 10% to 25% higher than the maximum operating pressure for a good 8 hours, to verify the integrity of seams, valves, etc.^{5,7} Once in operation, big transmission pipelines are periodically inspected by methods ranging from visual assessment a couple times per year (from vehicles including aircraft flying along the pipeline's route) to instrumented, torpedo-shaped "smart pigs" inside the pipeline. Carried along by the fluid itself at the speed of a human runner (2 to 4 meters per second or 5 to 9 miles per hour), every few millimeters a smart pig's sensors looks for metal loss from mechanical damage or corrosion with ultrasonic transducers and magnetic flux leakage detection. Using GPS, the smart pig's inertial navigation system notes deviations in the position or direction of the pipeline due to settling or upheaval; calipers around the pig feel whether the pipe is wrinkled or gone out of round. If a problem is detected, maintenance crews can isolate a section of pipeline with pig plugs on either side to block

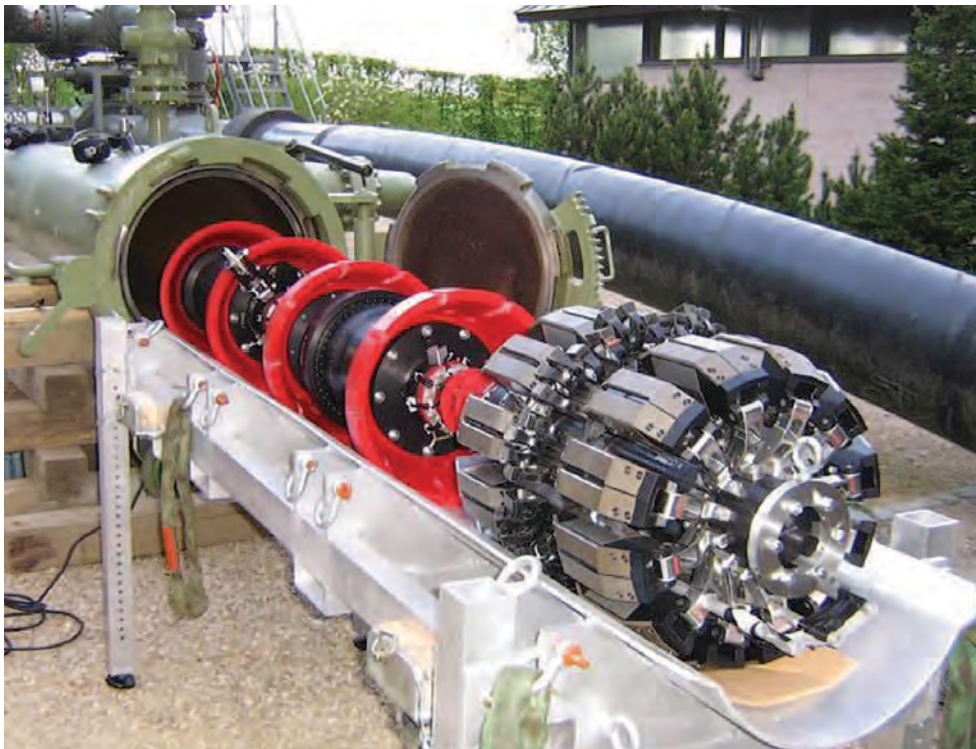


ABOVE: When 30-inch transmission pipeline Line 6B owned and operated by Enbridge Energy ruptured along a welded seam on July 25, 2010, near Marshall, MI, it released between 843,000 and 1.1 million gallons of dilbit (diluted bitumen, a type of oil sands heavy crude) into Talmadge Creek and the Kalamazoo River. It was the largest onshore oil spill in the United States. Photo: National Transportation Safety Board. BELOW: View of part of an oil pipeline SCADA control room. Photo: AOPL/API Pipeline101.org



fluid flow and allow the repair.⁴⁴ The U.S. Department of Transportation (DOT), which oversees transmission and distribution pipelines, requires smart pigging every five years.^{1,5} Today, smart pigs conduct 93% of inspections.²¹

Human operators control and monitor the pipeline 24/7 from SCADA central control rooms as instrumented as NASA mission control. SCADA—standing for Supervisory Control And Data Acquisition—systems have been around for decades, controlling drinking water systems, chemical plants, manufacturing systems, nuclear power plants, and electric power grids. Among other functions, SCADA systems collect real-time data all along a pipeline, display the data, sound alarms if line pressure drops or if metered-out quantity of product delivered is less than metered-in,⁴⁵ and enable operators to start and stop pumps or compressor stations that may be hundreds of miles away. Communications links throughout a pipeline network may include satellite, Wi-Fi, cellphones, Internet, and hardwired dedicated



One type of 'smart pig' used for internal inspection of oil pipelines. Photo: AOPL/API Pipeline101.org

landlines. Some pipelines also use computational pipeline management (CPM): algorithmic modeling of the moment-by-moment state of the pipeline to enhance the ability of a controller to recognize hydraulic anomalies.

The DOT's Pipeline and Hazardous Materials Safety Administration (PHMSA, pronounced FIM-sa) issues safety regulations for pipeline construction and operation and control room procedures and also inspects transmission lines. The DOT's National Transportation Safety Board—yes, the same NTSB that investigates airline accidents—also investigates major pipeline accidents.

"A barrel of crude oil or petroleum product shipped by pipeline reaches its destination safely more than 99.999% of the time," states the Association of Oil Pipelines (AOPL) and American Petroleum Institute (API) in their *Annual Liquid Pipeline Safety Performance Report & Strategic Plan 2013*, published in January 2014, a figure widely quoted ever since for pipeline reliability.^{4,5} The exact figure AOPL and API gave for 2012 was 99.9998% (report page 15).⁴

99.9998% reliable?

Quite apart from begging the question whether any complex, human-engineered system can meaningfully claim 99.9998% reliability, is using volume of product delivered even the right metric? And how does that assertion square with the record?

In a 281-page technical *Leak Detection Study* to PHMSA in December 2012, pipeline engineering consultants Kiefner & Associates, Inc., (KAI) examined 30 months of recent pipeline "incidents" to (among other tasks) study the use of leak detection systems (LDS) in the pipeline industry and determine if additional LDS could have reduced their consequences.

From the PHMSA incident report database, KAI documented 1,337 "unintentional releases" between January 1, 2010 and July 7, 2012—that's more than one per day somewhere in the nation. 766 were spills of hazardous liquids (including crude oil, refined products, and other fluids); 295 were natural gas leaks from transmission pipelines, and

276 more from distribution pipelines. Dozens were catastrophic.

Of 18 "above-the-average" releases KAI singled out for individual case studies, the hazardous liquids list included the single largest onshore oil spill in U.S. history: on July 25, 2010, Enbridge's 30-inch Line 6B ruptured near Marshall, MI, discharging 843,444 gallons—more than 20,000 barrels at 42 gallons per barrel—of a type of Canadian tar sands crude called diluted bitumen ("dilbit") into suburban Talmadge Creek, ultimately fouling 40 miles of the Kalamazoo River, a tributary to Lake Michigan.³⁸ KAI's list of above-the-average natural gas incidents included the horrific week-day afternoon explosion of a 30-inch PG&E natural gas pipeline in the

densely populated San Francisco suburb of San Bruno on September 8, 2010, during evening rush hour, leaving a crater, igniting fierce fires, destroying 38 homes, killing 8, and injuring many more.⁴⁰ And that isn't even the biggest gas release on the list.

Undetected for 11 days

Lest one think that particular 30 months was just a bad stretch for the pipeline industry, major unintentional releases continue apace. For example, in September 2013, near Tioga, North Dakota, a volume of crude oil comparable to the Kalamazoo River spill—20,600 barrels (865,200 gallons) flowed from a dime-sized hole in a 6-inch pipeline, flooding seven acres, undetected for 11 days by the pipeline owner Tesoro Logistics.³¹ It was the wheat farmer who discovered oil bubbling up from his field. Now underway through 2015 is a two-year cleanup. And this past July 4th weekend, Crestwood Midstream's underground hazardous liquids pipeline conveying hydraulic fracturing wastewater across the Fort Berthold Indian Reservation in North Dakota spilled some 24,000 barrels—over 1 million gallons—of toxic waste near Bear Den Bay, a tributary of Lake Sakakawea, a Missouri River drinking water reservoir.⁴⁹

If pipelines are regularly inspected, how is it that spills—including such big ones—happen every year? And if operators are monitoring and controlling pipelines 24/7, how can major leaks go undetected for days?

First, smart pigging every five years may not be frequent enough. Second, the terabytes of data transmitted by smart pigs return are not analyzed in real time—indeed, data analysis can take up to nine months: such inspection data were pending in at least four of KAI's 18 "above-the-average" major releases. Third, smart pigs, having a detection rate of about 90%,⁵ miss stuff. They especially miss corrosion or tiny cracks that follow a pipe's longitudinal welded seam—a type of crack quite common as a result of welding using low-frequency current as done until the 1970s. Pipelines from that era still account for about a third of the mileage of hazardous liquid pipelines in service. That

type of seam crack was implicated in the Enbridge spill into the Kalamazoo River.²¹ Fourth, some pipelines may not be “piggable” because of narrow diameters, tight turns, or changes in radii.⁴³ Fifth, the pipeline owner/operator has to *act* on inspection test results in a timely manner, another factor in the Enbridge spill.

Most importantly, an early-warning leak detection system has to be in place! “Both SCADA and CPM systems are seen as primary means within the control room for pipeline operating personnel to detect releases on hazardous liquid pipelines,” observed the KAI LDS report. “Pressure/Flow monitoring is universally claimed as a form of leak detection.” But here lie technical snares. For example, in a gas transmission pipeline, a “downstream leak may have almost no effect on flow rate”—indeed, “pressures in a gas system require a very large leak to have any effect on pressure.” Therefore, “we expect this to provide at best large rupture detection and all interviewed operators concede this.”³²

SCADA is a control system, not a leak-detection system, contends KAI. Yet, because of cost accounting practices that rely on only 1 to 5 years for return on investment—despite the fact that pipelines have an operational lifetime of decades—and offer no way of weighting the avoidance of costs for cleanup and fines, operators “fear investing in leak detection systems, with...no way to truly measure success in a standardized way.” Thus, they prefer using equipment already in place instead of investing in a dedicated leak-detection system such as acoustic and pressure wave analysis, fiber optic cables, hydrocarbon sensors, or thermal imaging. Indeed, the report points out, one dedicated LDS may not be enough as “a basic engineering robustness principle calls for [implementing] at least two methods that rely on entirely separate physical principles.” However, after performing a detailed accounting analysis on “notional” liquids and gas pipelines for cost invested versus accidents averted, KAI observes: “In an engineering application, any investment that yields factors of 1.5–2 ROI is usually regarded as valuable. At the ten-year horizon, nearly all the technologies pass this threshold for a liquids pipeline.” Even gas pipelines in high-consequence areas (e.g., urban areas, wetlands) “can economically consider most technologies.”

Without investigating

Last, when a SCADA or CPM system does give an alarm, operators need to investigate. In the 2010 Enbridge rupture, the SCADA system did sound alarms—three times. All three times, *without investigating*, the operators famously dismissed the alarms, even trying to start up the pipeline twice, each time discharging more dilbit.³⁸ Notes KAI: “A recurring theme is that of false alarms. The implication is that an LDS is expected to perform as an elementary industrial information alarm, with an on/off state and six-sigma reliability. Any alarm that does not correspond to an actual leak is, with this thinking, an indicator of a failure of the LDS system. The impact on operators is that often they set the thresholds for a leak alarm so wide that the sensitivity of the detection suffers. Although there are no false alarms any more, *there are also very few alarms of any kind* so at best only large ruptures are reported.”³²

Pipelines on rails?

Because pipelines are not being laid as fast as oil wells are being drilled and bitumen is being mined, energy companies are increasingly shipping crude oil by rail.

From 2008 through 2013, the volume of oil transported by rail skyrocketed over 45 times,⁴⁷ giving rise to so-called “unit trains”: dedicated trains hauling 80 to 120 DOT-111 tank cars, pictured below, from one point of origin to one destination²²—effectively a pipeline on rails. Slightly diluted



bitumen is now also being shipped by rail in cars steam-heated to keep the viscosity low, earning a product nickname of “railbit.”¹¹

With the rise in the use of rail has risen the number of “incidents” involving crude oil trains: from 8 in 2008 to 119 in 2013, two of them in 2013 (in Aliceville, Alabama, and Casselton, North Dakota) resulting in large spills. In a 2014 report, the U.S. Government Accountability Office cited a NTSB study that showed tank cars are not adequately designed to resist punctures and “the catastrophic release of hazardous materials can be expected when derailments involve DOT-111 cars.”²²

That fact was tragically demonstrated in July 2013 when a 72-car crude oil train from the Bakken shale derailed and exploded in Lac-Mégantic, Quebec, igniting a fierce blaze that killed 47 and devastated the city’s downtown. Canada’s Transportation Safety Board found the contents of the surviving cars had been mislabeled as a less flammable liquid than it actually was.

In response, in February 2014, the U.S. DOT issued an emergency order requiring stricter labeling standards to transport crude oil.⁵⁴ Six months later, PHMSA issued a notice of proposed rule-making standards and controls for high-hazard flammable trains. Washington State is also concerned about oil cars passing over bodies of water.

Q: In water, does crude oil float or sink? A: That depends on the crude. And some oil sands heavy crudes sink.

Half of Canadian oil output in 2013 came from oil sands, also called tar sands.¹⁶ The sands, mostly in Alberta, are permeated with bitumen, an extra-heavy form of petroleum that is semi-solid at room temperatures. As pithily noted in a June 2014 report by the Canadian Association of Petroleum Producers (CAPP), “Bitumen at 10° Celsius [50°F] has the consistency of a hockey puck;”¹¹ at warmer temps it is more like black peanut butter. Bitumen is so viscous that in surface deposits it is pit-mined (strip-mined). From deeper deposits, it is brought up by injecting steam underground to melt it so it can be pumped to the surface, a technique called in situ drilling.

In its natural state, oil sands bitumen will not flow in a pipeline. It also contains sand (no surprise), clay, and water and is “sour,” meaning it has a high sulfur content. These processing challenges are beyond the capabilities of ordinary oil refineries. Alberta’s five bitumen upgraders can produce petroleum products ranging from an intermediate refinery feedstock to synthetic crudes (called syncrudes) and even diesel. But together they can process only about half the bitumen mined; moreover, facilities are so costly and economics so dependent on market conditions that Canada



U.S. and Canadian pipelines in service and proposed. Credit: CAPP 2014¹¹

for international tankers or under-sea pipelines.¹⁰ Few have studied either dilbit's behavior in freshwater or technologies for detecting and recovering submerged or sunk-oil sands products. That is of concern because proposed pipelines carrying dilbit would pass over or under major U.S. rivers including the Missouri and Mississippi. Moreover, Enbridge is now expanding its existing Lakehead

pipeline system to carry Alberta tar sands heavy crude, including through Line 5B: twin 20-inch pipelines installed in 1953 lying on the bottom of the Straits of Mackinac between Lake Michigan and Lake Huron. Should one of those 62-year-old pipes leak, strong and rapid currents could rapidly disperse crude widely throughout both these major sources of drinking water, and 150-foot depths could further complicate cleanup.^{2,36}

Last, in the event of an oil sands spill, the U.S. National Oceanic and Atmospheric Administration (NOAA) recently identified two appalling regulatory shortcomings: 1) Oil sands products are exempted from the excise tax that provides funds for cleaning up spills in the U.S., and 2) Specific product information is unavailable from oil sands facilities and transporters for what was in the pipeline at the time of the spill.³⁷

Bombs underfoot?
Over the past 18 months, aging pipelines in the natural gas distribution system—some older than a century in major East Coast cities—have repeatedly grabbed headlines and the attention of legislators. They leak. A lot. In 2013 and 2014, a team of researchers from Duke University, Stanford University, and other organizations drove every street in Boston and Washington, D.C., measuring methane in the ambient air and issuing from manholes. In Boston there were more than 3,000 gas leaks, and in the District of Columbia nearly 5,900, including a dozen telecommunications manholes where natural gas exceeded 50,000 parts per million—that is, 5% gas in air, the minimum explosive limit.^{20,30} Independently, in 2012, New York City's two distributors of natural gas reported finding over 9,900 leaks in their systems combined.³⁵

All those leaks mean that collectively, the nation's consumers annually pay at least \$20 billion for gas they are not receiving, revealed a 2013 report.³ The report also documented 796 "significant incidents" in the nation's gas distribution system between 2002 and 2012, including several hundred explosions, 116 fatalities, 465 injuries, and nearly \$811 million in property damage. The explosion hazard made

Submerge or sink

The fact that some heavy crudes can submerge or sink has been known for a decade. While both synbit and dilbit can float on saltwater, when choppy ocean waves mix suspended fine sediments with the dilbit, the mixture can sink. Several studies have evaluated the risk to marine environments

the front page of *The New York Times* in March 2014³⁵ after an 8-inch gas main on upper Park Avenue in East Harlem exploded, killing 8 and injuring 48, destroying a five-story building and causing a fire that raged for six days⁴¹—repeating the suffering in Birmingham, AL, in 2013; Austin, TX, in 2012; Allentown, PA, in 2011; and San Bruno, CA, in 2010.

Rust and corrode

Although most of the 1.2 million miles of gas mains today are made of plastic or protected steel, as of 2012 nearly 8% were still of bare steel (61,000 miles) or, worse, cast or wrought iron (32,000 miles)²⁰ some dating back to before World War I (the one that exploded in East Harlem was installed in 1911). When either iron or bare steel are exposed to moisture, they rust and corrode. Even coated pipelines are not immune to corrosion, as older polyethylene coatings degrade over time. Plastic pipes also have their issues: the NTSB has documented that some installed in gas distribution systems from the 1960s into the 1980s have become brittle and cracked.⁵¹ Nationwide, in 2013, gas distributors reported an average of 12 leaks per 100 miles of pipeline³⁵—that is, 120 leaks per 1,000 miles.

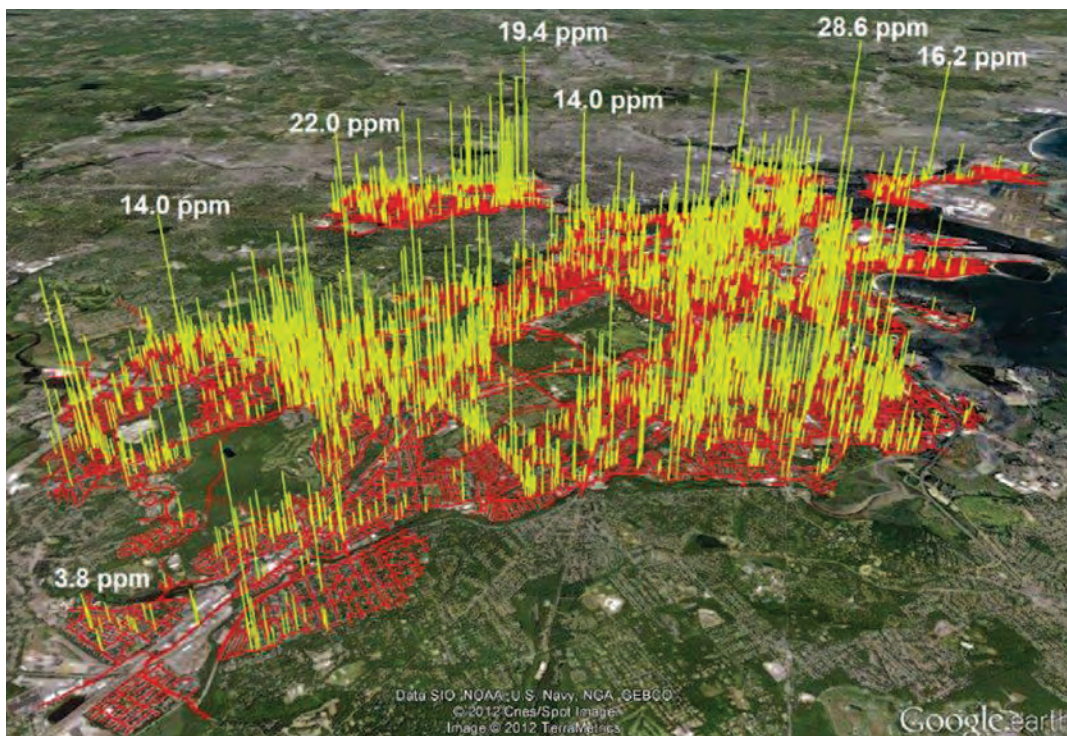
In July 2014, the Office of the Inspector General (OIG) of the U.S. Environmental Protection Agency (EPA) recommended that the EPA work with PHMSA “to address methane leaks from a combined environmental and safety standpoint.”²⁰

Hacking pipelines

Since the Al-Qaeda attacks of September 11, 2001, the U.S. Congressional Research Service (CRS) has been concerned about the possibility of terrorism against energy pipelines on U.S. soil. But terrorists wouldn’t need IEDs or a hijacked aircraft to trigger an explosion or spill. Over the years, like all computer technology, SCADA systems have evolved toward



ABOVE: An accident waiting to happen: Methane at 10% (100,000 ppm) gas concentration —well above the lower explosive limit of 5% —was measured in a telecommunications manhole in Washington, D.C. Driving every street in the District, researchers found 5,893 natural gas leaks from the city’s aging pipe system. Photo: Robert B. Jackson, Duke University. BELOW: Concentrations of methane from leaks measured in Boston. Graphic: Robert B. Jackson, Duke University



adding greater intelligence, automation, and networking as well as using open systems architectures and off-the-shelf technologies, including Microsoft Windows operating systems. Ironically, that modernization and standardization has led to greater vulnerability.¹² Although SCADA systems have been infiltrated through computer networks since the late 1990s, that fact riveted public attention in 2008 and 2009 with revelations that two versions of malware called Stuxnet accessed Siemens controllers in the Natanz

Fuel Enrichment Plant in Iran. The intent was to destroy cascades of centrifuges by manipulating the control system and the calibration of sensor readings so as to increase the gas pressure (2008) or the rotor speed (2009) until reaching mechanical failure. In a fascinating 38-page report *To Kill a Centrifuge* published in 2013, cyber security expert Ralph Langner asserted that “between 2008 and 2009 the creators of Stuxnet realized that they were onto something much bigger than to delay the Iranian nuclear program: History’s first field experiment in cyber-physical weapon technology.”³⁴

In April 2011, U.S. Department of Homeland Security (DHS) Transportation Security Administration—yes, the same TSA that is in charge of airline security—issued Pipeline Security Guidelines. In March 2012, however, the Industrial Control Systems Cyber Emergency Response Team (ICS-CERT) within the DHS reported “an active series of cyber intrusions targeting natural gas pipeline sector companies” that it “positively identified” as “related to a single campaign with spear-phishing activity dating back to as early as December 2011.”²⁵ Spear-phishing is a type of cyber-attack attempting to gain access to confidential data. Five months later, the U.S. Congressional Research Service (CRS) reported that in a natural gas or oil pipeline “...cyber infiltration of supervisory control and data acquisition (SCADA) systems could allow ‘hackers’ to disrupt pipeline service and cause spills, explosions, or fires—all from remote locations via the Internet or other communication pathways.”¹³

Gathering storm

In rural areas, gathering pipelines are neither systematically counted nor federally regulated. U.S. General Accountability Office (GAO) estimates that gathering pipelines total “at least” 230,000 miles.^{22,48} The only gathering lines PHMSA regulates are those bigger than 8-5/8 inches in non-rural areas, if operating above a certain pressure, or within a quarter-mile of an “unusually sensitive area” (e.g., drinking water source or a wetland). Altogether those account for only about 10%.

Of the 542,500 new miles of pipelines projected to be built by 2035, the vast majority (87.5%) would be new gathering lines for gas (303,100 miles) and oil (171,600 miles).²⁹ That additional 474,700 miles would more than triple the existing 230,000 miles to 704,700 miles, far exceeding the mileage of transmission pipelines. The GAO is concerned²⁴ because with the shale boom, wells are being built mere hundreds of feet from homes in many rural areas, although 90% of gathering lines are not subject to PHMSA safety construction standards or safety regulations. Moreover, some newer gathering lines—or “transportation-related flow lines” in newer lingo³²—have diameters as large as 30 to 36 inches and operate at higher pressures, more closely resembling transmission lines, so a spill could affect a larger area.²²

To the degree that statistics are available, the safety record of gathering lines appears poorer than for transmission lines. A 2013 report *Alaska North Slope Spills Analysis*, which analyzed 681 North Slope spills between July 1, 1995, and December 31, 2011, showed that flowline

spills both outnumbered and “outvolumed” transmission pipeline spills. Over the 800 miles of flowlines on the North Slope, which ranged from 6 to 36 inches in diameter, “there were an average of 4.8 spills per year. Flowlines remain the largest contributor (22%) with 268,358 gallons to the total volume spilled.”⁴² When normalized to number of spills per year per 1,000 miles, flowlines suffered about double the incident rate of transmission lines.

Contradicting the 99.9998% reliability assertion in the AOPL/API *Annual Liquid Pipeline Safety Performance Report* are other figures on the very same page. In 2012, there were 93 “releases from onshore transmission pipelines” out of 185,599 “liquid pipeline miles operated.”⁴⁴ That gives one “release” (leak) every 1,996 miles, or about 0.50 leaks per 1,000 miles of transmission pipeline in 2012—consonant with the average found in the North Slope report. It also squares with a figure of 0.34 incident per 1,000 miles per year of natural gas transmission pipelines derived from a 2012 INGAA study that examined reportable incidents from 1992 through 2011.⁵²

“Major leak 57% probable”

Today the nation is crisscrossed with 505,000 miles of transmission pipeline, and counting. The industry average of 0.34 to 0.5 incident per 1,000 miles per year translates to 170 to 250 incidents per year somewhere in the nation—a number actually about half of what is observed. Statistically, the record shows that several per year are catastrophic. PHMSA data from 2001 to 2011 compelled KAI to conclude: “The ‘average’ pipeline therefore has a 57% probability of experiencing a major leak, with consequences over the \$1 million range, in a ten-year period.”³²

If past industry averages and practices hold, as pipeline mileage increases, so will accidents—including ones involving fatalities or dilbit in major waterways. (I haven’t even mentioned ExxonMobil’s 200,000-gallon dilbit spill in Mayflower, AR, in March 2013.) For at least three years running, because of aging pipelines and SCADA vulnerabilities, enhancing pipeline safety has made the NTSB’s top ten “Most Wanted” list of critical transportation changes needed to reduce transportation accidents and save lives.³⁹ The American Society of Civil Engineers (ASCE) in its *2013 Report Card for America’s Infrastructure* for energy—including oil and natural gas pipelines—kept its previous grade of D+, in part because of aging pipelines and SCADA vulnerabilities.⁵³

Promoting policies

Pipeline safety has united the AFL-CIO (concerned about worker safety) and environmental organizations (concerned about the release of methane—a powerful greenhouse gas—into the atmosphere) to create the BlueGreen Alliance, promoting policies and innovative financing approaches to fix leaky gas pipelines.⁹

The 2011 Pipeline Safety, Regulatory Certainty, and Job Creation Act promulgated new federal safety requirements, but the Act will expire on September 30, 2015, unless renewed.⁵⁰ The energy industry seems unfazed at the prospect of investing \$641 billion—nearly two-thirds of a trillion dollars—between now and 2035 on new pipelines.²⁹

Quite apart from the whole separate question of whether the nation should charge full speed ahead toward locking in a half-century commitment to a high-carbon fossil-fuels future, it's imperative that national attention and significant resources be focused on upgrading the safety and security of existing pipelines underfoot.



Because of the shale boom, gathering lines (under construction at the far left of the drilling rig) that will transport natural gas from the well (being drilled) pass close to individual farm homes, such as this one in eastern Ohio, photographed in April 2013. Yet 90% of rural gathering lines are not subject to federal regulations for construction and safety. Photo: Trudy E. Bell

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