The Costs of Compliance to EPA's Advance Notice of Proposed Rulemaking on the PCB Use Authorization for Interstate Natural Gas Pipelines

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Prepared by

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Foreword

On April 7, 2010, the Environmental Protection Agency ("EPA") issued an Advance Notice of Proposed Rulemaking ("ANPR") entitled *Polychlorinated Biphenyls ("PCBs"); Reassessment of Use Authorizations*. In this ANPR, EPA is contemplating a proposal to reassess the existing PCB use authorizations under the Toxic Substances Control Act ("TSCA"), including the use authorization for PCBs in natural gas pipelines, air compressor systems and porous surfaces. As part of this reassessment, EPA is contemplating to revise and/or eliminate these use authorizations in a way that could significantly and dramatically impact natural gas pipeline operations. Natural gas pipelines have been subject to programs addressing PCBs for the past 30 years, starting with EPA's Compliance Monitoring Program ("CMP") in the early 1980s to the EPA's present comprehensive regulatory program, better known as the PCB Mega Rule.

The Interstate Natural Gas Association of America ("INGAA") is a trade association representing virtually all interstate natural gas transmission companies operating in the United States. INGAA therefore has a direct interest in EPA's ANPR and accordingly has prepared comments in response. In support of these comments, INGAA has commissioned several independent experts to prepare "White Papers" providing key analysis of the complex issues raised by EPA's ANPR with respect to the presence of PCBs in the interstate natural gas pipeline system. These papers address pipelines and pipeline operations, the presence of residual PCBs in the pipeline system, the risks to health and the environment associated with PCB-impacted pipelines, the technical feasibility of removing increasingly diminished concentrations of PCBs, and the anticipated economic impacts resulting from the contemplated proposals.

Analysis Group Inc. was commissioned to examine the economic impacts of the ANPR, with particular focus on the specific microeconomic effects to individual natural gas pipelines. The data and calculations employed in support of the economic analysis are for modeling purposes only and are not necessarily reflective of the nature and extent of PCBs in the natural gas pipeline system today. While commissioned by INGAA in support of its comments, this paper is an independent analysis, and its conclusions are based on the expertise of the authors.

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Executive Summary[1]

Like many other parts of the nation's infrastructure and economic base, natural gas infrastructure systems are currently regulated by the Environmental Protection Agency ("EPA") with respect to the historic use of lubricants containing polychlorinated biphenyls ("PCBs") in their equipment. EPA is now contemplating to propose in its "Advance Notice of Proposed Rulemaking" ("ANPR")[2] modifications of these regulations in ways that would have significant economic impacts for pipeline systems that provide natural gas to the nation and for the customers they serve.

[1] This report has been authored by Susan F. Tierney, Ph.D. and Robert Earle, Ph.D., of Analysis Group Inc., at the request of the Interstate Natural Gas Association of America ("INGAA").

Dr. Tierney, a Managing Principal at Analysis Group, is an expert on economics, regulation and policy in the electric and gas industries. She has consulted to business, industry, government, and other organizations on energy markets, economic and environmental regulation and strategy, and energy facility projects. She previously served as the Assistant Secretary for Policy at the U.S. Department of Energy, and held senior government positions in Massachusetts (Secretary for Environmental Affairs; Commissioner at the Massachusetts Department of Public Utilities; Chairman of the Board of the Massachusetts Water Resources Authority; executive director of the Massachusetts Energy Facilities Siting Council). She recently served as chair of the Massachusetts Oceans Advisory Commission, and she co-chaired the Department of Energy Agency Review Team for the Obama/Biden Presidential Transition Team. Dr. Tierney has authored numerous articles and reports. She serves on a number of boards of directors and advisory committees, including as co-chair of the National Commission on Energy Policy; a director of Evergreen Solar, Inc.; a director of EnerNOC, Inc.; a director of several environmental organizations (World Resources Institute, Clean Air Task Force; Clean Air – Cool Planet; and the Northeast States Clean Air Foundation). She chairs the External Advisory Council of the National Renewable Energy Laboratory (NREL), and she has taught at the Massachusetts Institute of Technology and at the University of California at Irvine. She earned her Ph.D. and M.A. degrees in regional planning at Cornell University.

Dr. Earle, a Vice President at Analysis Group, has extensive experience in the electric and gas industries. His areas of expertise include the economics of environmental mitigation, the water industry, electric power and gas market design, utility regulatory policy and ratemaking, demand response, and system optimization. Having worked as a consultant as well as an industry manager, he currently supports clients in analyzing market opportunities, strategy, regulatory issues, and litigation. Dr. Earle has worked extensively on tariff and market design, including as an expert witness before a number of regulatory commissions. He was the architect of an economic model used to evaluate alternative methods for environmental mitigation including BPM/BACT technology, incentives, and markets. Results from this work were used in numerous studies for investment decisions, policy studies, and litigation. Prior to joining Analysis Group, Dr. Earle was manager of economic analysis at the California Power Exchange where his responsibilities included developing an overall analytic infrastructure for market analysis, analysis of new products, and briefing regulatory and legislative bodies. Dr. Earle holds Ph.D. and M.S. degrees in Operations Research, both from Stanford University.

[2] Federal Register 75, no. 66 (April 2010): 17645.

Natural gas has emerged over the past few decades as a critical fuel for the nation's energy economy. Since the mid-1980s, use of natural gas has risen 40 percent.[3] Since 2000, virtually all of the power plant capacity added in the United States has been at generators that burn natural gas (or gas and oil).[4] The use of natural gas in power production facilities has helped to lower the overall emissions of conventional air pollutants from the generation of electricity. Further, a large number of American consumers have converted their heating systems to use natural gas as they have sought an affordable, clean fuel with low emissions and waste byproducts.

Some portions of today's gas pipeline infrastructure were exposed to PCBs in the past, when companies used lubricants and greases containing PCBs in the valves, compressors, and other parts of the system. Although no new PCBs were introduced into the interstate system after the 1970s and pipeline companies have expended significant effort over the years to remove material from the system consistent with federal regulations,[5] there are some quantities of PCBs that remain in many pipelines. Those sections of the pipelines where it is known that PCBs are present above 50 parts per million ("ppm") currently operate under a "use authorization" allowed by EPA's regulations on PCBs. For PCB concentrations greater than 50 ppm, this use authorization approach requires pipeline owners to implement engineering practices and operating procedures to contain and reduce the contamination, and to prevent PCB migration into other systems, but still allows pipelines to perform their gas-delivery functions.

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[3] In 1986, total consumption of natural gas in the U.S. was 16,221,296 MMcf; in 2009, it was 22,810,168. Energy Information Agency ("EIA") data. Accessed at: http://tonto.eia.doe.gov/dnav/ng/ng_cons_sum_dcu_nus_a.htm.
[4] Of the capacity added by generating units that came online between 2000 and 2008, almost 88 percent was from generating units whose main energy source was natural gas. EIA, "Existing Electric Generating Units in the United States," 2008, accessed at: http://www.eia.doe.gov/cneaf/electricity/page/capacity/capacity.html.
[5] S.S. Papadopulos & Associates, Inc., "PCBs in the Interstate Natural Gas Transmission System – Status and Trends", prepared for INGAA, August 2010.

EPA's ANPR seeks to determine whether the agency should further reduce PCBs in the nation's natural gas pipeline systems in order to reduce risks to the public associated with potential exposure to PCBs. This is an important contemplated public policy proposal from EPA, one that in the end will hopefully find the right balance between PCB regulation, public health goals, energy security, economic impact, and cost efficiency.

As it decides next steps, EPA should consider the possibility that the proposals contemplated in the ANPR would dramatically affect the operations, investment, and operating costs of the nation's interstate natural gas system and, in turn, affect the availability, price, and use of natural gas. While the full costs to comply cannot be known fully today for a variety of technical reasons (including the lack of time to analyze full impacts), we have attempted to calculate some cost scenarios to illustrate the kinds of economic effects that might occur.

If the ANPR's contemplated proposal to eliminate the use authorization for PCB concentrations in pipelines above 1ppm were introduced in 2020, then an estimated 23,000 to 71,000 miles of pipeline around the country (or around 10 to 30 percent of the high pressure system) would no longer be able to operate. In theory, it would cost between $17 billion and $466 billion to replace that system's functional capacity. Even assuming that there was a feasible way to acquire land, permit new pipelines to replace the old, engineer and install them, remove the existing contaminated systems, and then switch over operations from the old system to the new without contaminating the latter, the economic costs would be staggering and the service interruptions unprecedented. By way of comparison, $496 billion was spent in 2008 on physician and clinical services in the U.S.[6] Another comparison is that in the decade starting in

[6] U.S. Department of Health and Human Services, Centers for Medicare and Medicaid Services, "National Health Expenditures 2008 Highlights," accessed at: http://www.cms.gov/NationalHealthExpendData/downloads/highlights.pdf.

2000, $32 billion was approved by Federal Energy Regulatory Commission ("FERC") to be spent on approximately 13,000 miles of expansion on major pipeline projects in the U.S.[7] According to the Interstate Natural Gas Association of America ("INGAA"), contaminated segments and connected equipment would have to be replaced simultaneously to prevent recontamination of adjacent pipeline segments, compression, or other replaced parts. Simultaneous replacement of all equipment is simply not feasible in light of constraints in the vendor and contractor markets, the supply of materials and equipment, the supply of qualified pipeline construction contractors, and most importantly, the inability to build a system in parallel before 2020 and then disrupt supply for the period it would take to switch operations from one system to the other.

From the perspective of assuring a reliable supply of natural gas to the nation, the task seems literally impossible. The interstate gas pipeline system is one that operates pursuant to various federal, state, and local requirements that together assure that it is designed and implemented to assure its safe and reliable operation and located in acceptable sites. As an essential public service, which imposes on the local distribution companies certain obligations to assure firm deliveries of gas to its customers without interruption, natural gas transporters must plan and operate their systems to meet peak demand conditions and supply contingencies. Short-term, let alone long-term, outages of pipelines to cut-over wholesale portions of their system for replacement by new pipe would leave industries, households, office buildings, schools, hospitals, and power plants with supply disruption (at best) and without the fuel they need for longer periods of time.

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[7] INGAA Foundation, "Building Pipelines," March 2009.

These costs are high enough that EPA should take them into consideration as it weighs the question of whether changes in the energy industry, control technology, exposures of humans to PCBs, and other factors warrant the types of changes anticipated in EPA's ANPR. Indeed, in previous proceedings, EPA has recognized that lowering the standard would cause serious economic harm to the natural gas industry.[8]

[8] Federal Register 49, no. 133 (July 1984): 28186.

Introduction and Overview

EPA has recently issued its ANPR[9] on revising the use authorization for PCBs. In this ANPR, EPA has stated that it is considering ending the current "use authorization" for PCBs under which interstate natural gas pipelines (among other entities) today are prohibited from introducing PCBs into their systems but may operate their facilities as long as they take steps to continue to contain and reduce concentrations of PCBs to below 50 ppm.[10] The ANPR is contemplating, among other things, terminating the use authorization in 2020, and only permitting operations of interstate natural gas pipeline systems that have PCB concentrations below 1 ppm after that date.[11] In addition, EPA is contemplating new, interim requirements before 2020.

While the contemplated proposal would affect many industries including many segments of the natural gas industry, this report focuses on the interstate natural gas transmission industry. In particular, this report attempts to provide for EPA's consideration some potential cost impacts of compliance by the interstate natural gas pipelines with the contemplated proposal.

If EPA were to adopt a new set of regulations that resembles those described in the ANPR – and specifically the elimination of the use authorization for pipelines for PCB concentrations greater than 1 ppm – the direct cost impact on the interstate natural gas transportation system (and by extension, its customers) could be severe. This is a reflection of the real effects of a new set of rules that could end up requiring replacement of a potentially large

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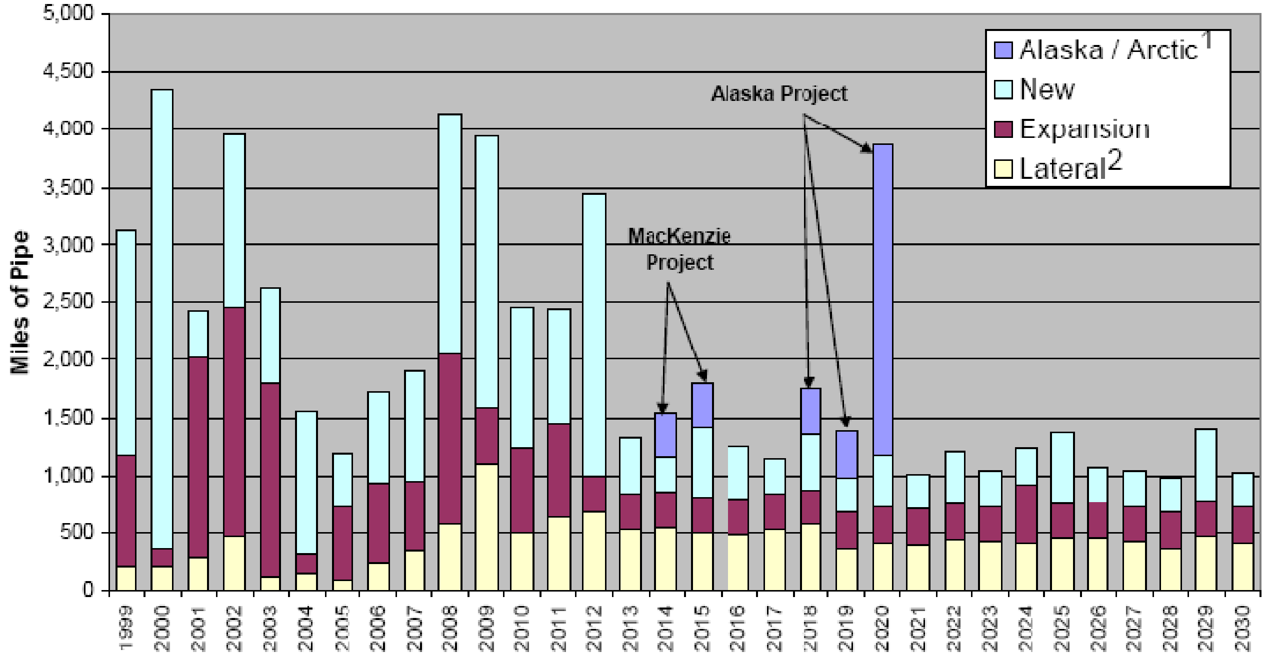
[9] Federal Register 75, no. 66 (April 2010): 17645.
[10] In issuing this ANPR, EPA is exercising its authority under the Toxic Substances Control Act ("TSCA") to regulate the use and distribution in commerce of PCBs. EPA has stated that it believes that in the 30 years since it first published regulations addressing the use of equipment containing PCBs, "many changes have taken place in the industry sectors that use such equipment, and EPA believes that the balance of risks and benefits from the continued use of remaining equipment containing PCBs may have changed enough to consider amending the regulations." Federal Register 75, no. 66 (April 2010): 17647.
[11] Federal Register 75, no. 66 (April 2010): 17657.

portion of the gas-delivery infrastructure. If, as indicated by INGAA, replacement would have to be implemented simultaneously on all interconnected components of the system in order to prevent recontamination, then the staggering impacts for the economy would be magnified by lengthy operational downtime needed to accommodate this fact. Further, it would profoundly challenge, at a minimum – if not entirely overwhelm – the ability of the nation's engineering, contracting, and construction industry to attempt to rebuild large segments of a 217,000-mile interstate gas transmission system at the same time.[12] For context, the natural gas pipeline system has undergone relatively rapid expansion during parts of the past decade (as shown below in Figure 1), with less than 25,000 miles of both interstate and intrastate pipeline added over a ten-year period (from 2000 through 2009) with peak year construction of about 4,000 miles.[13] In the decade starting in 2000, $32 billion was approved by FERC to be spent on approximately 13,000 miles of expansion on major pipeline projects in the U.S.[14] Even at the past decade's high growth rate, this would be far less than might be required if significant portions of the 217,000-mile existing interstate system had to be replaced, as could reasonably be required if the use authorization were eliminated or significantly reduced.

[12] EIA, "Estimated Natural Gas Pipeline Mileage in the Lower 48 States, Close of 2008," accessed at: http://www.eia.doe.gov/pub/oil_gas/natural_gas/analysis_publications/ngpipeline/mileage.html.
[13] EIA data.
[14] INGAA Foundation, "Building Pipelines," March 2009.

Figure 1
Projected U.S. and Canadian Pipeline Additions
(Historical 1999-2008, and Estimated (2009-2030)



[1] Includes pipeline mileage of downstream expansions on existing corridors in the U.S. and Canada in addition to the pipeline associated with the arctic Canada and Alaska frontier projects.

[2] Lateral is defined as a spur off the main transmission line, normally used to connect production, storage, power plants, LNG terminals or isolated demand centers.

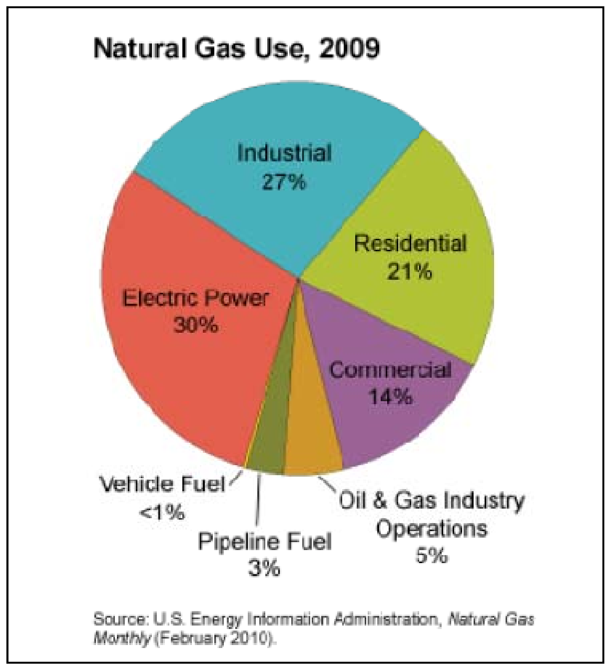
Source: ICF International, "Natural Gas Pipeline and Storage Infrastructure Projections Through 2030," prepared for the INGAA Foundation, October 20, 2009, Figure 31.

The Role of Natural Gas in the U.S. Economy, and the Role of Interstate Pipelines as Part of the Natural Gas Infrastructure System

Natural Gas Use in the U.S. Economy

Today's interstate natural gas pipeline system plays an important role in the nation's energy economy; it moves natural gas from producing areas and liquefied natural gas ("LNG") importation terminals, to customers including local gas distribution companies in distant parts of the country who in turn deliver gas supply to end-use consumers.

Figure 2



Natural gas is the third largest source of U.S. energy consumption. Natural gas accounts for roughly 23 percent of the energy consumed in the U.S., after oil (39 percent) and coal (27 percent).[15] As shown in Figure 2, in 2009, of the 22.8 trillion cubic feet ("tcf") consumed in the U.S., 62 percent went to residential, commercial, and industrial consumers and 30 percent went to electric power plants that consume natural gas.[16]

Because it is versatile and burns cleanly, natural gas is common in a variety of applications, including commercial and residential heating, cooking, lighting, and industrial

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[15] American Gas Association, "What is Natural Gas?," accessed at: http://www.aga.org/Kc/aboutnaturalgas/consumerinfo/whatisng.htm.

[16] EIA data. Accessed at: http://tonto.eia.doe.gov/dnav/ng/ng_cons_sum_dcu_nus_a.htm.

process feed stock. In the residential sector, over 50 percent of occupied housing units[17] and almost 60 percent of single family homes completed in 2008 used natural gas heating.[18] In the commercial sector, natural gas is used mainly for space heating and cooling, water heating, cooking, and dehumidification. The industrial sector, one of the largest consumers of natural gas, uses it for much more than heating, cooling and cooking. Industrial natural gas applications include waste treatment and incineration, metals preheating, drying and dehumidification, glass melting, food processing, and fueling industrial boilers. Moreover, gases (such as butane, ethane, and propane) extracted from the gas production stream can be used as feedstock for products such as fertilizers and pharmaceutical products.[19] Natural gas used to produce electricity accounts for roughly 30 percent of the natural gas consumed in the U.S. Since 2000, virtually all of the power plant capacity added in the U.S. that was not renewable generators was at plants that burn natural gas.[20]

The Natural Gas Industry – Infrastructure and Players

Like many parts of the energy industry, the natural gas industry is now made up of a number of segments. The industry includes large and small gas companies involved with one or more of the following activities: natural gas production, gathering systems, the interstate transmission pipeline system, gas storage, LNG terminals, and local distribution systems. These industry segments are shown below in Figure 3.

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[17] U.S. Bureau of the Census, "Annual Housing Survey: 2007," accessed at: http://www.aga.org/NR/rdonlyres/3398C72B-2E9A-4DA7-A6C2-DEA8FF05A33D/0/Table105.pdf.

[18] U.S. Bureau of the Census, "Characteristics of New Housing 2008," accessed at: http://www.aga.org/NR/rdonlyres/3001F287-3668-4D44-8209-3830F3D60DA3/0/Table103.pdf.

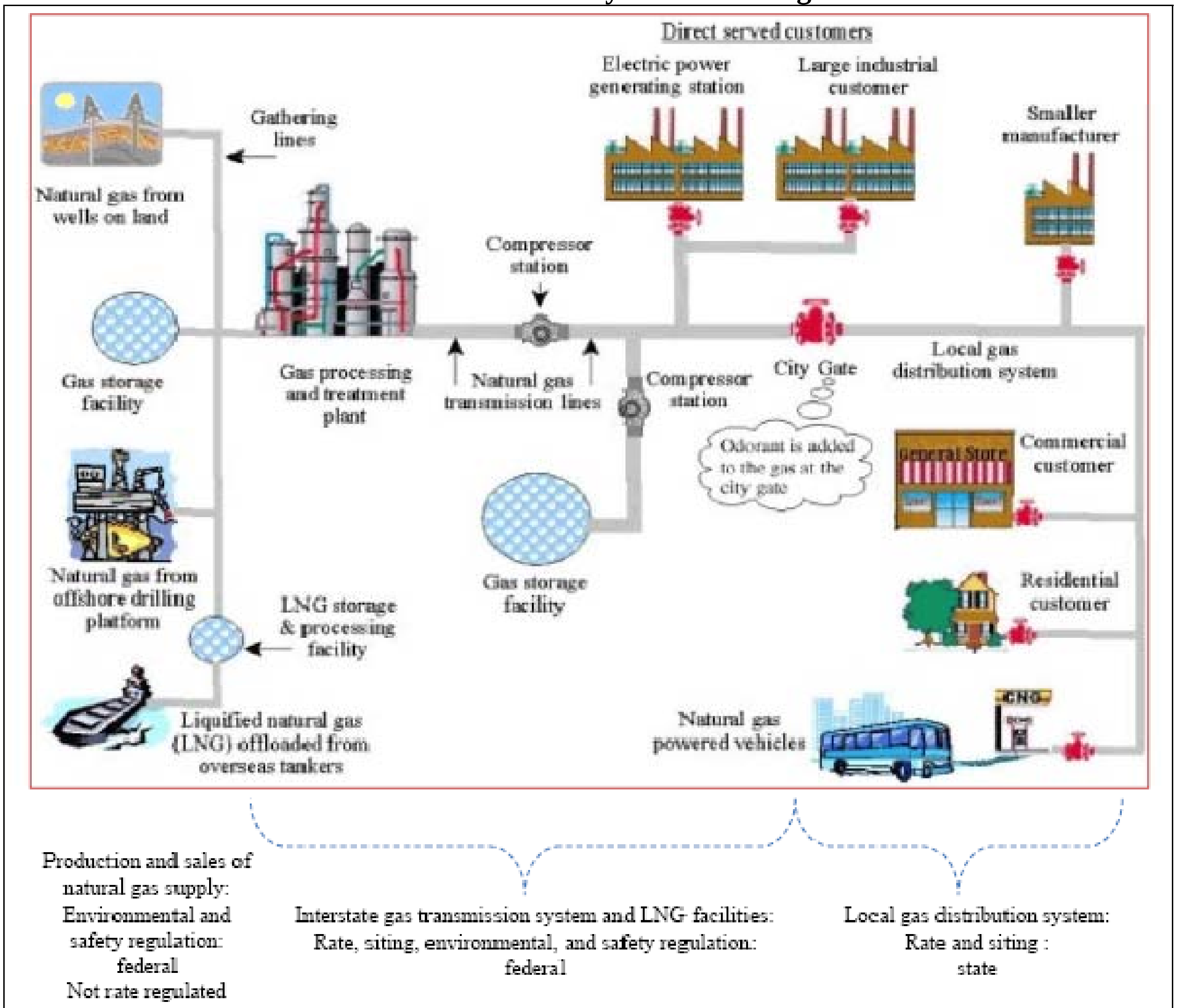
[19] NaturalGas.org, "Uses in Industry," accessed at: http://www.naturalgas.org/overview/uses_industry.asp.

[20] Ceres, et al., "Benchmarking Air Emissions of the 100 Largest Electric Power Producers in the United States," June 2010.

All told, the "natural gas system" is made up of thousands of parts, owned by hundreds of entities. In the U.S., gas is produced from approximately 475,000 natural gas wells (some of which also produce oil).[21] Gas is imported from foreign production basins through a dozen LNG terminals located in coastal areas or in off-shore locations of the Gulf of Mexico and Eastern coastal U.S. There are over 1,200 compressor stations on the interstate system, 400 active underground and above-ground gas storage facilities,[22] over 217,000 miles of interstate pipelines, another 90,000 miles of intrastate high-pressure gas pipelines,[23] and 1,200,000 miles of local distribution pipes and mains.[24] (See Figure 4, below, for the major interstate and intrastate pipelines.)

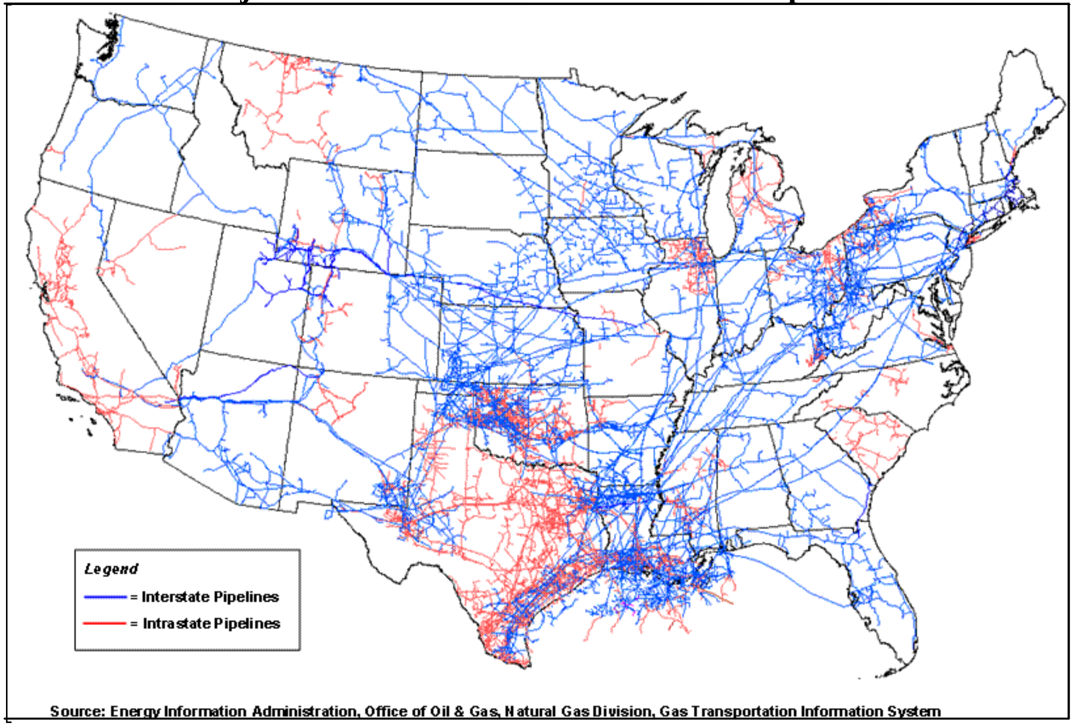
[21] EIA, "Number of Producing Gas Wells," accessed at: http://www.eia.gov/dnav/ng/ng_prod_wells_s1_a.htm.
[22] EIA, "Natural Gas Compressor Stations on the Interstate Pipeline Network: Developments Since 1996 EIA," accessed at http://www.eia.doe.gov/pub/oil_gas/natural_gas/analysis_publications/ngcompressor/ngcompressor.pdf. EIA, "About U.S. Natural Gas Pipelines – Transporting Natural Gas." accessed at: http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/ngpipeline/index.html.
[23] EIA, "Estimated Natural Gas Pipeline Mileage in the Lower 48 States, Close of 2008," accessed at: http://www.eia.doe.gov/pub/oil_gas/natural_gas/analysis_publications/ngpipeline/mileage.html.
[24] AGA, "About Natural Gas," accessed at: http://www.aga.org/Kc/aboutnaturalgas/.

Figure 3
The Natural Gas Industry's Business Segments



Source of figure: http://primis.phmsa.dot.gov/comm/NaturalGasPipelineSystems.htm?nocache=8905

Figure 4
Major U.S. Interstate and Intrastate Gas Pipelines



http://www.marcellusshales.com/sitebuildercontent/sitebuilderpictures/natural-gas-pipeline-map.gif

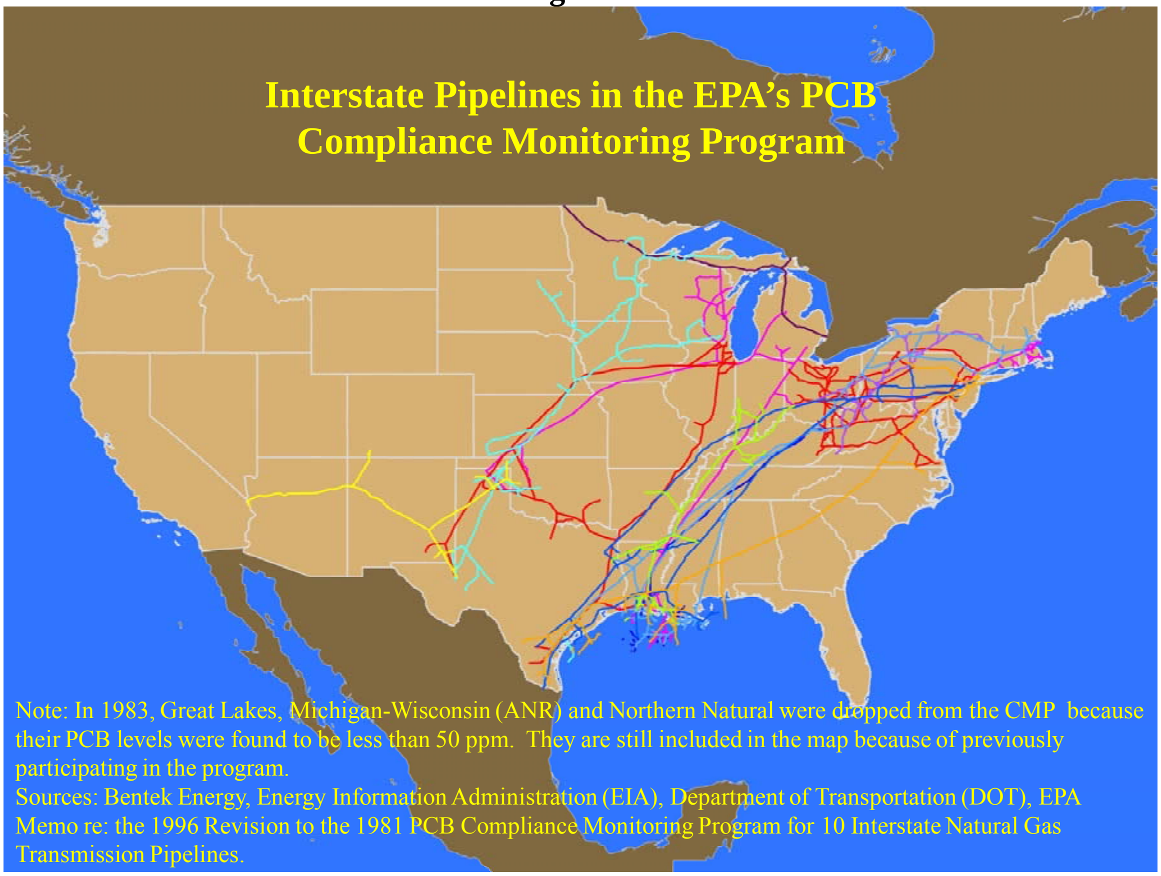
Today's Context – Overview of Economic/Cost Activities in the Interstate Pipeline System Under the "Use Authorization" Framework

The total extent of PCB contamination in the interstate natural gas infrastructure is unknown. So, our estimate of costs to clean up to a level of 1 ppm begins with a description of certain reasonably "known" boundary conditions describing the pipelines that may be affected.

Prior to the 1970s, many interstate and local gas distribution company pipelines and other entities had used lubricant oils containing PCBs in compressors that generate and maintain pressures on the natural gas delivery system, and greases containing PCBs were used to seal certain plug valves. Even though new PCBs were not introduced into the system after the 1970's, the legacy of prior PCB use has required significant effort by regulators and the industry to contain and reduce their presence in the interstate natural gas pipeline system, and to properly dispose of the PCBs removed from facilities.

After TSCA became effective in the late 1970s, EPA took many steps to control the manufacture, processing, distribution in commerce, and use of PCBs. After testing interstate pipelines for the presence of PCBs, EPA determined in 1981 that 13 of the 24 major interstate pipeline systems had instances of samples with PCBs greater than 50 ppm. As a way to allow continued operations of the pipeline systems while also addressing PCB levels, EPA established the "Compliance Monitoring Program" ("CMP"). The CMP required the affected pipeline systems to develop plans to ensure proper storage and disposal of PCBs, to contain them within limited areas of their transmission systems, to allow no new PCBs into the system, to reduce remaining PCB contamination, and to maintain records of actions. Figure 5 depicts the pipelines that were part of the CMP program.

Figure 5



EPA's CMP formed the start of the framework in which affected pipelines have operated over the past three decades, with respect to remediating, monitoring, disposing of, and otherwise addressing PCBs within their systems. In the second half of the 1990s, EPA issued a "PCB MegaRule," starting with a proposed "MegaRule" at the end of 1994 and culminating with a final rule in June 1998, which replaced the individualized CMPs with the current system of "use authorizations" for natural gas pipelines. Specifically, EPA authorized the use of PCBs in natural gas pipelines and included specific requirements for pipelines with PCB concentrations above 50 ppm.[25]

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[25] Codified at 40 C.F.R. § 761.30(i) (1)(iii), these requirements include:
(1) *Notice*: submitting to EPA upon request a written description of the nature and location of PCBs $\geq$ 50 ppm;
(2) *Characterization*: within 120 days after discovery of the requisite PCB level characterizes extent of contamination by sampling upstream and downstream of the segment;

Current EPA rules have established a 50 ppm threshold as the level of PCB concentration in natural gas pipeline liquids that triggers the conditions of the use authorization.[26] Some parts of the interstate gas pipeline system that have integral components and segments with equipment in service since prior to 1970 have some level of PCB contamination and have been operating under the use authorization model with the 50 ppm standard as the trigger for use authorization conditions. In two pipelines in the Eastern part of the U.S., for example, fluids in roughly 30 percent of the pipeline (or 3,086 miles of pipeline) have been tested at PCB concentrations above 50 ppm over the past 4 years.[27]

To illustrate the potential breadth of possible contamination, consider two categories of pipelines. The first is pipelines that were part of the CMP program (shown in Figure 5, above), which, as mentioned, were known to have facilities with PCB management requirements. The second, shown in Figure 6, involves major on-shore pipelines with pre-1980 components and represents the facilities in place during a period when PCBs were used by the industry. Without representing that either of these maps identifies facilities that are now contaminated above 1 ppm, these two categories of pipelines illustrate the potentially broad reach of EPA's interest in eliminating the current use authorization model for facilities with PCBs above 1 ppm as of 2020.

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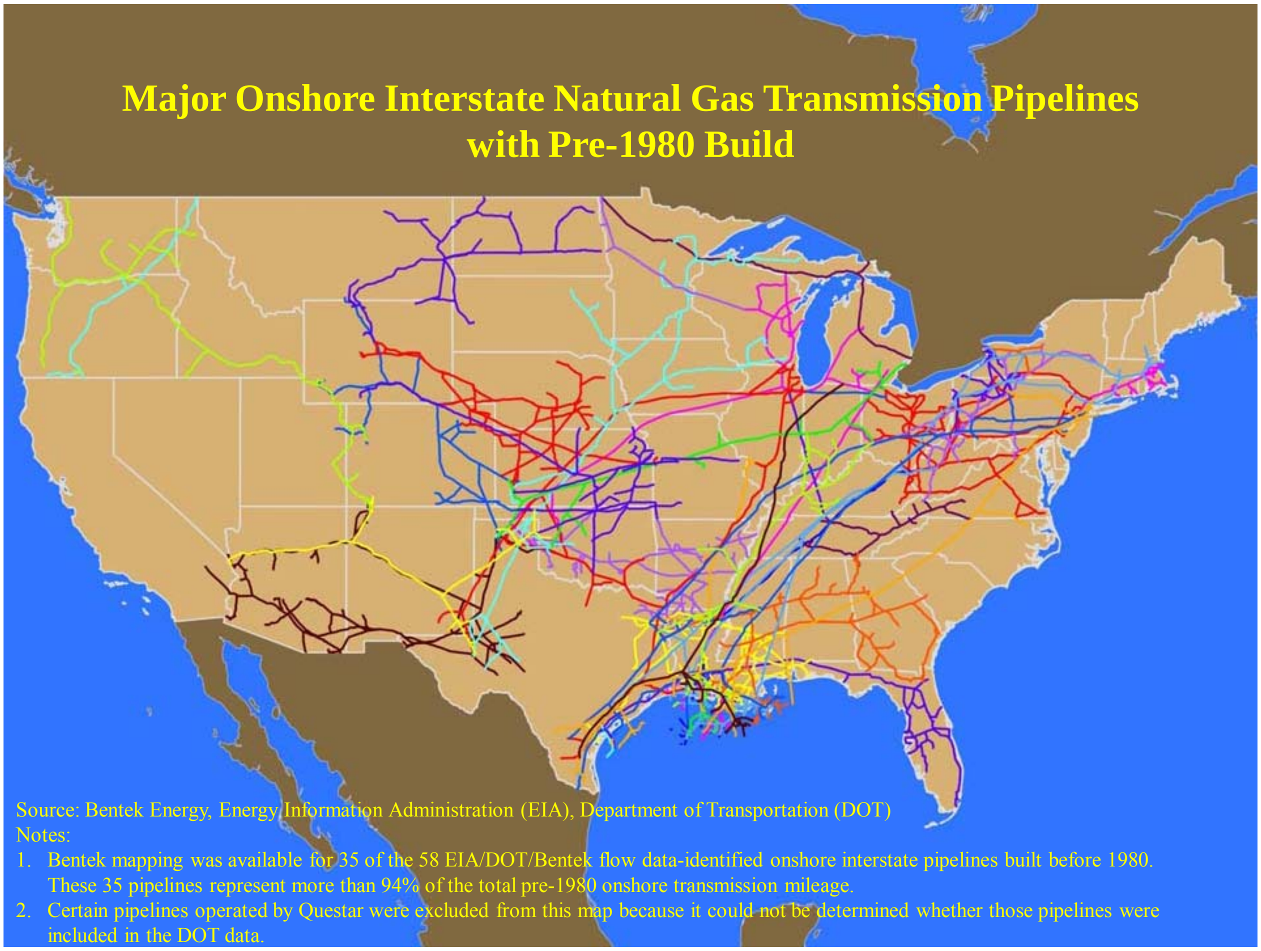
(3) *Sampling for sources*: within 120 days of characterization, sample and analyze all potential sources of PCB;
(4) *Reduce*: within 1 year of characterization reduce all demonstrated sources of PCBs above 50 ppm to below 50 ppm OR removes the sources from the system OR implement other engineering measures or methods to reduce PCB levels to 50 ppm and to prevent further introduction of PCBs ≥ 50 ppm;
(5) *Annual sampling*: repeat sampling and analysis at least annually where PCBs ≥ 50 ppm until sampling results indicate below 50 ppm PCB in two successive samples;
(6) *Marking*: mark aboveground sources of PCB liquids with ML where historical or recent sampling indicate ≥ 50 ppm. With these requirements EPA terminated the CMP, releasing those companies from any obligations under that program. *Additionally, EP*A authorized certain low exposure use and re-use for PCB-Contaminated (50 - < 500 ppm) natural gas pipelines that have been drained of all free flowing liquids. EPA notes the basis for this is its own risk assessment for natural gas pipe. The preamble explains, "The final use and reuse authorization of PCBs in natural gas pipeline systems envisions a declining PCB concentration over time to below 50 ppm." EPA also amended the disposal requirements under which natural gas pipeline systems can be abandoned in place or disposed of without posing an unreasonable risk.
[26] Codified at 40 C.F.R. § 761.30(i) (1)
[27] Based on communications with an interstate gas transmission company.

Figure 6



INGAA reports the specific engineering steps taken to achieve the reduction of PCBs on the nation's interstate pipeline system under the current EPA policy; affected natural gas pipeline companies in operation today have attempted over several decades to clean sections of pipeline via multiple methods including, but not limited to, pigging of the pipeline, [28] replacement of valves, installation of filter separators, replacement of meters, and flushing of valves and piping in hopes of decreasing both the concentration of PCBs and the total volume of the material in the pipeline system.

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[28] Pipeline inspection gauges ("pigs") are used to carry out operations on a pipeline without stopping the flow of the natural gas. Pigging, in this context, means the cleaning of the pipeline by a pig.

Looking ahead, continued reduction of contamination is subject to decreasing returns. That is, the amount of effort needed on a going-forward basis to eliminate a given amount of PCBs from the interstate pipelines will increase as the amount of PCBs in the system decreases.[29] Current and previous efforts to clean pipes have significantly reduced the amount of PCBs in the system. A dramatic decrease in the use authorization will likely result in an exponentially dramatic increase in the costs of mitigation, with progressively lower benefit obtained per unit of cost.

Economic Analysis of Post-2020 Compliance

In terms of analyzing the cost to comply with what is outlined in EPA's ANPR, ending the use authorization for PCBs over 1 ppm for natural gas pipelines would likely mean one of two possible outcomes. First, pipelines, or sections thereof, that had (or were expected to have) concentrations of PCBs above 1 ppm at that point would have to be replaced. INGAA has asked us to assume for the purpose of this analysis that the only way to guarantee fully that the system would have PCB concentrations less than 1 ppm would be to replace pipelines with contamination over 1 ppm. As we understand the basis for this instruction, the amount of effort needed to eliminate a given amount of PCBs from the interstate pipelines increases exponentially as the amount of PCBs in the system decreases, because of the diffusion characteristics of PCB contamination in these systems, as well as the physical and operational complexity of these systems and the equipment employed on them.

[29] S.S. Papadopulos & Associates, Inc. report.

Second, pipelines that exceed 1 ppm could simply be shut down with no direct replacement, but some other incremental new pipeline capacity could be built to provide the functionality that the interstate natural gas delivery system would require at that point in the market's development.

It does not appear that any measure short of the preceding two outcomes would allow for mitigation down to 1 ppm. Both of these outcomes would cause significant economic impact for pipeline companies and for consumers of natural gas.

While these two scenarios describe possible paths to the interstate pipeline industry's response to EPA's 1 ppm limit with no use authorization allowed beyond 2020, one of these scenarios (i.e., the first one, which assumes replacement of some portion of the interstate gas pipeline system) is amenable to relatively straightforward analysis and is the basis for our cost estimate here. The other would depend upon a number of assumptions about complex variable and dynamic interactions among them, which has not been possible to analyze within the time frame allowed in this ANPR comment period.

Replacing Portions of the Interstate Natural Gas Pipelines

Replacing significant portions of the interstate natural gas pipelines would be a vast undertaking. To assess the range of what impacts could conceivably be, we posit two scenarios to frame our analysis: one based on the mileage of pipelines involved in the former CMP system for managing PCBs; and the other based on the mileage of pipelines in place prior to 1980, a period when PCBs were introduced into portions of the interstate pipeline system.

First, in the CMP scenario, only pipelines that were part of the CMP program are candidates to have sections replaced. As a percentage of miles in the system, the CMP pipes comprise 42 percent of the interstate gas pipeline system. Second, in the pre-1980 scenario, only pipelines with portions built before 1980 when the PCB ban went into effect are candidates to have sections replaced. On average, 79 percent of the miles of these pipelines were built before 1980. As a percentage of miles in the system, the pre-1980 pipes comprise 65 percent of the interstate gas pipeline system.

For the purpose of our analysis, we use these two estimates of mileages of potentially affected pipelines and assume them to have some level of contamination at a level above 1 ppm. Although we do not have information about the levels of current contamination (if any) of these former CMP pipelines and the pre-1980 pipelines, we are informed by data from an interstate natural gas pipeline company that at least two pipelines in the eastern U.S. have estimated contamination above 2 ppm of approximately 65 percent of those systems.[30] Based on this information and seeking to develop a conservative estimate of exposures, we use two assumptions about the breadth of pipeline mileage with contamination above 2 ppm – i.e., an assumption of 25 percent of the miles and another assumption of 50 percent of the miles – and then apply each of these assumptions to analyzing potential replacement costs for the CMP pipelines and the pre-1980 pipelines.

Using these 25 percent and 50 assumptions, this would mean that under the CMP scenario, between 23,000 and 46,000 miles of pipeline would need to be replaced, as would between 1.7 and 3.6 million horse power of compression. Under the pre-1980 scenario, these assumptions would mean that between 35,000 and 71,000 miles of pipeline and between 2.7 and

[30] Based on communications with an interstate gas transmission pipeline company.

5.5 million horse power of compression would need to be replaced. Tables 1 through 3 show the resulting costs.

These estimates yield high costs. As shown in the three tables, the estimates of pipeline system replacement costs vary, depending on the source of data (i.e., data from INGAA versus data from Penn Energy versus data from one pipeline company) and the assumptions (of mileage and percentage of miles with contamination above 2 ppm). But in all cases, these estimates produce high cost estimates. If 50 percent of the pipelines needed to be replaced, replacement costs would range from $33 to $145 billion (using data from INGAA in Table 1), from $51 to $206 billion (using Penn Energy data, shown in Table 2), and from $104 to $466 billion (using data from one pipeline company's experience and estimates, shown in Table 3).[31]

These costs are high under both the CMP and pre-1980 scenario, and do not include either the costs to characterize pipeline systems that would occur prior to 2020 or the costs to dispose of replaced pipeline equipment. Given the wide range of possible costs, which reflects the inherent uncertainty about a number of factors, data sources, and other inputs that affect these estimates, one cannot assume where (or if) the actual costs would fall within such ranges. Setting aside the challenge of knowing the breadth of contamination that exists across the miles of pipeline now operating, these estimates still have some built in "conservative" elements in that they neglect many additional costs such as the incremental costs of replacement fuel during supply interruptions, impacts on the general cost of natural gas, and other macro-economic effects.

[31] For the replacement cost of the pipes, inch-mile replacement costs were developed or taken from each data source and then the number of inch miles in the affected parts of the system under each scenario was multiplied by that cost to get the replacement cost. A similar procedure was followed for the replacement of compressors based on a system wide average of horsepower of compression per pipeline mile. Estimates based on data provided by a major pipeline company are reported in 2010 dollars. Estimates based on data provided by Penn Energy's cost are reported in 2008-2009 dollars for pipeline and 2007-2008 dollars for compression. Estimates based on data provided by INGAA are reported in dollars that may vary from 1993 dollars to 2007 dollars.

Table 1
Replacement Cost Estimates for CMP and Pre-1980 Pipelines
Using INGAA Unit Cost Estimates

	CMP Pipelines		Pre-1980 Pipelines	
Total Miles of Line-Pipe	92,242		142,009	
Total Horsepower (HP) of Compression	7,173,684		11,044,134	
	Low	High	Low	High
INGAA Unit Cost Estimates:				
Replacement Cost per Inch-mile	$30,000	$100,000	$30,000	$100,000
Compression Replacement Cost per HP	$1,400	$1,800	$1,400	$1,800
Cost of Replacing 25% ($Billions):				
Total Line-Pipe Replacement Cost	$14.3	$47.6	$20.2	$67.3
Total Compression Replacement Cost	$2.5	$3.2	$3.9	$5.0
Total Replacement Cost	$16.8	$50.8	$24.1	$72.3
Cost of Replacing 50% ($Billions):				
Total Line-Pipe Replacement Cost	$28.5	$95.1	$40.4	$134.7
Total Compression Replacement Cost	$5.0	$6.5	$7.7	$9.9
Total Replacement Cost	$33.6	$101.6	$48.1	$144.6

Table 2
Replacement Cost Estimates for CMP and Pre-1980 Pipelines
Using Penn Energy Unit Cost Estimates

	CMP Pipelines			Pre-1980 Pipelines		
Total Miles of Line-Pipe	92,242			142,009		
Total Horsepower (HP) of Compression	7,173,684			11,044,134		
	Low	Average	High	Low	Average	High
Penn Energy Unit Cost Estimates:						
Replacement Cost per Inch-mile	$50,925	$70,238	$131,388	$50,925	$70,238	$131,388
Compression Replacement Cost per HP	$959	$1,895	$5,213	$959	$1,895	$5,213
Cost of Replacing 25% ($Billions):						
Total Line-Pipe Replacement Cost	$24.2	$33.4	$62.5	$34.3	$47.3	$88.5
Total Compression Replacement Cost	$1.7	$3.4	$9.3	$2.6	$5.2	$14.4
Total Replacement Cost	$25.9	$36.8	$71.8	$36.9	$52.5	$102.9
Cost of Replacing 50% ($Billions):						
Total Line-Pipe Replacement Cost	$48.4	$66.8	$125.0	$68.6	$94.6	$176.9
Total Compression Replacement Cost	$3.4	$6.8	$18.7	$5.3	$10.5	$28.8
Total Replacement Cost	$51.9	$73.6	$143.7	$73.9	$105.0	$205.7

Table 3
Replacement Cost Estimates for CMP and Pre-1980 Pipelines
Using Major Pipeline Company Unit Cost Estimates

	CMP Pipelines			Pre-1980 Pipelines		
Total Miles of Line-Pipe	92,242			142,009		
Total Horsepower (HP) of Compression	7,173,684			11,044,134		
	Low	Average	High	Low	Average	High
Major Pipeline Company Unit Cost Estimates:						
Replacement Cost per inch-mile	$103,557	$170,298	$326,150	$103,557	$170,298	$326,150
Compression Replacement Cost per HP	$1,756	$2,483	$4,885	$1,756	$2,483	$4,885
Cost of Replacing 25% ($Billions):						
Total Line-Pipe Replacement Cost	$49.2	$81.0	$155.1	$69.7	$114.7	$219.6
Total Compression Replacement Cost	$3.1	$4.5	$8.8	$4.8	$6.9	$13.5
Total Replacement Cost	$52.4	$85.4	$163.9	$74.6	$121.5	$233.1
Cost of Replacing 50% ($Billions):						
Total Line-Pipe Replacement Cost	$98.5	$162.0	$310.2	$139.4	$229.3	$439.2
Total Compression Replacement Cost	$6.3	$8.9	$17.5	$9.7	$13.7	$27.0
Total Replacement Cost	$104.8	$170.9	$327.7	$149.1	$243.0	$466.2

One important consideration in evaluating these three replacement cost estimates is the question of whether the construction, equipment supply, and contracting systems could supply the level of equipment anticipated in either of these scenarios during the time frames that would be required to install the new pipelines by 2020. In past ten years, the maximum amount of pipeline miles added to the U.S. (both interstate and intrastate) has been less than 4,000 miles in any year.[32] Add in the time frame to engineer and permit new pipeline (discussed further below) along with the current industry plans for adding new pipeline to meet growing demand (as shown on Figure 1), and it is apparent that any replacement scenario that would involve even 25 to 50 percent of the original CMP pipelines or the 1980 pipelines and a relatively short period for cutting over from the existing system to the new would not be viable, from a practical point of view.

Of course, it is not clear that either the CMP or pre-1980 scenario would be sufficient to reduce the level of contamination to 1 ppm in those pipelines, or whether all of the sections on any pipeline with contamination greater than 1 ppm would have to be replaced in order to guarantee compliance with a 1 ppm standard. If this were the case for either the CMP or pre-1980 scenario, then the costs would rise to between $67 billion and $655 billion under the CMP scenario and between $96 billion and $932 billion under the pre-1980 scenario.

Other Cost Implications for Direct Pipeline Costs

Given the character of the cost assumptions underlying these costs estimates – it is possible that these costs greatly understate the costs because of the massive demand on labor, material, and capital that would be required. Additionally, other costs would be incurred beyond

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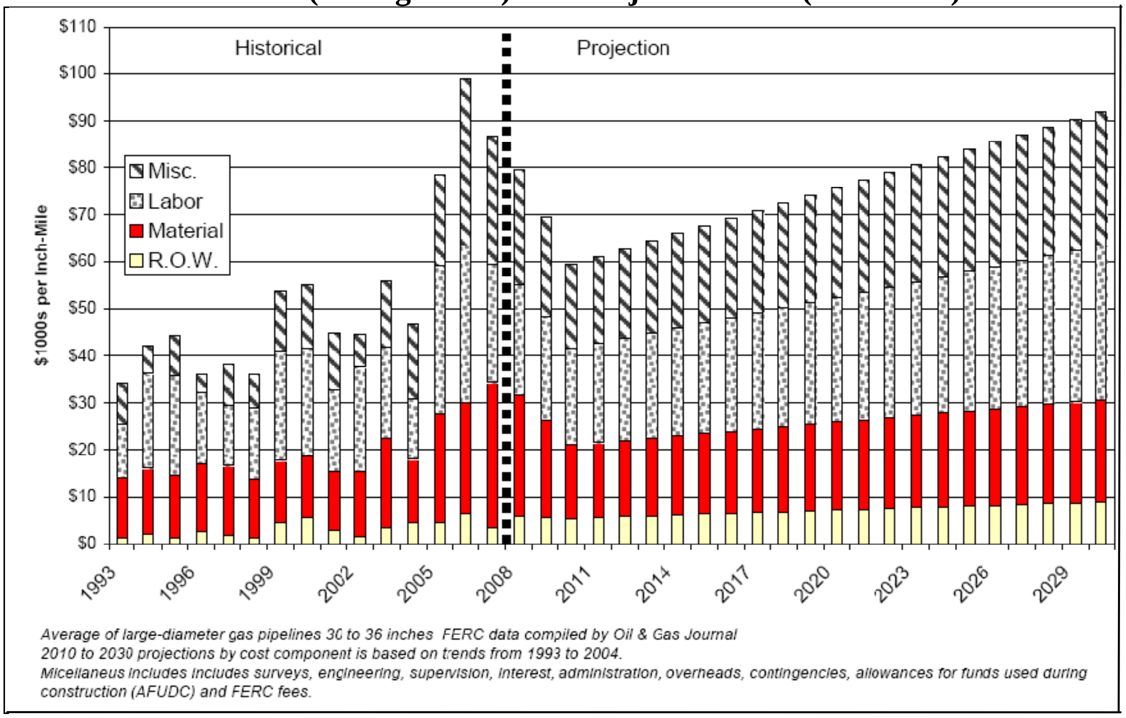
[32] EIA data.

those tied to replacing pipeline segments, such as incremental replacement fuel and power costs that could be incurred temporarily while sections of pipeline are taken out of service for replacement.

The amount of steel required under the CMP and pre-1980 scenarios, for example, would be 10 million tons and 14 million tons, respectively for the 50% replacement scenario. For context, this represents between 11 and 15 percent of 91 million tons of total U.S. steel production that occurred in 2008.[33] During the mid-years of the prior decade, when world-wide economic growth led to increased demand for inputs to production, the price of steel and other construction inputs rose, creating construction cost increases for infrastructure industries like natural gas pipeline systems. Figure 7 shows the increase in pipeline construction prices from 2005 to 2008, followed by the reductions in forecasted prices for the years 2009 forward that were anticipated as of the time this figure was created. (The worldwide economic crisis that started at the end of 2008 led to these price declines, as demand for commodities declined even farther than anticipated at the time this figure was prepared.)

[33] World Steel Association, "Crude Steel Statistics Total 2008," accessed at: http://www.worldsteel.org/?action=stats&type=steel&period=latest&month=13&year=2008.

Figure 7
Natural Gas Pipeline Costs ($1,000 per inch-mile) –
Historical (through 2008) and Projected Costs (2009-2030)



Source: ICF International, "Natural Gas Pipeline and Storage Infrastructure Projections Through 2030," prepared for the INGAA Foundation, October 20, 2009, Figure 24.[34]

Figure 8 shows a similar, although somewhat modulated set of cost increases for constructing compressors during those same years. The point in providing these historical numbers is to shed light on what one might expect in terms of input price escalation, if there

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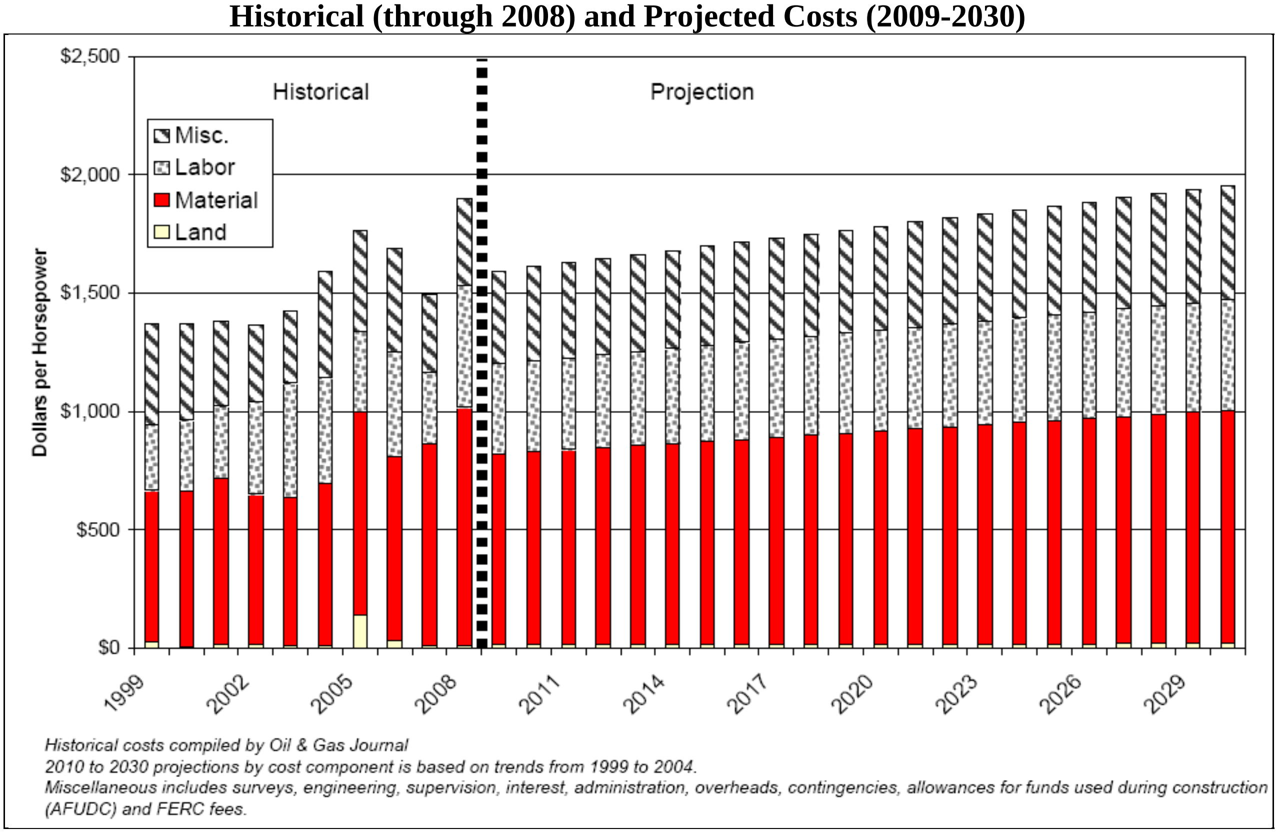
[34] Note that analysis from this ICF report for INGAA in 2009 reported: "The cost of building natural gas pipeline[fn] infrastructure varied between $30,000 and $100,000 per inch-mile from 1993 to 2007…Through 2004, increases in pipeline construction costs were generally modest. After 2004, however, costs began to escalate dramatically, nearly doubling previous levels by 2006. This was due, in part, to high world commodity prices, especially the price of steel. Costs have declined recently and the several year cost run-up is expected to only be temporary. … Construction costs are projected to decline through 2010. After 2010, costs resume a general upward pattern consistent with the pre-2004 cost trends, which are slightly less than the assumed future inflation rate of 2.5 percent per year… Between 1999 and 2007, the cost of building pipeline compression ranged from $1,400 to $1,800 per horsepower …Compression costs have not been as volatile as pipeline costs. Similar to pipeline costs, compression costs are expected to trend upward at a rate near inflation, consistent with recent historical trends. Materials costs, which account for one-half of the cost of adding horsepower, represent the single largest component of the total cost of adding horsepower, because they include the manufactured compressor itself. Labor costs and the miscellaneous component, which includes engineering and environmental compliance, account for roughly one-fourth each. Land costs in connection with adding compression are insignificant. Unlike pipelines that can extend for many miles and cross the property of multiple landowners, the cost of land in connection with adding compression is limited to the immediate area surrounding the compressor station." ICF International, "Natural Gas Pipeline and Storage Infrastructure Projections Through 2030," prepared for the INGAA Foundation, October 20, 2009, pages 47-48.

were a significant increase in demand for the materials that go into construction of pipelines and compressors (such as could occur in the event that EPA adopted a PCB rule similar to what is contemplated in the ANPR). Potentially amplifying the impact is the fact that some of the same materials would of course be in demand in other industries as well (e.g., electric power plants, transmission lines, distribution systems, not to mention natural gas distribution systems and factories, which might also need to take steps to respond to a revised PCB rule).

The cost trends shown in Figures 7 and 8 give insights into the types of increases that might be expected in pipeline system construction inputs, like the price of steel. But such price increases are not reflected in the replacement cost scenarios presented previously.

Figure 8
Natural Gas Compression Costs ($ per Horsepower)
Historical (through 2008) and Projected Costs (2009-2030)



Source: ICF International, "Natural Gas Pipeline and Storage Infrastructure Projections Through 2030," prepared for the INGAA Foundation, October 20, 2009, Figure 25.

Additionally, in light of the high replacement cost scenarios, an enormous amount of capital would need to be secured. This could likely take some time because financial institutions might prove reluctant to lend or underwrite too much in a given sub-sector of the economy. As a result, because of the high demand for capital, the cost of capital for building the projects would likely increase.

Clearly, the costs of replacement calculated under any of the scenarios depicted in Tables 1 through 3 would be extremely high. In light of the regulated nature of natural gas pipeline systems, it is likely that a larger percentage, if not all of those construction and financing costs, would be passed along to natural gas consumers.

On top of those direct costs, the infrastructure replacement process would be fraught with difficulties and risks. For example, the process of developing, siting, permitting, acquiring land for, and constructing new interstate pipelines is highly regulated and relatively time-consuming. The Federal Energy Regulatory Commission ("FERC") has primary jurisdiction over such siting, permitting, and environmental reviews, as well as for issuing certificates of public convenience and necessity. Building a new line is a long and expensive process. When the process goes smoothly, it typically takes two to three years to obtain FERC approval and all other permits for a major pipeline construction project, and 6-24 months to complete construction.

Siting pipelines in the geographic corridors leading to and within consumer regions would be particularly daunting, in light of the built-up environment that has evolved since the time when the original pipelines were installed. Not only have these corridors been narrowed by development that has occurred since many of these lines were constructed in the 1950s and

1960s, but many of these facilities were constructed prior to the time period during which environmental regulations were promulgated (including the requirements to prepare environmental impact assessments and mitigate other environmental impacts associated with pipeline construction and operations). As a result, it would be extremely difficult, and in some cases impossible, to replace existing pipelines in portions of their current right-of-way. This would require deviating from the existing pipeline route and developing a new pipeline corridor, which in many parts of the country would be difficult, time-consuming, and extremely expensive.

Abandoning existing pipelines also requires regulatory approvals from the FERC. All companies wishing to abandon pipelines – that is, to no longer operate an existing pipeline system – must provide detailed reasons for abandonment. With the exception of small pipelines, a company must provide an environmental report in their application to abandon a pipe. Other documents that the FERC requires include copies of each contract or other agreement with a party that may be potentially affected by the abandonment of a given pipe, a flow diagram explaining the physical nature of the pipe, an analysis of how the abandonment of the pipe will affect customers, an analysis of how the abandonment will affect existing tariffs, a description of the accounting treatment of the abandonment, and a detailed geographic map of the pipeline. Additionally, the applicant must make a good faith effort to notify all affected landowners and towns, communities, and local, state, and federal governments and agencies involved in the project. Anyone desiring to participate in the process is allowed to file a petition to intervene and the FERC schedules a hearing for all projects that the FERC determines have significant effects. The FERC determines which pipelines will be allowed to be abandoned based on the outcome of these hearings. Many, if not most, pipeline systems that are approved for abandonment are situations where the owner implements an "abandonment in place," leaving the pipeline in the ground and making arrangements to assure its and the public's safety in the pipeline's inoperable, abandoned condition.

The direct and complete replacement of an existing pipeline is a relatively uncommon event, and might involve some combination of removal and replacement of pipe in its current location and/or placement of pipelines and other necessary infrastructure in a different location. These two approaches have different implications for the ability of the pipeline system to continue operating during construction of the replacement system without service disruptions to customers. They also have implications for total land area affected between the current and replacement system(s), and the ability to obtain the necessary approvals, given different siting, permitting, construction, and other environmental impacts of facilities in different locations.

In the event that many portions of the interstate gas delivery system had to be replaced in exactly the same location as existing facilities (or near them) and/or abandonment in place were deemed undesirable, then these circumstances would require the digging up and removal of contaminated segments in a safe and environmentally acceptable fashion, combined with the replacement of those infrastructure pieces in time to avoid service disruptions of supply or in a fashion that provided suitable alternative supply arrangements with equivalent firm service reliability and at acceptable costs to businesses and residential consumers.

Installation and operation of new pipelines would be difficult in their own right, in light of the linear, interconnected nature of the pipeline systems. But replacing a system would also require the permitting, engineering, and replacement of new compressor stations in order to assure that the new systems were both reliable and could operate under any new EPA PCB requirements. New metering stations would also need to be added, replacing any contaminated meter stations at the interconnections between one pipeline system and another (e.g., at the junctures where local distribution systems or direct industrial customers take gas from the interstate system). Both compressor stations and metering stations take up more space at a given spot along the pipeline than does the pipeline itself; this could create new siting, engineering, land acquisition, and construction replacement issues.

The demand for natural gas peaks in the winter season months of November through April and the summer cooling season months of May through September. During these times many critical portions of the systems operate at full capacity and even during off-peak seasons (e.g., which is also a busy time for storage operations), the removal and replacement process would need to take place in portions of the off-peak season. And in order to avoid contamination of the newly replaced segments through interactions with existing systems with legacy contamination, there would need to be extreme care in planning the progress of the replacement process in ways that satisfied gas deliverability, safety, environmental, and public health requirements.

Doing all of these together in order to replace so much pipeline infrastructure within a relatively short window of time would be extraordinarily challenging, if possible to do at all. As such, it seems likely that – in those circumstances where land availability and local permitting requirements allowed – a natural gas pipeline operator would need to build an entirely new line while the contaminated line would continue to operate, and then cut over service once the new facilities were fully in place.

Another costly impact of the contemplated proposal would be the disposal of contaminated natural gas pipeline and pipeline equipment. Regardless of whether an owner of a natural gas pipeline opted to rebuild all of its system or portions of it, contaminated transmission equipment would need to be properly disposed of. Table 4 shows the potential disposal costs under the CMP and pre-1980 scenarios by examining the cost implications on only the pipes and compressors, while ignoring other components such as valves and meters. The disposal costs are primarily driven by the weight of the material being disposed of, and most of that is in the pipe itself. Disposal costs would add another $5 to $8 billion to the costs of post-2020 compliance under the 50 percent scenario, resulting in total compliance costs that include replacement and disposal of up to $474 billion.

Table 4
Estimated Disposal Cost of Potentially Contaminated Natural Gas Pipeline

	CMP Pipelines[1]		Pre-1980 Pipelines[1]	
Pipeline % to be Replaced	**25%**	**50%**	**25%**	**50%**
Tons of line-pipe to be disposed of	4,900,138	9,800,277	6,911,185	13,822,370
Line-pipe disposal cost per ton of steel [2]	$559	$559	$559	$559
Total line-pipe disposal cost	$2,740,534,590	$5,481,069,181	$3,865,266,627	$7,730,533,254
Total compressors to be disposed of	127	255	196	392
Disposal cost per compressor [3]	$55,000	$55,000	$55,000	$55,000
Total compressor disposal cost	$7,009,729	$14,019,459	$10,791,720	$21,583,439
Total Disposal Cost	**$2,747,544,320**	**$5,495,088,639**	**$3,876,058,347**	**$7,752,116,693**

Notes:

[1] A pipeline is classified as potentially contaminated if it was at one point part of the EPA's Compliance Monitoring Program (CMP) or if it was built prior to 1980 (the year that the manufacturing of PCBs was effectively banned in the United States).

[2] Pipeline disposal cost for a contaminated inch-mile of line-pipe is derived from a major pipeline company's disposal cost estimate of a 30-inch pipe and includes transportation costs.

[3] Compressor disposal cost for a contaminated compressor is provided by a major pipeline company and does not

Sources:

[1] U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration, "2008 Transmission Annuals Data," accessed at: http://www.phmsa.dot.gov.

[2] EPA, "1996 Revision to the 1981 PCB Compliance Monitoring Program (CMP) for 10 Interstate Natural Gas Transmission Pipelines," accessed at: www.epa.gov/wastes/hazard/tsd/pcbs/pubs/cmp96.pdf.

[3] Data provided by a major pipeline company.

Complicating this massive disposal effort further, there are currently few facilities in the U.S. certified for the disposal of PCB contaminated equipment.[35] Any PCB contaminated liquids would need to be incinerated (a process itself requiring large amounts of natural gas). The lack of disposal facilities and the questionable ability of current ones to handle this volume of PCB contaminated equipment would certainly result in increased costs for disposal. Moreover, the potential lengthened time in which facilities could safely dispose of the contaminated material might result in delays and the need for temporary storage of contaminated pipeline awaiting safe disposal.

Conclusions

This report has attempted to depict in reasonably transparent terms the potential direct costs of compliance with EPA's ANPR, were it to be promulgated as currently conceived. It is clear that the costs are potentially enormous. There would be extraordinarily large economic consequences under reasonable assumptions about the state of conditions in the industry and the costs that might be incurred in addressing the remaining PCB contamination issue to take it from 50 ppm (with use authorization) to 1 ppm (with none).

This description of costs has been framed in terms of impacts on the interstate pipelines and its owners, rather than on the users of these pipeline services. Since for the most part, interstate pipelines are rate regulated based on cost-of-service principles, those entities that purchase transportation service from the pipelines (e.g., local gas distribution companies that in turn provide gas service from pipelines; industrial gas users; power plants) will see at least a

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[35] A list of available facilities can be found at: http://www.epa.gov/solidwaste/hazard/tsd/pcbs/pubs/stordisp.htm.

large portion (if not all) of these compliance costs passed through in their rates for natural gas.

This report has not looked at the benefit side of the equation, but it does shed light on the significant costs that could attend a decision to modify PCB regulations so as to lower the allowed level of contamination to 1 ppm and to terminate the use authorization framework now in place. The range of costs is quite high, as is the prospect for ever diminishing returns in this area of environmental regulation.