DOCKET R-2020-3018835

Hearing Date: July 8, 2020

Ex 1	Rate Increase Request
Ex 2	Printout dated April 24, 2020
Ex 3	NiSource document
Ex 4	Pipeline Safety Management Systems
Ex 5	Deferred Prosecution Agreement
Ex 6	Accident Report

For Columbia Gas of Pennsylvania, Inc.'s Rate Increase Request

Docket No. R-2020-3018835

Wednesday, July 8, 2020, 1:00PM

R-2020-3018835
7/8/20
Exhibit-1

Introduction – Richard C Culbertson, 1430 Bower Hill Road, Pittsburgh PA (Mt. Lebanon)

I thank you for the opportunity to testify on this Columbia Gas Rate Case. My approach to this testimony – is to provide facts provide an analysis of those fact and provide some conclusions as to why this proposed rate increase should not occur. It is time to level the spending curve.

Employment or other professional activities – Owner of a small real estate investment business and operate around Pittsburgh and in the state of California. I own four housing units that are serviced by Columbia Gas of Pennsylvania as such I am an interested party to this rate case.
-- Improve world-wide organizational asset manage by good ASTM and ISO Asset Management standards.
-- I have the elected Chair position of ASTM E53 Asset Management Committee (186 members) of which writes, vets, and promulgates international asset management consensus standards, e.g. ASTM E2279 Guiding Principles of Property Asset Management has been adopted by the US Department of Defense in their DoD Instruction DODI 5000.64 ACCOUNTABILITY AND MANAGEMENT OF DOD EQUIPMENT AND OTHER ACCOUNTABLE PROPERTY. This standard is also used as a reference in ISO 55000 Asset Management standard of which is identified in the bibliography of ANSI/API 1173 Pipeline Safety Management Systems of which has been adopted by NiSource and Columbia Gas of Pennsylvania.
-- Member and elected Membership Secretary of ASTM/ANSI/ISO Technical Committee (TC) 251 Asset Management of which has responsibility for U.S. representation in the international TC 251 of which has produced and is responsible for the ISO 55000 Asset Management standard.
-- Elected Senior Fellow and Director of Asset Leadership Network.
-- Member and elected Vice President of the Three Rivers Chapter of the National Property Management Association.
-- 40 years employment with Lockheed Martin and GE in various forms of Asset Management. Represented Lockheed before the Government and Aerospace Industries Association (AIA). At AIA was former committee chairman and worked significantly on improving Government regulations, e.g., Federal Acquisition Regulation Part 45 Government Property. Was Lockheed's leading subject matter expert on asset management business systems including internal controls, accounting, and accountability of company and Government property. Was responsible for good decision making and internal controls: policy; operations; reporting – Government property, fixed assets and including Sarbanes Oxley; compliance; safeguarding assets; and maintaining and improving Government Property Systems at multiple sites with multiple products. It was my job to protect Lockheed internally and externally from out bound conduct, material weaknesses and significant deficiencies while making good business decisions, sustainable infrastructure and passing internal and Government audits.

Utilities are all about various forms of asset management.

My responsibilities – To be a responsible citizen. Not only to know but do. Know something – see something – say something on significant issues. Protect property rights as provided as the US Constitution 5th and 14th Amendments and Pennsylvania Constitution Article 1 Paragraph 1 "[I]ndefeasible rights, among which are those of enjoying and defending life and liberty, of *acquiring,*

possessing and protecting property". Back in September 9, 1969 while entering the US ARMY, I swore an oath, as other's entering Government service. I take that responsibility seriously --- to know – observe and drive correction if necessary.

Educational background --- B.S in Management at California State University Northridge, MBA Pepperdine, Graduate of GE's Financial Management Program, Certified Lean Six Sigma Black Belt (This is a recognized status of expertise in effective and efficient business operations), Certified in solid waste transportation per 49 CFR … (Occurred while part of the management team and was responsible among other things for solid waste management and transportation for the project to decommission Shippingport Nuclear Power Station.)

Testimony before the Public Utilities Commission

- August 2018 in Washington Pennsylvania regarding Columbia Gas Rate Case;
- A hearing regarding a complaint against Columbia Gas in **February 2019** of which was filed in **May 2017** and of which the PUC still has not ruled. I have been in dispute with Columbia Gas since July 7, 2016.
- April 2019 in Monroeville, Pennsylvania -- Peoples Gas Rate Case.

Recommendations regarding Columbia's proposed 17.84 percent increase (This could be 19.09 percent if sales tax applies.)

- For Columbia Gas, withdrawal the request until reasonable assurances are exhibited of effective internal controls – effective and efficient operations, reliable reporting and compliance with laws and regulations.
- For the Pennsylvania Public Utilities Commission, if Columbia does not withdraw the proposed rate increase, proceed with due diligence and due process using appropriate audit and investigation standards. Rate increase or decrease should only be determined by auditing internal controls and performance in accordance with the requirements of the GAO Green Book (Standards for Internal Control in the Federal Government) and the GAO Yellow Book (Generally Accepted Government Auditing Standards (GAGAS). There must be reasonable assurance of effective internal controls including reliable financial reporting for the purposes of cost recovery.

This recommendation is based upon connecting the dots of known facts and history of legal and regulatory requirements regarding public utilities, NiSource, and Columbia Gas of Pennsylvania.

- The complaint from Pennsylvania Office of Consumer Advocate *" A preliminary examination of Columbia's filing indicates that the proposed increase in rates may be unjust, unreasonable**, in violation of law**, and will or may produce an excessive return on investment in violation of the Public Utility Code, 66 Pa. C.S. § 1301, et seq."* I agree with this statement and hope they can prove it.
- Columbia's rate base must comply with Pennsylvania Law: TITLE 66 PUBLIC UTILITIES § 102. Definitions. "Rate base." The value of the whole or any part of the **property of a public utility** which is **used and useful in the public service.**
- Title 66 § 501. General powers. (a) Enforcement of provisions of part --In addition to any powers expressly enumerated in this part, **the commission shall have full power and authority, and it shall be its duty to enforce**, execute and carry out, by its regulations, orders, or otherwise…
- (b) Administrative authority and regulations. --The commission shall have general administrative power and **authority to supervise** and regulate all public utilities doing business within this Commonwealth. The commission may make such regulations**, not inconsistent with law,** as may be necessary or proper in the exercise of its powers or for the performance of its duties.

- (c) **Compliance**.--**Every public utility**, its officers, agents, and **employees,** and every other person or corporation subject to the provisions of this part, affected by or subject to any regulations or orders of the commission or of any court, made, issued, or entered under the provisions of this part, **shall observe, obey, and comply with such regulations or orders**, and the terms and conditions thereof.

- Columbia Gas is a monopoly.
- Columbia makes money by spending money – the size of the rate base.
- Federal laws places some long standing constraints on gas utilities "15 U.S.C. COMMERCE AND TRADE § 717c - **All rates and charges** made, demanded, received by any natural-gas company for or in connection with the transportation or sale of natural gas … **shall be just and reasonable,** and any such rate or charge that is **not just and reasonable is** declared to be unlawful."

- Columbia presents different messages to the public and to investors.
    - **Public** -- "Columbia Gas of Pennsylvania Files Request for **Investment in Safety Through Replacing and Upgrading Aging Infrastructure**" from Columbia's Press Release https://www.nisource.com/news/article/columbia-gas-of-pennsylvania-files-request-for-investment-in-safety-through-replacing-and-upgrading-aging-infrastructure-20200424
    - **Investors:** NiSource – A Premier Regulated Utility Company -- Compelling Annual Total Shareholder Return -- Proposition **~$30B of 100% Regulated Utility Infrastructure Investment –** Opportunities-- Scale Across Seven States -- **Delivering on our Commitments** -- **Industry-Leading Safety and Performance** https://investors.nisource.com/company-information/default.aspx

- Press release: "If the request is approved as filed, **the total average residential customer bill** in 2021 would still be more than 28 percent lower than it was in 2010, when adjusted for inflation." https://www.columbiagaspa.com/our-company/news-room/article/columbia-gas-of-pennsylvania-files-request-for-investment-in-safety-through-replacing-and-upgrading-aging-infrastructure-cpa
    - This is offensive and misleading – Columbia is an infrastructure company, not a gas company and the commodity price of natural gas extraction is outside of their operations and is irrelevant to Columbia's infrastructure spending.
- M. A. Huwar Statement No. 1 http://www.puc.state.pa.us/pcdocs/1661259.pdf What are the Company's future plans for infrastructure replacement?
    - A. **The Company intends to continue replacement at an accelerated pace** in order to retire its remaining bare steel and cast-iron facilities as soon as possible.

- DOT Pipeline and Hazardous Materials Safety Administration, Pipeline Replacement Background https://www.phmsa.dot.gov/data-and-statistics/pipeline-replacement/pipeline-replacement-background "In 2011, following major natural gas pipeline incidents, DOT and PHMSA issued a **Call to Action** to accelerate the repair, rehabilitation, and replacement of the **highest-risk pipeline infrastructure.**"
  https://en.m.wikipedia.org/wiki/List_of_pipeline_accidents_in_the_United_States_in_2011 (No mention of service lines. **The highest risk mostly were transmission lines rather than distribution lines. Transmission lines can have a large volume with high pressure. Distribution lines generally do not. PG&E's San Bruno explosion was of a 30-inch transmission line operating at 375 PSI. service lines are generally less than two inches, and many operate at low pressure, generally .5 psi.**
- Service lines have been relatively safe and should not be **highest-risk pipeline infrastructure.**

- Leaking service lines rarely cause explosions because of natural laws – natural gas is lighter than air, it weighs 65.6% of air, natural gas has a flammability range of approximately 5 to 15 percent. That means that any mixture containing less than 5 percent or greater than 15 percent natural gas to air will not support combustion. Natural gas, when mixed with the right amount of air and exposed to an ignition source, is combustible. Most major damage occurs when uncontrolled gas is released of gas in a confined space and can result in explosion if there is a spark.
- There is no Federal legal nor regulatory requirement to accelerate spending on gas infrastructure.
- The call to action was is essentially an editorial and is not enforceable. If regulator tried to make it a regulation it would have failed the vetting process because it would been deemed arbitrary and capricious under the Administrative Procedure Act of 1946.
- Good management uses risk management, e.g., ISO 31000 Risk Management or ASME standards (49 CFR 192.7 – documents incorporated by reference. It is not reasonable to replace plumbing/ pipeline infrastructure, which has remaining useful life arbitrarily.
- Acceleration of unnecessary expenditures is not reasonable nor prudent.

- **Information targeted to investors:**

  Reformatted and Normalized NiSource Facts For Investors

  https://investors.nisource.com/company-information/default.aspx

Utility -- State	~ No. of Customers (In 000)	Miles of Pipe	Calculated Miles of pipe per customer	Miles of Bare Steel and Cast Iron	Rate Base ($ 000,000)	Calculated Rate Base Per Customer $
NIPSCO	840	17500	.020	23*	1700	**2024**
COH	1500	20200	.013	2000	3200	2133
CKY	137	2600	.019	2600	327	2387
CMA	327	5000	.019	540	1100	3364
CVA	274	5300	.019	140**	850	3102
CMD	34	660	.018	50	149	4382
CPA	436	7700	.018	1200	1900	**4358**
TOTAL (2019)	3548	58,960		6390	9226	**3107 AVE.**

*Bare Steel and Wrought Iron

** Bare steel

-- (Why the difference of CPA and CMD as compared to NIPSCO? CMD and CPA operate under the same management.)

-- Total current rate base is **$9.226 Billion** yet NiSource asserts **~$30 Billion** of 100% Regulated Utility Infrastructure Investment – Opportunities.

- Both CPA and CPM are seeking huge rate increases from customers.
  - Columbia Gas of Maryland Files Request for Investment in Safety Through Replacing and Upgrading Aging Infrastructure Pennsylvania -- **15.17** percent https://www.nisource.com/news/article/columbia-gas-of-maryland-files-request-for-investment-in-safety-through-replacing-and-upgrading-aging-infrastructure-20200515
  - Columbia Gas of Pennsylvania Files Request for **Investment in Safety** Through Replacing and Upgrading Aging Infrastructure -- **17.84 percent** https://www.nisource.com/news/article/columbia-gas-of-pennsylvania-files-request-for-investment-in-safety-through-replacing-and-upgrading-aging-infrastructure-20200424
  - Money doubles in five years at 15 percent

- Columbia Gas of Pennsylvania, Inc., 2020 General Rate Case, Docket No. R-2020-3018835 Standard Filing Requirements, Testimony – All, Volume 10 of 10 (514 pages) http://www.puc.state.pa.us/pcdocs/1661259.pdf
- The rate case document does not provide how or how much the customer benefits from **their investment in safety**. The phrase in not included in the 514 page document. The phrase is deceptive to the public and is meant to stifle debate and public comment.
- Safety issues are generally people issues, not pipe issues…. bad practices and procedures, lack of training and quality assurance and lack of care.
- **Spending to come:**

Figure 1

Columbia Gas of Pennsylvania Capital Program ($000)					
Budgeted Capital Expenditures					
Class	**2020**	**2021**	**2022**	**2023**	**2024**
Growth	$36,252	$37,727	$38,378	$43,640	$49,873
Betterment	$11,700	$42,400	$20,800	$14,800	$9,400
Public Improvement	$7,500	$6,000	$6,000	$7,500	$7,939
Replacement	$250,634	$259,559	$279,578	$336,817	$348,635
Support Services	$2,000	$2,600	$1,950	$1,750	$1,600
Total Gross Capital	**$308,085**	**$348,286**	**$346,705**	**$404,507**	**$417,448**

Internal Controls

- Since the Securities and Exchange Act of 1934 (15 U.S.C. § 78m) - Periodical and other reports publicly traded corporations were required to (2)"… devise and maintain a system of **internal accounting controls** sufficient to provide **reasonable assurances** … to permit preparation of financial statements in conformity with generally accepted accounting principles (GAAP) or any other criteria applicable to such statements, and (II) to maintain accountability for assets;"

- After several accounting scandals around 2000, Congress enacted the Sarbanes Oxley Act of 2002 a focus was on internal controls, governance, and accountability of management. It "directed the

[**U.S. Sentencing Commission**] to review and amend, as appropriate, the guidelines and related policy statements to ensure that the guidelines that apply to organizations in this chapter "are sufficient to deter and punish organizational criminal misconduct."" https://www.ussc.gov/guidelines/2015-guidelines-manual/2015-chapter-8

- "Organization" means "a person other than an individual." 18 U.S.C. § 18. The term includes **corporations,** …, **governments** and political subdivisions thereof, …
- (E) An individual **"condoned"** an offense if the **individual knew** of the offense and did not take reasonable steps to prevent or terminate the offense.
- (J) An individual was **"willfully ignorant of the offense"** if the individual **did not investigate** the possible occurrence of unlawful conduct despite knowledge of circumstances that would lead a reasonable person to investigate whether unlawful conduct had occurred.

The Committee of Sponsoring Organizations of the Treadway Commission **(COSO)** https://www.coso.org/Pages/default.aspx in 2013 issued **Internal Control — Integrated Framework** https://www.coso.org/Documents/990025P-Executive-Summary-final-may20.pdf

- **Provided the opportunity to expand the application of internal control beyond reporting to other forms of reporting, operations, and compliance**
  - **Definition -- Internal control is a process, effected by an entity's board of directors, management, and other personnel, designed to provide reasonable assurance regarding the achievement of objectives relating to operations, reporting, and compliance.**
  - Objectives – the framework provides for three categories of objectives, which allows organizations to focus on differing aspects of internal control:
    - Operations Objectives – These pertain to effectiveness and efficiency of the entity's operations, including operational and financial performance goals and safeguards of assets against loss.
    - Reporting Objectives – These pertain to internal and external financial and non-financial reporting and may encompass reliability, timeliness, transparency, or other terms as set forth by regulators, recognized standard setters or entity's policies.
    - Compliance Objectives – these pertain to adherence to laws and regulations to which the entity is subject."

- September 10, 2014 The Government Accountability Office issued the GAO Green Book *Standards for Internal Control in the Federal Government.* https://www.gao.gov/assets/670/665712.pdf
  - The Internal Control Cube:

"The Green Book adapts these principles for a government environment."

- 2 CFR 200 - UNIFORM ADMINISTRATIVE REQUIREMENTS, COST PRINCIPLES, AND AUDIT REQUIREMENTS FOR FEDERAL AWARDS https://www.gpo.gov/fdsys/pkg/CFR-2014-title2-vol1/pdf/CFR-2014-title2-vol1-part200.pdf
    - States and utilities receive Federal awards
    - § 200.303 Internal controls. The non-Federal entity must: (a) Establish and maintain effective internal control over the Federal award that **provides reasonable assurance** that the non-Federal entity is managing the Federal award in compliance with Federal statutes, regulations, and the terms and conditions of the Federal award.
    - Subpart E—**Cost Principles** -- 200.404 Reasonable costs. A **cost is reasonable if, in its nature and amount, it does not exceed that which would be incurred by a prudent person under the circumstances** prevailing at the time the decision was made to incur the cost.
    - Additional guidance on the cost principles is included in FAR Part 31 https://www.acquisition.gov/content/part-31-contract-cost-principles-and-procedures
    - 200.434 **Contributions and donations**. (a) Costs of contributions and donations, including cash, property, and services, from the non-Federal entity **to other entities, are unallowable.**
    - § 200.501 **Audit requirements**. (a) Audit required. A non-Federal entity that expends **$750,000** or more during the non-Federal entity's fiscal year in Federal awards must have a single or program-specific audit conducted for that year in accordance with the provisions of this part.
    - § 200.504 Frequency of audits. … **audits required by this part must be performed annually.**
    - § 200.514 Scope of audit. (a) General. **The audit must be conducted in accordance with GAGAS. (GAO Yellow Book Generally Accepted Government Auditing Standards)** The audit must cover the entire operations of the auditee,…
        - **(Audits are not audits unless they are conducted in accordance with GAGAS.)**
    - § 200.7 Auditor. Auditor means an auditor who is a public accountant or a Federal, **state,** or local government audit organization, **which meets the general standards specified in generally accepted government auditing standards (GAGAS).**
        - **(Auditors are not auditors unless they meet the GAGAS standards.)**

- (b) Financial statements. The auditor must determine whether **the financial statements** of the auditee **are presented fairly in all material respects in accordance with generally accepted accounting principles.**
- (c) Internal control. (1) The compliance supplement provides guidance on internal controls over Federal programs based upon the guidance **in Standards for Internal Control in the Federal Government issued by the Comptroller General of the United States (GAO Green Book) and the Internal Control—Integrated Framework, issued by the Committee of Sponsoring Organizations of the Treadway Commission (COSO).**
- **(c)(4) …**However, the auditor must report a significant deficiency or material weakness in accordance with §200.516 Audit findings, assess the related control risk at the maximum, and consider whether additional compliance tests are required because of ineffective internal control.
- **(d) Compliance. (1) In addition to the requirements of GAGAS, the** auditor must determine whether the auditee has complied with Federal statutes, regulations**, and the terms and conditions of Federal awards that may have a direct and material effect on each of its major programs.**

- **Management Directives – Governor's Office**

MANAGEMENT DIRECTIVE

Commonwealth of Pennsylvania
Governor's Office

Subject: Standards for Internal Controls in Commonwealth Agencies	***Number:*** 325.12 Amended
Date: May 15, 2018	***By Direction of:*** Randy C. Albright, Secretary of the Budget
Contact Agency: Office of the Budget, Office of Comptroller Operations, Bureau of Audits, Telephone 717.783.0114	

This directive establishes policy, responsibilities, and procedures for implementing effective internal control systems within commonwealth agencies. This update adjusts language and aligns the directive with *Management Directive 325.13, Service Organization Controls*.

1. **PURPOSE.** To establish policy, responsibilities, and procedures for internal control systems within commonwealth agencies.

2. **SCOPE.**

   a. This directive applies to all departments, boards, commissions, and councils (hereinafter referred to as "agencies") under the Governor's jurisdiction.

   b. This directive applies to all aspects of an agency's operations, reporting, and compliance with applicable laws and regulations.

3. **OBJECTIVE.** To adopt and implement the internal control framework outlined in ***Standards for Internal Control in the Federal Government*** (Green Book) and ensure agencies use the components, principles, and attributes to design, implement, operate, and assess an effective internal control system.

MANAGEMENT DIRECTIVE

Commonwealth of Pennsylvania
Governor's Office

Subject:	***Number:***
Performance of Audit Responsibilities	325.3 Amended
Date:	***By Direction of:***
January 10, 2011	Mary A. Soderberg, Secretary of the Budget

Contact Agency:
Office of the Budget, Office of Comptroller Operations, Bureau of Audits,
Telephone 717.783.0114

This directive establishes policy, responsibilities, and procedures for the performance of audits and nonaudit services for commonwealth agencies. This amendment includes changes to definitions, policy, responsibilities, and procedures as a result of the rescission of *Management Directive 325.4, Agency Annual Audit Plan.* Marginal dots are excluded due to major changes.

1. **PURPOSE.** To establish policy, responsibilities, and procedures for the performance of audit and nonaudit services for commonwealth agencies.

2. **SCOPE.**

   a. This directive applies to all departments, boards, commissions, and councils (hereinafter referred to as "agencies") under the Governor's jurisdiction.

   b. Audit organizations within the scope of this directive include, but are not limited to: Agency Audit Organizations, Comptroller Operations Audit Organizations, certified public accountants (CPAs) performing audits for the commonwealth, and public accountants performing audits for the commonwealth.

   c. Policy and responsibilities contained herein apply to audits performed under an agency's direction and are not intended to limit audit functions performed by the Department of the Auditor General, State Treasurer, or Legislative Budget and Finance Committee.

3. **OBJECTIVE.** To ensure Agency Audit Organizations, Comptroller Operations Audit Organizations, and other qualified auditors understand the policy, responsibilities, and procedures established for performing audits and nonaudit services.

d. ***Government Auditing Standards*** **(commonly referred to as the "Yellow Book"):** A publication issued by the U.S. Government Accountability Office, Comptroller General of the United States, which contains standards for audits of government organizations, programs, activities, and functions, and of government assistance received by contractors, nonprofit organizations, and other nongovernment organizations.

5. POLICY.

a. Audits of commonwealth organizations, programs, activities, and functions are to be performed by qualified auditors, and must be performed in accordance with generally accepted government auditing standards (GAGAS), promulgated by the United States Government Accountability Office in its publication, ***Government Auditing Standards***, except where it is determined to be more cost effective and operationally effective to have an audit performed in accordance with generally accepted auditing standards promulgated by the American Institute of Certified Public Accountants.

GOVERNMENT AUDITING STANDARDS 2018 Revision https://www.gao.gov/assets/700/693136.pdf

- 3.18 In all matters relating to the GAGAS engagement, auditors and audit organizations must be **independent** from an audited entity.

- 3.109 Auditors must use **professional judgment** in planning and conducting the engagement and in reporting the results
- 4.03 The audit organization's management must assign auditors who before beginning work on the engagement possess the **competence** needed for their assigned roles.
- Requirements: General 4.16 Auditors who plan, direct, perform engagement procedures for, or report on an engagement conducted in accordance with GAGAS should develop and maintain their professional competence by completing at least **80 hours** of CPE in every 2-year period as follows.
- 4.24 Subject matter that directly enhances auditors' professional expertise to conduct engagements may include, but is not limited to, the following: … c. topics related to accounting, acquisitions management, **asset management**, budgeting, cash management, **contracting**, data analysis, program performance, or procurement;
- 5.60 Each audit organization conducting engagements in accordance with GAGAS **must obtain an external peer review** conducted by reviewers independent of the audit organization being reviewed.
- Glossary
    - **Abuse:** Behavior that is deficient or improper when compared with behavior that a prudent person would consider reasonable and necessary business practice given the facts and circumstances, but excludes fraud and noncompliance with provisions of laws, regulations, contracts, and grant agreements.
    - **Audit:** Either a financial audit or performance audit conducted in accordance with GAGAS.
    - **Audit organization:** A government audit entity or a public accounting firm or other audit entity **that conducts GAGAS engagements**.
    - **Auditor:** An individual assigned to planning, directing, performing engagement procedures, or reporting on GAGAS engagements (including work on audits, attestation engagements, and reviews of financial statements) **regardless of job title.** Therefore, individuals who may

have the title auditor, information technology auditor, analyst, practitioner, evaluator, inspector, or other similar titles are considered auditors under GAGAS.

- **Fraud:** Involves obtaining something of value through willful misrepresentation. Whether an act is, in fact, fraud is determined through the judicial or other adjudicative system and is beyond auditors' professional responsibility.
- **Waste:** The act of using or expending resources carelessly, extravagantly, or to no purpose. Waste can include activities that do not include abuse and does not necessarily involve a violation of law.

FORM 10-K NiSource Inc For the fiscal year ended December 31, 2019.

- Management's Annual Report on Internal Control over Financial Reporting Our management, including our chief executive officer and chief financial officer, are responsible for establishing and maintaining internal control over financial reporting, as such term is defined under Rule 13a-15(f) or Rule 15d-15(f) promulgated under the Exchange Act. … **Our management has adopted the 2013 framework set forth in the Committee of Sponsoring Organizations of the Treadway Commission report, Internal Control - Integrated Framework** …

The NTSB Final Report Overpressurization of Natural Gas Distribution System, Explosions, and Fires in Merrimack Valley, Massachusetts, September 13, 2018

2.2 **NTSB Urgent Recommendations to NiSource**

In the November 14, 2018, safety recommendation report, Natural Gas Distribution System Project Development and Review, the NTSB also **issued four urgent recommendations** to NiSource (NTSB 2018).

- **Review and ensure that all records and documentation of your natural gas systems are traceable, reliable, and complete. (P-18-7) (Urgent)**
- In its May 10, 2019, letter, NiSource responded it had completed locating, marking, and mapping control (regulator-sensing) lines at all 2,072 low-pressure regulator runs across its system. NiSource said that these facilities are depicted in isometric drawings and are visible in its GIS. In addition, NiSource contracted with a third-party natural gas engineering firm to verify the assets required to safely operate its low-pressure natural gas systems and ensure these assets are clearly indicated on relevant maps and records. **On July 22, 2019, Safety Recommendation P-18-7 was classified Closed——Acceptable Action."**
- **July 31, 2019 A house exploded in Washington County, PA https://triblive.com/local/regional/columbia-gas-on-washington-county-home-explosion-we-are-deeply-sorry/ Home not equipped with pressure regulator. (Again, records and overpressurization of house gas lines)**

The remains of a home that was destroyed by an explosion in North Franklin Township Wednesday, July 31, 2019.

- "The homeowner called 911 to report smelling natural gas Wednesday afternoon and North Franklin firefighters responded and shut off the gas to the home. They were within a few feet of the house when it exploded, Washington County public safety director Jeff Yates said. **"It's a miracle they weren't killed," Yates said." At least five people injured**
- **The fire chief and the homeowner were among those injured.** **https://observer-reporter.com/news/localnews/five-injured-in-north-franklin-township-house-explosion/article_2a722694-b3cd-11e9-a137-1f81bc7773a1.html**

NiSource and Columbia Gas of Massachusetts Faces Judgement

- June 23, 2020 -- Columbia Gas Sentenced in Connection with September 2018 Gas Explosions in Merrimack Valley -- Company to sell its business in Massachusetts and pay $53 million fine, **the largest criminal fine ever imposed under the Pipeline Safety Act** https://www.justice.gov/usao-ma/pr/columbia-gas-sentenced-connection-september-2018-gas-explosions-merrimack-valley
- NiSource enters into a Deferred Prosecution Agreement with the United States of America –
    - Agreement 11 . NiSource also agrees, as to each of its subsidiaries involved in the distribution of gas through pipeline facilities in Massachusetts, Indiana, Ohio, **Pennsylvania,** Maryland, Kentucky and Virginia **to implement and adhere** to **each of the recommendations** from the National Transp01iation Safety Board ("NTSB ") related to NTSB Accident ID PLD 18MR003 regarding the Event.
    - 13. If, however, during the Term of this Agreement, NiSource (1) **commits any felony under U.S. federal law including, but not limited to, any felony violation of the Pipeline Safety Act;** (2) gives deliberately false, incomplete, or misleading testimony or information to the Government or to the Court; or (3) otherwise fails to perform or fulfill each of NiSource's obligations under this Agreement**, NiSource will thereafter be subject to prosecution for any federal criminal violation of which the Government has knowledge**, including, **but not limited to**, federal criminal violations related to the conduct alleged in the CMA Criminal

Information, the Event, or CMA's and NiSource's restoration work in the Merrimack Valley following the Event.

The NTSB Final Report (Continued) Overpressurization of Natural Gas Distribution System, Explosions, and Fires in Merrimack Valley, Massachusetts,

- 1.8 Pipeline Safety Management Systems (ANSI/API RP-1173 Pipeline Safety Management Systems (2015) https://www.api.org/~/media/files/publications/whats%20new/1173_e1%20pa.pdf
- "NiSource began its SMS efforts several years prior to the overpressurization, as evidenced by the company being listed as a participant in the American Gas Association's (AGA) SMS project. Interviews with NiSource executives revealed that **they had initiated SMS development in 2015** and accelerated efforts since the accident. NiSource employees indicated that they were excited about SMS development, but were **still early in the process**."

MA Attorney General Reaches Agreement With Columbia Gas, Company Will Pay **$56 Million – July 2, 2020** https://boston.cbslocal.com/2020/07/02/columbia-gas-maura-healey-agreement-merrimack-valley-explosions/

Michael J Davidson in Statement provides his version of the status of the adoption of API 1173 in this rate case. http://www.puc.state.pa.us/pcdocs/1661259.pdf (April 24, 2020)

- "The API RP1173 **Standard** for Pipeline Safety Management Systems **is only a recommended practice,** but Columbia and NiSource have chosen to pursue the adoption and implementation of a Safety Management System ("SMS"). **As an early adopter of deploying an SMS,** Columbia has aggressively educated the entire workforce and key contractor resources on what it is and why we are using API 1173 as our guideline to measure progress. We have implemented a **Corrective Action Program ("CAP")** with all employees and key contractor resources that enables a more robust and formal process **for identifying risks** and developing actions to reduce risk. We have also established a new governance model to review and prioritize identified risks. The building of additional capacities within our SMS are underway and will continue, centered in process safety improvements**, asset management improvements** and safety culture improvements.

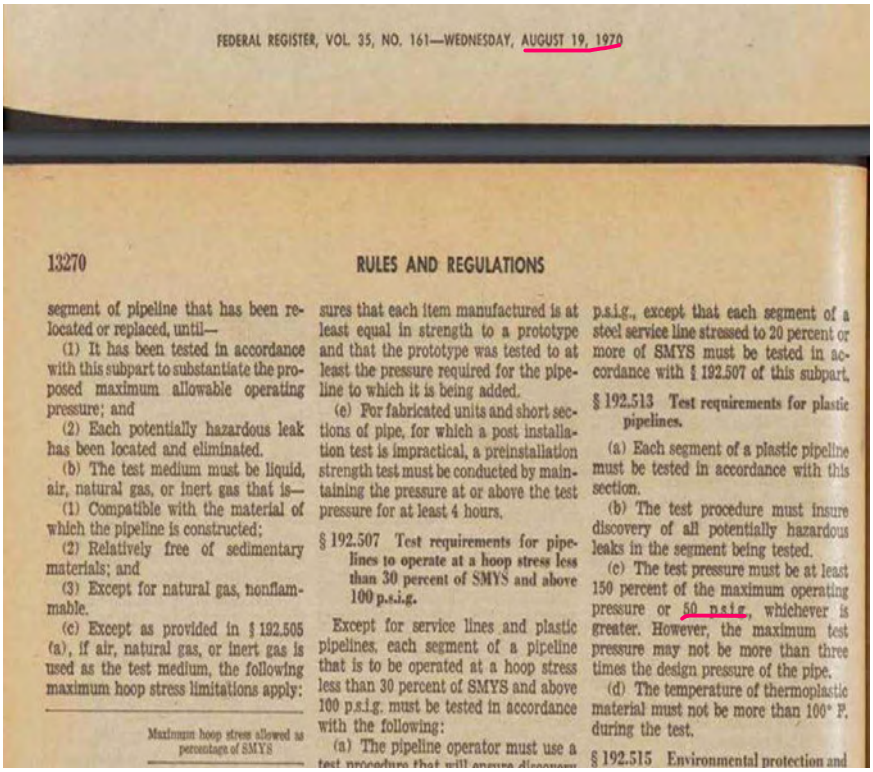
From API 1173: 3 Terms, Definitions… 3.1.8 **Corrective actions:** The steps established either to **correct nonconforming** aspects of the PSMS identified during an audit or evaluation, or actions taken to manage threats recognized during day-to-day activities.

NISOURCE CODE OF BUSINESS CONDUCT Page 9
https://www.nisource.com/docs/librariesprovider2/nisource-documents/nisource-policies/nisource-code-of-business.pdf?sfvrsn=33#:~:text=Each%20day%2C%20our%20NiSource%20team,leading%20gas%20and%20electric%20utility.&text=Our%20Code%20of%20Business%20Conduct,%2C%20honesty%2C%20integrity%20and%20trust.
"USING SOLID JUDGMENT--- NO CONTRACT OF EMPLOYMENT
INVESTIGATIONS - It is the policy of the Company to ensure that allegations of ethics and compliance violations are **investigated promptly**, **thoroughly, competently** and**, to the extent consistent with law and Company policies,** confidentially. The policy also states that matters must be resolved consistently and fairly, and that appropriate matters are reported to senior management of the Company and the Board of Directors or its appropriate committees.
Reports that concern **a possible violation of the law or the Code**, [regulations and company policy] or any complaints or concerns about accounting, auditing, disclosure or other financial or reporting

practices **will be referred to the executive vice president and chief legal officer.”**

49 CFR § 192.513 Test requirements for plastic pipelines.

(c) The test pressure must be at least 150 percent of the maximum operating pressure or **50 p.s.i.** (345 kPa) gage, **whichever is greater.** (**August 19, 1970**)



FEDERAL REGISTER, VOL. 35, NO. 161—WEDNESDAY, AUGUST 19, 1970

13270 RULES AND REGULATIONS

segment of pipeline that has been relocated or replaced, until—

(1) It has been tested in accordance with this subpart to substantiate the proposed maximum allowable operating pressure; and

(2) Each potentially hazardous leak has been located and eliminated.

(b) The test medium must be liquid, air, natural gas, or inert gas that is—

(1) Compatible with the material of which the pipeline is constructed;

(2) Relatively free of sedimentary materials; and

(3) Except for natural gas, nonflammable.

(c) Except as provided in § 192.505 (a), if air, natural gas, or inert gas is used as the test medium, the following maximum hoop stress limitations apply:

Maximum hoop stress allowed as percentage of SMYS

sures that each item manufactured is at least equal in strength to a prototype and that the prototype was tested to at least the pressure required for the pipeline to which it is being added.

(e) For fabricated units and short sections of pipe, for which a post installation test is impractical, a preinstallation strength test must be conducted by maintaining the pressure at or above the test pressure for at least 4 hours.

§ 192.507 Test requirements for pipelines to operate at a hoop stress less than 30 percent of SMYS and above 100 p.s.i.g.

Except for service lines and plastic pipelines, each segment of a pipeline that is to be operated at a hoop stress less than 30 percent of SMYS and above 100 p.s.i.g. must be tested in accordance with the following:

(a) The pipeline operator must use a

p.s.i.g., except that each segment of a steel service line stressed to 20 percent or more of SMYS must be tested in accordance with § 192.507 of this subpart.

§ 192.513 Test requirements for plastic pipelines.

(a) Each segment of a plastic pipeline must be tested in accordance with this section.

(b) The test procedure must insure discovery of all potentially hazardous leaks in the segment being tested.

(c) The test pressure must be at least 150 percent of the maximum operating pressure or 50 p.s.i.g., whichever is greater. However, the maximum test pressure may not be more than three times the design pressure of the pipe.

(d) The temperature of thermoplastic material must not be more than 100° F. during the test.

§ 192.515 Environmental protection and

Columbia Gas of Pennsylvania (A NiSource Company) Standards for Customer Service Lines, Meters and Service Regulators
https://www.columbiagaspa.com/docs/default-source/pdf's/plumbers-guide.pdf

- A.4.3 Requires for plastic pipe test pressure of **90 psig**

Pennsylvania Construction Code Act (35 P. S. § § 7210.101—7210.1103). Title 34—LABOR AND INDUSTRY under the DEPARTMENT OF LABOR AND INDUSTRY includes PART XIV. Uniform Construction Code Chapters 401 AND 403. (Customer’s service lines of which are past the delivery point are subject to the Pennsylvania Construction Code)

Dormont Borough Council, for example adopted the IBC, International Building Code, Act 45 (2009 Edition).

- 101.4.1 Gas. The provisions of the International Fuel Gas Code shall apply to the installation of gas piping from the **point of delivery**, gas appliances and related accessories as covered in this code.

- "406.4.1 Test pressure. The test pressure to be used shall be no less than 1 and 1/2 times the proposed maximum working pressure, (that is .**5 PSI**) **but not less than 3 psig** (20 kPa gauge), irrespective of design pressure. https://up.codes/s/inspection-testing-and-purging **(Columbia Gas of Pennsylvania / NiSource requires in their test methods of other's property to be tested 30 times applicable code.)**

Columbia's Tariff -- 8.4 Ownership and Maintenance -- The Company shall own, maintain, and renew, **when necessary**, its main extension and/or service line from its main to the **point of delivery**, as defined in Rule 7.1. (outlet side of the curb valve, or the property or lot line if there is no curb valve)

Observations and Conclusions:

- **Columbia's proposed 17.84 percent increase (could be as high as 19.09 if sales tax applies) is outrageous and unreasonable, thus unlawful.**
- **Proportionally most NiSource customers are responsible less than half of what of the rate base is in Pennsylvania**

Utility -- State	~ No. of Customers (In 000)	Miles of Pipe	Calculated Miles of pipe per customer	Miles of Bare Steel and Cast Iron	Rate Base ($ 000,000)	Calculated Rate Base Per Customer $
NIPSCO	840	17500	.020	23*	1700	**2024**
COH	1500	20200	.013	2000	3200	2133
CMD	34	660	.018	50	149	4382
CPA	436	7700	.018	1200	1900	**4358**

The differences between what has occurred in Indiana and Ohio and what has occurred in Pennsylvania and Maryland are significantly different. The Pennsylvania Public Utilities Commission needs to find out why … it is their duty and the public needs to know.

- **The concept of accelerated spending is counter to Federal and state laws and regulations.**
- **Accelerated spending may not be necessary spending.**
- **The Tariff 8.4 allows Columbia to only renew mains and service lines only when necessary.**
- **Columbia intends to increase spending and rates to customers in the coming years.**
- **NiSource believes it has opportunities to spend $30 Billion more on infrastructure while having a current rate of $9.2 Billion**
- **These types of increases are not in the public interest and will push more customers to seek public assistance and will diminish the quality of life of customers and property owners.**
- **There is no reasonable assurance that this amount of spending is necessary.**
- It does not appear anyone is watching the store on Columbia spending.

- The PUC does not audit Columbia's books, records, and performance in accordance with the GAO Yellow Book as require by the Governor's Directive.
- The NiSource external public accounting firm does not audit in accordance with the GAO Yellow Book, Federal requirement (2 CFR 200) and Pennsylvania requirements.
- There is no reasonable assurance that the rate base is comprised of just "the value of the whole or any part <u>of the property of a public utility</u> **which is used and useful in the public service**."
    - The repair of public streets and the rearrangement of dirt are period cost as they are not owned by the utility.
    - Replacement of customer's service lines are not utility property and are donations – thus unallowable.

- NiSource/ Columbia Gas of Pennsylvania has adopted and is subject to the COSO Internal Control Framework per the claims of management, but Columbia provides no reasonable assurance of compliance with the internal control framework in the areas of **effective and efficient operations**, **reliable reporting** and **compliance with laws and regulations.**
- Columbia Gas of Pennsylvania, Inc. 2020 General Rate Case Docket No. R-2020-3018835 Standard Filing Requirements Testimony – All Volume 10 of 10 (514 pages) In this large document there is <u>no inclusion of the terms: internal controls, effective and efficient operations reliable reporting.</u>
    - There are a few mentions of compliance with laws and regulations. One for example Vice President of Construction Services "My responsibilities include: … Assuring construction is in compliance with Federal, State and local regulations as well as in alignment with industry best practices;"
    - As shown, NiSource is not in compliance with some to the most basic requirements such as test pressure on plastic lines. DOT Safety Standards 49 CFR § 192.513 Test requirements for plastic pipelines of which has been in effect for fifty years 50 P.S.I. maximum vs. Columbia's requirement of 90 P.S.I. and for customer's service line subject to the International Fuel Gas Code it is 3 P.S.I. **(Columbia should know by now overpressureization is dangerous for people and harmful to property.)**
    - In an organization, if it is publicly transparent that the most basic requirements are not performed per standard, this reflects upon other requirements not publicly transparent … everything becomes suspect.
    - Regardless what this person and others state about Columbia's compliance program there is no assurance that it is effective – on the contrary the most basic requirement of test pressure on plastic pipe has been wrong for fifty years (50 vs.90 psig) and for customer's service lines 3 vs. 90 psig.) nothing in internal operations can be trusted.

      How can so many be so wrong for so long on important requirements?

    - There is significant misalignment in getting things right. An ethics report regarding test pressure does not go the ethics officer or the V.P. of Construction to investigate and resolve, it goes to **executive vice president and chief legal officer … either no one has reported the non-compliance with Government regulation or the executive vice president and chief legal officer does not investigate and correct such non-compliances. Internal and external investigations should find out.**

- Processing and investigating rate cases requires due diligence. Once a sister company has plead guilty to criminal conduct, heightened due diligence must be exercised. When the parent company of has also signed a **deferred prosecution agreement** (DPA) it would be reckless not to look for the same and other weakness and deficiencies in Pennsylvania.
    - From the Department of Justice : "CMA disregarded the known safety risks related to control lines, and instead focused on the timely completion of construction projects **to maximize earnings** under the company's GSEP. https://www.justice.gov/usao-ma/victim-and-witness-assistance-program/united-states-v-bay-state-gas-company-dba-columbia-gas-massachusetts
    - If the Massachusetts PUC had discovered the deficiencies and weakness in with the operations of Columbia prior to the disaster it is reasonably certain they would have tried to prevent what occurred.
- In that NiSource companies operate under the same general policies and perhaps culture, now it is urgent that the PA PUC to investigate and find out the risks for financial and non-financial activities of Columbia Gas of Pennsylvania and force corrections prior to another explosion.
- Columbia Gas had operational deficiencies for a long time and has avoided the discipline and management approach of good companies. Adopting API 1173 is a good step. But Columbia must come clean, API 1173 is no longer a recommendation practice, but a requirement NiSource has committed to with the NTSB and the state of Massachusetts. Columbia Gas of Pennsylvania is certainly not an early adopter of this 2015 issued standard. They certainly knew the details and knew that they were not operating to the standard.

  A Corrective Action Program should have been adopted about twenty years with the adoption of od standard ISO 9000 Quality Management. Companies that have adopted ISO 9000 frequently have – system for corrective actions and continuous improvement – Corrective Action Request, (CAR) Corrective Action Plan (CAP), which is used to address the CAR. These systems should be designed to be non-threatening and non-punitive.

- Columbia is in a very weak position to pass a GAO Yellow Book Audit, a GAO Internal Control Audit and API 1173 assessment. As such Columbia should not be submitting this rate case until they can provide reasonable assurance of effective internal controls consistent with top management's assertion in the NiSource 10-K "Our management has adopted the 2013 framework set forth in the Committee of Sponsoring Organizations of the Treadway Commission report, Internal Control - Integrated Framework,". That assertion does not appear to be true for Columbia Gas of Pennsylvania. If it is not, the NiSource Deferred Prosecution Agreement may no longer be deferred.
- The Pennsylvania Public Utilities Commission is in a similar condition. There is no evidence that the Commission has adopted the GAO Yellow Book and the GAO Green Book as required by the Governor's Directives and 2 CFR 200 - UNIFORM ADMINISTRATIVE REQUIREMENTS, COST PRINCIPLES, AND AUDIT REQUIREMENTS FOR FEDERAL AWARDS CFR 200

  The Commission has no reasonable assurance of internal controls within its own operations let alone the operations of Columbia Gas of Pennsylvania. It would we reckless for both organizations to proceed with this rate case.

- We all have the burden of knowing.

I hope Columbia Gas will withdraw this rate case for their own benefit and the people of Pennsylvania and focus on self-correction. "If you do what you've always done, you always get what you've always gotten"

I thank you for your time. May we all fulfil our duties and abide by our oaths.

Richard C Culbertson

https://www.columbiagaspa.com/our-company/news-room/article/columbia-gas-of-pennsylvania-files-request-for-investment-in-safety-through-replacing-and-upgrading-aging-infrastructure-cpa

April 24, 2020

Columbia Gas of Pennsylvania Files Request for Investment in Safety Through Replacing and Upgrading Aging Infrastructure

Columbia Gas of Pennsylvania, Inc., a subsidiary of NiSource Inc. (NYSE: NI), filed a request today with the Pennsylvania Public Utility Commission (PA PUC) to approve revised rates for further upgrading and replacement of the company's underground natural gas distribution pipelines. If approved, these proposed rate adjustments would not go into effect until 2021.

Columbia Gas is committed to upgrading aging infrastructure and replaces an average of 115 miles of pipeline every year. As part of its long-term plan to modernize and expand its natural gas distribution system, Columbia Gas has invested more than $2.2 billion in Pennsylvania over the past decade and plans to continue to invest in infrastructure replacement for the safety of its communities. Economic development of the 26-county area that Columbia Gas serves benefits greatly from this investment.

This filing is the first rate revision request by Columbia Gas in over two years.

Response to COVID-19

With the communities we serve in mind and in response to COVID-19, Columbia Gas has suspended shutoffs for nonpayment for residential and commercial customers. That suspension will remain in effect until further notice. Columbia Gas offers a wide

R-2020-3018835
7/8/20
Exhibit-2

array of customer assistance and energy efficiency programs that provide resources and tools for customers to save money and energy.

"We want to assist our customers during the COVID-19 pandemic," said Columbia Gas President and Chief Operating Officer Mike Huwar , "With that in mind, we are offering our most flexible payment plans to customers who have been impacted or are experiencing hardship as a result of COVID-19, and we are suspending late payment charges until at least June 1."

At all times, Columbia Gas is committed to providing our low-income customers with the tools, resources, and programs to stay safe and warm in their homes. These programs help customers mitigate the impact of a rate adjustment or financial changes due to economic conditions.

Customer Assistance Initiative

In order to assist Columbia Gas's residential customers who are experiencing a loss of income due to the pandemic, but are not eligible to participate in the company's existing assistance programs, Columbia Gas is seeking to implement a temporary program that will provide grants to customers in need. To achieve this, Columbia Gas has filed a petition with the PA PUC requesting authority to use a portion of pipeline penalty credits and refunds that the PA PUC has previously approved for hardship funds, matched by a contribution from the NiSource Charitable Foundation, to fund the grants.

Review Process by PA PUC

Columbia Gas made its decision to file a request for a rate adjustment nearly one year ago, and the company notified the PA PUC in February of its intent to file such a request. While the company filed its request with the PA PUC today, April 24, 2020, it is important to note that after filing for a rate adjustment, the review process by the PA

PUC will take approximately nine months. As a result, in this case, any approved and adjusted rates by the PA PUC would not go into effect until 2021.

In today's filing, Columbia Gas is seeking an annual revenue increase of approximately $100.4 million. Approval of the proposal would result in the average total bill for a residential customer who purchases 70 therms of gas per month from Columbia Gas to increase from $87.57 to $103.19 per month, or by 17.84 percent. The total bill for a small commercial customer purchasing 158 therms of gas from Columbia Gas per month would increase from $145.15 to $167.77, or by 15.58 percent. Rates for a small industrial customer purchasing 1,328 therms of gas from Columbia Gas per month would increase from $999.04 to $1,124.93 per month, or by 13.17 percent.

If the request is approved as filed, the total average residential customer bill in 2021 would still be more than 28 percent lower than it was in 2010, when adjusted for inflation.

How Customers Can Participate in the Rate Review Process

It is important to note that the rate review process is very public. Anyone interested in the case can participate by reaching out to the PUC, and we encourage active involvement by our customers and any interested parties. Customers can participate in the rate review process in multiple ways, including through written comments, attendance at public hearings, and various consumer advocacy organizations that participate in the proceedings.

Customers with questions regarding the proposed rates may call Columbia Gas at 1-888-460-4332 or visit ColumbiaGasPA.com for more information.

"Our nearly 800 fulltime employees and 1,500 contractors are proud of our pipeline replacement program and our ability to continue to serve our valued customers safely and reliably," said Huwar. "We also remain committed to providing a positive customer experience through an educated and trained workforce that is focused on safely meeting or exceeding all federal and state requirements while operating, upgrading and expanding our distribution system."

NYSE: NI$22.35**+0.02**
4:00 PM | JUN 26, 2020
https://investors.nisource.com/company-information/default.aspx

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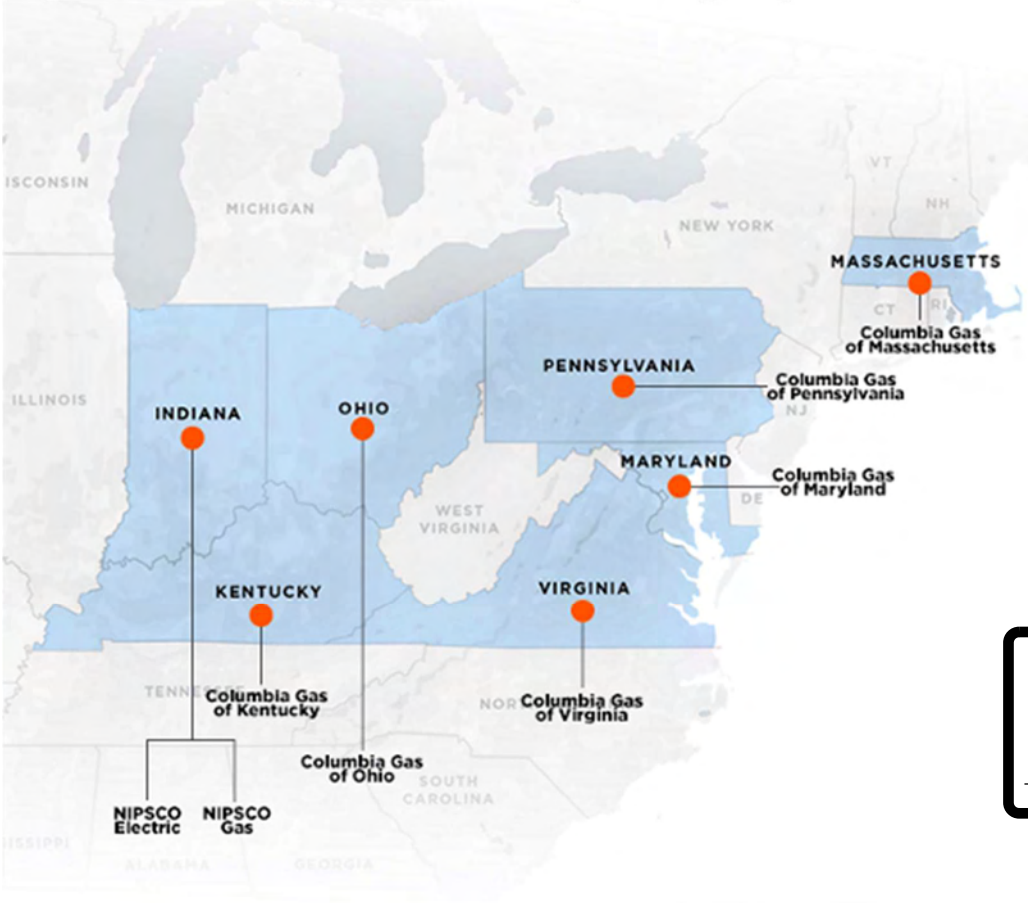
COMPANY INFORMATION

A premier regulated utility company



R-2020-3018835
7/8/20
Exhibit-3

We're one of the largest natural gas utility companies in the United States, serving more than 3.5 million customers in seven states under the Columbia Gas and NIPSCO brands. The company also provides electric distribution, generation and transmission services to nearly 500,000 NIPSCO electric customers in northern Indiana.

Our **growth strategy focuses on the systematic modernization and replacement of its utility infrastructure,** paired with complementary system expansions, customer programs and regulatory initiatives. Under this strategy, the company is investing in

electric system environmental upgrades and transmission expansions; **natural gas system replacements** and expansions; and enhancement of customer services.

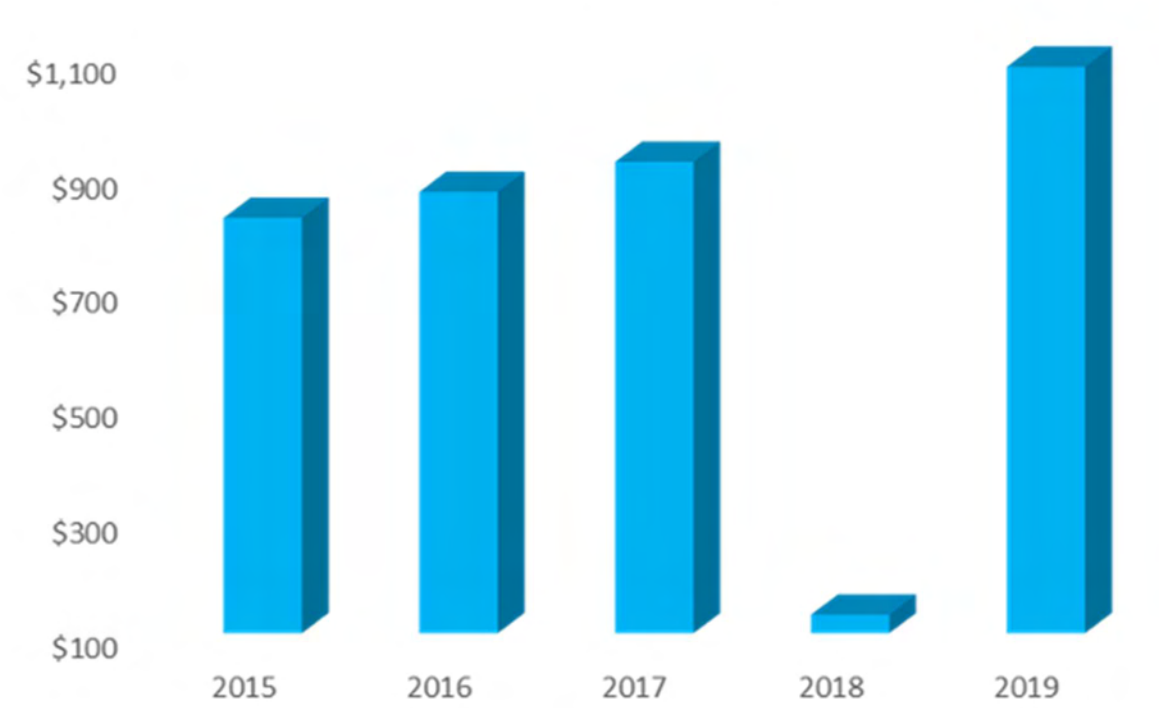
Our core business strategy is expected to drive stable long-term earnings and dividend growth, supported by stable revenue streams, contemporary rate designs and approximately **$30 billion in infrastructure investment opportunities** spanning the **next 20-plus years.**

Significant Scale Across Seven States

- ~3.5M Gas LDC Customers
- **~$9.2B Gas LDC Rate Base**
- ~500K Electric Customers
- $4.7B Electric Rate Base

CAPITAL INVESTMENT DRIVES GROWTH, CUSTOMER BENEFITS

HISTORICAL OPERATING INCOME** ($ MILLIONS)



** Historical NiSource Gas Distribution and Electric Operations Reported Operating Income

VALUE PROPOSITION AND STRATEGIC APPROACH

Annual Total Shareholder Return of 8%-10%*

- ~$30B of 100% Regulated Utility Infrastructure Investment Opportunities
- Scale Across Seven States
- Transparent Earnings and Cash Flow Drivers
- Constructive Regulatory Relationships and Mechanisms
- Commitment to Investment Grade Credit

*Estimated total shareholder return at a constant P/E ratio

Delivering on our Commitments

- Industry-Leading Safety and Performance
- Top-Tier Customer Satisfaction
- Investments that Systematically and Efficiently Deliver Service Integrity
- Dependable, Predictable and Timely Service and Emergency Response
- Growing Our Customer Base by Expanding into Unserved Areas
- Recognized Among the Best Places to Work by All in Our Communities

COMPANY FACTS

Columbia Gas of Kentucky

- Second Largest Gas-Only local distribution company (LDC) in KY (~137K Customers)
- ~ 2,600 Miles of Pipe
- ~ 350 Miles of Bare Steel & Cast Iron
- ~ $327M Rate Base

Columbia Gas of Maryland

- Complementary to PA Operations (~34K Customers in MD)
- ~ 660 Miles of Pipe
- ~ 50 Miles of Bare Steel & Cast Iron
- ~ $149M Rate Base

Columbia Gas of Massachusetts

- Largest Gas-Only LDC in MA (~327K Customers)
- ~ 5,000 Miles of Pipe
- ~ 540 Miles of Bare Steel & Cast Iron
- ~ $1.1B Rate Base

Columbia Gas of Ohio

- Largest LDC in Ohio (~1.5M customers)
- ~ 20,200 Miles of Pipe
- ~ 2,000 Miles of Bare Steel & Cast Iron
- ~ $3.2B Rate Base

Columbia Gas of Pennsylvania

- Third Largest LDC in PA (~436K Customers)
- ~ 7,700 Miles of Pipe
- ~ 1,200 Miles of Bare Steel & Cast Iron
- ~ $1.9B Rate Base

Columbia Gas of Virginia

- Third Largest LDC in VA (~274K Customers)
- ~ 5,300 Miles of Pipe
- ~ 140 Miles of Bare Steel
- ~ $850M Rate Base

Indiana Electric (NIPSCO)

- Third Largest Electric Utility in Indiana (~475K Customers)
- 2,850 MW of Environmentally Compliant Generation
- ~10,000 Distribution Line Miles
- ~3,000 Transmission Line Miles
- ~ $4.7B Rate Base

Indiana Gas (NIPSCO)

- Largest LDC in Indiana (~840K Customers)
- ~ 17,500 Miles of Pipe
- ~ 23 Miles of Bare Steel & Wrought Iron
- ~ $1.7B Rate Base

FORWARD-LOOKING STATEMENTS

This web page contains “forward-looking statements” within the meaning of federal securities laws. Investors and prospective investors should understand that many factors govern whether any forward-looking statement contained herein will be or can be realized. Any one of those factors could cause actual results to differ materially from those projected. These forward-looking statements include, but are not limited to, statements concerning our plans, strategies, objectives, expected performance, expenditures, recovery of expenditures through rates, stated on either a consolidated or segment basis, and any and all underlying assumptions and other statements that are other than statements of historical fact. All forward-looking statements are based on assumptions that management believes to be reasonable; however, there can be no assurance that actual results will not differ materially. Factors that could cause actual results to differ materially from the projections, forecasts, estimates and expectations discussed on this web page include among other things, our debt obligations; any changes to our credit rating or the credit rating of certain of our subsidiaries; our ability to execute our growth strategy; changes in general economic, capital and commodity market conditions; pension funding obligations; economic regulation and the impact of regulatory rate reviews; our ability to obtain expected financial or regulatory outcomes; our ability to adapt to, and manage costs related to, advances in technology; any changes in our assumptions regarding the financial implications of the Greater Lawrence Incident; compliance with the agreements entered into with the U.S. Attorney’s Office to settle the U.S. Attorney’s Office’s investigation relating to the Greater Lawrence Incident; the pending sale of the Columbia of Massachusetts business, including the terms and closing conditions under the Asset Purchase Agreement; potential incidents and other operating risks associated with our business; continuing and potential future impacts from the COVID-19 pandemic; our ability to obtain sufficient insurance coverage and whether such coverage will protect us against significant losses; the outcome of legal and regulatory proceedings, investigations, incidents, claims and litigation; any damage to our reputation, including in connection

with the Greater Lawrence Incident; compliance with applicable laws, regulations and tariffs; compliance with environmental laws and the costs of associated liabilities; fluctuations in demand from residential commercial and industrial customers; economic conditions of certain industries; the success of NIPSCO's electric generation strategy; the price of energy commodities and related transportation costs; the reliability of customers and suppliers to fulfill their payment and contractual obligations; potential impairment of goodwill; changes in taxation and accounting principles; the impact of an aging infrastructure; the impact of climate change; potential cyber-attacks; construction risks and natural gas costs and supply risks; extreme weather conditions; the attraction and retention of a qualified workforce; the ability of our subsidiaries to generate cash; our ability to manage new initiatives and organizational changes; the performance of third-party suppliers and service providers; changes in the method for determining LIBOR and the potential replacement of the LIBOR benchmark interest rate; and other matters in the “Risk Factors” section of our Annual Report on Form 10-K for the fiscal year ended December 31, 2019 and subsequent SEC filings. A credit rating is not a recommendation to buy, sell or hold securities, and may be subject to revision or withdrawal at any time by the assigning rating organization. In addition, dividends are subject to board approval. All forward-looking statements are expressly qualified in their entirety by the foregoing cautionary statements. We undertake no obligation to, and

expressly disclaim any such obligation to, update or revise any forward-looking statements to reflect changed assumptions, the occurrence of anticipated or unanticipated events or changes to the future results over time or otherwise, except as required by law.

REGULATION G DISCLOSURE STATEMENT

This web page includes financial results and guidance for NiSource Inc. with respect to net operating earnings and operating earnings, which are non-GAAP financial measures as defined by the SEC’s Regulation G. NiSource Inc. includes such measures because management believes they permit investors to view NiSource Inc.'s performance using the same tools that management uses and to better evaluate NiSource Inc.'s ongoing business performance. With respect to such guidance, it should be noted that there will likely be differences between such measures and GAAP equivalents due to various factors, including, but not limited to, fluctuations in weather, asset sales and impairments, and other items included in GAAP results. NiSource Inc. is not able to estimate the impact of such factors on GAAP earnings and, as such, is not providing earnings guidance on a GAAP basis.

CORPORATE HEADQUARTERS

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Merrillville, IN 46410 Map

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Events & Presentations

R-2020-3018835
7/8/20

Exhibit-4

Pipeline Safety Management Systems

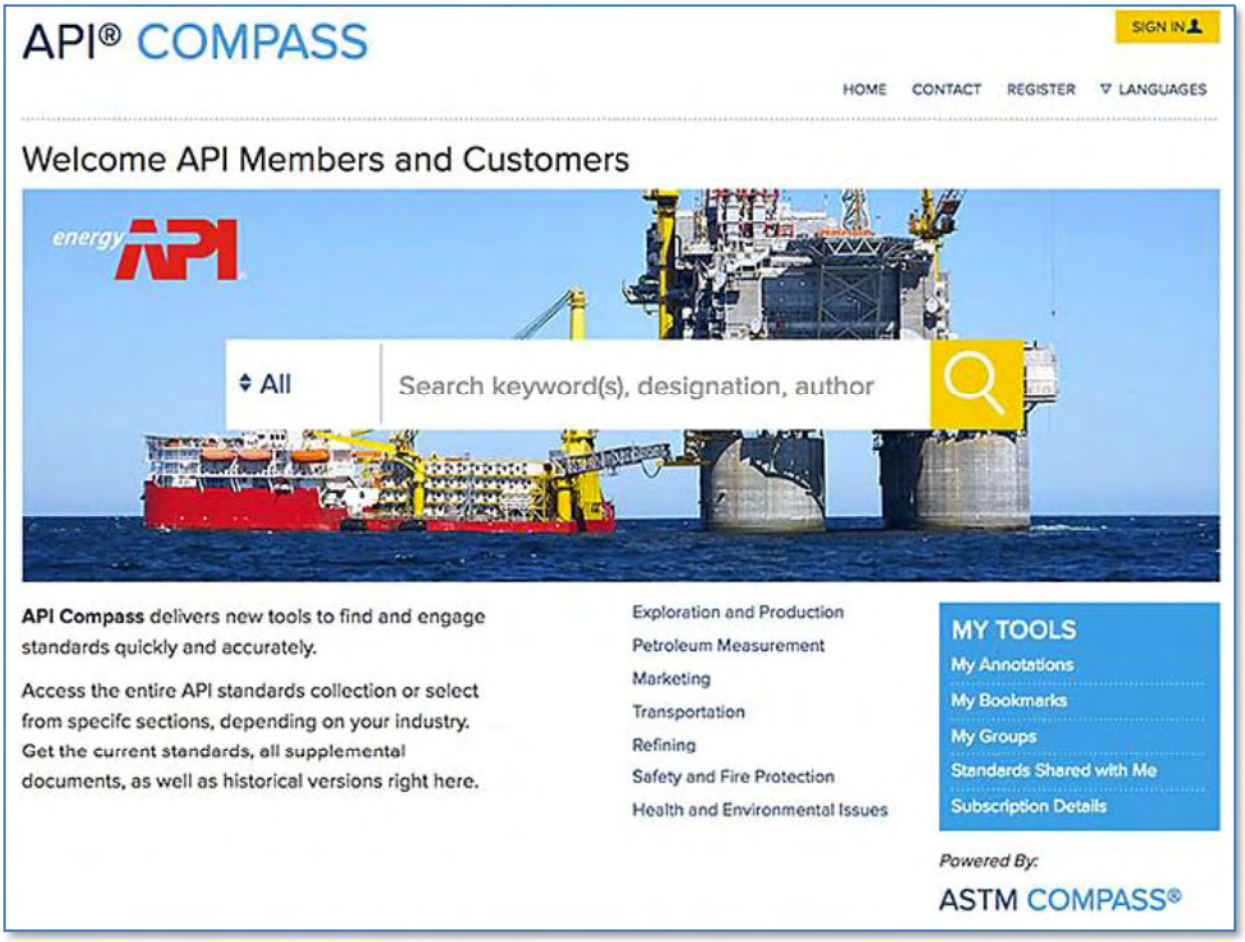
ANSI/API RECOMMENDED PRACTICE 1173
FIRST EDITION, JULY 2015

energy API
AMERICAN PETROLEUM INSTITUTE

ANSI

API Compass®

One Platform. All of Your Content.



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Suggested revisions are invited and should be submitted to the Standards Department, API, 1220 L Street, NW, Washington, DC 20005, standards@api.org.

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Introduction

This Recommended Practice (RP) provides guidance to pipeline operators for developing and maintaining a pipeline safety management system (PSMS). The elements of this RP are structured to minimize nonconformity with other pipeline safety processes and procedures. While this RP may include some elements of other management systems (such as those particular to environmental management, occupational health, personnel safety management, financial management, or insurance risk management), it does not include all requirements specific to those systems. This RP may be used either in conjunction with or independent of other industry-specified documents. Finally, this RP builds upon and augments existing requirements and is not intended to duplicate requirements of any other consensus standards or regulations.

Managing the Safety of Complex Processes

Safe and effective pipeline operation requires awareness and management of many linked activities, yielding complex processes. Examples of such activities include designing, constructing, operating, and maintaining the pipeline. Major accidents with high consequences rarely occur but when they do, the accident occurs because of an alignment of weaknesses or failures across multiple activities. While safety efforts may be applied individually to each activity, more effective safety performance is achieved when viewing the linked activities as processes that are better dealt with holistically.

Managing processes requires different techniques than managing individual activities. Pipeline safety management includes determining needs throughout the pipeline life cycle, provisioning sufficient qualified human and financial resources, identifying the proper sequence of a series of activities, monitoring and measuring the effectiveness of the activities performed, and applying changes or corrections to those activities as needed.

Safety Management Systems

Managing the safety of a complex process, as well as simpler systems, requires coordinated actions to address multiple, dynamic activities and circumstances. Pursuing the industry-wide goal of zero incidents (see Note 1) requires comprehensive, systematic effort. While process-related incidents are relatively infrequent, they can lead to serious consequences. The elements of a safety management system address ways to continually (see Note 2) operate safely and improve safety performance.

NOTE 1 Incident as used in this RP applies to both incidents as defined in 49 *CFR* 192.3 and accidents as defined in 49 *CFR* 195.2.

NOTE 2 "Continuous" is used to indicate constant; "continual" is used to indicate periodic or incremental. "Continuous improvement" is used so widely and is used herein even where improvement is periodic or continual.

The following principles comprise the basis of this safety management system recommended practice.

a) Commitment, leadership, and oversight from top management are vital to the overall success of a PSMS.

b) A safety-oriented culture is essential to enable the effective implementation and continuous improvement of safety management system processes and procedures.

c) Risk management is an integral part of the design, construction, operation and maintenance of a pipeline.

d) Pipelines are designed, constructed, operated, and maintained in a manner that complies with Federal, state, and local regulations.

e) Pipeline operators conform to applicable industry codes and consensus standards with the goal of reducing risk, preventing releases, and minimizing the occurrence of abnormal operations.

f) Defined operational controls are essential to the safe design, construction, operation, and maintenance of pipelines.

g) Prompt and effective incident response minimizes the adverse impacts to life, property, and the environment.

h) The creation of a learning environment for continuous improvement is achieved by investigating incidents thoroughly, fostering non-punitive reporting systems, and communicating lessons learned.

i) Periodic evaluation of risk management effectiveness and pipeline safety performance improvement, including audits, are essential to assure effective PSMS performance.

j) Pipeline operating personnel throughout the organization must effectively communicate and collaborate with one another. Further, communicating with contractors to share information that supports decision making and completing planned tasks (processes and procedures) is essential.

k) Managing changes that can affect pipeline safety is essential.

Plan-Do-Check-Act

The above principles are applied in a recurring manner to achieve continuous assessment and improvement. The Plan–Do–Check–Act (PDCA) cycle is a four-step model for carrying out these efforts within ten elements (Figure 1). This methodology can be applied to the management system as a whole as well as to all individual elements and processes within the system. The PDCA principle is at the core of many management systems, and its principal aim is to encourage creating strategies and plans, executing those strategies and plans in line with guidelines, checking those actions for conformity, and using those results to adjust the next generation of plans. This cycle is iterative and is maintained to achieve continuous improvement.

There are inputs (e.g. data, information, and resources) to the processes within each element yielding a set of outputs (e.g. prioritized work that reduce risk and ultimately improve safety performance). The pipeline operator defines PSMS inputs and outputs within the execution of each of the essential elements. The pipeline operator defines these inputs and outputs for each of the elements to be described and, through the PSMS, reviews them periodically.

The PDCA cycle is useful when starting a new improvement project; when developing a new or improved design of a process, product, or service; or when defining a repetitive work process.

The PDCA cycle is also useful for the management system as a whole as a model for continuous improvement and when planning data collection and analysis, when selecting and prioritizing threats or causes, and when implementing any changes.

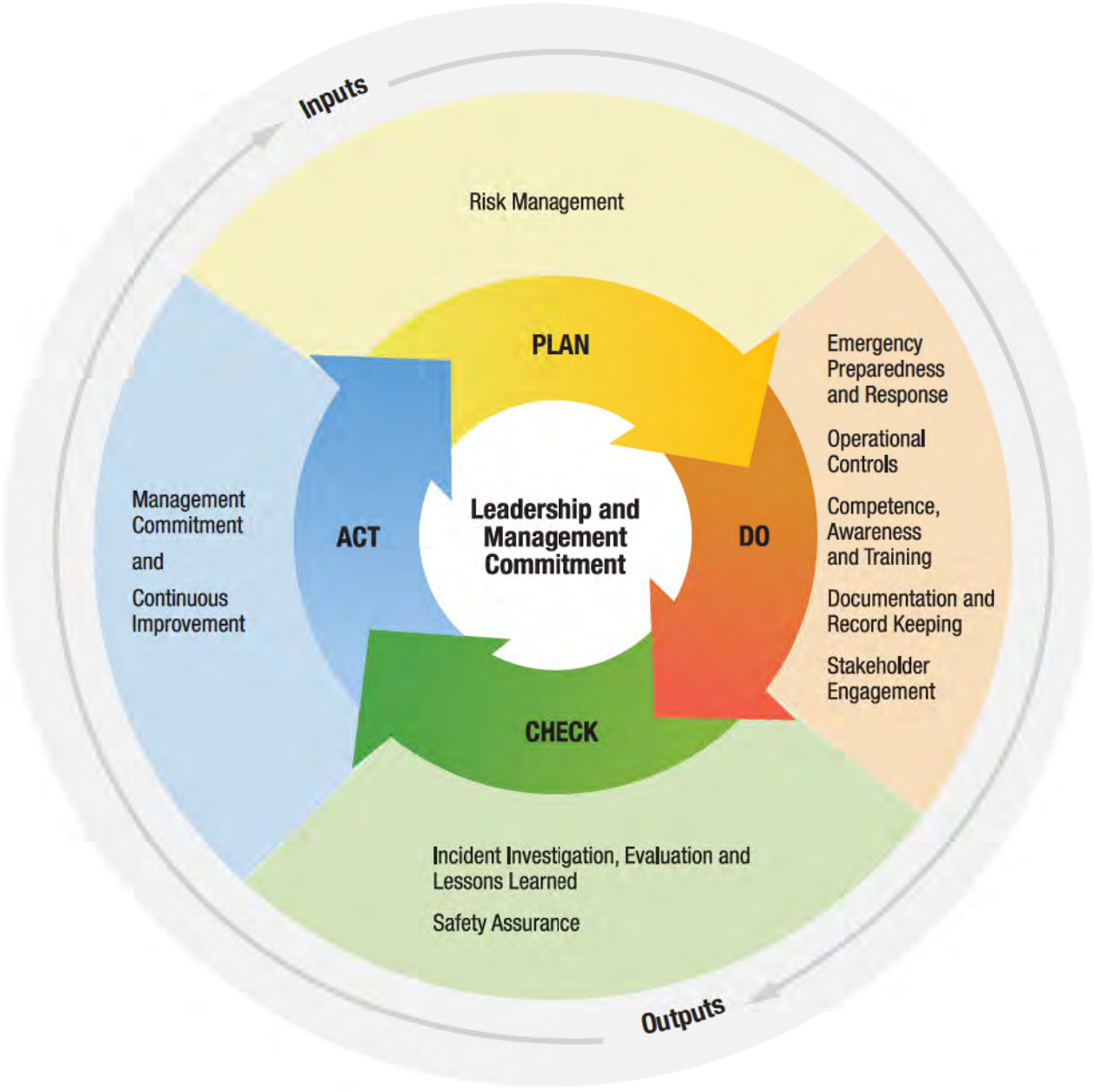
The components of the PDCA cycle are:

Plan: This step entails establishing the objectives and processes necessary to deliver results in accordance with the organization's policies and the expected goals. By establishing output expectations, the completeness and accuracy of the process is also a part of the targeted improvement.

Do: This step is the execution of the plan designed in the previous step.

Check: This step entails the review of the results compared with established objectives. Comparing those results to the expected goals to ascertain any differences; looking for deviation in implementation from the plan.

Act: This step is where a pipeline operator takes actions to continuously improve process performance, including corrective actions on significant differences between actual and planned results, analyzes the differences to determine their root causes, and determines where to apply changes that will include improvement of the process or product.



NOTE Elements to be identified in Section 4 that serve as the framework for this RP are depicted with PDCA. The placement of elements is provided as an example. The designation and placement of particular elements may differ among operators. Some elements bridge across multiple aspects of PDCA.

Figure 1—Plan–Do–Check–Act (PDCA) Cycle

Reflecting the cyclical nature of PDCA and the dynamic/evolutionary nature of the PSMS, the entire process begins again from the start. Each cycle through PDCA produces opportunities for improvement. In addition, the application of PDCA logic to individual elements within the process can provide similar insights and opportunities for improvement within that element.

Goal of this Document and its Safety Management System Framework

The goal of this document is to provide pipeline operators with a framework to review an existing PSMS or develop and implement a new PSMS. Newly developing or improving a PSMS will enhance effectiveness of risk management and enable continuous improvement of pipeline safety performance. Operators seeking to conform to this document will work to build upon existing safety processes and establish new safety processes. Operators should seek to mature their PSMS consistent with continuous improvement. Regardless of an operator's starting point relative to existing systems or processes, the iterative or cyclic nature of the approach described provides the opportunity for continuous improvement. While operators should seek to gain conformance with a sense of urgency, timeframes to reach significant and widespread maturity across all elements are measured in years. As a PSMS matures, it is subject to assessment and continuous improvement.

The framework builds upon an operator's existing pipeline safety management programs by drawing upon industry experiences, lessons learned, and existing standards. The intent of the framework is to comprehensively define elements that can identify, manage and reduce risk throughout the entirety of a pipeline's life cycle and, at the earliest stage, help prevent or mitigate the likelihood and consequences of an unintended release or abnormal operations.

NOTE "Pipeline" is defined in Section 3 to address, more broadly, pipeline systems.

Particular emphasis is placed on increased proactivity thinking of what can go wrong in a systemic manner, clarifying safety responsibilities throughout the pipeline operator's organization (including contractor support), the important role of top management and leadership at all levels, encouraging the non-punitive reporting of and response to safety concerns, and providing safety assurance by regularly evaluating operations to identify and address risks. These factors work together to make safety programs and processes more effective, comprehensive, and integrated.

Flexibility

The framework is to be applied with flexibility to account for the current state of development of particular elements of management systems within a company. In cases where an operator is already operating under its own comprehensive PSMS, this framework serves as a basis of comparison and review between the industry recommended practice and the operator's system. Other operators may have some number of individually established safety systems but no comprehensive PSMS. For them, this RP provides a means to integrate and add to those efforts to establish a comprehensive PSMS. Still other operators may have no formal safety systems. For those operators, adoption of the recommended framework would be a starting point to build a PSMS, while learning from more advanced operators. In all cases, operators are intended to have the flexibility to apply this RP as appropriate to their specific circumstances.

Scalability

The framework is also intended to be scalable for pipeline operators of varying size and scope. The number of employees at a liquid pipeline operator can range from a handful to thousands. A local gas distributor or municipal operator may have only a few employees. An interstate transmission pipeline company may have entire divisions of subject matter experts. The 10 essential elements comprising the framework apply to organizations of any size and sophistication. Specific application of those elements to the operations and processes of a given operator will reflect the scale of that operator. The framework elements and principles underlying it are broadly applicable, and strongly recommended, for energy pipeline operators of all sizes. It is the clear view of the committee generating this document that the level of detail in each pipeline operator's PSMS should be appropriate for the size of their operations and the risk to the public and the environment. For very small operators with a handful of employees, adoption of all provisions within this RP may not be practical. However, even small operators can build on selected provisions herein.

Safety Culture

A positive safety culture is essential to an organization's safety performance regardless of its size or sophistication. Safety culture is the collective set of attitudes, values, norms, beliefs, and practices that a pipeline operator's employees and contractor personnel share with respect to risk and safety. A positive safety culture is one where employees and contractor personnel collaborate; have positive attitudes towards compliance (meeting and exceeding minimum standards); feel responsible for public safety, and protection of the environment, for each other's safety, and for the health of the business; and fundamentally believe in non-punitive reporting.

Because of their number and complexity, pipeline operational activities with safety impacts are best managed cohesively and systematically using a PSMS rather than piecemeal using various, discrete processes and procedures. And, although a positive safety culture can exist without a formal PSMS, an effective PSMS cannot exist without a positive safety culture. Therefore, operators should actively work to assess and improve their safety cultures.

Maintaining a positive safety culture requires continual diligence throughout an organization to address issues including complacency, fear of reprisal, over confidence, and normalization of deviance. Examples of indicators of a positive safety culture within an organization are listed below.

The organization:

— embraces safety (personnel, public, and asset) as a core value;

— assures everyone understands the organization's safety goals;

— fosters systematic consideration of risk, including what can go wrong;

— inspires, enables, and nurtures change when necessary;

— allocates adequate resources to assure individuals can successfully accomplish their PSMS responsibilities;

— encourages employee engagement and ownership;

— fosters mutual trust at all levels, with open and honest communication;

— promotes a questioning and learning environment;

— reinforces positive behaviors and why they are important;

— encourages two-way conversations about learnings and commits to apply them throughout the organization; and

— encourages non-punitive reporting and assures timely response to reported issues.

Adopting and implementing a PSMS will strengthen the safety culture of an organization. Leaders, managers, and employees acting to make safety performance and risk reduction decisions over time will improve pipeline safety, thereby strengthening the safety culture of an organization. With this RP, operators are provided a framework to manage and reduce risk and promote continuous improvement in pipeline safety performance. The individual elements, when executed as deliberate, routine, and intentional processes, are designed to result in improved communication and coordination, which yield a cohesive system and a stronger safety culture.

Pipeline Safety Management Systems

1 Scope

This recommended practice (RP) establishes a pipeline safety management systems (PSMS) framework for organizations that operate hazardous liquids and gas pipelines jurisdictional to the US Department of Transportation. Operators of other pipelines may find this document applicable useful in operating to their systems.

This RP provides pipeline operators with safety management system requirements that when applied provide a framework to reveal and manage risk, promote a learning environment, and continuously improve pipeline safety and integrity. At the foundation of a PSMS is the operator's existing pipeline safety system, including the operator's pipeline safety processes and procedures. This RP provides a comprehensive framework and defines the elements needed to identify and address safety for a pipeline's life cycle. These safety management system requirements identify what is to be done, and leaves the details associated with implementation and maintenance of the requirements to the individual pipeline operators. The document does not explicitly address personnel safety, environmental protection, and security, but the elements herein can be applied to those aspects of an operation.

Information marked "NOTE" are not requirements but are provided for guidance in understanding or clarifying the associated requirement.

NOTE This document defines the requirements of a safety management system applicable to pipelines. When the document refers to a requirement of a safety management system, it can mean a requirement specified by this pipeline safety management system or another safety management system in use by an operator that meets the intent of this document.

2 Normative References

No other document is identified as indispensable or required for the application of this standard. A list of documents associated with API 1173 are included in the bibliography. The bibliography includes references a pipeline operator may consider in developing or improving a PSMS.

3 Terms, Definitions, Acronyms, and Abbreviations

3.1 Terms and Definitions

For the purposes of this document, the following definitions apply.

3.1.1
accountability
Answerable for the correct and thorough completion of work.

3.1.2
allocation
Assignment, distribution, or apportionment.

3.1.3
audit
An examination of conformity with this RP and implementation of the PSMS.

NOTE An audit may be performed by qualified external or internal personnel not involved in the operations being audited.

3.1.4
authority
Assigned power to control work by an organization, including power to delegate.

3.1.5
cascading failure
A failure in a system of interconnected parts in which the failure of a part can trigger the failure of successive parts.

3.1.6
conformance
Meets a specified requirement.

3.1.7
contractor
Person(s) doing work on behalf of the pipeline operator, including all levels of subcontractors.

3.1.8
corrective actions
The steps established either to correct nonconforming aspects of the PSMS identified during an audit or evaluation, or actions taken to manage threats recognized during day-to-day activities.

3.1.9
document [*noun*]
As used in this RP, written statement of requirements or record of actions taken and completion of requirements.

3.1.10
effective(ness)
Extent to which planned activities are completed and planned results achieved. [From BS EN ISO 9000:2005, 3.2.14.]

3.1.11
employee
A person who is employed by the pipeline operator.

3.1.12
evaluation
When used as an alternative to an audit in 10.2 (also see 5.6(d) which references audit and evaluation plans developed under requirements in Section 10), it is an assessment of the effectiveness of a pipeline operator's PSMS and progress made toward improving pipeline safety performance.

3.1.13
gas
Natural gas, flammable gas, or gas which is toxic or corrosive.

3.1.14
goal
Desired state or result.

3.1.15
hazardous liquids
Petroleum, petroleum products, highly volatile liquids, carbon dioxide, or anhydrous ammonia.

3.1.16
inspection
Demonstration through observation or measurement that an activity or condition conforms with specified requirements.

3.1.17
key performance indicator
KPI
Quantifiable measure that an organization uses to gauge or compare performance.

3.1.18
leadership
Establishing clear vision translated into policies and objectives; sharing them with others so they will follow willingly; providing information, knowledge, and methods to realize the objectives; and coordinating and balancing competing interests of all stakeholders; also used collectively to refer to those persons, at any level in the organization, who provide these functions.

3.1.19
legal requirement
Statutory or regulatory obligations imposed on a pipeline operator.

3.1.20
management [*noun*]
Person or group of people, as defined by the pipeline operator, who directs and controls all or part of a facility, location, department, or other function; has fiscal responsibility for the organization; and is accountable for compliance with legal and other applicable requirements.

NOTE For some pipeline operators, top management and management are the same.

3.1.21
management system
A framework of elements that an organization uses to direct and control work to achieve its objectives in an intentional and continual manner.

3.1.22
maturity
A point at which the safety management system has become embedded into the processes of an organization and planned activities are completed and planned results achieved regularly, without gaps.

3.1.23
maturity model
A description of the levels of a maturity continuum and the characteristics, attributes, indicators or patterns associated with each stage.

3.1.24
near-miss
An unplanned sequence of events that could have resulted in harm or loss if the conditions were different or if the events were allowed to progress. [From the Center for Chemical Process Safety, Risk-Based Process Safety.]

3.1.25
non-punitive reporting
Acting to encourage employees and contractor personnel to report noncompliance with regulations, non-conformance with procedures, and human errors without fear of punishment or disciplinary action, only punishing a person when he/she acts in a reckless manner; demonstrates a pattern of carelessness or noncompliance; or puts oneself, their co-workers, the public, or the pipeline at risk by intentionally violating essential safety rules.

3.1.26
objective
Subordinate step that supports a goal.

3.1.27
organization
A group of people and facilities with an arrangement of responsibilities and authorities; united for the purpose of operating a pipeline.

3.1.28
outsource
Function or process that is performed by a contractor on behalf of the operator.

3.1.29
pipeline
That which includes physical facilities through which hazardous liquids or gas moves in pipeline transportation, including pipe, valves, fittings, flanges (including bolting and gaskets), regulators, pressure vessels, pulsation dampeners, relief equipment, and other appurtenances attached to pipe, pumps and compressor units, metering stations, regulator stations, and fabricated assemblies. [Adapted from ASME B31.4 and B31.8 definitions.]

3.1.30
pipeline operator
Organization that operates a pipeline.

3.1.31
pipeline safety
Protection of the public, employees, and pipeline against the consequences of physical failure, human error, organizational failure, damage, or other undesirable events.

3.1.32
procedure
Documented method that is followed to perform an activity under controlled conditions to achieve conformity to specified requirements.

3.1.33
process
A series of interrelated or interacting activities or steps with anticipated outputs applied in operation of a pipeline.

3.1.34
record (noun)
Document providing evidence of activities performed or results achieved.

3.1.35
responsibility
Obligation to complete work.

3.1.36
risk
Situation or circumstance that has both a likelihood of occurring and a potentially negative consequence; the product of likelihood of failure and consequence.

3.1.37
risk analysis
Methodology for predicting the likelihood and consequence of a threat or threats to the pipeline system.

3.1.38
risk management
Systematic application of management policies, processes, procedures, finite financial and human resources, and practices to the tasks of identifying, analyzing, assessing, applying prevention practices, and mitigating risk in order to protect employees and contractor personnel, the general public, the environment, and the pipeline.

3.1.39
resources
Infrastructure, technology, equipment, materials, personnel with specialized skills, and financial resources that are applied to achieve objectives.

3.1.40
safety assurance
Demonstration of the proper application of the PSMS and progress toward effective risk management and improved pipeline safety performance.

3.1.41
safety culture
The collective set of attitudes, values, norms, beliefs, and practices that an operator's employees and contractor personnel share with respect to risk and safety.

3.1.42
service
Performance of an activity by one function or organization for another.

3.1.43
stakeholder
Person or organization (internal or external) who participate in and/or benefit from the processes established to implement and execute an effective PSMS.

3.1.44
system
An integrated set of elements, including people, hardware, software, information, procedures, facilities, services, and support facets, that are combined in an organizational or support environment to accomplish a defined objective.

3.1.45
target
Desired KPI value or measurable indication of achievement of an objective.

3.1.46
threat
A condition that could cause harm to a pipeline; the operator's personnel and contractors; or the organizational culture.

3.1.47
top management
A person or group of people, as defined by the operator, who direct and control the organization at the highest level.

NOTE Top management can include an organization's chairman, president, executive director, city manager, and their direct reports.

3.2 Acronyms and Abbreviations

For the purposes of this document, the following acronyms and abbreviations shall apply.

KPI	key performance indicator
MOC	management of change
PDCA	plan-do-check-act
PSMS	pipeline safety management system

4 Essential Pipeline Safety Management System (PSMS) Elements

The essential elements for this RP include the following:

1) leadership and management commitment (Section 5);
2) stakeholder engagement (Section 6);
3) risk management (Section 7);
4) operational controls (Section 8);
5) incident investigation, evaluation, and lessons learned (Section 9);
6) safety assurance (Section 10);
7) management review and continuous improvement (Section 11);
8) emergency preparedness and response (Section 12);
9) competence, awareness, and training (Section 13);
10) documentation and record keeping (Section 14);

NOTE At the operator level, these elements may not appear distinctly in a single document but should be identifiable in a clear and mandated process within the operator's procedures.

5 Leadership and Management Commitment

5.1 General

The pipeline operator shall establish and maintain a PSMS and build a shared understanding of safety culture. Top management shall communicate expectations by documenting the pipeline operator's policies, goals, and commitment to safety, as well as identifying safety responsibilities of personnel at all levels. The pipeline operator shall improve upon the PSMS and measure its effectiveness and maturity in accordance with the requirements of this document.

5.2 Goals and Objectives

Top management shall establish goals and objectives for its PSMS. The objectives shall be measurable and consistent with overall safety policies and objectives. Top management shall also create a culture within the

organization that encourages openness and two-way dialogue so learnings from incidents and events can ultimately reduce the risk of recurrence. The health of this culture should be assessed and leadership commitment needs to be visible to address areas of concern and opportunity.

5.3 Planning

Management shall ensure that:

a) processes and procedures are defined to support execution of each PSMS element;

b) a process is defined to address regulatory and legislative requirements for pipeline safety and the impact on the PSMS;

c) plans, processes, and procedures are integrated to ensure that data, results, and findings are shared across relevant elements, processes, teams, employees, and contractors; and

d) budgets and resource planning, including for personnel and supporting technology requirements, are developed to design, implement, and improve the PSMS.

5.4 Responsibilities of Leadership

5.4.1 Top Management

Top management shall lead and demonstrate its commitment to the development, implementation, continuous improvement, and evaluation of the maturity of its PSMS by:

a) establishing and maintaining policies, goals, and objectives;

b) promoting a positive safety culture and assessing how this culture is changing over time;

c) ensuring that the elements set forth in this RP are in place, with clear accountability for implementation and with a clear connection between objectives and day-to-day activities;

d) fostering risk management processes that reveal and manage risk, making compliance and risk reduction routine;

e) leading a resource allocation process;

f) establishing high-level performance measures;

g) identifying the executive(s) accountable for implementation and continuous improvement, and managers responsible for each element of the PSMS;

h) communicating commitment to the PSMS with internal and external stakeholders;

i) ensuring that processes are in place to enable dependent and interrelated functions within the organization are sharing information and working to achieve the policies and objectives;

j) establishing appraisal, recognition, and discipline policy that promotes the PSMS;

k) promoting engagement and leadership at all levels of the organization;

l) promoting an environment of mutual trust; and

m) evaluating recommended changes for incorporation into the PSMS.

5.4.2 Management

Management, supported by top management, shall:

a) establish, implement, evaluate, and improve processes, procedures, systems, and training to meet policies, goals, and objectives;

b) ensure there is a clear connection between objectives and day-to-day work activities, including those needed to meet the requirements of this document;

c) assess, evaluate, and continually improve the safety culture;

d) ensure that risk management occurs routinely by establishing intentional actions designed to assure compliance, and reveal and manage risk;

e) develop, implement, and continuously improve processes that apply resources to planned work and emerging risks throughout the year;

f) identify, seek, and allocate resources sufficient for safe, environmentally sound, reliable, and efficient operations;

g) establish performance measures that address each element of the PSMS;

h) ensure that relevant data, results, findings, and lessons learned are shared and integrated among appropriate operator and contractor processes to the extent necessary to execute the requirements defined in the PSMS, and that communications about operations occur routinely with employees and contractors;

i) identify personnel responsible for PSMS elements, supporting initiatives, and oversight;

j) conduct annual management reviews of the PSMS that evaluate and recommend changes to the organization's PSMS; and

k) develop and implement processes, including training, to ensure employees attain appropriate levels of competence to fulfill their responsibilities and execute all aspects of the PSMS.

5.4.3 Employees

Employees supported by management and top management shall:

a) follow the procedures set forth by the organization;

b) identify and reveal risks to management;

c) identify improvements to safety processes and procedures, considering fellow employees, contract personnel, and the public when addressing an abnormal condition or nonconforming process or procedure, and

d) be mindful of cascading failures early on and take action to prevent a catastrophic event.

5.5 Responsibility, Accountability, and Authority

Responsibilities, accountabilities, and authorities in developing, implementing, and continually improving the PSMS shall be defined, documented, and communicated throughout the pipeline operator's organization. Accountability for resource allocation shall be assigned to management with appropriate authority.

5.6 Making Communication, Risk Reduction, and Continuous Improvement Routine

Top management shall ensure routine processes are in place to foster deliberate communication, risk reduction, and continuous improvement. Processes shall provide a means to identify when scheduled management system requirements become due and notify management, and top management if appropriate, if not completed. The processes include the following.

a) Resource allocation—identify and review assets, systems, and other resources needed to operate in a safe, environmentally sound, and efficient manner.

b) Review the PSMS and whether improvements should be made.

c) Review operations performance and its impact on pipeline safety.

d) Audit and evaluation plans—define the schedule and locations for upcoming audits and evaluations.

e) Incentives—top management shall review how incentives encourage safety and conformance with the PSMS, and make adjustments in the incentive plan that are expected to make it more effective.

f) Pipeline system assessment—review the pipeline system's condition.

g) Pipeline asset integrity management shall be updated by integrity management subject matter experts on known threats, assessment and repair effectiveness, and adequacy of the plan(s).

h) Review processes and progress to reduce risk, including communicating incident investigation findings and lessons learned; construction progress—scope, schedule, and cost; efficiency and productivity enhancements; progress on employee and contractor safety programs; and review of leading indicators and their meanings.

6 Stakeholder Engagement

6.1 General

The pipeline operator shall maintain a process and a plan for communication and engagement with internal and external stakeholders regarding risk identification and management, safety performance, and as appropriate, other PSMS elements. The plan shall identify the organization's stakeholders, both internal and external, and the communication responsibilities of pipeline operator personnel.

Stakeholder engagement plans shall identify specific objectives and the personnel responsible for sharing and receiving information. The operator shall identify the types of information to be shared and how it is valuable in improving pipeline safety.

6.2 Internal

The pipeline operator shall establish processes to communicate the importance of meeting requirements of the PSMS to appropriate functions within the organization. Employees and contractors shall understand the policies, goals, objectives, and procedures pertinent to their work that are driven by the PSMS.

The pipeline operator shall maintain a process for employees and contractor personnel to raise concerns to management and make recommendations for improvements in risk identification, prevention, and mitigation. Management shall promote an environment encouraging two-way communication. Management shall also implement a process for communicating and applying lessons learned.

6.3 External

The pipeline operator shall maintain a process and a plan for two-way communication with external stakeholders. The process shall address providing information, engaging regulatory bodies, and handling of feedback from representatives of the public. The pipeline operator shall identify external stakeholders through ongoing use of appropriate company and public processes, events, social media, or other methods. The objectives are to provide a means through which stakeholders can acquaint themselves with the company and the company can be acquainted with stakeholders who want to maintain an ongoing dialogue regarding safety and asset-related concerns. The communication process should address a high-level view of company safety operations, the current focus of risk management efforts, and measures the operator uses to gauge safety performance.

To the extent possible, the pipeline operator shall identify personnel who are available to the public to exchange information regarding pipeline safety matters, particularly where stakeholders can provide the operator with information about changing risk in the physical environment surrounding the pipeline. Operators shall develop and execute plans to share safety performance with those that live, work, and play in proximity to their pipelines and identify personnel who can receive input regarding concerns about information transparency.

NOTE 1 Examples include members of the public; local, state, and federal regulators; industry organizations; shippers; shareholders; emergency responders; law enforcement; and others as identified by the company. This includes peer-to-peer information sharing within the industry.

NOTE 2 Refer to API 1162, *Public Awareness Programs for Pipeline Operators*.

7 Risk Management

7.1 General

The pipeline operator shall maintain (a) procedure(s) for the performance of risk management. The operator shall maintain a description of the assets comprising the pipeline, including the surrounding environment, to identify threats to pipeline safety.

The operator shall analyze risk considering the threat occurrence likelihood and consequence. The operator shall evaluate pipeline safety risk and make decisions on how to manage it through preventive controls, monitoring, and mitigation measures.

NOTE 1 Risk management is used to understand and evaluate threats throughout the pipeline life cycle and their interrelationships along particular pipelines. Risk management steps are undertaken to reduce risk and support achieving a goal of zero incidents.

NOTE 2 The term “threat,” meaning threats to pipeline safety, is used in this document in a similar way that “hazard” is used in other industries. The intent in identifying threats or hazards is to define “what can go wrong?”. Threats in this context are broader than the set typically considered for pipeline integrity.

NOTE 3 The term “threat” can be applied broadly in a PSMS, such as a threat to a safety culture (NEB Statement on Safety Culture), or a threat to the knowledge and experience of an organization through retirements and attrition. These threats can be assessed using risk assessment and managed with prevention and mitigation measures.

7.2 Data Gathering

The pipeline operator shall maintain an inventory of the pipeline and environment in proximity to the pipeline that is required to define safe operating conditions (e.g. maximum operating pressure [MOP] and maximum allowable operating pressure [MAOP]) as well as maintenance. Recognizing that where there are historical gaps in data, the operator shall work to close gaps through on-going work related to operations, maintenance, and pipeline integrity or use conservative assumptions in setting operating parameters until a gap can be closed.

These data serve as the foundation of risk management and shall include available data over the pipeline life cycle and shall be updated based on work performed and as needed during the life of the pipeline. Incident data, including the cause of incidents, shall be included as appropriate. The pipeline operator shall conduct a regular review to identify data gaps and evaluate data quality as part of risk assessment, consistent with continuous improvement.

7.3 Risk Identification and Assessment

Risks to pipeline safety that could result in an unintended release or abnormal operating conditions shall be identified, based on data and information, as well as knowledge and experience with similar facilities. The operator shall maintain a process to identify threats that are posed by operations and the operating environment, including changes in conditions that could occur between assessments. The process shall identify locations where multiple threats are potentially interactive and thereby increase risk. In conducting an assessment of threats, operators should be mindful of "what can go wrong?".

Risk assessment shall consider the likelihood and severity of threats using any one of a variety of risk management tools. Risk assessments shall be performed and updated as information and conditions change to identify and understand the collective threats and support the selection of prevention and mitigation measures to minimize the likelihood of the occurrence and consequences of an unintended release and the likelihood of abnormal operating conditions.

NOTE Refer to ASME B31.8S, *Managing System Integrity of Gas Pipelines*, Section 5 and API 1160, *Managing System Integrity for Hazardous Liquid Pipelines*, Section 7.

7.4 Risk Prevention and Mitigation

Risk prevention and mitigation measures to reduce the likelihood and consequences of a release shall be identified and evaluated to improve situational awareness. Information to consider shall include, at a minimum:

a) learnings from internal and external events;

b) review of equipment operability, including control systems and materials;

c) review of procedures, authorities, responsibilities, and accountabilities;

d) review of training, drills, and scenario development;

e) review of incident response preparation, including response time adequacy and the ability to coordinate and stage an incident command system with response personnel internal and external to the organization;

f) identification of areas of high consequence; and

g) in selecting measures to reduce risk, preference shall be given to prevention measures that eliminate or reduce the likelihood and/or consequences of incidents. Operators shall implement the selected measures and evaluate their impact on risk.

7.5 Periodic Analyses

Risk assessments shall be reviewed at least annually, and updated as warranted, using data and information gained from operations and maintenance, inspection and testing, integrity-related work, and incident investigations.

7.6 Risk Management Review

Risk management results, including selected risk mitigation methods and their intended effectiveness shall be reviewed, at least annually, with top management.

8 Operational Controls

8.1 Operating Procedures

8.1.1 General

The pipeline operator shall maintain procedures that address safe work practices to assure the safe conduct of operating, maintenance, and emergency response activities and the control of materials that impact pipeline safety. Pipeline operating personnel shall follow written procedures. In cases where an employee believes that following a procedure will cause an unsafe condition, he/she shall have authority to stop work and seek permission to deviate. Deviations should be documented for future analysis. Pipeline operating personnel shall have responsibility and authority to raise concerns through designated processes.

8.1.2 Content of Operating Procedures

The pipeline operator shall maintain procedures for the safe operation of each facility consistent with the pipeline operator's safety policies and objectives. The procedures shall:

a) identify operating conditions and define processes for the following phases of operation, including (as applicable):

   1) initial start-up (new or modified facilities),

   2) normal operation,

   3) temporary operations, as the need arises,

   4) emergency operations, including emergency shutdowns,

   5) normal shutdown, and

   6) start-up or restoration of operations following maintenance or outage;

b) identify operating limits relating directly to safety.

8.1.3 Review

Operating procedures shall be reviewed to identify improvements and lessons learned. The frequency of the review shall be based on the levels of risk identified, but no less often than annually. Changes to the procedures shall be documented.

8.2 System Integrity

8.2.1 General

The pipeline operator shall assure that pipeline systems subject to this document are designed, manufactured, fabricated, installed, operated, maintained, inspected, and tested pipeline systems subject to this document to maintain safety in a manner consistent with the specified requirements, regulations, and applicable standards.

8.2.2 Manufacturing and Construction

The pipeline operator shall maintain (a) quality control procedure(s) so that materials and construction are in accordance with the design and purchase specifications.

8.2.3 Manufacturing and Construction Inspection

The pipeline operator shall maintain inspection procedures so that the manufacturing and installation of equipment conforms with design and purchase specifications and the manufacturer's instructions prior to start-up.

8.2.4 Maintenance

The pipeline operator shall maintain procedures to control maintenance activities.

8.2.5 Testing and Inspection

The pipeline operator shall maintain inspection and testing procedures for pipeline safety-related equipment connected to the pipeline system such as relief valves, regulators, etc.

8.3 Management of Change (MOC)

8.3.1 General

The pipeline operator shall maintain a procedure for management of change (MOC). For each MOC, the pipeline operator shall identify the potential risks associated with the change and any required approvals prior to the introduction of such changes.

8.3.2 Types of Change

The types of changes that a MOC procedure addresses shall include:

1) technology,

2) equipment,

3) procedural, and

4) organizational.

This procedure shall consider permanent or temporary changes. The process shall incorporate planning for the effects of the change for each of these situations.

8.3.3 Elements of MOC Procedure

A MOC procedure shall include the following:

a) reason for change;

b) authority for approving changes;

c) analysis of implications;

d) acquisition of required work permits;

e) documentation of change process;

f) communication of change to affected parts of the organization;

g) time limitations; and

h) qualification and training of personnel affected by the change (including contractors).

NOTE 1 Refer to ASME B31.8S for gas transmission pipelines and ASME B31.4 for hazardous liquid pipelines.

NOTE 2 Application of MOC may trigger use of risk assessment to evaluate the impact of change on overall risk.

8.4 Use of Contractors

When a pipeline operator elects to outsource activities on the pipeline affected by the PSMS, it shall define and document the process for:

a) communicating requirements of the PSMS applicable to the contractor's scope of work;

b) defining responsibility, accountability, and authority for managing the outsourced activities;

c) incorporating lessons learned into the operator's operations;

d) training and orientation on safety policies;

e) evaluating contractor safety performance;

f) communicating risks at the work site; and

g) communicating the MOC procedure.

9 Incident Investigation, Evaluation, and Lessons Learned

9.1 Investigation of Incidents

9.1.1 General

The pipeline operator shall maintain a procedure for investigating incidents and near-misses that led, or could have led, to an incident with serious consequences. Incident investigations shall be initiated as promptly as possible considering the need to secure the incident scene, protect people and the environment, and maintain and recover important evidence and testimony.

9.1.2 Investigation

The investigation of an incident or near-miss shall include the following:

a) identification of the cause(s) of the incident and any contributing factors, including consideration of potential consequences;

b) investigation findings and lessons learned;

c) an evaluation and review of the effectiveness of all emergency response procedures and processes implemented as relevant to the incident;

d) recommendations for pipeline safety performance improvement, including changes to processes and procedures that are identified as a result of the investigation; and

e) recommendations for transferring lessons learned from the investigation to the risk assessment and control processes, including a review of the consequence and likelihood of failure, current procedures, training, and resource allocation.

9.2 Follow-up and Communication of Lessons Learned

The pipeline operator shall establish a procedure to determine and document the response to each finding and lesson learned from the incident investigation. The pipeline operator shall assure that actions to implement risk assessment and pipeline safety performance improvement recommendations are tracked and completed.

The procedure shall assure that the cause(s), contributing factors, recommendations to prevent recurrence, and lessons learned are communicated to appropriate personnel. The operator may share lessons learned externally through peer-to-peer interactions. Records of the investigation and resulting actions shall be maintained for possible use in subsequent risk assessments.

9.3 Learning from Past Events

The pipeline operator shall establish a process to periodically reevaluate past incident investigations of high consequence and significant near-miss events. This process should focus on:

a) generating new lessons learned from past events;

b) evaluating the effectiveness of organizational learning from the known lessons learned.

9.4 Learning from External Events

The pipeline operator shall establish a process for evaluating events external to its operations to identify opportunities to learn from those events. Potential sources of information include information gained from peers, regulators, the affected public, landowners, public officials, and emergency planning and response personnel.

NOTE 1 Examples of lessons learned include relevant reported releases, publicly available information on failures, and results of incident investigations.

NOTE 2 Examples of sources of external events include: NTSB Investigations of pipeline failures, PHMSA advisory bulletins and failure reports, and Common Ground Alliance Damage Incident Reporting Tool System Reports for information on damages to pipelines.

10 Safety Assurance

10.1 General

The operator should evaluate the application of its PSMS and determine whether expected progress toward effective risk management and improved pipeline safety performance are being achieved. The pipeline operator shall demonstrate the proper application of its PSMS and continually improving risk management and pipeline safety performance.

10.2 Audit and Evaluation

10.2.1 General

As part of the safety assurance process, the pipeline operator shall use audits to examine conformity of the PSMS to the requirements of this document, including how it applies to service providers and contractors. Based on those audits and other forms of evaluation discussed below, the operator shall assess the effectiveness of its risk management and progress made toward improving pipeline safety performance.

The pipeline operator shall maintain procedures for planning, conducting, and documenting both audits and evaluations. Planning of audits and evaluation shall consider the results of previous audits and evaluations and place greater weight on processes involving a higher safety risk as well as business criticality.

10.2.2 Audits

The pipeline operator shall perform audits to examine its conformity with this RP and the implementation of its PSMS. The audits shall determine whether the pipeline operator's PSMS is implemented, maintained, and conforms to this RP. It is critical that the operator discerns that each of the PSMS elements and processes are in place and effective.

The pipeline operator shall identify the audit criteria, scope, frequency, and methods used to assess the application of and conformance with its PSMS and this RP. Risk and complexity of operations are key drivers in the prioritization and frequency of audits. The operator shall assure that each of the elements of the PSMS is audited at least once every three years.

An audit may be performed by external professionals or internal personnel not involved in the work of the PSMS or the operations being audited. Examples may include personnel of a separate operating unit, an organization's compliance unit, an organization's internal audit group, or external parties such as professional auditors, subject matter experts, or peer operators.

10.2.3 Evaluation of Risk Management and Safety Performance

A pipeline operator shall perform evaluations to assess the effectiveness of its risk management and progress made toward improving pipeline safety performance. Operators shall assure they evaluate their safety culture. Evaluations shall review processes and procedures and the maturity of their implementation.

Evaluation of risk management and safety performance shall consider the results of stakeholder engagement under Section 6; risk analysis under Section 7; management of change under Section 8; any incident investigations, findings, recommendations, and lessons learned, both internal and external, under Section 9; audits under Section 10; management reviews under Section 11; emergency response issues under Section 12; personnel issues under Section 13; as well as near-miss experiences and abnormal operating data, as appropriate. Evaluation of progress toward improving pipeline safety performance shall also include results of the safety culture evaluation per 10.2.4 and PSMS maturity of 10.2.5.

10.2.4 Evaluation of Safety Culture

The pipeline operator shall establish methods to evaluate the safety culture of its organization. Operators shall assess their safety culture using methods that assess employee perception of the safety culture. Methods to assess the perception of the culture include but are not limited to questionnaires, interviews, and focus groups. Policies, operating procedures, considering risk in decisions and practice, reporting processes, sharing of lessons learned, and employee and contractor participation support an operator's safety culture. Observations and audits of how each of these are being applied in the daily conduct of operations provide indications of the health of an organization's safety culture. Failure in application of these provides an indication of potential deterioration of the safety culture. Management shall review the results and findings of perception assessments, observations and audits and define how to improve application of the supporting attributes.

10.2.5 Evaluation of PSMS Maturity

The pipeline operator shall establish a method to evaluate the growth and development, otherwise known as maturity, of its PSMS. Beyond basic conformity with the RP audited in 10.2.2, evaluation of the maturity of the PSMS enhances continual safety performance improvement by providing information on the degree to which the PSMS is comprehensive, systematic, and integrated throughout the organization. The evaluation method should allow the operator to objectively determine the strengths and weaknesses of its personnel and processes that support each of the elements of the PSMS, as well as areas of its PSMS needing improvement. The method should be flexible to provide the right level of focus on the elements depending on the operator's stage of PSMS development, even if it is an early stage, with subsequent periodic reviews.

As the PSMS matures, pipeline operators shall maintain a method to evaluate the extent to which the development and deployment of the PSMS, and means to measure performance (e.g. key performance indicators [KPIs]) are:

a) comprehensively applied (applied system wide);

b) systematically applied (applied in a uniform, consistent way); and

c) integrated (applied drawing upon the collective experience of personnel and use of data across the system).

The pipeline operator shall engage in benchmarking with other operators and publicly available information when evaluating the maturity of its PSMS.

If the operator is at the early stages, the operator may begin by simply determining whether:

a) a maturity assessment approach has been developed or a model is available;

b) deployment has been undertaken;

c) results have been measured; and

d) continuous improvement initiatives have been undertaken that are focused on greater effectiveness.

10.2.6 Audit and Evaluation Review and Closure

Management shall define response times for addressing identified findings of audits and evaluations. The management responsible for the area being audited or evaluated shall ensure that findings are addressed within the defined response times. The results of internal audits and the status of corrective actions shall be reported in the management review (see 11.1.2). Records of internal audits shall be maintained.

10.3 Reporting and Feedback System

In addition to other reporting and feedback processes an operator maintains, the pipeline operator shall establish and maintain a reporting and feedback process for employees and contractors. The need for an anonymous reporting system should also be considered after reviewing the benefits and drawbacks of an anonymous and/or non-punitive system. Data and information obtained from the implementation of the process shall be monitored to identify new and emerging risks to consider in risk evaluation and to evaluate performance of risk mitigation.

10.4 Performance Measurement and Analysis of Data

The pipeline operator shall establish and maintain a procedure to identify key performance indicators (KPIs) to measure the effectiveness of risk management, and the effectiveness and adequacy of the PSMS.

The pipeline operator shall establish and maintain a procedure for the identification, collection, and analysis of data generated from operations and maintenance, integrity management, audits and evaluations (see 10.2), management reviews (see Section 11), and other relevant sources related to the suitability and effectiveness of the PSMS.

The operator shall monitor, at a minimum, fatalities, injuries, and property damage resulting from planned as well as unplanned releases; these are referred to as lagging KPIs. The pipeline operator shall establish leading KPIs, which are those measures demonstrating risk reduction. The pipeline operator shall establish process KPIs, i.e. those measures that demonstrate completion or improvement of elements and their supporting processes and procedures. The pipeline operator shall define the frequency with which to review the KPIs and trend performances to identify adverse trends and take corrective action.

NOTE KPIs reflect the outcomes of execution of the PSMS. Leading KPIs are often referred to as precursor or leading measures. Examples include the number of integrity evaluations completed (including mileage), the number of near-term repairs made (including conditions warranting immediate action), and the number of preventive and mitigation actions implemented. Process KPIs are often referred to as proactive measures. Examples include the number of improvement initiatives planned and the number completed, the number of processes improved, and the number of procedures modified and improved. For examples of process safety performance indicators refer to API 754.

11 Management Review and Continuous Improvement

11.1 Management Review

11.1.1 General

The pipeline operator's PSMS and safety performance shall be reviewed to determine the extent to which the performance goals and objectives have been met.

11.1.2 Input Requirements

At the direction of top management, management shall conduct a review guided by products of the elements of the PSMS, including:

a) the goals and objectives that the management system is intended to help achieve (see 5.2);

b) the status and effectiveness of corrective actions resulting from previous management reviews;

c) performance measures and KPIs (see 10.4);

d) the results of the risk management review (see Section 7);

e) results and recommendations of incidents investigations, evaluations, and lessons learned (see 9);

f) results of internal and external audits and evaluations (see 10.2);

g) changes that could affect the PSMS, including changes to legal, regulatory, and other applicable requirements (see 5.3);

h) stakeholder feedback (see 6.2 and 6.3);

i) the evaluation of PSMS maturity (see 10.2.5); and

j) opportunities for improvement and the need for changes to the PSMS, including the pipeline safety policies and objectives (see 11.2).

11.1.3 Output Requirements

The output from the management review shall include a summary assessment of the effectiveness of the PSMS and any resulting improvements in risk management effectiveness and pipeline safety performance. The assessment shall include any decisions and actions, changes to required resources, and improvements to the processes and procedures made to meet requirements. Recommendations for improvement shall be integrated into the next iteration of the PSMS plan and supporting processes.

11.2 Continuous Improvement

Management shall evaluate risk management effectiveness and foster improvement in pipeline safety performance by using a PSMS. Management shall continuously improve the effectiveness of the PSMS by using the pipeline safety audit and assessment results, data analysis, and management review to identify corrective and preventive actions. Management shall also periodically evaluate new technology that may enhance pipeline safety.

11.3 Top Management Review

Top management shall, at least annually, review and approve the output of management reviews (see 5.6). Management reviews shall be documented.

12 Emergency Preparedness and Response

The pipeline operator shall maintain procedures for responding effectively to a pipeline incident. Emergency preparedness and response plans shall be in place and ready for immediate implementation. The plans shall be accessible and communicated to all personnel and contractors. The plans shall be based on applicable laws and regulations.

The emergency preparedness and response procedures shall include, minimally, the following elements:

a) determination of potential types of emergencies (spills, releases, weather events, security threats, fires, loss of utilities (power, water, etc.), pandemics, and civil disturbances);

b) internal and external notification requirements;

c) identification of response resources and interfaces, including local emergency responders;

d) recognition and use of Unified Command/Incident Command Structure;

e) safety, health, and environmental protection processes;

f) communication plan;

g) training and drills, including involvement of external agencies and organizations;

h) lessons learned and improvement process; and

i) periodic review and updating of the plans.

13 Competence, Awareness, and Training

The pipeline operator shall assure that personnel whose responsibilities fall within the scope of the PSMS have an appropriate level of competence in terms of education, training, knowledge, and experience. Where contractors are used to support the PSMS, the pipeline operator shall assure that they have the requisite competence.

The pipeline operator shall define the need for and provide training to enable development and implementation of the PSMS elements. Training shall include refresher training and raising awareness where executing the safety assurance and continuous improvement sub-elements reveal opportunities to improve processes and procedures. Records of training shall be maintained.

The pipeline operator shall provide training and updates as necessary so that personnel and contractors who have accountabilities, responsibilities, and authorities in executing the requirements of the PSMS are updated and aware of:

a) applicable elements of the PSMS that affect their job requirements;

b) newly emerging or changing risks, problems in execution of the PSMS, and opportunities to improve processes and procedures; and

c) potential consequences of failure to follow processes or procedures.

14 Documentation and Record Keeping

14.1 Control of Documents

The pipeline operator shall maintain a procedure for the identification, distribution, and control of documents required by its PSMS. The procedure shall specify responsibilities for document approval and re-approval, and shall identify the controls needed to assure that the documents required by the PSMS, including revisions, translations, and updates:

a) are reviewed and approved for adequacy prior to issue and use;

b) identify changes and revision status;

c) remain legible and readily identifiable; and

d) are readily available and accessible to workers performing an activity.

Obsolete documents shall be removed from all points of issue or use, or shall otherwise be identified to assure against unintended use if they are retained for any purpose.

14.2 Control of Records

The pipeline operator shall maintain a procedure to identify the controls and responsibilities needed for the identification, collection, storage, protection, retrieval, retention time, and disposition of records.

Records shall be established and controlled to provide evidence of conformity to requirements and the pipeline operator's PSMS.

Records shall remain legible, identifiable, and retrievable. Records shall be retained as defined by the pipeline operator's record retention policy or as otherwise required by legal and other applicable requirements.

14.3 Pipeline Safety Management System Documents

The PSMS documentation shall include:

a) statements of the safety policies and objectives;

b) procedures established for the PSMS as required by this document and/or the pipeline operator;

c) documents and records of work required by the PSMS;

d) identification of regulatory, and other applicable requirements; and

e) other records identified by the pipeline operator needed to show the effective operations of the PSMS.

14.4 Procedures

All procedures referenced within this document shall be established, documented, implemented, and maintained for continued suitability.

15 Executing a Pipeline Safety Management System Strengthens Safety Culture

15.1 General

Implementing PSMS elements strengthens an organization's safety culture. Establishing safety as a core value strengthens the overall organization's belief in its importance, acting as a unifying force to improve safety performance.

The execution of the elements depends on the actions of every individual and organizational unit at all levels of the organization. Each of the elements can be expected to contribute to different aspects of the safety culture, and these combined aspects reflect the strength of the culture. The PSMS, with all its discrete elements, supports the culture, and the culture feeds back into the management system in a continuous process, yielding an increasingly mature organization.

15.2 Contribution of Leadership and Management Commitment

Management leading and demonstrating their responsibilities as outlined in this element are essential to improved safety and a positive safety culture. While establishing pipeline safety policies is essential, it is the commitment of management in implementing the processes to meet the objectives of a PSMS that produces the desired performance outcome. Employees will understand that safety is valued if they see management in the constant practice of acting on assessments and evaluations, improving plans and processes, allocating resources, and maintaining connections between objectives of safety critical functions and findings. Further, assessing the implementation and maturity of each of the elements in this PSMS will provide indicators of how the organization's safety culture is evolving.

During execution, leadership recognizing excellent performance through incentives is extremely powerful and contributes to the expectation that everyone will support the desired behavior. Clear accountability and performance objectives drive employees to progress toward the goals. Safety is seen to be integral to all business decisions. There is a clear responsibility and obligation for all employees to stop work they consider unsafe and to never leave a question about safety unresolved.

By preparing and enabling every level of employees to recognize adverse situations and respond directly, they will be ready for unusual day-to-day operational challenges if an actual or a potential catastrophic event occurs. This preparation and freedom to act will bring an important sense of confidence and resolve to an operator's employees.

Leaders ensure the workforce effectively learns from past incidents and approaches current operation from the perspective of what might go wrong. This type of mindset enables employees to have a greater capacity to notice cascading events early on and to take actions to prevent a catastrophic event.

15.3 Contribution of Stakeholder Engagement

This element demonstrates the comprehensiveness of the organization's commitment to safety by engaging all stakeholders. Through the engagement process, the operator is more thorough in its management of risk and more expansive in its partnerships for safety performance. Stakeholders can help maintain a heightened sense of vigilance in identifying risk and contribute to their own protection.

15.4 Contribution of Risk Management

The practice of risk management, and particularly the thoroughness of the process and the responsiveness to employee-identified risks, builds their understanding and confidence in management's commitment to safety. Management's allocation of resources to evaluate and manage risk visibly demonstrates that commitment. Following their leadership's engagement, employees will be guided in making safety a priority.

Employees sense that the actions they take to maintain the pipeline system are important. As they are closest to the pipeline system and are an important source of information about it, they "own" it and should be respected for the value they bring to managing risk. They will see that every action or decision made on behalf of the system-at-large connects to public safety and the well-being of the system, with the same discipline as with personal safety. Further, the thorough practice of the risk management element provides the opportunity to build trust in employees that their organization is fully committed to safety.

15.5 Contribution of Operational Controls

Operational controls lead to greater certainty that the pipeline operator and pipeline system perform as expected. A greater sense of certainty about all aspects of operations contributes to the perception that there is an intentional commitment to safety. Employees share this sense of purpose, and it influences how they interact with each other and how they participate in owning and reinforcing this value. Employees will know that the practice of safety tasks is important. Employees will have confidence that they can stop work and identify problems for management resolution.

15.6 Contribution of Incident Investigation, Evaluations, and Lessons Learned

Expanding the framework for this element reinforces the commitment to safety performance improvement. Taking a more robust approach to this element invests more organizational effort into assuring that the right information is gathered from events and is applied to managing risk. "Lessons learned" becomes more than a clichéd phrase and instead is an integral part of the organization's PSMS. The timeliness of sharing information and tracking corrections demonstrates the positive sense that safety is a top priority and complacency about risk is unacceptable. Employees understand the importance of learning and making improvements throughout the organization. Equally important is the understanding that management encourages and insists on the sharing of safety concerns. This contributes to an environment in which employees and contractor personnel are comfortable about identifying and speaking up about risk. This element provides the opportunity to put emphasis on the urgency of communicating risk information up, down, and across the organization.

15.7 Contribution of Safety Assurance

A focus on safety assurance is a form of defense-in-depth, i.e. multiple layers of safety assurance in managing risk. Applying the multiple layers demonstrates commitment to improved performance. This element assures the operator checks and validates that risk management processes are systematic and disciplined. This element specifically speaks to the critical nature of employee engagement, reporting, and feedback on issues of concern. The opportunity is here to evaluate the culture of trust and openness in the organization, which is vital to growing a more resilient organization. The quality and independence of the assessment and audit process conveys vigilance in general and shows responsiveness to employee concerns about safety. This element provides for rigor that should result in increased organizational confidence and positive peer attitudes, which feed motivation for engaging with safety.

15.8 Contribution of Management Review

While perhaps less visible to all employees than the practice of the other elements, this element is nonetheless essential to the visibility of commitment and is a reflection of the importance of accountability for safety. Top management defines opportunities for continuous improvement. The sense of discipline from the practice of the element, following up on the other elements of the SMS, is exemplified by management and, as a result, conveys a sense of safety as a priority—the actions executives exhibit in their own performance is noticed by employees.

15.9 Contribution of Emergency Preparedness and Response

While applying PSMS and working on its supporting elements leads to improved performance, operators cannot anticipate every event. Employees, contractor personnel and outside stakeholders know this reality. They appreciate planning for a full range of emergencies, especially when planning leads to a better understanding of potential

scenarios. Being prepared leads to good safety culture characteristics: resiliency and a realistic sense of vulnerability. Without a sense of vulnerability, it is impossible to maintain vigilance.

15.10 Contribution of Competency, Awareness, and Training

The practice of assuring competency at all levels is a form of investment in an organization's employees. Employees see competency as critical to the sustainability of the organization and its success. Investment in building competency, like continual learning, builds trust and confidence that management prioritizes safety, their employees and contractor personnel, and the public. When competencies are defined, identified gaps in qualifications are addressed, and skill sets are refreshed, employees perceive that they are getting the support they need. They are then able to accept and carry out safety responsibilities. This practice contributes to the sense of security in the organization.

15.11 Contribution of Documentation and Record Keeping

Like the practice of other operational controls, this element leads to greater certainty that the pipeline system will perform as expected. This element is an opportunity to demonstrate commitment and discipline. If something is not written down, it doesn't exist. Procedures and work practices are essential documents. Work products of each PSMS element are essential records.

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7 American Gas Association, 400 N. Capitol St., NW, Suite 450, Washington, DC 20001, www.aga.org.
8 Interstate Natural Gas Association of America, 20 F Street, NW, Suite 450, Washington, D.C. 20001, www.ingaa.org.
9 Organisation for Economic Co-operation and Development, 2, rue André Pascal, 75775 Paris Cedex 16, France, www.oecd.org.
10 Health and Safety Executive, Knowledge Centre, (1G) Redgrave Court, Merton Road, Bootle, Merseyside, L20 7HS, www.hse.gov.uk.

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[11] National Transportation Safety Board, 490 L'Enfant Plaza, SW, Washington, DC 20594, www.ntsb.gov.
[12] Pipeline and Hazardous Materials Safety Administration, U.S. Department of Transportation, East Building, 2nd Floor, 1200 New Jersey Ave., SE, Washington, DC 20590, http://phmsa.dot.gov.
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[14] National Energy Board (Canada), 517 Tenth Avenue SW, Calgary, Alberta, T2R 0A8, https://www.neb-one.gc.ca.
[15] Institute of Nuclear Power Operations, 700 Galleria Parkway, SE, Suite 100, Atlanta, GA 30339-5943, http://www.inpo.info.

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UNITED STATES DISTRICT COURT
DISTRICT OF MASSACHUSETTS

UNITED STATES OF AMERICA	)	
v.	)	Criminal No.
NiSOURCE, Inc.	)	
Defendant.	)	

DEFERRED PROSECUTION AGREEMENT

1. Andrew E. Lelling, United States Attorney for the District of Massachusetts (by Assistant U.S. Attorneys Neil J. Gallagher, Jr. and Evan Gotlob) (the "Government"); and defendant NiSource, Inc. ("NiSource") (by counsel Alejandro N. Mayorkas, Esq., Wilmer-Hale, LLP and NiSource Chief Executive Officer Joseph Hamrock) hereby enter into the following Deferred Prosecution Agreement ("Agreement").

2. It is the intention of the parties that this Agreement will cover any and all of NiSource's federal criminal liability in the District of Massachusetts arising from the conduct of its wholly-owned subsidiary, Bay State Gas Company, d/b/a Columbia Gas of Massachusetts ("CMA"), or any of NiSource's conduct that is related to the conduct alleged in the criminal information filed against CMA ("the CMA Criminal Information"), attached to this Agreement as **Exhibit A**, and covered by the plea agreement dated February 24, 2020 between the Government and CMA ("the CMA Plea Agreement," attached to this Agreement as **Exhibit B**), or that is in any other way related to the Merrimack Valley Over-Pressurization Event on September 13, 2018 (hereinafter, "the Event"), including CMA's and NiSource's restoration work in the Merrimack Valley following the Event that is currently known to the Government.

R-2020-3018835
7/8/20
Exhibit-5

3. This Agreement is effective for a period beginning on the date on which this Agreement is signed ("Effective Date") and ending thirty-six (36) months from the Effective Date (the "Term").

4. The Government enters into this Agreement based upon the individual facts and circumstances of this case, including:

a. NiSource's agreement to use reasonable best efforts to sell CMA or CMA's gas distribution business, to a qualified third-party buyer consistent with the requirements of M.G.L. c. 164, § 96 and Interlocutory Order on Standard of Review, D.P.U. 10-170 and upon the completion of any such sale, to cease and desist any and all gas pipeline and distribution activities in the District of Massachusetts;

b. In the event that CMA or its gas distribution business is sold within CMA's three (3) year term of probation, NiSource's agreement to forfeit and pay a monetary penalty equal to the total amount of any profit or gain from the sale of CMA or CMA's gas distribution business;

c. NiSource's prior voluntary payments of restitution to the victims of the Event including, but not limited to, payments to the individuals, businesses and municipalities affected;

d. NiSource's agreement to seek to resolve all pending civil claims, including NiSource's agreement to seek to settle the claims filed by the Massachusetts Department of Public Utilities ("MA DPU");

e. NiSource's acknowledgement that, based on the allegations in the CMA Criminal Information, the Government has sufficient basis to allege that NiSource is responsible for CMA's conduct as alleged in the CMA Criminal Information; and

f. NiSource's commitment to fulfill all of the terms of this Agreement.

5. The Government agrees that so long as NiSource adheres to and complies with the provisions of this Agreement, the Government will not file criminal charges against NiSource, either for NiSource's conduct or CMA's conduct, related to the allegations in the CMA Criminal Information, the Event, or CMA's and NiSource's restoration work in the Merrimack Valley following the Event that is currently known to the Government. In the event

of a breach of this Agreement, the Government reserves the right to prosecute NiSource for the conduct related to the allegations in the CMA Criminal Information, the Event, or CMA's and NiSource's restoration work in the Merrimack Valley following the Event that is currently known to the Government or any other conduct the Government in its sole discretion deems appropriate.

6. In consideration of the Government's agreement described above in paragraph 5, NiSource waives its right to a speedy trial pursuant to the Sixth Amendment to the United States Constitution and Rule 48(b) of the Federal Rules of Criminal Procedure. NiSource also expressly waives and will not plead, argue, or otherwise raise any statute of limitations or other similar defenses to any criminal charges brought by the Government related to the allegations in the CMA Criminal Information, the Event, or CMA and NiSource's restoration work in the Merrimack Valley following the Event, except to the extent to which such a defense would have been available had charges been brought on or before the date on which this Agreement is executed.

NISOURCE'S OBLIGATIONS

7. NiSource acknowledges that, based on the allegations in the CMA Criminal Information, the Government has sufficient basis to allege that NiSource is responsible for CMA's conduct alleged in the CMA Criminal Information. NiSource will not, through any person authorized to speak on its behalf, make any public statement, in litigation or otherwise, contradicting in whole or in part NiSource's acknowledgement set forth above.

8. NiSource agrees that it will use reasonable best efforts to sell CMA or CMA's gas distribution business to a qualified third-party buyer consistent with the requirements of M.G.L. c. 164, § 96 and Interlocutory Order on Standard of Review, D.P.U. 10-170, and, upon the

completion of any such sale, NiSource will cease and desist any and all gas pipeline and distribution activities in the District of Massachusetts.

9. In the event of a sale of CMA or CMA's gas distribution business following the execution of a definitive purchase and sale agreement within the three (3) year period of probation under the terms of the CMA Plea Agreement, within thirty (30) days of the later of the sale becoming final or the date on which post-closing adjustments to the purchase price are finally determined in accordance with the agreement to sell CMA or its gas distribution business, NiSource will forfeit and pay a monetary penalty equal to the total amount of any profit or gain from the sale of CMA or its gas distribution business.

10. Upon request of the Government, NiSource will also promptly provide any and all records regarding the sale including but not limited to audited financial statements and income tax returns of NiSource, to the extent required to verify the accuracy of any profit, gain or loss amount that resulted from the sale of CMA or CMA's gas distribution business.

11. NiSource also agrees, as to each of its subsidiaries involved in the distribution of gas through pipeline facilities in Massachusetts, Indiana, Ohio, Pennsylvania, Maryland, Kentucky and Virginia to implement and adhere to each of the recommendations from the National Transportation Safety Board ("NTSB") related to NTSB Accident ID PLD18MR003 regarding the Event.

GOVERNMENT'S OBLIGATIONS AND RIGHTS

12. If NiSource fully complies with all of its obligations under this Agreement, the Government will not file any criminal charges against NiSource related in any way to the allegations in the CMA Criminal Information, the Event, or CMA's and NiSource's restoration work in the Merrimack Valley following the Event currently known to the Government.

13. If, however, during the Term of this Agreement, NiSource (1) commits any felony under U.S. federal law including, but not limited to, any felony violation of the Pipeline Safety Act; (2) gives deliberately false, incomplete, or misleading testimony or information to the Government or to the Court; or (3) otherwise fails to perform or fulfill each of NiSource's obligations under this Agreement, NiSource will thereafter be subject to prosecution for any federal criminal violation of which the Government has knowledge, including, but not limited to, federal criminal violations related to the conduct alleged in the CMA Criminal Information, the Event, or CMA's and NiSource's restoration work in the Merrimack Valley following the Event.

14. The Government, in its sole discretion, will determine whether NiSource has breached the Agreement and whether, as a result, the Government will pursue prosecution of NiSource and any such prosecution may be premised on information provided by NiSource.

15. NiSource also agrees that, in the event that the Government determines, in its sole discretion, that NiSource has violated any provision of this Agreement, an extension of the Term of the Agreement may be imposed by the Government, in its sole discretion, for up to a total additional time period of twelve (12) months. Any extension of the Agreement extends all terms of this Agreement throughout the extension period.

16. In the event the Government determines that NiSource has breached this Agreement, the Government agrees to provide NiSource with written notice of such breach prior to instituting any prosecution resulting from such breach. Within thirty (30) days of receipt of such notice, or within any longer period of time the Government agrees to in writing, NiSource may respond to the Government in writing to present its position regarding whether a breach has in fact occurred; whether any breach was material; whether any breach was knowingly or willfully committed; and any other facts and circumstances that NiSource submits are relevant to

the Government's determination of breach. The Government agrees to consider NiSource's written submission in determining whether a breach occurred and, if so, whether to institute a prosecution of NiSource.

17. In the event the Government institutes a prosecution due to its determination that NiSource has breached this Agreement: (a) all statements made by or on behalf of NiSource or CMA to the Government or to the Court and any testimony given by or on behalf of NiSource before a grand jury, a court, or any tribunal, or at any legislative hearings, whether before or after this Agreement, will be admissible in any criminal proceedings brought by the Government against NiSource; and (b) NiSource will not assert any claim under Rule 11(f) of the Federal Rules of Criminal Procedure; Rule 410 of the Federal Rules of Evidence; or any other federal rule that any such statements or testimony made by or on behalf of NiSource or CMA before or after this Agreement, are inadmissible.

18. NiSource acknowledges that the Government has made no representations, assurances, or promises concerning what sentence may be imposed by the Court if NiSource breaches this Agreement, the Government pursues criminal charges, and this matter proceeds to judgment. NiSource further acknowledges that any such sentence is solely within the discretion of the Court and that nothing in this Agreement binds or restricts the Court in the exercise of its discretion.

19. NiSource also agrees that in the event that CMA's guilty plea is not accepted by the Court or is withdrawn for any reason, or if CMA should fail to perform an obligation under the CMA Plea Agreement prior to the sale of CMA or its gas distribution business, the Government may, at its sole option, render this Agreement null and void.

20. This Agreement is between NiSource and the United States Attorney's Office for the District of Massachusetts. This Agreement does not bind any other federal, state, or local prosecuting authorities. Furthermore, this Agreement does not prohibit the United States, any agency thereof, or any third party from initiating or prosecuting any civil or administrative proceedings directly or indirectly involving NiSource, including, but not limited to, proceedings by the Internal Revenue Service relating to potential civil tax liability.

21. Any notice, certification, resolution, or report to the Government under this Agreement will be given by personal delivery, overnight delivery by a recognized delivery service, or registered or certified mail, addressed to:

Chief, Public Corruption and Special Prosecutions Unit
U.S. Attorney's Office for the District of Massachusetts
John Joseph Moakley Federal Courthouse
One Courthouse Way, Suite 9200
Boston, MA 02210

22. Any notice to NiSource under this Agreement will be given by personal delivery, overnight delivery by a recognized delivery service, or registered or certified mail, addressed to:

Alejandro N. Mayorkas, Esq.
Wilmer-Hale LLP
1875 Pennsylvania Avenue NW
Washington, DC 20006

Carrie J. Hightman
Chief Legal Officer
801 East 86th Avenue
Merrillville, IN 46410

23. Notice will be effective upon actual receipt by the Government or NiSource.

24. The Government's acceptance of delivery of any notice, certification, resolution, or report referenced in this Agreement, or the absence of any response thereto, is not, and will

not be construed as, evidence of compliance with this Agreement or any other applicable laws, policies, or procedures.

25. This Agreement, to become effective, must be signed by all of the parties listed below. No promises, agreements, terms, or conditions other than those set forth in this Agreement will be effective unless memorialized in writing and signed by all parties or confirmed on the record before the Court.

FOR THE UNITED STATES

ANDREW E. LELLING
UNITED STATES ATTORNEY

By:_____
Neil J. Gallagher, Jr.
Evan Gotlob
Assistant United States Attorneys

FOR NISOURCE, INC.

By:_____
Joseph Hamrock
Chief Executive Officer
NiSource, Inc.

By:_____
Carrie J. Hightman
Executive Vice President and Chief Legal Officer
NiSource, Inc.

By:_____
Alejandro N. Mayorkas, Esq.
WilmerHale, LLP
Counsel for NiSource, Inc.

Overpressurization of Natural Gas Distribution System, Explosions, and Fires in Merrimack Valley, Massachusetts September 13, 2018

Accident Report

NTSB/PAR-19/02
PB2019-101365

National Transportation Safety Board

R-2020-3018835
7/8/20
Exhibit-6

NTSB/PAR-19/02
PB2019-101365
Notation 59529
Adopted September 24, 2019

Pipeline Accident Report

Overpressurization of Natural Gas Distribution System, Explosions, and Fires in Merrimack Valley, Massachusetts September 13, 2018

National Transportation Safety Board

490 L'Enfant Plaza, S.W.
Washington, D.C. 20594

National Transportation Safety Board. 2019. *Overpressurization of Natural Gas Distribution System, Explosions, and Fires in Merrimack Valley, Massachusetts, September 13, 2018*. Pipeline Accident Report NTSB/PAR-19/02. Washington, DC.

Abstract: On September 13, 2018, about 4:00 p.m. local time, a series of structure fires and explosions occurred after high-pressure natural gas was released into a low-pressure natural gas distribution system in the northeast region of the Merrimack Valley in the Commonwealth of Massachusetts. The natural gas distribution system was owned and operated by Columbia Gas of Massachusetts, a subsidiary of NiSource, Inc. Columbia Gas of Massachusetts delivers natural gas to about 325,000 customers in Massachusetts. One person was killed and 22 individuals, including three firefighters, were transported to local hospitals due to injuries; seven other firefighters incurred minor injuries. The fires and explosions damaged 131 structures, including at least 5 homes that were destroyed in the city of Lawrence and the towns of Andover and North Andover. Most of the damage occurred from fires ignited by natural gas-fueled appliances; several of the homes were destroyed by natural gas-fueled explosions. Fire departments from the three municipalities were dispatched to the fires and explosions. First responders initiated the Massachusetts fire-mobilization plan and received mutual aid from neighboring districts in Massachusetts, New Hampshire, and Maine. Emergency management officials had the electric utility shut down electrical power in the area, the state police closed local roads, and freight and passenger railroad operations in the area were suspended. Columbia Gas of Massachusetts shut down the low-pressure natural gas distribution system, affecting 10,894 customers, including some outside the area who had their service shut off as a precaution. The National Transportation Safety Board made new recommendations to the Pipeline and Hazardous Materials Safety Administration; the 31 states with an industrial exemption for natural gas infrastructure projects; the Commonwealth of Massachusetts Executive Office of Public Safety and Security; and NiSource, Inc.

NOTE: This report was reissued on November 7, 2019 with corrections to page 60 to remove NiSource employee information.

Contents

Figures

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Acronyms and Abbreviations

AGA	American Gas Association
ANSI	American National Standards Institutes
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
CFR	*Code of Federal Regulations*
CMA	Columbia Gas of Massachusetts
CoMIRS	Commonwealth of Massachusetts Interoperable Radio System
DPU	Massachusetts Department of Public Utilities
EOC	emergency operations center
ERP	emergency response plans
FMEA	failure modes and effects analysis
FOL	field operations leader
GIS	geographic information system
IC	incident commander
LFE	leader of field engineering
M&R	Measurement and Regulation
MAOP	maximum allowable operating pressure
MEMA	Massachusetts Emergency Management Agency
MOC	management of change
NG	National Grid United States
NCEES	National Council of Examiners for Engineering and Surveying
NSPE	National Society of Professional Engineers
NTSB	National Transportation Safety Board

ON	Operational Notice
OQ	operator qualification
P.E.	professional engineer
PHMSA	Pipeline and Hazardous Materials Safety Administration
PSAP	Public Safety Answering Points
psi	pounds per square inch
psig	pounds per square inch, gauge
PSMS	Pipeline Safety Management Systems
RP	Recommended Practice
RSPA	Research and Special Programs Administration
SCADA	Supervisory Control and Data Acquisition system
SCIP	Statewide Communications Interoperability Plan
SMS	safety management systems
w.c.	water column
WMS	work management system

Executive Summary

On September 13, 2018, about 4:00 p.m. local time, a series of structure fires and explosions occurred after high-pressure natural gas was released into a low-pressure natural gas distribution system in the northeast region of the Merrimack Valley in the Commonwealth of Massachusetts. The natural gas distribution system was owned and operated by Columbia Gas of Massachusetts, a subsidiary of NiSource, Inc. Columbia Gas of Massachusetts delivers natural gas to about 325,000 customers in Massachusetts. One person was killed and 22 individuals, including three firefighters, were transported to local hospitals due to injuries; seven other firefighters incurred minor injuries. The fires and explosions damaged 131 structures, including at least 5 homes that were destroyed in the city of Lawrence and the towns of Andover and North Andover. Most of the damage occurred from fires ignited by natural gas-fueled appliances; several of the homes were destroyed by natural gas-fueled explosions. Fire departments from the three municipalities were dispatched to the fires and explosions. First responders initiated the Massachusetts fire-mobilization plan and received mutual aid from neighboring districts in Massachusetts, New Hampshire, and Maine. Emergency management officials had National Grid United States (the electric utility) shut down electrical power in the area, the state police closed local roads, and freight and passenger railroad operations in the area were suspended. Columbia Gas of Massachusetts shut down the low-pressure natural gas distribution system, affecting 10,894 customers, including some outside the area who had their service shut off as a precaution.

The accident investigation focused on the following safety issues:

- Adequacy of natural gas regulations
- Project documentation
- Constructability review
- Project management
- Risk assessment
- Safety management systems
- Licensed professional engineer approval of natural gas projects
- Emergency response

The National Transportation Safety Board determines that the probable cause of the overpressurization of the natural gas distribution system and the resulting fires and explosions was Columbia Gas of Massachusetts' weak engineering management that did not adequately plan, review, sequence, and oversee the construction project that led to the abandonment of a cast iron main without first relocating regulator sensing lines to the new polyethylene main. Contributing to the accident was a low-pressure natural gas distribution system designed and operated without adequate overpressure protection.

1. Factual Information

1.1 Accident Synopsis

On September 13, 2018, about 4:00 p.m. local time, a series of structure fires and explosions occurred after high-pressure natural gas was released into a low-pressure natural gas distribution system in the northeast region of the Merrimack Valley in the Commonwealth of Massachusetts. The natural gas distribution system was owned and operated by Columbia Gas of Massachusetts (CMA), a subsidiary of NiSource, Inc. CMA delivers natural gas to about 325,000 customers in Massachusetts. The fires and explosions damaged 131 structures, including at least 5 homes that were destroyed in the city of Lawrence and the towns of Andover and North Andover. (See figure 1.) Most of the damage occurred from fires ignited by natural gas-fueled appliances; several of the homes were destroyed by natural gas-fueled explosions. Fire departments from the three municipalities were dispatched to the fires and explosions. First responders initiated the Massachusetts fire-mobilization plan and received mutual aid from neighboring districts in Massachusetts, New Hampshire, and Maine. Emergency management officials had National Grid United States (NG) (the electric utility) shut down electrical power in the area, the state police closed local roads, and freight and passenger railroad operations in the area were suspended. CMA shut down the low-pressure natural gas distribution system, affecting 10,894 customers, including some outside the affected area who had their service shut off as a precaution.

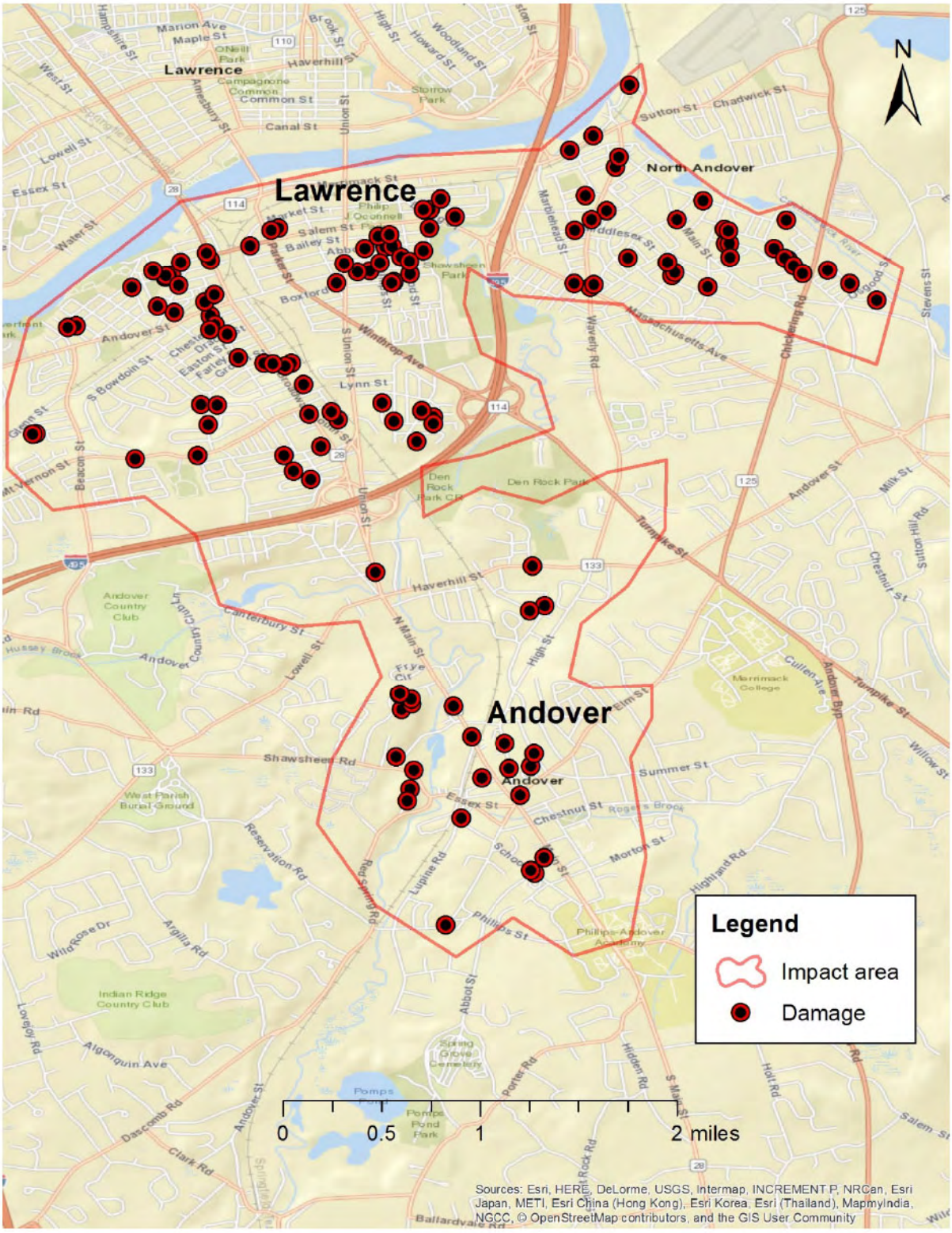

Figure 1. Map of the damaged structures in the area impacted by the overpressurization.

An 18-year-old male was killed when a home exploded, and the chimney fell onto the vehicle where he was sitting. (See figure 2.) Another person in the vehicle at the time of the

explosion was seriously injured, as was someone on the second floor of the house. In total, 22 people, including 3 firefighters, were transported to hospitals for treatment of their injuries. Injuries included respiratory injuries related to smoke inhalation from fires and musculoskeletal injuries from evacuating. Some people were transported to hospitals to maintain ongoing medical treatment that could not be continued in their homes because of the shutdown of natural gas and electricity and the evacuation of residents.

Figure 2. Remnants of house where the fatality and two severe injuries occurred.

1.2 Background

1.2.1 NiSource

NiSource, Inc. is an Indiana-based energy holding company whose subsidiaries are regulated natural gas and electric utility companies serving about 3.9 million customers in seven states.[1] Its natural gas distribution operations comprise about 60,000 miles of pipeline and include 732 low-pressure natural gas distribution systems. NiSource's Massachusetts subsidiary, CMA,

[1] NiSource is the successor to a corporation organized in 1987 under the name of Northern Indiana Public Service Company Industries, Inc., which changed its name to NiSource in 1999.

delivers natural gas to over 325,000 natural gas customers in southeastern Massachusetts, the greater Springfield area, and the Merrimack Valley.[2]

1.2.2 Feeney Brothers

CMA contracted with Feeney Brothers, a pipeline services firm, to work on a CMA project to replace an existing cast iron main with a polyethylene main.[3] About 7:00 a.m. on the day of the accident, a CMA construction coordinator, along with four employees of Feeney Brothers, arrived at Salem and South Union Streets in Lawrence, Massachusetts, to continue work on this project. The work they performed that day led to the overpressurization of the natural gas distribution system. All crewmembers were trained and qualified in accordance with the Pipeline Operator Qualification Rule, commonly known as OQ.[4] Following the accident, the contractor crewmembers, along with the CMA construction coordinator, were alcohol and drug tested in accordance with Title 49 *Code of Federal Regulations* (*CFR*) Part 199. The test results were negative for alcohol or other drugs.

1.2.3 Natural Gas Distribution Systems

Natural gas distribution systems deliver natural gas to customers for heating, cooking, lighting, and other uses. A basic distribution system has three elements: (1) natural gas mains that transport natural gas underground, (2) service lines that deliver natural gas from the mains to customers, and (3) meters that measure the quantity of natural gas used by each customer. Customer piping takes natural gas from the meter to customer's appliances where it is used. To minimize service interruptions, normal maintenance and natural gas distribution system upgrades are typically performed with the system operating.

Both low-pressure and high-pressure natural gas distribution systems are used to supply natural gas to customers. In a low-pressure natural gas distribution system, the natural gas in the mains is essentially the same pressure as the pressure provided to the customer's piping and used by the appliances. Natural gas is typically supplied to the mains from a high-pressure source through a regulator station that reduces the pressure to that required by the customers. The low-pressure natural gas distribution system in the Merrimack Valley was installed in the early 1900s with cast iron mains. The system used 14 regulator stations to supply natural gas to the mains and control pressure.[5] The regulator stations each contained two regulators in series—a worker regulator and a monitor regulator—each with a sensing line that feeds back the pressure in the main to the regulator, forming a redundant closed-loop control system. The worker regulator is the primary regulator that maintains the natural gas pressure, and the monitor regulator provides a redundant backup to the worker regulator. Each of the regulator stations reduced the natural gas

[2] Although CMA had internal guidance documents specifically for its employees, NiSource also had guidance documents that employees in all its subsidiaries were required to follow. In this report, guidance documents are identified accordingly.

[3] Feeney Brothers, a utility services firm headquartered in Dorchester, Massachusetts, was established in 1988 and employs over 700 employees and operates throughout Massachusetts, Connecticut, and New York.

[4] Title 49 *Code of Federal Regulations* (*CFR*) Part 192, Subpart N.

[5] *Regulator stations* house the worker and monitor regulators that are used to maintain natural gas pressure.

pressure from about 75 pounds per square inch gauge (psig) to 12 inches of water column (w.c.), about 0.5 psig, for distribution through the mains and delivery to customers.[6]

Since the regulator stations are the primary means of pressure control in the low-pressure systems, an overpressure condition in a natural gas distribution system could affect all customers served by the system. This is an inherent weakness of a low-pressure natural gas distribution system.

Figure 3 shows a typical arrangement for the low-pressure natural gas distribution system used in the Merrimack Valley before the accident.

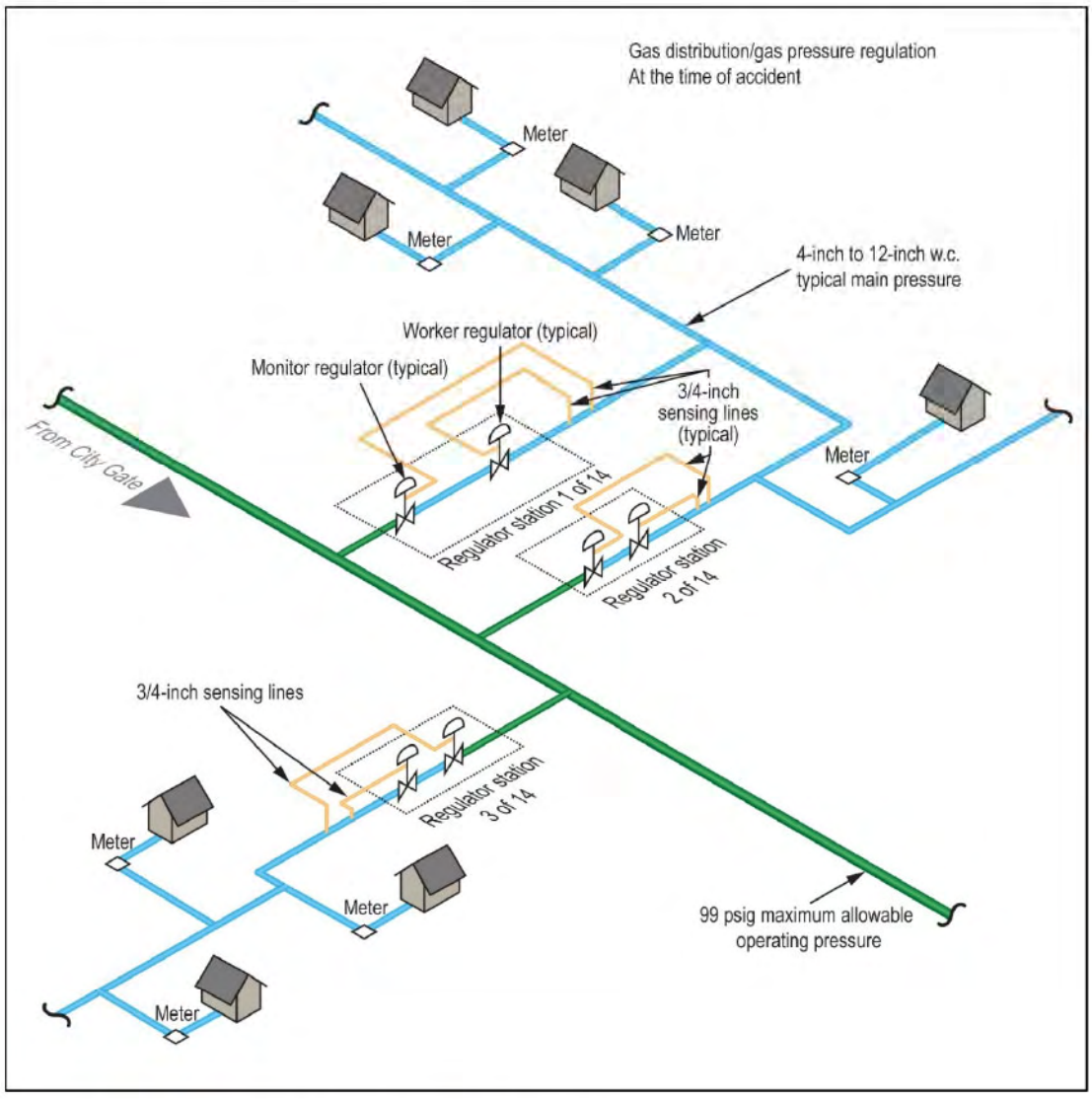

Figure 3. Typical configuration of the Merrimack Valley low-pressure natural gas distribution system.

[6] In the pipeline industry, it is customary to measure anything less than 1 psig in inches of water column. A measurement of 1 inch w.c. equals 0.0361 psig.

In a high-pressure natural gas distribution system, the natural gas pressure in the main is substantially higher than that required by the customer. A pressure regulator is installed at each meter to reduce the pressure. These regulators incorporate an overpressure protection device to prevent overpressurization of the customer's piping and appliances should the regulator fail. Additionally, excess flow valves are installed in the service line.[7] Because each customer's service in a high-pressure natural gas distribution system is protected by an excess flow valve and a pressure regulator, it is highly unlikely that an overpressure condition in the main would impact multiple customers. Figure 4 shows a typical high-pressure natural gas distribution system. This is the type of natural gas distribution system that was installed postaccident in the Merrimack Valley.

[7] An *excess flow valve* is a mechanical safety device installed on a gas service line to a residence or small commercial gas customer. In the event of damage to the gas service line between the street and the meter, the excess flow valve will minimize the flow of gas through the service line. Current federal regulations require a gas distribution company to install such a device on new or replacement service lines for single-family residences and certain multifamily and commercial buildings where the service line pressure is above 10 psig. See 49 *CFR* 192.383 for specific requirements.

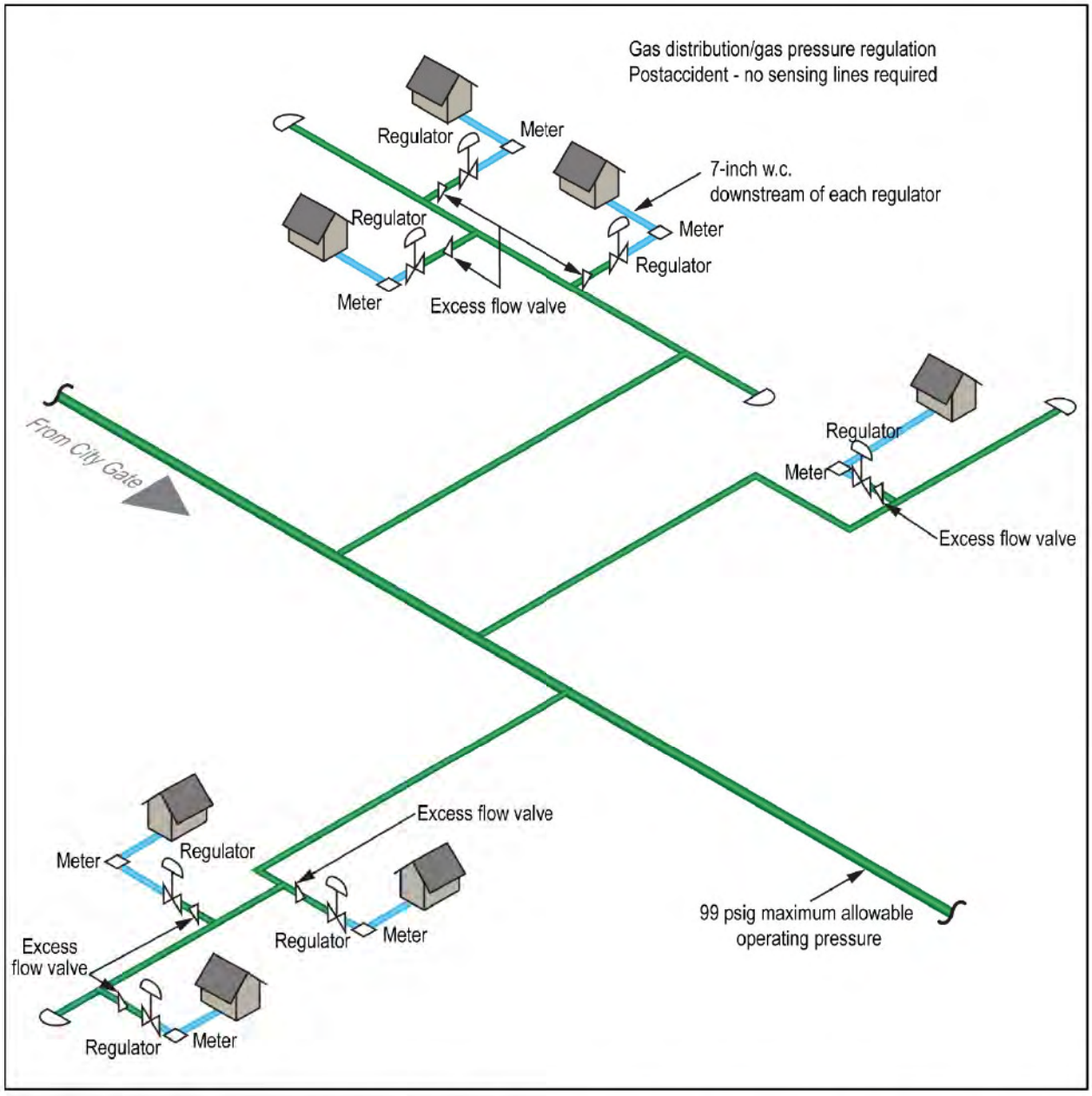

Figure 4. Typical configuration of high-pressure natural gas distribution system installed postaccident.

1.3 Events Preceding the Overpressure

About 7:00 a.m. on the day of the accident, a CMA construction coordinator, along with four employees of Feeney Brothers, arrived at Salem and South Union Streets in Lawrence, Massachusetts, to continue work on a CMA project to replace an existing cast iron main with a polyethylene main.

The crew completed the installation according to the CMA work plan, placed the new tie-ins into service, and isolated the existing cast iron main shortly before 4:00 p.m., by closing

valves on a 2-inch plastic bypass pipe between the cast iron and polyethylene mains.[8] The crew then cut the bypass pipe to abandon the cast iron main. (See figure 5.) In postaccident interviews, crewmembers said that within minutes of closing the valves and cutting the bypass, they observed the pressure gauge on the polyethylene main exceed the expected readings.[9] Furthermore, a fitting on the polyethylene natural gas main blew off into the hand of one of the workers. The crewmembers said that they responded quickly to plug the blowing natural gas, and they heard emergency vehicles in the neighborhood and observed smoke plumes in multiple directions within minutes.

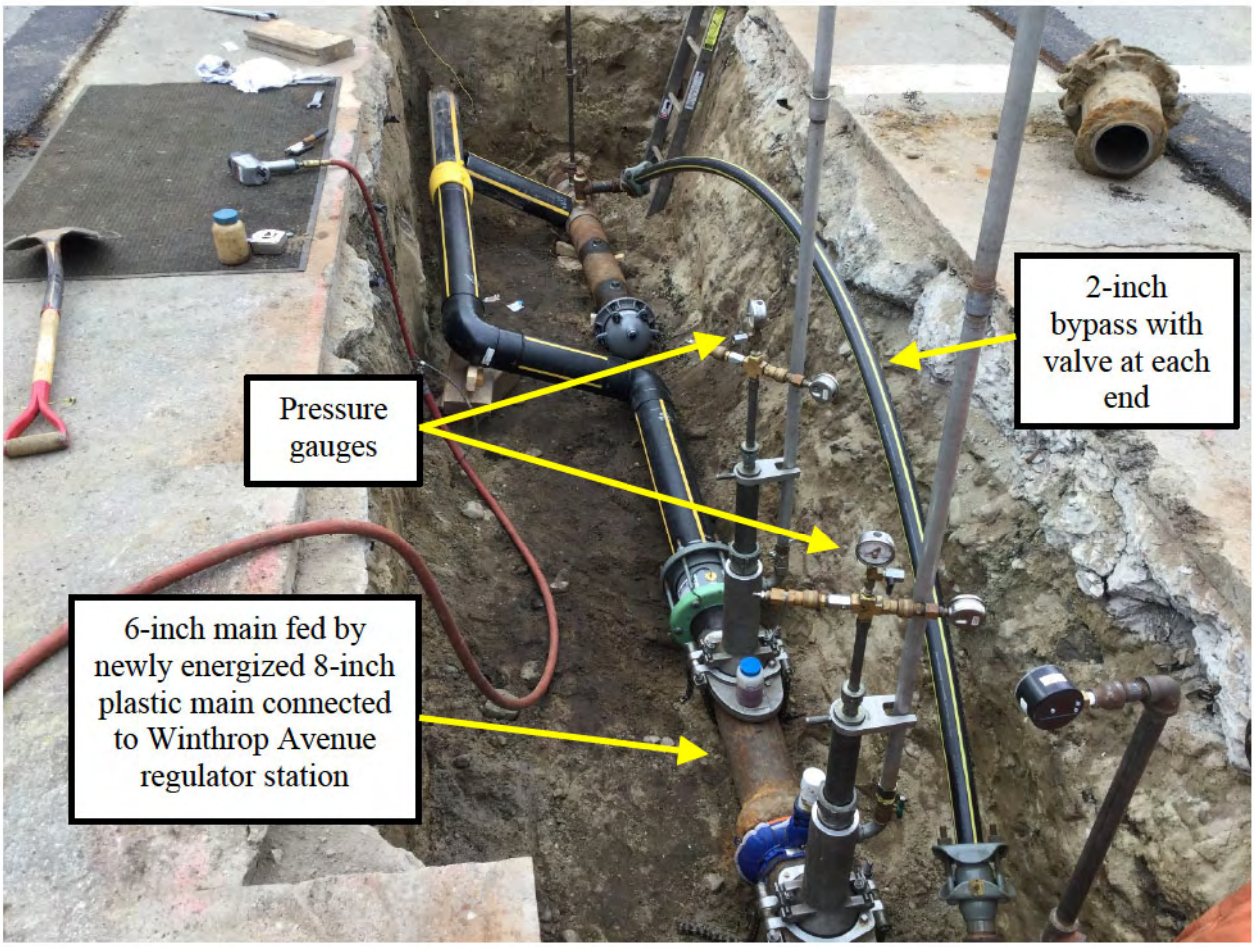

Figure 5. Salem Street tie-in for the South Union Street project (looking west). Photograph courtesy of Feeney Brothers.

At the Winthrop Avenue regulator station, about 0.5 mile south of the work area, the abandoned cast iron main was still connected to the regulator sensing lines providing input to the two pressure regulators used to control the system pressure.[10] (See figure 6.) Once the contractor

[8] A *tie-in* involves connecting new piping to existing piping. In this case, the main ran north and south while the branches ran east and west. When the main was replaced, the east and west branches needed to be tied into the new main.

[9] Supporting documentation referenced in this report can be found in the public docket for this accident, accessible from the NTSB Accident Dockets web page by searching PLD18MR003.

[10] *Sensing lines* are also called *control lines* or *static lines*.

crew isolated the cast iron main, the natural gas pressure began to drop in the cast iron main and in the regulator sensing lines. As the pressure dropped, the pressure regulators responded by opening further, increasing pressure in the natural gas distribution system. Since the Winthrop Avenue regulators no longer sensed system pressure, they fully opened, allowing high-pressure natural gas to be released into the low-pressure natural gas distribution system.

Figure 6. Location of September 13, 2018, tie-in and the Winthrop Avenue regulator station.

1.4 Emergency Response

1.4.1 Local and State Response

The overpressurization of the low-pressure natural gas distribution system in the Merrimack Valley impacted over 10,000 natural gas customers in three municipalities—Lawrence, North Andover, and Andover. The emergency call centers in these municipalities, known as public safety answering points (PSAP) began receiving 9-1-1 calls immediately following the overpressurization from residents and businesses reporting fires and explosions and requesting assistance.

Shortly after 4:00 p.m., the fire departments in Lawrence, North Andover, and Andover were inundated with emergency calls reporting structure fires and explosions. Within the first 30 minutes, all three fire departments had exhausted their list of mutual aid. The incident commanders (IC) from all three fire departments, who were either the fire chief or deputy chief,

told National Transportation Safety Board (NTSB) investigators they had never responded to a natural gas accident of this magnitude. Table 1 shows information on the local fire response from each of these municipalities.

Table 1. Local fire response.

Municipality	Time of notification	Number of stations	Number of responding firefighters	Number of injured firefighters
Lawrence	4:11 p.m.	6	124	4
Andover	4:19 p.m.	3	68	0
North Andover	4:13 p.m.	3	44	1

In Massachusetts, municipalities determine their own emergency radio communications and resources because Massachusetts Home Rule grants them the responsibility for the welfare of their residents.[11] The Commonwealth of Massachusetts Interoperable Radio System (CoMIRS) is a statewide network of connected but individually managed radio systems and dispatch networks that supports over 30,000 devices statewide. The Massachusetts State Police and North Andover use CoMIRS, but Lawrence and Andover do not.

Once the 10th alarm level was reached, a request to the Massachusetts Emergency Management Agency (MEMA) to activate the statewide Fire Mobilization Plan was triggered. The plan activated 15 task forces across the state, and over 180 fire departments and 140 law enforcement agencies responded to the scene.

Massachusetts State Police also responded to the affected area after receiving emergency calls. During the next 24 hours, they dispatched over 200 officers, which included detectives, members of the fire and explosion group, and crime-scene technicians. A total of 362 uniformed assets were deployed in the subsequent 4 days. They assisted in closing portions of Interstate 495, State Route 28, and State Route 114, and the police also escorted firefighters and technicians into the affected area.

Shortly after 4:00 p.m., the Massachusetts State Fire Marshal was notified of the natural gas events. Unified command was initiated and collaboratively operated by the Massachusetts State Fire Marshal and the director of MEMA and was staged in South Lawrence.[12]

About 5:20 p.m., NG received the first of several requests from CMA using a priority phone number to shut down electricity in the area to reduce sources that could ignite the released natural gas.

The mayor of Lawrence issued an evacuation order for areas south of the Merrimack River. The evacuation alert was issued over cell phones and media broadcasts to residents in the area. North Andover authorities issued a voluntary evacuation for all occupied structures with natural

[11] According to the National Association of Counties, *home rule* "gives local government the capability to shape the way it serves the needs of its constituency (Coester 2004)."

[12] In an IC system, a *unified command* is an authority structure in which the role of the IC is shared by two or more individuals, each already having authority in a different responding agency.

gas utility service, using local cable channels, the town website, and a citizen alert telephone system to send public service messages.[13] The Andover fire chief called for an evacuation using a citizen alert telephone system and social media, and instructed residents to turn off natural gas service meters if they knew how to and to evacuate if they did not feel safe or smelled natural gas. In total, over 50,000 residents were asked to evacuate following the overpressurization (MEMA 2018). Five centers were set up in the three municipalities to receive displaced people; four of the centers became overnight shelters and remained open for several days. Although residents were allowed to return to their homes in all three municipalities on September 16, 2018, 3 days after the accident, many were uninhabitable at that time. As explained in section 1.4.3, many residents were unable to live in their homes for several months after the accident.

1.4.2 Columbia Gas Response

On September 13, the NiSource Gas Systems Control monitoring center in Columbus, Ohio, received pressure alarms on its supervisory control and data acquisition (SCADA) system, which recorded a sudden increase of pressure in the Merrimack Valley low-pressure natural gas distribution system at 3:57 p.m. The SCADA capability was only able to monitor system pressures; it was unable to remotely control the natural gas system.[14]

The first SCADA high-pressure alarm activated at 4:04 p.m. for the South Lawrence regulator station, noting a pressure of 15.02 inches w.c.[15] A second high-pressure alarm activated for the Riverina SCADA pressure-monitoring center in Andover, noting a pressure of 16.94 inches w.c. at 4:05 p.m. The controller acknowledged both alarms and called the on-call technician for the CMA measurement and regulation (M&R) department at 4:06 p.m. A rate-of-change alarm was activated at 4:07 p.m., as well as a high-high pressure alarm at 4:08 p.m. for the Riverina station, which the controller acknowledged immediately.[16] At 4:16 p.m., the CMA on-call technician reported to the monitoring center that he saw smoke and explosions from a distance.

In response to the phone call from the SCADA center, the Lawrence technician called the M&R technicians about the alarms at 4:06 p.m. The M&R technicians immediately responded to perform field checks on the affected 14 regulator stations in the Merrimack Valley natural gas distribution system to identify and shut down any station that was feeding high-pressure natural gas into the system. At 4:30 p.m., one of the M&R technicians at the Winthrop Avenue regulator station heard a loud sound and recognized that a large quantity of natural gas was flowing through the regulators there. He adjusted the setpoint on the two regulators to reduce flow and isolated them. He noticed that the sound of the flowing natural gas began to decrease.

[13] The alert system automatically called every landline. Cell phones and private numbers had to be registered.

[14] The natural gas distribution system complies with all applicable regulatory requirements.

[15] Interviews with NiSource controllers defined a *high-pressure alarm* as elevated pressure in the system and *high-high pressure* is when the pressure in the system has reached its maximum allowable operating pressure (MAOP).

[16] A rate-of-change alarm is triggered by a rapid change in pressure.

A CMA field engineer and the CMA field operations leader (FOL) were at another construction site when they received notification at 4:18 p.m. to contact the CMA construction department, from whom they learned that fires were coming out of house chimneys.[17]

Due to traffic congestion, a police officer escorted the FOL toward the work site at Salem and South Union Streets. The FOL arrived around 5:08 p.m.[18] When the FOL arrived, the crewmembers told him they had confirmed the pressure in the entire low-pressure natural gas distribution system was in the normal range before removing the bypass. He then went to a home near the Salem and South Union Streets construction site and with the assistance of a pipefitter using a pressure gauge, found there was elevated pressure of 2.5 psi at 5:19 p.m. He then recommended to his supervisor, the Lawrence Operations Center manager, that CMA shut down the low-pressure natural gas distribution system.

After being designated as the CMA IC by the Lawrence Operations Center manager, the FOL then called the engineering department for the list of valves that needed closing to isolate and shut down the system. While waiting for this information, he requested all distribution crews to meet him at the work site at Salem and South Union Streets. The FOL assigned crews to regulator stations and directed them to verify with the engineering department the correct valve to close once they arrived at a regulator station. Once confirmed, they closed the valves. The FOL confirmed the closure of all valves at 7:24 p.m.

Low-low pressure alarms, indicating that the system was losing pressure, were received from the Riverina and South Lawrence SCADA pressure-monitoring points between 7:19 p.m. and 7:24 p.m., confirming the system was shutting down. At 7:43 p.m., the president of CMA declared a Level 1 emergency, in accordance with CMA's emergency response plan (ERP).[19]

Beginning at 8:39 p.m., the FOL sent pipefitters to different points in the system to take pressure readings to see if the pressure was dropping. About midnight, crews were dispatched to the affected areas in all three municipalities to assist the fire department personnel in shutting off meters and responding to fires, leak calls, and odor complaints. Locksmiths also were requested by CMA to provide technicians access to secured properties that needed to be checked for leaking natural gas.

On September 14 at 2:52 a.m., NiSource submitted a request to the Northeast Gas Association seeking mutual assistance from service technicians and supervisors from other natural gas companies. A total of 586 service technicians and 57 supervisors from 27 different natural gas companies responded to the area.

During the night, CMA's M&R department worked at the FOL's direction to confirm all regulator stations were locked in.[20] At 6:27 a.m., all 14 regulator stations were locked in and the

[17] A FOL primarily handles customer requests and responds to natural gas incidents and leaks.

[18] The location of the FOL was recorded by a global positioning system tracker in the NiSource system.

[19] *Level 1* is defined in NiSource's Emergency Manual as "Catastrophic Event-Which if not handled in an appropriate manner may dramatically impact NiSource's reputation, assets, or cause liability. Corporate Crisis Plan activated." Level 1 scenarios include a loss of a major natural gas facility or loss of critical natural gas infrastructure.

[20] *Lock in* refers to the inlet and outlet valves being completely closed and, as a result, there is no natural gas flowing in the regulator station.

low-pressure natural gas distribution system was confirmed shut down for 8,447 customers in the Lawrence, Andover, and North Andover areas. An additional 2,447 customers outside the immediate area had their natural gas shut off as a precaution.

1.4.3 Community Impact

Residents who were evacuated from the impacted area were allowed to return to their homes by 7:00 a.m. on September 16, 2018. However, restoration of residential natural gas and electricity required more time and involved multiple steps to coordinate the activities safely. CMA restored natural gas service to most customers in the impacted areas of Lawrence, North Andover, and Andover by December 16, 2018, 3 months after the accident.

On September 14, 2018, the governor of Massachusetts authorized Eversource Energy as the lead organization of the recovery process and to manage the restoration of the utility services in Andover, North Andover, and the portion of Lawrence that was south of the river (Commonwealth of Massachusetts 2018).[21] Between September 14 and September 16, 2018, NG coordinated with CMA and Eversource Energy to restore electrical power, following a required procedure to ensure that it was safe to re-energize homes without igniting any natural gas. As a precaution, the fire department sent assets to neighborhoods in case structure fires occurred when the electric service was turned on.

Until natural gas service was restored, many customers were without heat, hot water, and the service of other natural gas-fueled appliances such as stoves and clothes dryers. MEMA, the American Red Cross, and local officials set up a Recovery Resource Center to provide the communities with food and other support services. Also, NiSource and MEMA collaboratively set up an alternative housing program that relocated about 2,300 families to hotels, apartments, and trailers until they moved back into their homes (MEMA 2018).

1.5 Natural Gas Main Replacement Project

1.5.1 Scope

Beginning in 2016, CMA initiated an effort to replace 7,595 feet of low-pressure cast iron and polyethylene mains with 4,845 feet of low-pressure and high-pressure polyethylene mains on South Union Street and neighboring streets. The project was estimated to last 96 days, encompassing 12 different projects with two work crews, and the work scope included 93 service lines—65 service line replacements and 28 service line tie-ins. This was the first of the projects that involved abandoning the existing pipe. A work package, which included materials such as isometric drawings and procedural details for disconnecting and connecting pipes, was prepared for each of the planned construction activities. However, no package was prepared for the relocation of the Winthrop Avenue sensing lines from the cast iron main to the polyethylene main.

[21] Eversource Energy is an energy company that offers retail electricity, natural gas service, and water service to about 4 million customers in New England.

Figure 7 shows the area of the replacement of the natural gas main in South Lawrence along South Union Street with the cross-street tie-ins. The work on the day of the accident was at the north end of the project at Salem Street. The Winthrop Avenue regulator station is at the south end of the project.

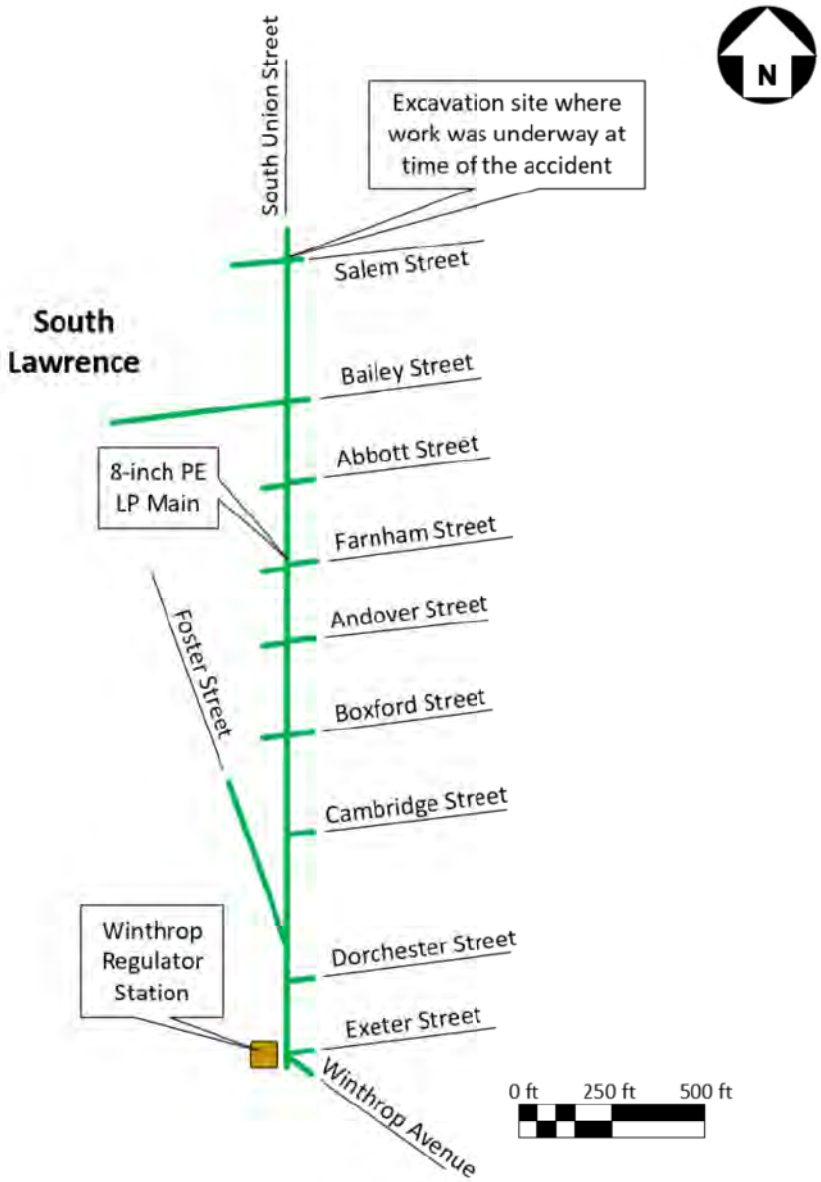

Figure 7. Areas along South Union Street with tie-ins impacted by the project.

The first stage of the project involved the installation of the polyethylene main, which was completed in late 2016. The regulator sensing lines at the Winthrop Avenue regulator station remained attached to the cast iron main, where they controlled natural gas flow through the

Winthrop Avenue regulator station into both the cast iron and polyethylene mains, which were connected in the low-pressure natural gas distribution system. (See figure 8.)

The city restrictions, due to paving in the area, delayed the South Union Street project for more than a year. Prior to the delay, CMA connected the polyethylene pipe to the distribution system, which allowed it to be monitored for pressure changes. The second stage of the project began in 2018 and involved installing the tie-ins to the polyethylene main and abandonment of the cast iron main. On the day of the accident, the sensing lines were still connected to the cast iron main and were functionally disconnected from the distribution system when the cast iron main was abandoned.

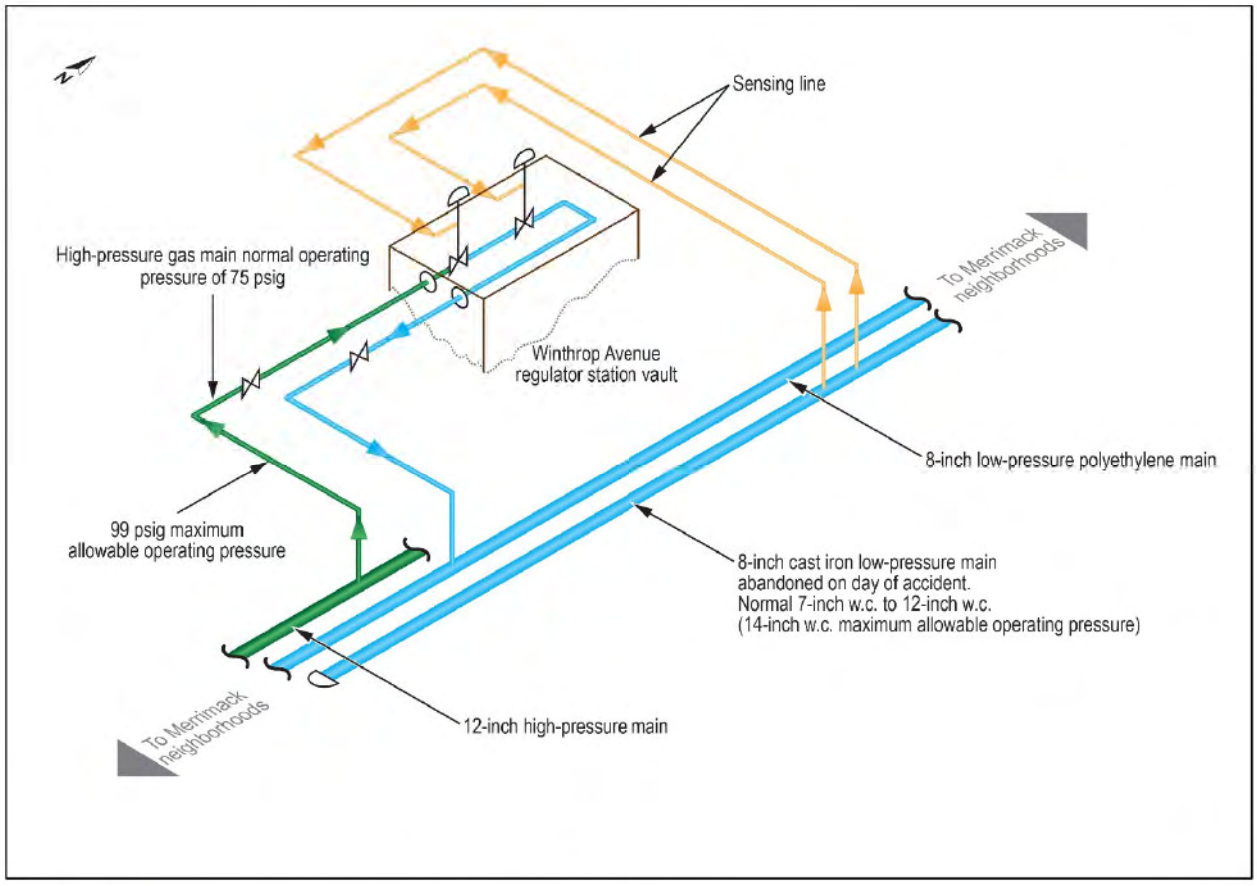

Figure 8. The Winthrop Avenue regulator station.

1.5.2 Project Reviews

CMA uses three types of documents that are found in a work package and that are used to control the workflow of a construction project. Once these documents were complete, they were submitted to engineering management for approval.

Table 2. Required CMA project workflow documentation.

Chronology	Title of document	Number of pages	Description
1	Capital Design Job Order Checklist	2	Details the individual steps and activities, accountabilities, and approvals performed and obtained by the field engineer during the project design and approval process.
2	Capital Project Execution Workflow	3	Provides the activity detail, handoffs, accountability, and approval that occurs throughout the construction process from the time a project is released until it is completed and submitted to the GIS Capital Closeout team for project closeout and mapping.
3	Constructability Safety Review	3	Documents a collaborative discussion between the project engineer and the construction leader to review the scope and details of a project before construction to identify and address potential obstacles to the execution of a project design.

Constructability reviews are a recognized and generally accepted good engineering practice for the execution of professional design services and are intended to provide an independent and structured review of construction plans and specifications to ensure there are no conflicts, errors, or omissions (Kirby and others 1989). Two constructability reviews of the South Union Street project were signed on March 1, 2016, and January 6, 2017. The second constructability review was signed again on December 14, 2017. The constructability review form had a required signature line for the engineering and construction departments and a signature line for M&R that was designated as optional. The constructability review forms for the South Union Street project did not include signature(s) for representatives from the M&R department.

Before the accident on September 13, 2018, the M&R department participation in constructability reviews was on a case-by-case basis. For example, if the project involved changing the design or location of a regulator station or installing or replacing a regulator, M&R would likely be involved in the constructability review and meetings in the field.

Postaccident review of the engineering work package and construction documentation for the project identified some omissions. Although CMA used its project workflow process to develop, review, and approve the engineering plans, the work package did not consider the existence of regulator sensing lines connected to the distribution lines that were slated to be abandoned within the scope of work. This omission was not identified by any of the CMA constructability reviews (NTSB 2018). In fact, none of the CMA workflow documents refer to natural gas distribution system pressure control nor do they refer to regulator control or sensing lines, and none of the documentation in the construction packages for the South Union Street project referred to sensing lines for regulator control. The 2018 constructability review document referenced pressure monitoring and stated that "if pressure rises/falls beyond these points, contact M&R."

1.5.3 Sensing Line Documentation

NTSB investigators spoke with an M&R department supervisor, who stated:

> Except for the newest stations, there's no, there is no, there is no drawings of control [sensing] lines. We frequently get asked to come out and help, you know, locators mark control lines. We can't really help them because we don't know where they are. Well, I mean a lot of the stations go back to the '50s and '60s. The new stations, we have the field engineers come out and draw them for us.

The M&R supervisor said that employees sometimes used older legacy recordkeeping systems to supplement newer isometric drawings of the regulator stations because critical information was missing from the new drawings. He described the documentation failures of the newer drawings, such the omission of valves, as "a deficiency on the engineers," although he said that it might not have been the fault of the engineers because "it wasn't clear enough when they explained to them what they wanted drawn."

He described the legacy recordkeeping system as "the old books," stating that "we call them our bibles." He said that even though employees "weren't supposed to have them anymore because they may not be current," during his tenure in his prior position in the field, he found them to sometimes be "more current than the new drawings."

Table 3 details the information associated with the sensing lines and the regulator stations including where it can be found and also includes other related documentation, such as the geographic information system (GIS) data. According to the director of field engineering, the GIS data did not provide project reviewers/approvers with sensing line location information at the time of the accident. These information sources were not in one location; hence, engineers would be required to visit multiple places to capture the true as-built configuration. M&R staff also had extensive institutional knowledge about sensing line locations.

Table 3. Sources of sensing line information and select regulator station documentation. Table courtesy of NiSource.

Document or source of information	Location	Description	Update interval	Responsible for updating
Critical Valve Book (contain sensing line information)	Lawrence Operations Center	Identifies the location of critical valves in relation to other system components, including regulator stations and sensing lines where applicable	As needed	Engineering
Work Done Files (contain sensing line information)	Lawrence Operations Center	Compilation by town and street of records and as-built sketches of work done on system, including sensing line installations, replacements, and relocations	As work is done	Distribution, Construction, Operations
Historical Maps (contain sensing line information)	Lawrence Operations Center	System maps predating implementation of GIS. Certain historical maps include sensing line locations	Historical	N/A

Document or source of information	Location	Description	Update interval	Responsible for updating
Capital Close Out Files (contain sensing line information)	Lawrence Operations Center	As-built drawings and other project documentation from inspector work order packets for capital projects, including as-built drawings of project sensing line installations, replacements, relocations	As projects are closed out	Construction/Capital Close Out
WMS (work management system) Docs (contain sensing line information)	WMS Docs Database	Electronic version of Capital Close Out files, including as-built drawings of project sensing line installations, replacements, relocations	As projects are closed out	Capital Close Out
M&R Regulator Books (contains sensing line information)	M&R Technician Vehicles	Books maintained for reference by M&R in the field. The books contain diagrams depicting the piping configuration around regulator stations, including the location of sensing lines	As needed	M&R
Regulator Station Inspection Record	Regulator Station	Record of station attributes, major components, station shut-off valve	As inventory changes	M&R
Regulator Station Inventory Record	Regulator Station	Record of station attributes, major components, station shut-off valve	As inventory changes	M&R
Station Isometric Drawing	Regulator Station	Depicts direction of flow through regulator station and sequence of major station components	As needed	Engineering
GIS Map Printout	Regulator Station	GIS record identifying location of regulator station's critical valve in relation to regulator station, station's inlet and outlet piping, and natural gas mains in the vicinity of station	As needed	Capital Close Out

1.6 Engineering Project Management

1.6.1 Staffing and Scope of Responsibilities

The field engineer assigned to the South Union Street project was based in the Lawrence Operations Center, and began work at CMA in July 2014, soon after graduating from college with a mechanical engineering degree. He was promoted from field engineer 1 to field engineer 2 in December 2016. He was responsible for developing and planning engineering modifications to the natural gas distribution system. He had about 1 year of experience when assigned to the South Union Street project in 2015, and he continued to work on that and other projects through 2018. He had worked as a field engineer with CMA for about 4 years when the accident occurred.

The field engineer had completed training from NiSource on various topics, including regulators, sensing lines, and company-wide NiSource Operational Notice (ON) 15-05; the latter discussed how sensing lines could be damaged by excavation close to a regulator station, and it highlighted the specific risk of overpressurization due to damage to sensing lines. However, he told NTSB investigators that sensing lines typically were not addressed in his work packages unless a project involved replacing a regulator station (such as in the 2014 work package) or vault. He could not recall if he had addressed sensing lines on previous projects. He added that he did

not know if the engineering department had access to sensing line information, although he believed that the M&R department did.

Field engineers are supervised by one of two leaders of field engineering (LFE), who both report to the manager of field engineering. There is one LFE for CMA's Brockton Operations Center and the other for CMA's Springfield and Lawrence Operations Centers. The LFE for the Springfield and Lawrence Operations Centers oversaw the South Union Street project. He began working for Bay State Gas Company (now CMA) as a co-op student on January 3, 1984. He was hired full time as an associate engineer in 1987 and worked within the engineering department until 2001. He then left the company and went into private consulting for 5 years. He came back to CMA in April 2007. He was promoted from field engineer to LFE in December 2013. In that capacity, his responsibilities included overseeing engineering projects in areas covering Springfield, Massachusetts, and Lawrence, Massachusetts. He had six full-time engineers who reported directly to him from the Springfield division and three engineers in the Lawrence Operations Center, where work packages for the South Union Street project were prepared.

The LFE earned a bachelor of science degree in mechanical engineering and a master of science degree in engineering management. He is licensed as a professional engineer (P.E.) in Massachusetts.

The field engineering group provides engineering support that includes the design of replacement projects, estimating, cost tracking, creation of tie-ins, and project management. For calendar year 2018, CMA established a goal to replace 58 miles of what was categorized as replacement pipe. The section of cast iron pipe related to the accident was part of this 58-mile scope.

In an interview, the LFE described the initiation of the South Union Street project. He said that as part of a natural gas system enhancement program, the field engineering department submits a 5-year pipe-replacement plan each year to the Massachusetts Department of Public Utilities (DPU). From there, the team develops a preliminary design to determine the project scope and prioritize tasks. After a preliminary estimate and preliminary design, the field engineering group meets with the construction group for a constructability review.

According to the LFE, once they finalize a plan:

> We make sure that we take a look at all of the material that's going to be installed and abandoned. We develop tie-in procedures, pressure-testing procedures. We make sure environmental concerns are addressed. And we actually have a checklist to go down to make sure that the protocol has been followed as far as constructability reviews, reviews of crews in the field—I mean, constructability reviews for the construction people so they understand the scope of the project.

The engineering review includes sign off by the LFE, the manager of field engineering, and the director of field engineering. During interviews with NTSB investigators, the LFE, and the manager and director of field engineering stated that their review did not include an evaluation of each step in the work package. The LFE stated, "I do not go through and actually—on every

single project look at every single step of the process." The LFE was not required or asked to review the work package and certify it under the standards of a Professional Engineer.

The director of field engineering indicated that he is responsible for approving projects with costs over $1 million, which included the South Union Street project. He said that his reviews typically were at a higher level, and he did not carefully review each step of work packages, particularly those that were routine in nature, as was the case with the work being done on the day of the accident. Moreover, he suggested that he would expect the managers of engineering to perform similar high-level reviews.

However, the director of field engineering indicated that he would expect the field engineers and the LFEs to work together to ensure that work packages were safely designed. He said that it was up to the LFE to assess the capabilities of each field engineer and provide the appropriate level of oversight based on their capabilities. He added that peer reviews, in which field engineers evaluated each other's work, were often used as well. However, he said that such reviews were informal and unstructured. He added that when field engineers were in the process of gathering information on a project, they looked at the documentation on the facilities that are in the scope of the work. He said that after the accident NiSource recognized that "we were short on readily available information around the sensing lines, the control lines."

1.6.2 Measurement and Regulation Department

The M&R department is responsible for maintaining the regulator stations in the CMA natural gas distribution system. On September 13, 2018, the M&R department consisted of 11 full-time technicians across Massachusetts, with 2 technicians in the Lawrence area who had more than 45 years of experience between them. The department is responsible for the regulator vaults, the regulators, and the sensing lines. CMA expects the M&R department to initiate work for existing sensing line maintenance. On capital projects, CMA expects the engineering department to work in coordination with M&R and the construction departments when sensing line work is needed.

The NTSB was provided an affidavit from the field engineer in which he stated that he discussed sensing line configurations in general with a member of the construction department during the design phase of the South Union Street project, and during the constructability review that took place on March 1, 2016. The field engineer also said that he contacted the M&R department to discuss sensing lines, though he no longer recalled "all the specifics of that conversation." The field engineer said that he concluded his discussion with the M&R department with the understanding that the engineering department did not need to do anything further regarding sensing lines on the South Union Street project. The affidavit did not reveal a plan to relocate the sensing lines. NiSource did not have a requirement to document conversations between the engineering and measurement and regulation departments regarding sensing lines.

NiSource provided the investigation with an e-mail, dated October 16, 2016, from the Lawrence construction leader to the M&R department. The Lawrence construction leader was involved in the South Union Street project and had signed the first constructability review for the project on March 1, 2016, (before sending the e-mail), and the second constructability review on January 6, 2017, (after sending the e-mail). However, the M&R department employee addressed

in the e-mail had left CMA and was not employed by the company at the time of the accident. The e-mail stated:

> We are working near the union st reg station. We are working on the low-pressure outlet and will be placing a tap fitting on the outlet and eventually moving the static lines to the new outlet piping. A new outlet valve will be installed. The shutdown of the pit will be scheduled for some time later. This is a notice that work in the area has started.

In addition, NiSource provided the NTSB with an affidavit from a contract inspector in its Lawrence Operations Center that stated that he discussed with the Lawrence construction leader the need to relocate the sensing lines before the existing cast iron main was abandoned.[22] The contract inspector said that the two agreed to discuss the relocation "in more detail, with input from others, once the project progressed further." He said that the construction crew, including the construction foreman, construction lead, and the NiSource local construction coordinator, also were aware of the need to relocate the sensing lines before the cast iron main was abandoned. Although several affidavits suggest there were conversations about sensing lines, and an e-mail exists that confirms that it was known that the sensing lines needed to be relocated, there is no evidence that a work order or formal plan was ever developed to address the issue.

In 2015, NiSource issued an operational notice, *Below Grade Regulator Control Lines: Caution When Excavating Near Regulator Stations or Regulator Buildings,* ON 15-05, requiring that M&R personnel be consulted on all future excavation work that was done within 25 feet of a regulator station with sensing lines, other communications and/or electric lines critical to the operation of the regulator station, or buried odorant lines. The ON provided that M&R personnel stand by the regulator station throughout the excavation if there was a risk that the excavation could damage any such line. The South Union Street project excavation work being performed on the day of the accident occurred over 2,000 feet away from the Winthrop Avenue regulator station and, thus, was beyond the 25-feet requirement in ON 15-05. The basis of the 25 feet in ON 15-05 is the assumption of a safe distance that encompasses the equipment associated with a regulator station, including sensing lines. According to the document:

> If a control line breaks, the regulator will sense a pressure loss, causing the valve to open further, resulting in an over pressurization on the downstream piping system, which may lead to a catastrophic event. The same result occurs if the flow through the control line is otherwise disrupted (e.g., control line valve shut off, control line isolated from the regulator it is controlling) (NiSource 2015).

As documented in the NTSB's November 14, 2018, Safety Recommendation Report on this accident, a former CMA employee informed NTSB investigators about a purported past policy or practice that CMA allegedly phased out, whereby M&R personnel stood by a regulator station when construction took place on its natural gas mains (NTSB 2018). During interviews with a NiSource employee and a former employee, investigators were told there were times in the past (at least 5 years earlier) when M&R personnel provided assistance while distribution system piping modifications were being tied over to live systems to minimize the risks associated with

[22] The affidavit was signed on May 2, 2019, 231 days after the accident.

overpressurization at natural gas mains. No documentation was found to support that such a policy or practice existed, except as outlined by ON 15-05. NiSource stated that no such policy or practice existed and; therefore, none was phased out or discontinued.[23]

1.7 Overpressure Protection

1.7.1 Overpressurization Protection Requirements

For low-pressure natural gas distribution systems, there is no requirement for a service regulator or protective device at the service location that would prevent the overpressurizing of customers' piping and appliances. Overpressure protection relies on the redundant worker and monitor regulators at the regulator stations where natural gas is introduced to the low-pressure natural gas distribution system.

Title 49 *CFR* 192.197 requires high-pressure natural gas distribution systems be equipped with a service regulator or protective devices at the service location that would prevent the overpressurizing of customers' piping and appliances. This is in contrast to the requirements for low-pressure natural gas distribution systems, where the pressure in the main is essentially the same as the pressure provided to the customer.

The American Society of Mechanical Engineers (ASME) sets forth guidelines for the safe design and construction of both high and low-pressure natural gas distribution systems. These guidelines, called The Code, include requirements for district regulator vaults, regulators, and control lines (ASME 2012).

Specifically, The Code states the following in section 845.3:

> (g) When a monitoring regulator, series regulator, system relief, or system shutoff is installed at a district regulator station to protect a piping system from overpressuring, the installation shall be designed and installed to prevent any single incident, such as an explosion in a vault or damage by a vehicle, from affecting the operation of both the overpressure protective device and the district regulator.[24]
>
> (h) Special attention shall be given to control [sensing] lines. All control lines shall be protected from falling objects, excavations by others, or other foreseeable causes of damage and shall be designed and installed to prevent damage to any one control line from making both the district regulator and the overpressure protective device inoperative.

Title 49 *CFR* 192.195 requires protection from the accidental overpressuring of natural gas distribution systems, and states that systems must have a pressure-relieving or pressure-limiting

[23] NiSource informed the NTSB that it had investigated this issue thoroughly, speaking with 18 field and supervisory employees from the construction and M&R departments at each of NiSource's operations centers—including the employees interviewed by the NTSB. NiSource also provided the NTSB with sworn affidavits from each of those employees regarding this issue.

[24] *Monitor regulators* are sometimes referred to as *monitoring regulators*.

device that meets the requirements outlined in 49 *CFR* 192.199 (g). Title 49 *CFR* 192.199 (g) states, "where installed at a district regulator station to protect a pipeline system from overpressuring, be designed and installed to prevent any single incident such as an explosion in a vault or damage by a vehicle from affecting the operation of both the overpressure protective device and the district regulator." The redundant worker and monitor regulators underground vault at the Winthrop Avenue regulator station met the overpressure requirements of 49 *CFR* 192 and the ASME guidelines.

1.7.2 Previous Overpressurization Accidents Investigated by the NTSB

Over the past 50 years, the NTSB has investigated several accidents that involved natural gas under high pressure entering low-pressure natural gas lines.[25]

On June 3, 1969, the NTSB investigated a natural gas pipeline overpressure incident in Gary, Indiana (NTSB 1969). The pipeline, owned by Northern Indiana Public Service Company (NIPSCO), which is the present-day NiSource, was overpressurized when an employee inadvertently opened a separation valve that allowed 20 psig gas to flow into a 0.25 psig system. The absence of any overpressure protection in the 0.25 psig system now subjected to the 20 psig resulted in a regulator diaphragm failure. Although operators recognized the error and closed the separation valve, the failed regulator allowed 20 psig gas into the natural gas distribution system. There were no fatalities; however, nine residents and five firefighters were injured. Seven homes were destroyed and several incurred damage. The property damage was about $350,000.

On November 6, 1969, a low-pressure natural gas distribution system in Burlington, Iowa, overpressurized when a bulldozer impacted one of 24 regulator stations on a 7,500-customer system (NTSB 1969a). The impact damaged the worker regulator. When the worker regulator was damaged, the monitor regulator activated; however, the monitor regulator failed to control the 55 psig inlet pressure to the required 0.25 psig as-designed setting. The Iowa Southern Utility Company estimated that the pressure reached 1.25 psig, which amounted to a four- to five-fold increase over the normal operating pressure. Although the sensing lines were bent in the mishap, their integrity to maintain pressure was not compromised. There were no fatalities, but two firefighters suffered minor injuries. There were no explosions, but six homes were totally destroyed; 42 other homes suffered fire damage. The Burlington Fire Department estimated the damages at $80,000.

On August 9, 1977, natural gas under high-pressure (20 psig) entered a Southern Union Gas Company low-pressure (6 ounces per square inch) natural gas distribution line and overpressured more than 750 customer service lines in a 7-block area in El Paso, Texas.[26] Flames from gas pilots and the burners of appliances burned out of control and caused fires in nearby flammable materials. The gas company was replacing a section of 10-inch cast iron low-pressure natural gas main and isolated it between two valves. The isolated sector contained the natural gas regulator pressure sensing control lines. When the pressure fell to 0 psig the natural gas regulators

[25] The reports cited in this section are available on http://www.ntsb.gov.
[26] For reference, 1 ounce per square inch, gauge equals 0.0625 psig which equals 1.73-inch w.c.

opened up to try to maintain the operating pressure and overpressured the rest of the affected system. The problem was corrected before any fatalities or major injuries resulted (NTSB 1978).

On May 17, 1978, a Columbia Gas of Ohio, Inc., construction crew in Mansfield, Ohio, mistaking an 8-inch low-pressure steel natural gas main for an 8-inch high-pressure steel natural gas main, drilled a small pilot bit hole through the wall of the low-pressure natural gas main and began to cut into the pipe wall with a large diameter bit.[27] The construction crew was making a "hot tap" to complete the final tie-in of an 8-inch, replacement natural gas main to the existing high-pressure natural gas distribution system.[28] The hot tap was to be made using a three-way tapping tee which had its side outlet welded to the live high-pressure replacement natural gas main and its bottom outlet mistakenly welded to the low-pressure natural gas main. When the 1-inch pilot bit on the tapping machine attached to the top outlet of the tee penetrated the wall of the low-pressure natural gas main, gas at 42 psig pressure from the high-pressure natural gas distribution system entered the 14-inch w.c. (about 1/2 psig pressure) low-pressure natural gas main and rapidly increased the pressure in the low-pressure natural gas system in a 4.8 square mile area of Mansfield. The Mansfield Fire Department began receiving reports of fires caused by excessively high appliance flames on natural gas appliances. There were no fatalities or injuries requiring hospitalization. Property damage to 16 houses resulted from the ignition of nearby combustibles by high-pilot flames; five of these houses were extensively damaged.

On January 28, 1982, in Centralia, Missouri, natural gas at 47 psig entered a low-pressure natural gas distribution system which normally operated at 11-inches w.c. (0.40 psig) after a backhoe bucket snagged, ruptured, and separated the 0.75-inch diameter steel pressure regulator control line at the Missouri Power and Light Company's district regulator station No. 1 (NTSB 1982). Because the regulator no longer sensed system pressure, the regulator opened and high-pressure natural gas entered customer piping systems, in some cases, resulting in high pilot light flames which initiated fires in buildings; while in other cases, the pilot light flames were blown out, allowing natural gas to escape within the buildings. Of the 167 buildings affected by the overpressurization, 12 were destroyed and 32 sustained moderate to heavy damage. Five occupants received minor injuries.

On September 23, 1983, natural gas pressure in the Boston Gas Company's distribution system in East Boston, Massachusetts, rapidly increased from 7-inches w.c. (about 0.25 psig) to more than 17-inches w.c. (about 0.6 psig).[29] The Boston Fire Department began receiving telephone calls about natural gas odors, high pilot lights, and fires. Natural gas company crews searching for the source of high-natural gas pressure found the district regulator vault at Bremen and Porter Streets (one out of four in the East Boston area) had been submerged in water following a broken water main. After the vault had been pumped out, inspection of the primary regulator

[27] For more information, see the NTSB letters, dated August 21, 1978, to Columbia Gas of Ohio (regarding NTSB Safety Recommendations P-78-45 through -49); Materials Transportation Bureau (regarding NTSB Safety Recommendations P-78-50 and -51); and American Gas Association (regarding NTSB Safety Recommendation P-78-52).

[28] *Hot tapping* is the method of making a connection to existing piping while the pipe is in service without interrupting the flow of natural gas.

[29] For more information, see the NTSB letter, dated April 9, 1984, to the Boston Gas Company regarding NTSB Safety Recommendations P-84-7 through -9.

showed that water had entered the regulator through leaks in a gasket and through the vent piping, filling the area above the regulator diaphragm, holding the regulator valve open and allowing natural gas pressure to increase in the distribution system. In addition, a dispatcher at the Boston Gas Company control center received an alarm about the substantial rise in pressure.[30] Many East Boston residents had been awakened to the sound and smell of blowing natural gas to see larger-than-normal natural gas pilot lights and natural gas appliance pilot flames in their homes. The Boston Fire Department responded immediately to telephone calls from the residents and began alerting and evacuating residents. The fire department turned off natural gas at customer meters and pursued fighting fires. A 1-square-mile section of East Boston was affected; one restaurant was destroyed by an explosion, two residences were destroyed by natural gas-fed fires, and other small fires occurred as a result of the natural gas overpressurization. No fatalities or injuries resulted from the accident.

On January 17, 1992, in the River West area of Chicago, Illinois, a crew from Peoples' Gas, Light and Coke Company (Peoples) was doing routine annual maintenance work on a monitor regulator at one of its regulator stations, when high-pressure natural gas at 10 psig entered a low-pressure natural gas distribution system (NTSB 1993). The natural gas escaped through appliances into homes and other buildings where it was ignited by several unidentified sources. The resulting explosion and fires killed 4 people, injured 4, and damaged 14 houses and 3 commercial buildings.

1.7.3 Previous NiSource Overpressurization Incidents

Over the past 15 years, there have been four overpressurization events and one near-miss within the NiSource network, not including this one on September 13.[31] NTSB did not investigate these incidents.

On March 1, 2004, a system with an inlet pressure of 50 psig and an outlet pressure of 13 inches w.c. was overpressurized to 4.5 psig when debris was lodged at the seat of the bypass valve in Lynchburg, Virginia.

On February 28, 2012, an operator error during an M&R station inspection resulted in accidental overpressurization in Wellston, Ohio. Over 300 customers were without service for 14 hours.

On March 21, 2013, a segment of pipe with a maximum allowable operating pressure (MAOP) of 1 psig was pressurized at over 2 psig in Pittsburgh, Pennsylvania. A work crew, under the direction of the local NiSource subsidiary, was making a tie-in and failed to monitor the pressure and flow of the existing low-pressure natural gas distribution system during the tie-in process. The pressure cycled from 12 inches w.c. up to 2 psig three times.

On August 11, 2014, a local NiSource crew in Frankfort, Kentucky, was excavating to repair a Grade 1 leak located on the outside of a regulator station building. The crew uncovered

[30] For more information, see the NTSB letter, dated November 27, 1984, to the Boston Gas Company regarding NTSB Safety Recommendations P-84-43 through -45.

[31] E-mail from NiSource to NTSB, March 25, 2019.

and narrowly missed hitting the 1-inch sensing line and tap located on the 8-inch outlet pipeline. The crew was unaware of the purpose of the 1-inch pipeline and called local M&R personnel. The M&R personnel advised the crew of the purpose of a sensing line and what would have happened had the line been broken.

On January 13, 2018, during the investigation of a service complaint, a pressure of 2 psig was discovered on a 14-inch w.c. natural gas distribution system in Longmeadow, Massachusetts. The cause was associated with debris accumulation on both the worker and monitor regulator seats at a regulator station. Once the debris was removed, the pressure returned to normal.

1.8 Pipeline Safety Management Systems

On July 25, 2010, a 30-inch diameter pipeline owned and operated by Enbridge Incorporated ruptured and released more than 840,000 gallons of crude oil into nearby wetlands and a creek that flowed into the Kalamazoo River in Marshall, Michigan. Unaware that the pipeline had ruptured, Enbridge employees continued pumping oil into the ruptured pipeline for 17 hours until a local utility worker discovered the oil and contacted the company (NTSB 2012).

The rupture was caused by fatigue cracks that grew and coalesced from crack and corrosion defects under disbonded polyethylene tape coating. Contributing to the accident were weak regulations for assessing and repairing crack indications as well as ineffective oversight of pipeline integrity management programs, weak pipeline control center procedures, and a low level of public awareness. As a result of the Marshall, Michigan, investigation, the NTSB made the following safety recommendation to the American Petroleum Institute (API):

> Facilitate the development of a safety management system standard specific to the pipeline industry that is similar in scope to your Recommended Practice 750, *Management of Process Hazards*. The development should follow established American National Standards Institute requirements for standard development. (P-12-17)

In response to this recommendation, API developed a recommended practice (RP), titled *Pipeline Safety Management Systems,* which was sanctioned by the American National Standards Institute (ANSI).[32] The API document, known as API RP-1173, exceeded the NTSB's intent in issuing the recommendation to facilitate the development of a safety management system (SMS) standard specific to the pipeline industry. In addition, API, which represents commercial concerns throughout the oil and natural gas industry, addressed safety culture and other safety-related issues in its API RP-1173 (API 2015). As a result, on October 22, 2015, the NTSB classified Safety Recommendation P-12-17 "Closed—Exceeds Recommended Action."

API formed a stakeholder group consisting of oil and natural gas pipeline operator personnel and trade association staff, other federal and state agency personnel, and safety experts representing the public. The group met monthly, surveyed the public, and developed actionable guidelines for the pipeline industry to work toward a goal of continuous safety improvement. The API RP-1173 established a pipeline safety management system (PSMS) framework for

[32] A *recommended practice* is a voluntary pipeline industry consensus standard.

organizations that operate hazardous liquids and natural gas pipelines under the jurisdiction of the US Department of Transportation.

In 2015, the pipeline industry completed the development of the PSMS framework, designed specifically for pipeline operators. It is a product of a collaboration between pipeline operators, state and federal regulators, and other stakeholders. Participants include API, the Association of Oil Pipe Lines, the American Gas Association, the American Public Gas Association, the Interstate Natural Gas Association of America, and the Canadian Energy Pipeline Association.[33] Since the availability of API RP-1173, many oil and natural gas companies have been aligning with its guidance and building PSMSs that suit their companies' situations and goals. To facilitate the continued success and use of PSMS guidance, the developers of API RP-1173 prepared a PSMS maturity model for companies to gauge the status of their PSMS build out. (See figure 9.) Five levels of maturity were defined in the maturity model (MM): planning (level 1), developing (level 2), implemented (level 3), sustaining (level 4), and improving (level 5). The "plan, do, check, act" cycle and; therefore, the full safety benefits of PSMS are realizable in levels 4 and 5.

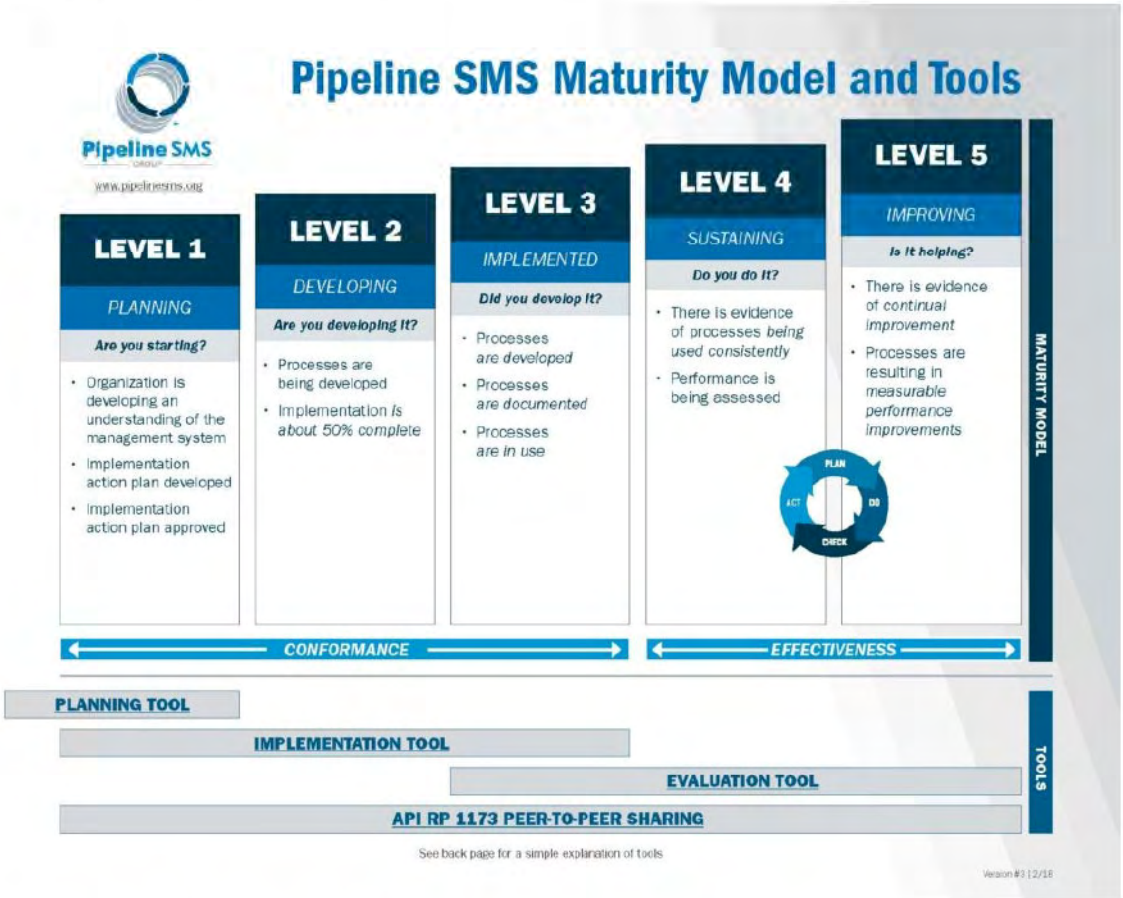

Figure 9. Pipeline SMS maturity model. Graphic courtesy of Pipelinesms.org.

[33] For more information, see https://pipelinesms.org.

NiSource began its SMS efforts several years prior to the overpressurization, as evidenced by the company being listed as a participant in the American Gas Association's (AGA) SMS project. Interviews with NiSource executives revealed that they had initiated SMS development in 2015 and accelerated efforts since the accident. NiSource employees indicated that they were excited about SMS development, but were still early in the process. They had not yet determined how they were going to assess the maturity of their SMS.

NiSource was among the first natural gas utility companies to embrace API RP-1173 for its operations when it was implemented at its subsidiary, Columbia Gas of Virginia, in 2015. Its initial efforts at Columbia Gas of Virginia began before the Merrimack Valley overpressurization. NTSB investigators interviewed senior executives at NiSource to better understand the status of its PSMS development and implementation efforts.

The director of pipeline safety for NiSource Corporate Services said that both he and the NiSource board of directors were excited about the deployment of PSMS. After the accident, he indicated that he had another opportunity to discuss the PSMS with the board, at which point PSMS efforts were "very much encouraged to move even faster," and NiSource has now accelerated implementation of PSMS in all its companies. When investigators asked about the maturity of the PSMS, he indicated that the maturity measures had not "been defined," though there was "certainly a lot of discussion" taking place on the topic, additional resources have been added to accelerate PSMS implementation, and there is not an "endpoint" because it involves a process of continual improvement.

He also said that NiSource, as well as third parties, would be involved in safety oversight. He indicated there would be checks and balances and stated that the "governance piece is really good." However, he also indicated that "the auditing process is yet to be defined." He said that NiSource is trying to get the primary elements of PSMS in place by the end of 2019.

NTSB investigators also spoke with a NiSource senior vice president about the implementation of PSMS. Direct reports to this senior vice president include the vice president of safety, the vice president of training, and the vice president of environmental. The senior vice president indicated that the initial plans for PSMS were a "sequential deployment" on a state-by-state basis. He said that he believed that a "generic gap analysis kind of at the (natural) gas segment level" had been performed. He added that NiSource was in the process of "really deploying and building safety management systems around the recommended practice [API RP-] 1173." He also indicated that gap analyses had been performed for Virginia and Indiana, and that NiSource is undertaking them in other states, including Massachusetts. The senior vice president indicated that many gaps had been improved upon, if not closed. When they began their effort, they performed a gap analysis based on the 10 elements within the API-1173 standard and determined that NiSource's Virginia-based safety programs were about 58 percent in agreement with the 10 elements. Relating to API-1173 implementation, Virginia was intended to be the pilot state for implementation; at the time of the accident, API-1173 implementation had yet to be

implemented in Massachusetts. Following the accident, CMA was ordered by the Massachusetts DPU to adopt API-1173.[34]

1.9 Professional Engineer Review and Approval

Professional engineer (P.E.) approval and stamping of drawings is a required practice for engineering projects to assure the safety of the public throughout the United States. P.E.s must be licensed by the state in which they practice. Although licensing laws vary state to state, they contain similar requirements for education and experience. To be licensed as a P.E., an engineer must earn a 4-year degree in engineering from an accredited engineering program, pass the Fundamentals of Engineering examination, complete 4 years of progressive engineering experience under the guidance of a licensed P.E., and pass the Principles and Practice of Engineering examination.

Projects requiring P.E. approval and stamping include, but are not limited to, roadways, bridges, tunnels, dams, and building structural design. Industrial exemptions allow utilities to perform engineering work related to public safety without the approval and stamp of a licensed P.E. In many cases, this exemption creates a loophole because there is no requirement to have work performed by an engineer at all. The P.E. who approves and stamps the project documents must be in responsible charge of the project.[35] This assures that all aspects of the project are performed under the supervision and direction of a qualified engineer. However, 31 states exempt public utilities from this requirement even though proper design is necessary for public safety. Prior to the overpressurization of the CMA natural gas system in Merrimack Valley, Massachusetts was one of those states that exempted utilities.

At the time of the accident, two NiSource employees who held P.E. licenses were involved with the South Union Street project: the LFE and the director of field engineering. Their employment roles required both employees to review and sign off on the South Union Street project, but there was no requirement to stamp the construction documents. Neither the LFE nor the director of field engineering was in responsible charge of the project. Therefore, none of the construction documents were issued with P.E. stamps.

The documents prepared for the South Union Street project were signed by a degreed engineer who had an engineer-in-training certificate, which is held by individuals preparing to take the P.E. examination. However, he was not yet eligible to take the P.E. examination because he had not satisfied the work experience requirement.

On November 14, 2018, the NTSB issued Safety Recommendation P-18-5 to the Commonwealth of Massachusetts that addressed the removal of a P.E. licensure exemption for such public utility work, along with a corresponding Safety Recommendation P-18-6 issued to NiSource, the parent company of Columbia Gas of Massachusetts, recommending P.E. approval

[34] Commonwealth of Massachusetts Department of Public Utilities Consent Order, D.P.U. 18-PL-03, November 30, 2018.

[35] *Responsible charge* refers to the degree of control an engineer is required to maintain over engineering decisions made personally or by others over whom the engineer exercises supervisory direction and control authority.

of natural gas pipeline projects within NiSource (NTSB 2018).[36] As described more fully in section 2.1, Massachusetts acted to satisfy Safety Recommendation P-18-5 less than 2 months after it was issued. Subsequent to this recommendation, the NTSB contacted two independent organizations seeking expert information on the current state of P.E. license oversight and the industrial exemptions among the United States and territories for major infrastructure projects.

The National Council of Examiners for Engineering and Surveying (NCEES) is a national nonprofit organization dedicated to advancing professional licensure for engineers and surveyors. NCEES develops, administers, and scores the examinations used for engineering and surveying licensure in the United States. It also facilitates professional mobility and promotes uniformity of licensure processes in the United States through services for its member licensing boards and licensees, including engineering and surveying examinations, examination preparation materials, records programs, and credentials evaluations.

The National Society of Professional Engineers (NSPE) is a professional association representing licensed P.E.s in the United States, in 53 state and territorial societies and over 500 local chapters (NSPE 2019). In August 2016, NSPE compiled a published report that documented the language of the individual states, including Washington, DC, pertaining to laws and regulations that govern the P.E. oversight of major infrastructure project practices and reviewed the industrial exemption provisions, as allowed by those laws and regulations. Currently 31 states have exemptions and 19 states and the District of Columbia do not. The State of New York is in the process of removing the exemption. Table 4 outlines the P.E. industrial exemption by state.

Table 4. P.E. industrial exemption for infrastructure project practices.

State	Exempt (Yes or No)	If Yes, action required for change
Alabama	Yes	Amend statute
Alaska	Yes	Amend statute
Arizona	Yes	Amend statute
Arkansas	Yes	Amend statute
California	Yes	Amend statute
Colorado	Yes	Amend statute
Connecticut	Yes	Amend statute
Delaware	No	
District of Columbia	No	
Florida	Yes	Amend statute
Georgia	Yes	Amend statute
Hawaii	No	
Idaho	Yes	Amend statute
Illinois	Yes	Amend statute
Indiana	No	
Iowa	Yes	Amend statute
Kansas	No	
Kentucky	Yes	Amend statute
Louisiana	Yes	Amend statute
Maine	Yes	Amend statute
Maryland	Yes	Amend statute
Massachusetts	No	Legislation passed and signed into law

[36] NTSB Safety Recommendation P-18-6 (Urgent).

State	Exempt (Yes or No)	If Yes, action required for change
Michigan	No	
Minnesota	Yes	Amend statute
Mississippi	Yes	Amend statute
Missouri	Yes	Amend statute
Montana	Yes	Amend statute
Nebraska	Yes	Amend statute
Nevada	Yes	Amend statute
New Hampshire	No	
New Jersey	No	
New Mexico	No	
New York	Yes	Amend statute[a]
North Carolina	Yes	Amend statute
North Dakota	No	
Ohio	No	
Oklahoma	No	
Oregon	No	
Pennsylvania	Yes	Amend statute
Rhode Island	No	
South Carolina	Yes	Amend statute
South Dakota	Yes	Amend statute
Tennessee	No	Amend statute
Texas	Yes	Amend statute
Utah	Yes	Amend statute
Vermont	No	
Virginia	Yes	Amend statute
Washington	No	
West Virginia	No	
Wisconsin	No	
Wyoming	Yes	Amend statute

[a] Legislation proposed.

1.10 Government Oversight

1.10.1 Federal Oversight

Federal pipeline safety statutes allow for states to assume safety authority over intrastate natural gas pipelines, hazardous liquid pipelines, and underground natural gas storage through certifications and agreements with the Pipeline and Hazardous Materials Safety Administration (PHMSA) under Title 49 *United States Code* 60105 and 60106. To participate in PHMSA's pipeline safety and underground natural gas storage programs, states must adopt the minimum federal pipeline safety regulations; however, states may pass more stringent state regulations for intrastate pipeline and underground natural gas storage safety through their state legislatures. If states do not participate in the pipeline safety programs, the inspection and enforcement of these intrastate pipeline facilities would be PHMSA's responsibility.

To support states participating in the pipeline safety programs, PHMSA certifies and provides grants to states to reimburse up to 80 percent of the total cost of the personnel, equipment, and activities reasonably required by the state agency for conducting its pipeline safety program during a given calendar year (PHMSA 2019).

1.10.2 Massachusetts Oversight

1.10.2.1 Massachusetts Department of Public Utilities

The Massachusetts DPU is a state-level adjudicatory agency overseen by a three-member commission. It is responsible for the oversight of investor-owned electric power, natural gas, and water utilities in Massachusetts. In addition, the DPU develops alternatives to traditional regulation, monitors service quality, regulates safety in the transportation and natural gas pipeline areas, and oversees the siting of energy facilities. The mission of the DPU is to ensure that customers of the covered utilities receive reliable and economical service, along with protecting the public from natural gas pipeline-related accidents and ensuring that residential ratepayers' rights are protected (Commonwealth of Massachusetts 2019).

The pipeline safety division of the DPU is an enforcement office, ensuring that operators of natural gas distribution companies, municipal natural gas departments, steam distribution companies, and other intrastate operators are following state and federal regulations governing safety. The pipeline safety division investigates natural gas incidents and determines the cause of those incidents, which is intended to improve public safety and prevent similar incidents. Incident investigations have resulted in new safety regulations for abandoned service lines, cast iron pipe, and liquefied natural gas plants. The DPU regulates pipeline safety within the Commonwealth of Massachusetts; however, pipelines that cross state boundaries (interstate) are regulated by PHMSA. The DPU also tests commonwealth natural gas meters for accuracy and leaks. After passing the test, each meter is marked with a stamp, showing that it is approved for use (Commonwealth of Massachusetts 2019a).[37] PHMSA audits the DPU annually and gives it a proficiency score based on its actions to ensure that operators comply with federal requirements. The proficiency score influences funding levels that DPU receives from PHMSA. In the 2017 audit, the DPU scored 112 points out of a possible 115, for an overall state rating of 97.5. Past DPU actions involving CMA violations are listed in appendix C.[38] Enforcement action by DPU on this accident is pending.

1.10.2.2 Massachusetts Executive Office of Public Safety and Security

The Commonwealth of Massachusetts Executive Office of Public Safety and Security oversees several agencies that deal with emergency response. According to its website, the Executive Office of Public Safety and Security "is responsible for the policy development and budgetary oversight of its secretariat agencies, independent programs, and several boards which aid in crime prevention, homeland security preparedness, and ensuring the safety of residents and visitors in the Commonwealth." (Commonwealth of Massachusetts 2019b).

[37] Massachusetts Code 220 *Code of Massachusetts Regulations* 69.00, "Procedures for the Determination and Enforcement of Violation of Safety Codes pertaining to Pipeline Facilities, Transportation of Natural Gas, and Liquified Natural Gas Facilities" is the guidance for the DPU enforcement actions.

[38] E-mail from NiSource to NTSB, May 13, 2019.

2 Postaccident Actions

2.1 NTSB Safety Recommendation to Commonwealth of Massachusetts

At the time of the accident, a Massachusetts P.E. stamp was not required on any utility system construction, operations, or maintenance projects as local natural gas distribution companies in the state had a utility exemption from requiring a P.E.'s stamp. On November 14, 2018, the NTSB issued a safety recommendation report, *Natural Gas Distribution System Project Development and Review*, in response to this accident and the events that followed (NTSB 2018). According to the report:

> The Commonwealth of Massachusetts' exemption for the requirement of registered Professional Engineer (P.E.) to perform industrial and public utility work limits the opportunities for competently trained and experienced engineers to uncover system design and work process deficiencies. By eliminating the exemption, especially for systems involving inherently dangerous materials such as natural gas distribution systems, companies, workers, and the public are provided greater safety assurance that competent and qualified engineers, who are ethically bound to work only on projects within the scope of their expertise, will review, assess, and execute the requisite work activities according to best engineering practices and with expected safeguards.

As a result of this investigation, the NTSB issued Safety Recommendation P-18-5 to the Commonwealth of Massachusetts

> Eliminate the professional engineer licensure exemption for public utility work and require a professional engineer's seal on public utility engineering drawings. (P-18-5)

Less than 2 months after the safety recommendation was issued, on December 28, 2018, Bill H.5005, requiring that licensed P.E.s review and approve engineering plans developed by or on behalf of natural gas companies, to ensure the safe construction, operation, and maintenance of natural gas infrastructure, was passed by the Massachusetts House of Representatives. The act applies to engineering work or services on natural gas distribution systems that could pose a material risk to public safety, as determined by the DPU, performed by or on behalf of a natural gas company. Moreover, the act requires any engineering plans or specifications for engineering work or services that could pose a material risk to public safety, developed by or on behalf of a natural gas company, to bear the stamp of approval of a licensed P.E.[39] After the Massachusetts Senate passed the act, it was signed by the governor on December 31, 2018, as Chapter 339 of the Acts of 2018. This new law included an emergency preamble and took effect immediately. Because it required natural gas work that might pose a material risk to the public be reviewed and approved by a certified P.E., Safety Recommendation P-18-5 is classified "Closed—Acceptable Action."

[39] See https://malegislature.gov/Bills/190/H5005. Accessed on May 25, 2019.

2.2 NTSB Urgent Recommendations to NiSource

In the November 14, 2018, safety recommendation report, *Natural Gas Distribution System Project Development and Review,* the NTSB also issued four urgent recommendations to NiSource (NTSB 2018). While the engineering design package for the South Union Street project underwent a constructability review, the review did not identify the impact on pressure regulation and control. The NiSource field engineer who developed the engineering plans told NTSB investigators he developed them without reviewing engineering drawings that documented the regulator sensing lines.

Because a comprehensive constructability review, which would require all departments to review each project, along with the seal of approval from a registered P.E., likely would have identified the omission of the regulator sensing lines, thereby preventing the error that led to the accident, the NTSB issued urgent Safety Recommendation P-18-6 to NiSource:

> Revise the engineering plan and constructability review process across all your subsidiaries to ensure that all applicable departments review documents for accuracy, completeness, and correctness, and that the documents or plans be sealed by a professional engineer prior to commencing work. (P-18-6) (Urgent)

In response to this recommendation, NiSource developed and implemented a new Gas Standard (GS 2810.050) detailing the stakeholder reviews that are required for design capital projects or projects where pipeline facilities are installed or replaced. The Gas Standard details the steps in project design and execution when additional stakeholder input is necessary to ensure safe work performance. With this Gas Standard, the use of an enhanced Constructability/Safety Review form is required across the organization to provide additional assurance that all applicable departments review project plans prior to the start of work.

Since January 1, 2019, NiSource requires that all relevant construction documents for complex projects are being sealed by a P.E. prior to the start of construction. In meetings with the NTSB, NiSource discussed that there were potentially large numbers of routine main extensions involving standard tie-ins, emergency main replacements requiring standard tie-ins, or new and replacement service lines, and that completing all of these standard designs would delay implementing this recommendation beyond what is appropriate given its urgent classification. Therefore, although NiSource agreed that construction work that could pose a material risk to public safety needed P.E. review and approval prior to commencing construction, NiSource developed criteria for when review by a P.E. is not necessary. In GS 2810.050, NiSource defines complex projects requiring that documents or plans be sealed by a P.E. as follows:

- Plans for installation or replacement of transmission-class pipelines or distribution mains with an MAOP equal to or greater than 200 psig
- Plans for the installation of or replacement of distribution mains with more than two tie-ins
- Plans for the installation of pipelines requiring a temporary bypass

- Projects which involve a change in system pressure
- Plans for the installation of distribution services requiring the interruption of natural gas flow to the adjacent transmission lines and/or distribution main
- Plans for nonstandard new points of delivery and district regulator stations
- Plans for regulator station work that require an interruption of natural gas flow on the inlet or outlet transmission lines and/or distribution mains

The development and implementation of GS 2810.050, including the requirement that construction documents and plans be sealed by a P.E., satisfies Safety Recommendation P-18-6 which is classified "Closed—Acceptable Action."

NiSource engineering plans used during the construction work did not document the location of regulator sensing lines. The NTSB believes that had accurate alignment sheets with comprehensive system information been prominently available and required within the toolsets used by the engineers, and diligently reviewed for completeness and technical/safety risks by engineering supervisors, the work package and construction activity plans would have accounted for the regulator sensing lines and prioritized their relocation before abandoning the cast iron main. As a result, the NTSB made the following urgent safety recommendation to NiSource:

> Review and ensure that all records and documentation of your natural gas systems are traceable, reliable, and complete. (P-18-7) (Urgent)

In its May 10, 2019, letter, NiSource responded it had completed locating, marking, and mapping control (regulator-sensing) lines at all 2,072 low-pressure regulator runs across its system. NiSource said that these facilities are depicted in isometric drawings and are visible in its GIS. In addition, NiSource contracted with a third-party natural gas engineering firm to verify the assets required to safely operate its low-pressure natural gas systems and ensure these assets are clearly indicated on relevant maps and records. On July 22, 2019, Safety Recommendation P-18-7 was classified "Closed—Acceptable Action."

NTSB investigators found that NiSource did not use management of change (MOC) procedures for managing maintenance and construction changes to pipeline operations. The company did not conduct separate risk assessments for each construction project, critical components of a PSMS program. MOC procedures require an analysis of implications, among several other elements. Additionally, a risk identification and assessment are necessary to establish the appropriate prevention and mitigation measures to reduce the likelihood of consequences should an incident occur. CMA failed to perform such an analysis and failed to establish appropriate controls to mitigate the risks of the work that was being performed. Had NiSource adequately performed MOC, it could have immediately addressed the issue and mitigated the

consequences of the event. Therefore, the NTSB issued Safety Recommendation P-18-8 to NiSource:

> Apply management of change process to all changes to adequately identify system threats that could result in a common mode failure. (P-18-8) (Urgent)

In response, NiSource improved its MOC process by developing and using Gas Standard 1680.010, "Tie-Ins and Tapping Pressurized Pipelines," and NiSource now requires the use of a written tie-in plan template. As part its PSMS development activities, NiSource initiated asset review and probabilistic risk assessments that focus on improving risk analysis, identification, and mitigation. NiSource also developed and implemented an MOC procedure for its construction employees and contractors that details the steps needed to ensure safety on a project during a change in personnel. These activities satisfy Safety Recommendation P-18-8 which is classified "Closed—Acceptable Action."

NTSB investigators also determined that had NiSource adequately performed system engineering management throughout its project work, the safety risk of an overpressurization likely would have been identified, along with appropriate mitigations implemented before undertaking the construction activities. For example, with recognition for potential overpressurization to the unprotected low-pressure distribution lines, mitigations could have been used, such as pressure relief valves, temporary slam-shut valves, or personnel positioned at critical points along the system and prepared to manually intervene by closing valves. NiSource failed to adopt and execute an appropriate system engineering management approach to this work and, consequently, neglected to perform important engineering reviews based on thorough system-level information which, consequentially exposed the company, its workers, and the public to the unexpected, albeit foreseeable through proper engineering practices, overpressurization. The NTSB issued Safety Recommendation P-18-9 to NiSource:

> Develop and implement control procedures during modifications to gas mains to mitigate the risks identified during management of change operations. Gas main pressures should be continually monitored during these modifications and assets should be placed at critical locations to immediately shut down the system if abnormal operations are detected. (P-18-9) (Urgent)

In a May 2019 letter, NiSource said that it has made "significant" enhancements to its tie-in and tapping procedures, including risk assessments, thorough checklists, and the development of contingency plans. NiSource also said that it was installing automatic pressure-control equipment and remote monitoring devices on every low-pressure natural gas distribution system across its operating area. These revisions satisfied Safety Recommendation P-18-9, which on July 22, 2019, was classified "Closed—Acceptable Action."

2.3 NiSource Emergency Preparedness and Response Actions

In early 2019, and as part of the company's SMS implementation, NiSource commissioned a cross-functional emergency preparedness and response team, led by a senior vice president for emergency preparedness, to enhance emergency preparedness activities and emergency response capabilities. The project is integrating improved preparedness plans and drills covering a broad

range of potential scenarios and levels of emergency with well-defined roles and clear responsibilities.

Key outcomes of the project include:

- A single emergency response plan (ERP) across the natural gas segment
- Consistent definitions for incident levels from less severe to the most severe
- Implementation of a single incident command system and structure regardless of incident level
- Consistent use of incident command system processes and terminology
- Enhanced training (computer-based, classroom and independent study) for all employees with roles in the ERP and incident command system
- Emergency drills in the third and fourth quarters to build familiarity with the plan, processes, and terminology

In addition to creating consistency across the NiSource natural gas segment, these efforts enhance consistency with key external partners who have used the incident command system for a number of years. A comprehensive project plan is guiding the team's work and remains on track. Key milestones achieved through the first half of 2019 included:

- Successfully completing classroom training and certification in Federal Emergency Management Agency ICS 100, 200, and 700 modules
- Reviewing and analyzing existing corporate and operating company emergency and crisis communications plans, as well as the corporation's business continuity plans
- Completing best practice visits with industry peers and internally
- Conducting more than 20 internal critical function interviews with individuals who spent significant time supporting Merrimack Valley restoration efforts
- Finalizing the first draft of the natural gas segment incident command structure in early April and the first draft of the natural gas segment ERP in late April

NiSource reported that its emergency preparedness response team is engaged with its technical training department to build comprehensive and individualized plans for those employees with emergency response roles. Concurrently, the team is working to develop comprehensive drills and exercises to test the plan, identify gaps, and make the necessary adjustments to strengthen overall company preparedness.

The NiSource corporate affairs and legal teams are working to develop a crisis communications "playbook" to support crisis response efforts. An ongoing assessment by

NiSource corporate affairs is the first phase of the effort. They plan to incorporate the crisis communications plans, processes, protocols and materials into the natural gas segment of the Emergency Preparedness and Response Plan.

2.4 Industry Actions

On November 26, 2018, AGA released a technical document titled *Leading Practices to Reduce the Possibility of an Over-Pressurization Event*, a document that serves as a resource for natural gas utilities to help avoid an overpressurization incident in a natural gas system (AGA 2018).

Following this natural gas accident, the AGA had information about the role of overpressurization that allowed the AGA to work to identify practices and procedures that can help avoid a similar accident in the future.

There are several leading practices included in the document:

- Design practices, including common overpressure protection designs and equipment
- Operating procedures and practices, including system monitoring, records, and damage prevention
- Human factors, including MOC, OQ, and field oversight
- Management of the risk of an overpressurization event, including addressing overpressurization under the operator's distribution integrity management plan

General practices the AGA considers key to managing the risk of an overpressure event include:

- Looking for opportunities to work with all stakeholders to proactively upgrade utilization pressure systems
- Defining risk criteria for overpressure events

This AGA document was developed with input from stakeholders and experts across the industry, with the focus on developing leading practices that can be used to help prevent overpressurization events.

3 Analysis

3.1 Exclusions

On the day of the accident, the crew that performed the last tie-in on the South Union Street project included one full-time CMA employee, who was a construction coordinator, and a contracted four-member utility construction crew, consisting of a foreman, a truck driver, and two laborers. The CMA employee had several years' experience running utility construction crews and had worked on multiple occasions with the contracted crew. All crewmembers were trained and qualified in accordance with OQ. In addition, a representative from the local police department was present for traffic control.

The type of instructions provided on the day of the accident were of the same format, layout, and overall content as that of the previous 12 tie-ins performed on the South Union Street project; but unique to this work was abandoning the cast iron main. The work package consisted of a computer-aided design drawing with item numbers on it that matched a project execution set of instructions. A review of the work performed by the contractor showed no deviations from the work instructions. Postaccident testing of the regulators from the Winthrop Avenue regulator station determined that they functioned as designed with no deficiencies.

Therefore, the NTSB concludes that none of the following were factors in this accident: the training and qualification of the construction crew, the use of alcohol or other drugs, or the condition and operability of the regulators at the Winthrop Avenue regulator station.

3.2 Overpressurization Protection for Low-Pressure Natural Gas Systems

The low-pressure natural gas distribution system in Merrimack Valley met the requirements for overpressure protection contained in 49 *CFR* 192.195 *Protection against accidental overpressuring* and 49 *CFR* 192.197 *Control of the pressure of gas delivered from high-pressure distribution systems*. At each of the 14 regulator stations feeding natural gas into the low-pressure natural gas distribution system, there were two regulators installed in series to control the natural gas flow from the high-pressure natural gas distribution system. The worker regulator and the monitor regulator were set to limit the pressure to the mains and then to the customer to a maximum safe value. However, a review of accidents investigated by the NTSB over the past 50 years (section 1.7.2) and prior NiSource incidents (section 1.7.3) demonstrate that this scheme for overpressure protection can be defeated in several ways. Three of the NTSB investigations (Gary, Indiana, June 3, 1969; Mansfield, Ohio, May 17, 1978; and Chicago, Illinois, January 17, 1992) detailed how operator error resulted in high-pressure gas being introduced into the low-pressure natural gas distribution system through an interconnection. In three other NTSB investigations (Burlington, Iowa, November 6, 1969; Centralia, Missouri, January 26, 1982; and East Boston, Massachusetts, September 23, 1983), outside force damage in or near the regulator vaults damaged equipment, resulting in high-pressure gas being introduced into the low-pressure natural gas distribution system through the regulators. The remaining NTSB investigation (El Paso, Texas, August 9, 1977) was nearly identical to this accident in Merrimack Valley because

it occurred when a cast iron main with sensing lines attached was isolated as part of a pipe replacement project.

In this accident, when the cast iron main with the sensing lines attached was isolated from the distribution system and abandoned in place, both regulators responded to the decreasing pressure, detected by the sensing lines, by fully opening. Both regulators were disabled simultaneously by the single event of isolating the cast iron main, which eliminated the redundancy of using dual regulators. In this accident and the earlier accidents discussed above, the overpressure occurred as the result of a single failure. In engineering analyses, such a situation is referred to as a common mode failure. Therefore, the NTSB concludes that the multiple overpressurization accidents investigated by the NTSB over the past 50 years demonstrate that low-pressure natural gas distribution systems that use only sensing lines and regulators as the means to detect and prevent overpressurization are not optimal to prevent overpressurization accidents. Thus, the NTSB recommends that PHMSA revise 49 *CFR* Part 192 to require overpressure protection for low-pressure natural gas distribution systems that cannot be defeated by a single operator error or equipment failure.

For regulator sensing lines, CMA only considered excavation damage as a risk to be mitigated. In engineering design, there are several methods available to assess and mitigate risk. A failure modes and effects analysis (FMEA) is a generally accepted and recognized engineering practice to identify and assess potential failures, including common mode failures. FMEA methodology is a structured and systematic technique for assessing and mitigating risks. FMEA was initially applied in the 1950s to understand and prevent malfunctions. Its use has continued to influence engineering design of systems and it has been expanded into several forms: risk assessment for design, functionality, and process failures; as well as criticality analyses of engineered systems. The NTSB concludes that a comprehensive and formal risk assessment, such as an FMEA, would have identified the human error that caused the redundant regulators to open and overpressurize the system. Although PHMSA rulemaking could take several years, it has other mechanisms to quickly communicate and encourage best safety practices. Therefore, the NTSB recommends that PHMSA issue an alert to all low-pressure natural gas distribution system operators of the possibility of a failure of overpressure protection; and the alert should recommend that operators use an FMEA or equivalent structured and systematic method to identify potential failures and take action to mitigate those identified failures.

3.3 CMA Engineering Processes

Early in the investigation, after determining that the contractors followed the instructions they were provided, it became apparent that there were deficiencies in several of NiSource's engineering processes. About 2 months after the accident, NTSB released a safety recommendation report, *Natural Gas Distribution System Project Development and Review*, which issued several urgent safety recommendations to NiSource (NTSB 2018). The following sections build on that report regarding records and documentation, constructability reviews, and risk management.

3.3.1 Records and Documentation

The field engineer responsible for the South Union Street Project largely relied on GIS to develop work packages. He also had access to isometric drawings containing schematics of the pipes in the regulator vaults as well as the piping and valve configurations. Sensing lines, however, were not included in the isometric drawings or GIS.

The field engineer told investigators that he did not know if the engineering department had access to sensing line information, though he believed that the M&R department did. According to NiSource, information about sensing lines for the Winthrop Avenue regulator station was available in hard-copy records in the Lawrence Operations Center. However, when investigators asked NiSource in an e-mail exchange about the instructions that NiSource provides employees with respect to how to find information about sensing lines, NiSource did not provide an answer; rather, it asserted that "CMA Engineering, Construction, and M&R personnel know how to obtain information about sensing line locations."[40] Moreover, an M&R manager suggested that locating accurate and up-to-date information about sensing lines was challenging because there was a shortage of information and confusion regarding what recordkeeping system would be used. The available evidence suggests that although the field engineer would have likely been able to seek out sensing line information, these data were not easily accessible electronically.

NiSource's director of engineering told investigators that the GIS was the company's centralized record system and that a goal of the system was to integrate data from various sources. That is, the company was taking data from old cabinets and binders and making it available electronically to all interested stakeholders. The director of engineering recognized that, at the time of the accident, there was a shortage of readily available information about the sensing lines. NiSource reported it has addressed the lack of sensing line data in the GIS after the accident.

An e-mail provided by NiSource showed that at least one employee, the Lawrence construction leader, knew that the sensing lines needed to be relocated. Moreover, an affidavit provided by NiSource suggested that other employees were aware of the need to relocate the sensing lines. However, NiSource stated in its submission for this accident investigation that after the South Union Project was delayed in 2016:

> There was a nearly complete turnover in project personnel. CMA did not effectively transfer the knowledge its 2016 construction personnel had about the status of the project sensing lines to its 2018 construction personnel.

Thus, according to NiSource, the successful execution of the South Union Street project was contingent upon employees remembering to transfer knowledge. In its evaluation of the probable cause of the accident, the company pointed to the city of Lawrence's "unprecedented suspension of project work," a 1 1/2-year delay, as a contributing factor. A delay in construction does not justify a catastrophic accident. However, NiSource does point to a true system defect in its list of contributing factors: "The project work order package did not explicitly address sensing line locations or their relocation."

[40] E-mail from NiSource to NTSB, May 31, 2019.

NiSource displayed an informal, unstructured approach for documenting this critical project step for the South Union Street project. The lack of documentation made it impossible to pinpoint the exact nature of the joint failure between the engineering, M&R, and construction departments to develop a formal plan for relocating the sensing lines. It is likely that more robust documentation and recordkeeping would have resulted in the sensing line issue being formally addressed prior to the work package being released to construction. As it was, the relocation of the sensing lines was not directed in an orderly top-down manner, but rather, NiSource relied on institutional knowledge. When the appropriate employees were not at the correct place at the correct time due to a project delay, there was no documentation to refer to for preventing a critical project step from being omitted. Therefore, the NTSB concludes that CMA's inadequate planning, documentation, and recordkeeping processes led to the omission of the relocation of the sensing lines for the South Union Street project. Furthermore, the NTSB concludes that the abandonment of the cast iron main without first relocating the sensing lines led to the system overpressurization, fires, and explosions.

Although there was a 2-year delay from the time the work order was developed until the time of the accident, NTSB investigators could find no evidence that the delay contributed to the accident. Had this work order been executed 2 years earlier, the system would have been overpressurized just as it was on September 13, 2018. The NTSB concludes that the delay between the development of the initial project work order and its execution had no impact on this accident.

3.3.2 Constructability Review

The engineering plans were included in the project package that was circulated for a constructability review. Constructability reviews are recognized and accepted as a necessary engineering practice for the execution of construction services. They are intended to provide structured reviews of construction plans and specifications to ensure functionality, sustainability, and safety—ensuring there are no shortcomings, inefficiencies, conflicts, or errors. Constructability reviews are essential in the engineering management of projects for verifying that all stakeholders have knowledge about and input into a work project.

Nonetheless, the constructability review process did not detect the omission of the need to relocate the sensing lines. Part of the failure of the process was likely due to the absence of a review by a critical department. Despite there being at least two constructability reviews for the South Union Street project, the M&R department did not participate. CMA requires the engineering department and the construction department to approve all projects, but the land services department and the M&R department are only required to review the packages on an "as-needed basis" as determined by the project engineer. The M&R department maintains the regulator stations, and with the project requiring the relocation of the sensing lines, the department should have been included. A review from someone in the M&R department may have resulted in the detection of the omission of a work order to relocate the sensing lines. The basis for the "need" is not described, nor are examples provided in the NiSource constructability review guidance.

There are several other factors that suggest an overall lack of robustness of the review process. The Lawrence construction leader signed all three reviews, but never objected to the lack of a work order to relocate the sensing lines, even though he had e-mailed the M&R department regarding the need to relocate the sensing lines between the first and second review. In addition,

the only indication of a third review is the set of signatures (dated December 14, 2017) on the paperwork for the second review (originally signed January 6, 2017). NiSource did not provide any additional documentation for the third review. This calls into question the thoroughness of the third review. The NTSB concludes that the CMA constructability review process was not sufficiently robust to detect the omission of a work order to relocate the sensing lines. After the accident, NiSource has been working to improve its constructability review process.

3.3.3 Engineering Risk Assessment

NiSource's ON 15-05 requires that M&R personnel be consulted on all excavation work that is performed within 25 feet of a regulator station with sensing lines, and for other specified work. This notice resulted from a near-miss incident in 2014, where excavation work almost struck sensing lines near a regulator.

The work being performed on the South Union Street project on the day of the accident did not occur within 25 feet of the Winthrop Avenue regulator station; therefore, ON 15-05 did not apply directly to the work. NiSource's ON 15-05 can be read in its entirety in appendix E.

Although the risk mitigations mandated in ON 15-05 did not apply, the language of the notice revealed that NiSource was aware that a catastrophic overpressurization of downstream piping would occur if flow should be disrupted through a segment of piping with active sensing lines for any reason. However, the controls implemented in the notice were only intended to prevent sensing lines from being struck during excavation.

More robust risk management was needed in the planning of the South Union Street project with respect to the analysis of the impact on the system, as discussed in NTSB Safety Recommendation Report PSR-18/02 (NTSB 2018). Moreover, as discussed earlier, broader risk management was needed with respect to overpressurization to the system in general. That is, engineering controls should have been implemented considering the vulnerability of the system to a common mode failure during the construction project. After the accident, NiSource has worked to improve its risk management processes and is installing automatic pressure-control equipment. Therefore, the NTSB concludes that NiSource's engineering risk management processes were deficient.

3.4 Professional Engineer Review and Approval

The NTSB recognizes that a P.E. license is a valued credential, especially for engineering projects affecting public safety. The P.E. license conveys that the holder maintains and demonstrates technical competency and imposes continuing education requirements in most states. Moreover, P.E. licensees are bound to a code of ethics for engineers, which creates a duty to hold public safety, health, and welfare paramount and to perform services only in the areas of their competence, among several other obligations. P.E. licensees are also personally accountable for the work they approve and stamp and must exercise responsible charge over all aspects of the work. As shown in table 4 of this report, 31 states have an industrial exemption for P.E. licensure. The NTSB concludes that requiring a licensed professional engineer to stamp plans would illustrate that the plans had been approved by an accredited professional with the requisite skills,

knowledge, and experience to provide a comprehensive review. Therefore, the NTSB recommends that those 31 states with an industrial exemption for natural gas infrastructure projects remove the exemption so that all future natural gas infrastructure projects require licensed professional engineer approval and stamping.

3.5 Emergency Response

3.5.1 Public Safety Answering Points

The PSAPs in each municipality were inundated with emergency calls, especially during the first hour after the accident. Each PSAP had alternate and final PSAPs as backup resources, to handle the overflow of incoming calls. The Lawrence PSAPs, which had the highest number of calls for aid from people affected by the overpressurization, reported that the number of incoming calls declined after the first hour of the event through midnight on September 13, 2018. The NTSB found no evidence that the high number of emergency calls delayed critical reports of damage nor requests for emergency assistance. Therefore, the NTSB concludes that the municipal PSAPs had available and ready resources to handle the large number of distress calls requesting emergency services.

3.5.2 Emergency Responder Communications

Radio communications among emergency responders was necessary for effective deployment and reassignment of emergency personnel and resources across the area affected by the natural gas overpressurization. Responding units from fire, police, and medical departments needed to coordinate activities, share situation-specific status information, and communicate instructions when required to move to new locations.

Each fire department had one radio channel for intradepartmental communications. In addition, some fire departments had radios capable of interdepartmental communications, allowing direct communications with other fire departments during the emergency response. ICs from each of the three municipalities reported to NTSB investigators that there was a high volume of "chatter" on the radio due to many responders and agencies using the single interdepartmental channel, making it difficult to understand and exchange information. NTSB investigators were told that the mix of radios used by the responding departments also created challenges because not all radios were interoperable. As a result, not all fire departments could directly access other departments.

When the 15 task forces were activated across the state, additional communication resources were included. On September 13, Communication unit leaders were sent to the overpressure accident. Communication unit leaders are responsible for developing communications plans in accordance with the Massachusetts Tactical Channel plan and assessing what resources are needed to maintain communications during an accident. Communication plans were developed for the Merrimack Valley natural gas accident through the operational period from September 13 through September 16. However, the first communication plan was not implemented until around 7:05 p.m., 3 hours after the fires began. Local fire departments needed additional tactical radio channels within the first 2 hours of the accident, when most emergency calls were

made. The NTSB concludes that the field radio communications used across fire departments on September 13 lacked adequate interoperability and availability to ensure that emergency responders had efficient means of interdepartmental and intradepartmental communications.

Statewide Communications Interoperability Plans (SCIP) are comprehensive plans to enhance and maintain emergency communications between multiple jurisdictions in the event of natural disasters, acts of terrorism, or other man-made disasters. Massachusetts issued its first SCIP in 2007 and noted that home rule poses challenges to radio interoperability because towns were given the authority to determine their own needs (Commonwealth of Massachusetts 2015). The SCIP identified six critical strategic initiatives that Massachusetts needed to put into place to achieve optimum communications interoperability, including the development of funding sources to support the program. The northeast region of Massachusetts, including Merrimack Valley, does have a regional communications system, but the SCIP suggested that the region needed greater interoperability and moment-to-moment sharing of information.

Massachusetts' SCIP was last updated in 2015 and outlined a multi-jurisdictional and multidisciplinary statewide strategic plan to enhance interoperable and emergency communications. The purpose of the updated SCIP was to provide a strategic plan for directing and aligning resources for interoperable and emergency communications at both state and local levels, as well as expanding existing systems for voice communications for sufficient capacity and coverage for first responders. The plan discusses critical elements to achieve successful interoperable communications such as developing standard operating procedures and upgrading technology. However, no guidance is provided on how to coordinate and implement a plan for emergency responders to effectively communicate during a multi-jurisdictional incident.

The Federal Emergency Management Agency (FEMA) developed "how-to" guides to assist state and local governments in developing effective hazard mitigation planning. This guidance helps local governments develop and implement multi-jurisdictional hazard mitigation plans to help assess and identify vulnerabilities within and across communities and formulate strategies to mitigate the consequences of such events (FEMA 2006).

The communications difficulties experienced by emergency responders in the multi-jurisdictional response to the overpressurization indicate that communications interoperability is still a problem in Massachusetts, despite the communication resources available to local jurisdictions, as outlined in the 2015 SCIP. The NTSB concludes that the communications issues during the September 13 overpressurization illustrate the need for emergency planning for a multi-jurisdictional response. Therefore, the NTSB recommends that the Commonwealth of Massachusetts Executive Office of Public Safety and Security develop guidance that includes a component for effective communications when deploying mutual aid resources within the first hours of a multi-jurisdictional incident.

3.5.3 NiSource Emergency Coordination with Municipal Responders

The ICs from Lawrence, North Andover, and Andover each told NTSB investigators that they attempted to reach CMA through dispatch, but they did not receive information from the company until hours later. They acknowledged that CMA likely was overwhelmed with

emergency calls, but they emphasized that responders needed to know in a timely manner about the company's response efforts and about which natural gas service sites were impacted.

The *NiSource Emergency Manual* states that when an overpressurization of the system occurs, there "may be a need" to communicate with local government officials and emergency management agencies as well as fire and police departments. The manual states that it is "imperative for all entities involved to remain informed of each other's activities." The manual states that the IC, in this case, the FOL, is required to establish appropriate contacts for communications purposes throughout the accident (NiSource 2018). However, during the initial hours of the event, the IC did not establish these requisite communication contacts because he was involved with shutting down the natural gas system. Moreover, although CMA representatives went to emergency responder staging areas and emergency operations centers, NTSB investigators were told that representatives could not address many of the questions from the emergency responders because they were not prepared with thorough and actionable information.

The NTSB concludes that the CMA IC faced multiple competing priorities, such as communicating with affected municipalities, updating the emergency responders, and shutting down the natural gas distribution system, which adversely affected his ability to complete his tasks in a timely manner.

The CMA ERP describes a detailed communications plan in which its director of government affairs (or designees) would be posted with the MEMA emergency operations center (EOC), who must have access to the CMA emergency coordinator, the CMA president, and the CMA vice president/general manager. According to the plan, appropriate maps and outage reports would be made available to these staff for the purpose of informing the EOC officials. MEMA officials and the state fire marshal stated that NiSource took too long to provide maps of the low-pressure system. They emphasized that emergency response officials needed street maps showing the layout of the natural gas system to understand where the affected customers were located. They also emphasized that emergency response officials needed updates on CMA's progress to shut down the natural gas system. The officials stated that CMA did not provide this requested information, either during the initial hours following the overpressurization or afterward, and that the absence of information from CMA impeded its public safety decision-making.

Without understanding the nature or extent of the overpressurization or the company's success in restoring control of the natural gas distribution system, emergency response officials and ICs had to make decisions to preserve public safety despite a lack of critical information. For example, decisions were made to evacuate thousands of people from homes and businesses and to shut down electricity throughout the region, including nonaffected neighboring areas. Because emergency officials did not have accurate information with respect to the affected area, they evacuated and shut down electricity in an area larger than necessary.

The evacuations led to major traffic congestion, which slowed CMA and NG technicians responding to the areas in and surrounding the accident location. The traffic issues were handled by the Massachusetts State Police, who were stationed at major intersections within an hour following the overpressurization. Travel delays on public roads and confusion caused by the uncertainty of the natural gas explosions and fires existed for hours following the overpressurization.

When electricity was shut off to the cities and towns, state and local officials had to manage a number of complex public safety issues, such as sustaining critical services in hospitals and critical-care facilities, police and fire departments, water and sewer treatment plants, and ensuring the security of numerous facilities, as well as maintaining orderly evacuations without traffic lights. State and local government and emergency response officials coordinated with NG, the electric utility company, to ensure that sensitive populations and critical infrastructure were prepared before shutting down the electric power. State and local police provided security to some facilities without electric power.

The lack of timely, thorough, and actionable information on the circumstances of the overpressurization evacuations and electricity shutdowns were conducted in areas where they were not needed, straining resources and further complicating the response. The NTSB concludes that CMA was not adequately prepared with the resources necessary to assist emergency management services with the response to the overpressurization. Therefore, the NTSB recommends that NiSource review its protocols and training for responding to large-scale emergency events, including providing timely information to emergency responders, appropriately assigning NiSource emergency response duties, performing multi-jurisdictional training exercises, and participating cooperatively with municipal emergency management agencies.

4 Conclusions

4.1 Findings

1. None of the following were factors in this accident: the training and qualification of the construction crew, the use of alcohol or other drugs, or the condition and operability of the regulators at the Winthrop Avenue regulator station.

2. The multiple overpressurization accidents investigated by the National Transportation Safety Board over the past 50 years demonstrate that low-pressure natural gas distribution systems that use only sensing lines and regulators as the means to detect and prevent overpressurization are not optimal to prevent overpressurization accidents.

3. A comprehensive and formal risk assessment, such as a failure modes and effects analysis, would have identified the human error that caused the redundant regulators to open and overpressurize the system.

4. Columbia Gas of Massachusetts' inadequate planning, documentation, and recordkeeping processes led to the omission of the relocation of the sensing lines for the South Union Street project.

5. The abandonment of the cast iron main without first relocating the sensing lines led to the system overpressurization, fires, and explosions.

6. The delay between the development of the initial project work order and its execution had no impact on this accident.

7. The Columbia Gas of Massachusetts constructability review process was not sufficiently robust to detect the omission of a work order to relocate the sensing lines.

8. NiSource's engineering risk management processes were deficient.

9. Requiring a licensed professional engineer to stamp plans would illustrate that the plans had been approved by an accredited professional with the requisite skills, knowledge, and experience to provide a comprehensive review.

10. The municipal public safety answering points had available and ready resources to handle the large number of distress calls requesting emergency services.

11. The field radio communications used across fire departments on September 13 lacked adequate interoperability and availability to ensure that emergency responders had efficient means of interdepartmental and intradepartmental communications.

12. The communications issues during the September 13 overpressurization illustrate the need for emergency planning for a multi-jurisdictional response.

13. The Columbia Gas of Massachusetts incident commander faced multiple competing priorities, such as communicating with affected municipalities, updating the emergency responders, and shutting down the natural gas distribution system, which adversely affected his ability to complete his tasks in a timely manner.

14. Columbia Gas of Massachusetts was not adequately prepared with the resources necessary to assist emergency management services with the response to the overpressurization.

4.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the overpressurization of the natural gas distribution system and the resulting fires and explosions was Columbia Gas of Massachusetts' weak engineering management that did not adequately plan, review, sequence, and oversee the construction project that led to the abandonment of a cast iron main without first relocating regulator sensing lines to the new polyethylene main. Contributing to the accident was a low-pressure natural gas distribution system designed and operated without adequate overpressure protection.

5 Recommendations

5.1 New Recommendations

As a result of this investigation, the National Transportation Safety Board makes the following safety recommendations:

To the Pipeline and Hazardous Materials Safety Administration:

Revise Title 49 *Code of Federal Regulations* Part 192 to require overpressure protection for low-pressure natural gas distribution systems that cannot be defeated by a single operator error or equipment failure. (P-19-14)

Issue an alert to all low-pressure natural gas distribution system operators of the possibility of a failure of overpressure protection; and the alert should recommend that operators use a failure modes and effects analysis or equivalent structured and systematic method to identify potential failures and take action to mitigate those identified failures. (P-19-15)

To the States of Alabama, Alaska, Arizona, Arkansas, California, Colorado, Connecticut, Florida, Georgia, Idaho, Illinois, Iowa, Kentucky, Louisiana, Maine, Maryland, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New York, North Carolina, Pennsylvania, South Carolina, South Dakota, Texas, Utah, Virginia, and Wyoming:

Remove the exemption so that all future natural gas infrastructure projects require licensed professional engineer approval and stamping. (P-19-16)

To the Commonwealth of Massachusetts Executive Office of Public Safety and Security:

Develop guidance that includes a component for effective communications when deploying mutual aid resources within the first hours of a multi-jurisdictional incident. (P-19-17)

To NiSource, Inc.

Review your protocols and training for responding to large-scale emergency events, including providing timely information to emergency responders, appropriately assigning NiSource emergency response duties, performing multi-jurisdictional training exercises, and participating cooperatively with municipal emergency management agencies. (P-19-18)

5.2 Previously Issued Recommendations

On November 14, 2018, the National Transportation Safety Board issued the following safety recommendations:

To the Commonwealth of Massachusetts:

> Eliminate the professional engineer licensure exemption for public utility work and require a professional engineer's seal on public utility engineering drawings. (P-18-5)
>
> This recommendation is classified "Closed—Acceptable Action" in section 2.1 of this report.

To NiSource, Inc.:

> Revise the engineering plan and constructability review process across all of your subsidiaries to ensure that all applicable departments review construction documents for accuracy, completeness, and correctness, and that the documents or plans be sealed by a professional engineer prior to commencing work. (P-18-6) (Urgent)
>
> This recommendation is classified "Closed—Acceptable Action" in section 2.2 of this report.
>
> Review and ensure that all records and documentation of your natural gas systems are traceable, reliable, and complete. (P-18-7) (Urgent)
>
> This recommendation is currently classified "Closed—Acceptable Action."
>
> Apply management of change process to all changes to adequately identify system threats that could result in a common mode failure. (P-18-8) (Urgent)
>
> This recommendation is classified "Closed—Acceptable Action" in section 2.2 of this report.
>
> Develop and implement control procedures during modifications to gas mains to mitigate the risks identified during management of change operations. Gas main pressures should be continually monitored during these modifications and assets should be placed at critical locations to immediately shut down the system if abnormal operations are detected. (P-18-9) (Urgent)
>
> This recommendation is currently classified "Closed—Acceptable Action."

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

ROBERT L. SUMWALT, III
Chairman

JENNIFER HOMENDY
Member

BRUCE LANDSBERG
Vice Chairman

Date: September 24, 2019

Appendix

Appendix A. The Investigation

The National Transportation Safety Board (NTSB) was notified about 4:00 p.m. local time on September 13, 2018, of an overpressurization of a low-pressure natural gas distribution system that occurred in the city of Lawrence and the towns of Andover and North Andover in Massachusetts that resulted in fires or explosions at over 60 locations. Columbia Gas of Massachusetts (CMA) owns and operates the natural gas distribution system in these jurisdictions.

Local emergency response officials urged all residents with homes serviced by CMA to evacuate, impacting about 146,000 residents. CMA isolated and depressurized the system to prevent further incidents. Electrical power in the area was shut off to minimize potential ignition sources. One person was killed and at least 10 people were injured in the event.

NTSB Board Chairman Robert L. Sumwalt, III, Board Member Jennifer Homendy, an investigator-in-charge, and 18 other staff launched to the accident scene.

Parties to the investigation included the Pipeline and Hazardous Materials Safety Administration (PHMSA); the Massachusetts Department of Public Utilities (DPU); the Massachusetts State Police; NiSource, Inc.; and CMA.

Appendix B. NiSource Safety Management System Plan

Figure 10. NiSource Safety Management System Plan Part A.

Figure 11. NiSource Safety Management System Plan Part B.

Appendix C. Enforcement Actions

Table 5. Massachusetts DPU enforcement actions for the 5 years previous to the accident. Data courtesy of the Massachusetts DPU.

Violation Date	PHMSA 192 Code Sections	Fine	Location	Description
March 7, 2012	192.13(c) 192.227 192.455 192.461 192.605	$7,500	55 Arthur's Place Bridgewater	Buried steel portion of transition fitting on a 2" plastic main had no cathodic protection; records did not indicate transition fitting or name of welder
July 26, 2012	192.13(c) 192.361(a) 192.375	$15,000	100 Union Street Attleboro	Shallow cover on service and outlet piping; transition fitting used as service riser, and exposed transition fitting
June 24, 2012	192.13(c) 192.605(a) 192.615(a)(2) 192.615(b)(2) 192.805(h) 192.727(a) 192.727(b) 220 *CMR* 107.04	$20,000	390 Fall River Avenue Seekonk	Shallow cover on service and outlet piping; transition fitting used as service riser, and exposed transition fitting
November 23, 2012	192.13(c) 192.605(a) 192.615(a)(3) 192.615(a)(5) 192.615(a)(7) 192.615(b)(2) 192.615(b)(3) 192.805(b) 192.805(d) 192.805(e) 192.805(h) 199.101 199.105(b) 199.202 199.225(a) 199.107(a) 40.277	$170,000	453 Worthington Street Springfield (leak)	CMA tech failed to follow proper procedures during leak investigation; during abnormal operating condition, CMA did not check other buildings in area per procedures; CMA did not properly evaluate tech's conduct; call center response to caller was inadequate, did not follow script; CMA did not follow its anti-drug and alcohol plans for testing
November 23, 2012	192.13(c) 192.481(a) 192.491(c) 192.605(a) 192.723(a) 192.723(b)(1) 192.805(h)	$150,000	453 Worthington Street Springfield (ignition)	CMA failed to show that it monitored service lines for atmospheric corrosion; provided insufficient evidence that it performed atmospheric corrosion inspections per procedures; insufficient evidence re leak surveys in business district; insufficiently calibrated leak detection equipment; personnel not properly requalified for leak investigation and surveys

Violation Date	PHMSA 192 Code Sections	Fine	Location	Description
May 1, 2012	192.13(c) 192.605(a) 192.615(a) 192.615(b) 192.727(a) 192.727(b) 220 *CMR* 107.04	$125,000	36 Maple Avenue Seekonk	Improper abandonment of service; failed to report leak and fire to Division; CMA integration center personnel failed to act after reports of fire from four employees; insufficient procedures; inadequate communications with Fire Dept; insufficient public awareness plan
November 17, 2012	192.13(c) 192.605(a) 192.615(a)(5) 192.615(a)(7) 192.615(b)(2) 192.615(b)(3) 192.703(a) 192.703(b) 192.703(c) 192.805(b) 192.805(e) 192.805(h) 220 *CMR* 101.06(21)(e)	$100,000	189 Washington Street Canton	CMA personnel failed to classify leak persuant to CMA's (natural) gas standard; supervisor did not have current operator qualifications necessary to classify leaks; CMA did not check guilding foundations in area
February 4, 2015	192.13(c) 192.605(a) 192.805(b) 192.805(h) 192.807(a) 192.805(b)	$35,000	335 Washington Street Taunton	Unqualified employee (service outage) attempted to install Trident Seal on leak; no mention of Trident Seal in procedures
February 15, 2016	192.201(a)(2)(i) 192.739(1) 192.195(b)(2) 192.603(b) 192.13(c) 192.605(b)(1)	$75,000	West Water Street Taunton	Overpressurization; MAOP exceeded; distribution system not designed to prevent accidential overpressuring; CMA failed to protect regulators from dirt and debris; failed to maintain records retesting, maintenance, inspection

Appendix D. Constructability Safety Review

CAPITAL DESIGN JOB ORDER CHECKLIST
For use by Columbia Engineering Team

Job Order Number: 16-0849062-00

Design to Build - Build as Designed

Constructability / Safety Review

€ **Project Scope** ✓

•

€ **Route and Drawings**

- Special Considerations
- Primary Construction Method(s)
- Permits
- ROW and Staking Requirements

•

€ **Tie-in Locations, Designs, and Sequencing** Re-email due to 2016 work

•

€ **Material** ACTION: REDUCERS & VALVES check P/A

- Special Fittings
- All Estimated Materials
- Long Lead-time Items
- Other

•

€ **Units for Estimate** ✓ Add 6" BAG TIE IN

- Labor
- Fill
- Restoration/Paving
- Survey Requirements
- Service Replacements/Tie-overs
- Tie-ins
- Traffic Control
- Shoring
- Test Holes
- Motor Move-outs

•

€ **Duration** ✓

- Working Hours
- Who is on Jobsite
- Number of Crews
- Special Conditions

•

€ **Land Services Requirements (permits, private ROW, etc.)** ✓

•

€ **Safety** ✓ 2 police

- Excavation Safety
- Tie-in Locations
- Traffic Control
- Operability/Damage Prevention

•

€ **Field Visit Needed?** (☐ Yes / ☒ No)

Page 1 of 2 Last updated: 7/30/14

CAPITAL DESIGN JOB ORDER CHECKLIST
For use by Columbia Engineering Team

Constructability / Safety Review

Job Order Number: 15-0849062-00

Comments/Adjustments

-
-
-
-
-
-
-
-

For Engineering: [redacted] 12/14/17 Date: 1/6/17

For Construction: [redacted] 12/14/17 Date: 1/6/17

For M&R: _____ Date: _____
(M&R only needs to sign when applicable)

For Land Services: _____ Date: _____
(Land Services only needs to sign when applicable)

* To be filed in WMSDocs Workspace(s)

Appendix E. NiSource Operational Notice ON 15-05

The following is NiSource's Operational Notice *Below Grade Regulator Control Lines: Caution When Excavating Near Regulator Stations or Regulator Buildings.*

NiSource

Distribution Operations

Operational Notice

Issue Date: 09/02/2015	**Below Grade Regulator Control Lines: Caution When Excavating Near Regulator Stations or Regulator Buildings**	Notice Number: **ON 15-05**
Supersedes: N/A		Page 1 of 3

Companies Affected:

☑ NIPSCO	☑ CGV	☑ CMD
	☑ CKY	☑ COH
	☑ CMA	☑ CPA

Purpose

This Operational Notice has the following objectives.

1. Bring awareness to Company and Contractor employees regarding the existence and importance of regulator control lines, other communications and electric lines that help to provide critical sensing information for the accurate monitoring and control of outlet pressure into the Company's piping systems, and buried odorant lines.
2. Set forth required actions for future Company excavations.

A Near Miss

A Company crew was excavating to repair a Grade 1 leak located on the outside of a regulator station building. They uncovered and narrowly missed hitting the 1-inch control line and tap located on the 8-inch outlet pipeline. The crew was unaware of the purpose of the 1-inch pipeline and called local M&R personnel. The M&R personnel advised the crew of the purpose of a control line and what would have happened if the line had been broken.

What is a Control Line?

Many regulators require external control lines, which sense the outlet pressure of the regulator. Based on the pressure sensed through the control line, the regulator valve will open or close to control the downstream pressure at the set point of the regulator. Regulators requiring control lines are found at City Gate/Town Border/Point of Delivery (POD), District Plant Regulator and Customer Measurement & Regulator (M&R) stations.

In accordance with existing gas standards, the current location for a control line tap is above grade on the outlet leg of the regulator setting downstream of the outlet valve. Aboveground control lines consist of stainless steel tubing (typically 3/8" or ½" diameter) and extend from the control line tap to a port on the regulator body. However, on certain installations some control line taps are located further downstream on the buried outlet piping based on the regulator manufacturer's recommendations, smoother operation of the regulator, or previous control line installation standards or practices. Control lines that extend to a below grade connection, normally a Continental or Mueller punch tee, transition above grade from stainless steel tubing to coated 1-inch steel pipe as required by our design standards.

Figure 1 is a schematic drawing showing a regulator setting with control lines extending below grade.

What Happens if a Control Line Breaks?

If a control line breaks, the regulator will sense a pressure loss, causing the valve to open further, resulting in an over pressurization of the downstream piping system, which may lead to

NiSource
Distribution Operations

Operational Notice

Issue Date: 09/02/2015	Below Grade Regulator Control Lines: Caution When Excavating Near Regulator Stations or Regulator Buildings	Notice Number ON 15-05
Supersedes: N/A		Page 3 of 3

Required Actions

General Excavation Requirements

Required state law excavation practices shall be followed, such as vacuum excavation (preferred method) or hand digging (if vacuum excavation in not reasonably available) within the tolerance zone of a marked (or known) facility.

City Gate/Town Border/POD Stations or District Plant Regulator Stations

Pre-excavation meetings with the plant/distribution or contract crew and M&R personnel shall be conducted for Company planned excavations within the footprint of a City Gate/Town Border/POD Station or a District Plant Regulator Station and/or within 25 feet of a station building or fence. Available as-built station drawings and/or electrical blueprints shall be reviewed for locations of buried conduits, control lines, and/or odorant lines. Known buried control lines, electric and communication lines, and odorant lines shall be located prior to excavation.

As a result of the near miss that occurred and what could have happened, any Company excavations within the footprint of a City Gate/Town Border/POD Station or a District Plant Regulator Station and/or within 25 feet of a station building or fence shall only proceed with M&R personnel standing by throughout the excavation, unless all control lines, other communications and electric lines critical to the operations of the station, and odorant lines, are verified to be located completely above ground.

Customer M&R Stations

Any Company excavations within 25 feet of a Customer M&R Station with control line(s), other communications and/or electric lines(s) critical to the operations of the station, or buried odorant lines, shall only proceed after a consultation with M&R personnel. The M&R personnel shall stand by throughout the excavation if there is a risk of damaging a control line, other communications or electric lines critical to the operation of the station, or a buried odorant line.

Next Steps (Leadership Actions)

NiSource Leadership will determine the feasibility of other Damage Prevention opportunities to identify situations where 3rd party excavators are digging within 25 feet of a City Gate/Town Border/POD Station or District Plant Regulator Station, so that excavations planned near these Company facilities require consultations and/or on-site monitoring.

[redacted]

CORRECTED COPY

NiSource
Distribution Operations

Operational Notice

Issue Date: 09/02/2015	Below Grade Regulator Control Lines: Caution When Excavating Near Regulator Stations or Regulator Buildings	Notice Number ON 15-06
Supersedes: N/A		Page 2 of 3

a catastrophic event. The same result occurs if the flow through the control line is otherwise disrupted (e.g., control line valve shut off, control line isolated from the regulator it is controlling).

Other Communications and Electric Lines Critical to the Operations of Regulators

Other lines if damaged, such as telemetry sensing lines and electric lines to equipment at the City Gate/Town Border/POD, District Plant Regulator or Customer M&R station, may also result in pressure monitoring and control issues, which may lead to a catastrophic event.

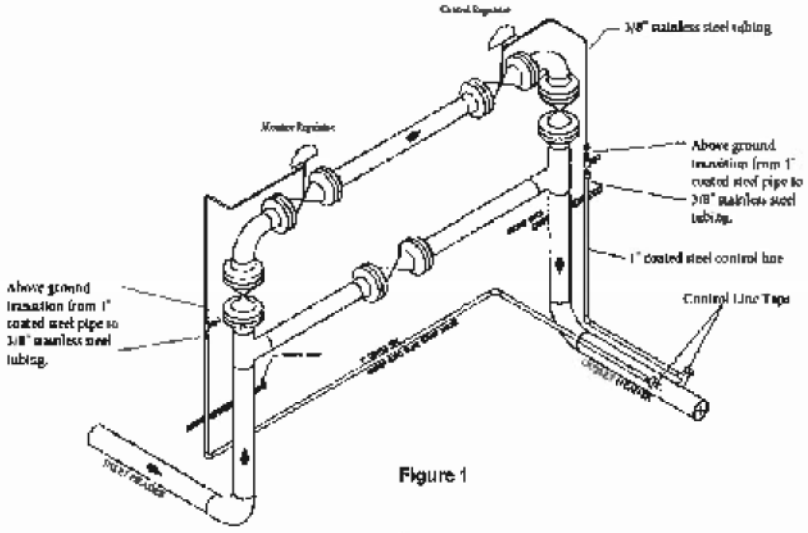

Figure 1

In Massachusetts, it is common to have closed looped systems, where the remote terminal unit (RTU) is continuously reading and controlling pressure at a valve that is acting as a regulator. The cables providing the signals to and from the RTU often run below ground through conduits within the existing footprint of the station, and if the cables or pressure sensing taps are damaged, this may result in pressure monitoring and control issues, which may lead to a catastrophic event.

Buried Odorant Lines

Occasionally, buried odorant lines, which transport odorant from an odorizer to an injection point into the downstream piping system, exist within the footprint of a City Gate/Town Border/POD Station. If an odorant line is damaged causing an odorant spill, the clean-up and impact on the public may be costly. Although odorizers are typically located at City Gate/Town Border/POD Stations, buried odorant lines may also exist at odorizers located at other sites, such as District Regulator Stations or Customer M&R Stations.

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