Independent Assessment of Columbia Gas of Massachusetts' Merrimack Valley Restoration Program

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Executive Summary

Introduction

On September 13, 2018, Columbia Gas of Massachusetts (CMA) over-pressurized a low-pressure gas system resulting in a series of explosions and fires in homes and business across various parts of the City of Lawrence, and the towns of Andover and North Andover (the Affected Communities) located in the northeast region of the Merrimack Valley (Incident). In the weeks and months following the Incident, CMA worked to restore natural gas (gas) service to customers (Restoration Program).

In October 2019, the Massachusetts Department of Public Utilities (DPU) commissioned Dynamic Risk Assessment Systems, Inc. (Dynamic Risk) to conduct an independent assessment of CMA's Restoration Program.

This Final Report encompasses the work product of this Assessment. This Executive Summary provides a high-level summary of the principal areas covered including:

- The Scope of the Assessment;
- The Panel;
- Guiding Principles;
- Work Performed;
- Observations and Recommendations; and
- Conclusions.

Further details on each topic are in the body of this Final Report.

Scope of this Assessment

This Assessment, which was conducted by the Independent Review Panel (the Panel), was focused on evaluating the gas pipeline installation and requalification work completed as part of the Restoration Program. The Panel offers its observations about the Restoration Program and evaluation of the operational safety of the assets, and makes certain recommendations for continuous improvements in pipeline safety.

The Panel

The Panel is comprised of recognized experts with diverse professional experience for the successful and timely execution of the project. This Panel and its technical team, which is comprised of well-qualified technical experts, bring unique experience, expertise and perspectives to this project. Panel and technical team names and information are set forth in Appendix C.1 and Appendix C.2, respectively.

Guiding Principles

The principles guiding the Panel in conducting this Assessment are independence, accuracy and transparency. Inherent in this approach is the Panel's neutrality relative to the desire of CMA or any other group, or specific outcome, or both.

About CMA's Restoration Program

CMA's Restoration Program involved a monumental task to return gas service to parts of the City of Lawrence, and the towns of Andover and North Andover in Massachusetts (Affected Communities). This work effort included:

- Design and installation of approximately 46 miles of new main pipeline and services;
- Requalifying nearly 12 miles of main and a certain number of services that had been installed after 1991;
- Tying the new and requalified mains and services (collectively, the Renewed Assets) into a portion of CMA's Legacy System; and
- Abandoning those assets that were replaced by the Renewed Assets by either decommissioning or repurposing them (e.g., plastic pipe inserted into cast iron mains).

Collectively, these actions created the natural gas system operating in the Affected Communities today.

Work Performed

The Panel undertook several key steps to conduct this asset-based evaluation. These included developing the framework for the evaluation, gathering data, and analyzing data and information provided by CMA about how they performed the work. This evaluation was primarily achieved through interviews and iterative information requests to CMA along with follow-up discussions, as needed.

This effort involved CMA producing over 8,000 documents containing over 40,000 pages of materials, drawings and other information. In addition, CMA provided over 100 spreadsheets and access to its in-house on-line systems to aid in data and document reviews.

Challenges soon became apparent as the Panel learned expected documentation was either not available or contained sufficient errors or inconsistencies to create concerns about the reliability of the documentation. CMA's lack of critical review of certain project results prior to this Assessment, and the supplemental responses that resulted in changes to data, also provided challenges.

The Panel prioritized its focus on verifying the adequacy of pressure test records for mains and services, and analyzing the number and nature of discovered leaks on the Renewed assets as a measure of their condition.

Observations and Recommendations

The Panel's observations arising from CMA's Restoration Program are set forth in this section. These observations are organized into two categories:

- About the CMA Restoration Program (Section 6.1); and
- The Assets (Section 6.2).

The Panel has organized the recommendation into three categories:

1. Recommendations for the Successor in Interest (Section 7.1);
2. Recommendations for the DPU (Section 7.2); and
3. Recommendations for CMA/NiSource (Section 7.3).

Conclusion

In 2018, CMA faced a monumental task to restore gas service to the Affected Communities before winter. It accomplished this task with the implicit and sometimes explicit support of the DPU and other stakeholders.

With the benefit of hindsight, this Assessment identifies the impact of certain decisions made to expedite the work. Significant changes to normal workflow, the impact of which went unidentified at the time, created gaps and issues with pressure test records, service line records and the abandonment of pipeline infrastructure. CMA's predominate reliance upon people more so than processes also resulted in gaps and missed opportunities with documentation, inspection and quality control.

This Assessment identifies gaps and provides opportunities for CMA and its Successor in Interest to close gaps over time. The new infrastructure of the Renewed Assets improves pipeline safety for the Affected Communities as compared to the low-pressure cast-iron system that it replaced. Implementing this Assessment's recommendations will further improve pipeline safety for the Affected Communities.

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1 Introduction

On September 13, 2018, Columbia Gas of Massachusetts (CMA)[1] over-pressurized a low-pressure gas system resulting in a series of explosions and fires in homes and business across various parts of the City of Lawrence, and the towns of Andover and North Andover (the Affected Communities) located in the northeast region of the Merrimack Valley (Incident).[2] In the weeks and months following the Incident, CMA worked to restore natural gas (gas) service to customers (Restoration Program).[3]

In October 2019, the Massachusetts Department of Public Utilities (DPU) commissioned Dynamic Risk Assessment Systems, Inc. (Dynamic Risk) to conduct an independent assessment of CMA's Restoration Program.[4]

This Summary Report encompasses the final work product of the Assessment. It includes observations and recommendations for the Successor in Interest,[5] for CMA or NiSource and for the DPU.

1 Columbia Gas of Massachusetts (Bay State Gas Company) is part of NiSource (an investor-owned utility providing gas services across several states). CMA currently provides gas service to customers in 3 operating areas within the Commonwealth (Springfield, Brockton, Andover/Lawrence areas).

2 See Appendix A, Incident and Emergency response based on the NTSB Final Report. These topics are outside the scope of the Assessment but the summary is provided as context for the Restoration Program.

3 Abbreviations used in this Final Report are set forth in Appendix B, Abbreviations.

4 This Assessment was authorized by the DPU's Chairman in the Twelfth Set of Orders under G. L. c. 25 § 4B (dated October 1, 2019) (Order). The Order required CMA to pay for, and cooperate with, the Assessment to be conducted by an independent party contracted through the DPU. This Assessment is separate from, and different than, the independent Statewide assessment conducted by Dynamic Risk (Statewide Assessment) and documented in the Final Report, Rev. 1, dated February 3, 2020 (Statewide Assessment Final Report). Nonetheless, there are applicable portions of the Statewide Assessment that may be referred to throughout this Summary Report.

5 In March 2020, CMA entered a plea to accept responsibility for violating the Natural Gas Pipeline Safety Act in its failure to implement procedures to prevent the Incident. In addition to CMA paying a fine of over $53 million, NiSource agreed to sell CMA and cease operations in Massachusetts. Eversource Energy agreed to buy substantially all of CMA's assets. The purchase is subject to DPU approval and other regulatory steps, and in light of the impacts of Covid-19, the timing of the completion of the sale remains uncertain at this time. Because the transaction will not have been completed when this report is issued, the Panel refers to the entity which will purchase, own and operate CMA's assets in the future as the Successor in Interest.

2 Background

Following the Incident and the emergency response, CMA undertook its Restoration Program to restore gas service lost as a result of the Incident. To do so, over 50 miles of mains and nearly 5,000 services would need to be replaced or returned to service (the Affected Areas).[6] This program included:

- Design and installation of approximately 46 miles of new main pipeline and services;[7]
- Requalifying[8] nearly 12 miles of main and a certain number of services that had been installed after 1991;
- Tying the new and requalified mains and services (collectively, the Renewed Assets) into a portion of CMA's Legacy System;[9] and
- Abandoning those assets that were replaced by the Renewed Assets by either decommissioning or repurposing them (e.g., plastic pipe inserted into cast iron mains).

Collectively, these actions created the natural gas system operating today in the Affected Area.[10] See Figure 1, below, for a map illustrating the Affected Area, the Renewed Assets and the Legacy System. See Table 1, Summary of Gas Mains by Materials.[11]

6 The Affected Areas are a subset of the natural gas distribution assets operating in the Affected Communities. Some portion of the gas mains and services which were already operating at the higher pressure, remained the same both before and after the incident. See discussion of the Legacy System, Footnote 9.

7 Distribution gas systems are comprised of mains and services. Mains generally distribute gas into an area. Services (or service lines) deliver gas from the mains to the meter at homes and businesses. Meters, which measure the gas being delivered to a customer, are installed at the end of the service line. There may be more than one meter for each service line.

8 The designation of pipe as requalified is one made by CMA. Federal or state pipeline safety regulations do not recognize a process of requalifying pipe in relation to gas pipelines. The process by which the MAOP of an existing plastic pipeline may be increased is called uprating. See 49 CFR Section 192.557. A discussion about CMA's use of requalified pipe instead of uprating the pipe in accordance with the Federal regulations is set forth in Section 6.1.6.

9 The Legacy System is an intermediate pressure natural gas distribution system that had been in existence and was operating, along with the lower pressure gas system involved in the Incident, within the Affected Communities prior to the incident. Assessing the structural integrity of the Legacy System is outside the Scope of this Assessment, but was evaluated by the engineering firm, TRC, in the fall of 2019. The TRC Materials Report arose from a request by CMA for permission from the DPU to increase the pressure on the Renewed Assets and the Legacy System, which remains under review. See the discussion in Section 6.1.4.1 and Appendix M. Of note, TRC found that the maximum allowable operating pressure (MAOP) of the Legacy System permitted by 49 CFR 192.121 was not 99 psig as CMA had been using for years; instead, it was either 98.46 psig or 98.80 psig (depending on the calculation used). In 2020, CMA began referring to the Legacy System as its "98 Pound System" instead of its "99 Pound System." By contrast, the Panel adopted the phrase "Legacy System" to refer to the system – which avoids mentioning the system's MAOP.

10 Before the Incident, CMA internally designated the Legacy System as "high pressure system 80001004." After the Renewed Assets were tied into the Legacy System during the Restoration Program, CMA continued to use the same designation for the combined Renewed Assets and Legacy System. This paradigm may have served CMA's purpose for establishing the MAOP of the Renewed Assets (see Section 6.1.6) but the adoption of the same system number for the broader set of assets invites confusion and likely contributes the difficulty of sorting out new versus older assets (e.g., see Section 6.2.2.1 regarding the changing number of services).

11 Information in Table 1 was an insert on a map dated March 9, 2020 provided by CMA in response to CMA_MV 15.03.

Figure 1: Affected Area, Renewed Assets, Legacy System, Requalified Pipe

Table 1: Summary of Gas Mains by Materials

Gas Main Material	Miles of Install	Miles of Requalified	Legacy System[12] Main	Total (in miles)
Bare Steel	0.0	0.0	0.7	0.7
Coated Steel	0.1	0.0	16.1	16.2
Plastic	45.8	11.8	26.6	84.2
Grand Total	45.9	11.8	43.4	101.1

2.1 Scope of this Assessment

This Assessment, which was conducted by the Independent Review Panel (the Panel), was focused on evaluating the gas pipeline work completed as part of CMA's Restoration Program and the operational safety of the Renewed Assets. The overall objectives of this assessment were to:

- Evaluate compliance with Massachusetts and Federal pipeline safety laws[13] during the construction of the Renewed Assets;[14]
- Assess whether the Abandoned Assets have been appropriately retired; and
- Evaluate whether the Renewed Assets can be safely operated and maintained, going forward based upon the available information and documentation.[15]

This Assessment included a detailed review of CMA's process and procedures relevant to the construction of the Renewed Assets and the regulatory compliance of those procedures. It also delved deeply into the available documentation related to materials, design, construction, testing, inspection and abandonment efforts related to the Renewed Assets. Operational safety of the Renewed Assets was evaluated by analyzing discovered leaks occurring on the Renewed Assets since the Restoration Program was deemed substantially complete in December 2018.

While not limited to these topics, the five main technical focus areas for assessing the CMA's Restoration Program include:

1. Design and Materials;
2. Joining;
3. Installation;
4. Pressure testing; and
5. Abandonment.

12 As discussed in Footnote 9, the construction and integrity of the Legacy System is outside the Scope of this Assessment.

13 Massachusetts pipeline safety laws are set forth in 220 CMR 101 et seq. The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) provides Federal oversight and enforcement of Federal pipeline safety laws, issues advisory bulletins, collects annual report and incident data, and establishes new regulations. As permitted under Federal law, PHMSA has delegated its oversight and enforcement of Federal pipeline safety laws related to intrastate pipelines like those operated by CMA to the Massachusetts DPU.

14 The Assessment is not intended to uncover or identify all potential non-compliance issues at CMA.

15 The Assessment provides no guarantee against future adverse gas events on the CMA's assets.

In conducting this Assessment, the Panel developed observations – which in turn – enabled the Panel to make recommendations for action. These are set forth in Sections 6 and 7, respectively.[16]

In addition to the Legacy System, topics or areas not evaluated in this Assessment include:

- Events giving rise to the Incident and CMA's emergency response;
- In-house gas piping downstream of the new meter (which is a portion of the House Ready work described in Section 5.1.2.2);
- Repair or Replacement of customer-owned appliances, including furnaces, water heaters, stoves, or clothes dryers;
- Paving, street and/or customer yard restoration efforts; and
- Any environmental work/remediation performed during the Restoration Program, or potential environmental compliance shortfalls more broadly.

2.2 The Panel

Dynamic Risk assembled an independent Panel (the Panel) comprised of recognized experts with diverse professional experience for the successful and timely execution of this project. This Panel and the project team, which is comprised of well-qualified technical experts, bring unique experience, expertise and perspectives to this project. Panel and project team names and information are set forth in Appendix C.1 and Appendix C.2, respectively.

2.3 Guiding Principles

The principles guiding the Panel in conducting this Assessment are independence, accuracy and transparency. Inherent in this approach is the Panel's neutrality relative to the desire of CMA or any other group, or specific outcome, or both.

The primary goals of the Panel in conducting this Assessment are to assess CMA's efforts to meet regulatory compliance in constructing and installing the Renewed Assets and provide recommendations that, if implemented, enhance the safe operation of the Renewed Assets.

2.4 Context of this Assessment

Following the Incident, CMA faced the daunting task of installing or requalifying over 50 miles of gas mains[17] and nearly 5,000 new gas services, along with moving meters, building new connections to replaced or refurbished appliances. In addition, given the hardships endured by all, it was important to complete the work in time to return displaced residents and business to gas service before winter arrived. CMA was successful in achieving this massive effort. Gas service, using the Renewed Assets, was principally restored by mid-December 2018.

[16] The scope of this Assessment is separate from and different than the Statewide Assessment. In the Statewide Assessment, the Panel undertook a program-level assessment to evaluate the physical integrity and safety of the Commonwealth's gas distribution systems operated by the seven investor-owned gas distribution companies and four municipal gas companies (collectively, the Gas Companies), and the operations and maintenance (O&M) policies and practices of those Gas Companies. This Assessment is an asset-based evaluation of the regulatory compliance and safe operations of the Renewed Assets. It includes a much more detailed deep-dive into the details involved in the design, installation and operation of the Renewed Assets.

[17] See Table 1 in Section 2 for a break-down of the specific mileage involved in part of the Restoration Program.

Subsequently, CMA largely returned to more typical day-to-day operations and addressing certain work activities deferred to support the Restoration Program. In the first two quarters of 2019, CMA also focused on remaining Restoration Program activities related to replacing or refurbishing customer-owned appliances while its geographical information system (GIS)[18] and engineering teams engaged in a close-out process of the Restoration Program.

In July 2019, a field technician reported an issue with the abandonment of a gas service line and meter. CMA conducted further investigation into the abandonment issues and on September 11, 2019, CMA raised the issue to the DPU. On September 27, 2019, a Grade 1 leak occurred on the Renewed Assets. At DPU's mandate, CMA inspected and, where necessary, remediated its abandonment of main valves, and also expanded its Service Line Abandonment Verification program through December 2019. [19]

As the Service Line Abandonment Verification program continued and new issues were identified, the Chair of the DPU recognized further assessment of CMA's Restoration Program was warranted and issued the 12th Order. By the end of October 2019, the DPU had contracted Dynamic Risk to conduct this Assessment.

[18] GIS is the acronym for a Geographical Information System. GIS is utilized as a record-keeping system to make data about pipeline systems readily available, and ideally, easy to update in the field. In the past, gas distribution system operators have relied upon paper records.

[19] The DPU required CMA to commence its Service Line Abandonment Verification program immediately after reporting it on September 11, 2019. This effort was expanded after the Grade 1 leak. Section 5.2 discusses this program further.

3 Work Performed in Assessment

This asset-based Assessment required an evaluation into the details related to the design, installation and operation of the Renewed Assets, as well as the applicable State and Federal regulations and CMA's own procedures. This section discusses the Guidelines for Engagement, the process for assessing and verifying CMA's activities related to the Restoration Program (including the framework for the assessment, the process and challenges in gathering the data, visits to the field to assess the abandonment verification portion of the Restoration Program) and the information requested from the DPU.

3.1 Guidelines for Engagement

The development of the appropriate Guidelines for Engagement with CMA and with the DPU occurred at commencement of the Assessment. These guidelines helped facilitate the process, provide transparency and protect the independence of the Panel during the Assessment. The guidelines, which set out the Panel's expectations and proposed boundaries, including the handling of potentially sensitive information, between the Panel, the DPU and CMA. They were discussed with CMA and subsequently provided to CMA early in the Process. Subsequently, the Guidelines of Engagement with CMA were revised to address the handling of critical energy infrastructure information (CEII).[20]

Among other topics, the Guidelines stated that discussions held as part of this Assessment would be conducted under Chatham House Rules. These are rules of engagement in which participants in a meeting, including Panel members, are free to use the information received; however, neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed. Chatham House Rules are often used in settings in which candid and open discussion by participants is required. Moreover, while Chatham House Rules allow information provided in any presentation or discussion to be shared with others outside the group, the Panel also encouraged all participants to exercise discretion in sharing the information learned during this Assessment to preserve the integrity of this Assessment and ensure that information and results are provided in full context.

In addition, the Guidelines required CMA to appoint an Executive Sponsor for the Restoration Assessment which it did in early November 2019. CMA chose an individual that brought sufficient knowledge about the scope of the Assessment as well as possessing the authority to bind the Company regarding actions it would be required to take as part of the Assessment. This included managing responses to Information Requests (IR), scheduling meetings, making resources available to the Panel, and managing follow-up and feedback related to the Assessment.

[20] Appendix Z, which is not available to the public, contains unredacted figures and tables with CEII or the names of personnel working on the Restoration Program. The former is generally not made available to the public due to a restriction that arose in the aftermath of the United States terrorist attacks on September 11, 2001. At that time, the Federal Energy Regulatory Commission put into place regulations to remove from easy public access certain CEII that could be useful to a person planning an attack on the critical energy infrastructure. This includes specific engineering or detailed design or location information about gas distribution systems. Generally, however, simply providing the general location of the infrastructure is not considered to be CEII. See 18 CFR Parts 375 and 388. The latter is not made public to protect the privacy of individuals.

3.2 Assessing CMA's Activities Related to the Restoration Program

To conduct the Assessment, the Panel undertook several key steps to collect, analyze and verify CMA's activities related to the Restoration Program. These included developing the framework for the evaluation, gathering information from CMA about how they performed the work, including interviews and information requests, and addressing the challenges created by the lack of documentation and lack of CMA's proactive critical review of certain project results prior this Assessment.

3.2.1 Developing the Framework of the Evaluation

As discussed in Section 4, there are many phases and processes involved in constructing a new gas distribution system and tying into the existing systems. To ensure the Panel considered each step of the phase and each process, the Panel developed a framework from which to work, as follows:

- Compliance with regulations
  - Review and analyze the critical Federal[21] and state[22] regulations applicable to each phase of the asset; and
  - Determine and verify if assets were designed, constructed, commissioned, or abandoned in accordance with these regulations.
- Compliance with company procedures
  - Review and analyze the critical CMA procedures applicable to each phase of the asset;[23] and
  - Determine and verify if assets were designed, constructed, commissioned, or abandoned in accordance with these procedures.[24]

[21] Federal regulations applicable to natural gas pipeline systems are set forth in 49 CFR Part 192. The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) is the Federal agency providing oversight and enforcement of Federal pipeline safety laws. It also issues advisory bulletins, collects annual report and incident data, and establishes new regulations. As permitted under Federal law, PHMSA has delegated its oversight and enforcement of Federal pipeline safety laws related to intrastate pipelines in Massachusetts like those operated by the Gas Companies to the DPU.

[22] The Commonwealth sets forth its pipeline safety laws at 220 CMR 101, et. seq. The State codes generally are consistent with the Federal code, with one substantive addition. The MA code specifies the minimum duration of the pressure test for a main (one hour) and for a service (15 mins). See 220 CMR 101.06 (18). A review of other critical regulations applicable to each phase of the installation and construction of the Renewed System, found no substantive difference.

[23] CMA did not identify what it considered to be the procedures specifically applicable to the Gas Ready portion of the process to either the Panel, or to its employees or contractors working on the Restoration Program when asked to do so. See IR 01.06 to which CMA responded by providing its procedures, which collectively comprise several thousand pages of information. These were made available on-line to field employees working on the Restoration Program.

[24] Federal pipeline safety law requires operators prepare, maintain and operate its pipelines in accordance with its own O&M and emergency response manuals (49 CFR 192.605). Failure to follow the procedures set forth in the company procedures is considered a regulatory violation.

- Inspection or other Quality Assurance and Quality Control (QA/QC) efforts
  - Review and analyze the inspections performed during the phases of the asset to determine:
    - Activities inspected/monitored; and
    - Frequency of inspection.
  - Findings from the inspection (e.g., rate of defects found/repaired)
  - Follow up on the findings to determine the cause of the defects, including
    - Understanding the cause of the defect to determine next steps to address the cause; and
    - Determine if the cause is one that could be applicable in other similar circumstances in the Renewed System or otherwise in CMA's system and develop a program to inspect and repair as needed.
- Operator Qualifications
  - Determine which individuals were identified as performing tasks for which having an Operator Qualification (Op Qual) is required;[25]and
  - Determine whether those individuals performing tasks for which an Op Qual is required, had the Op Qual for the task they performed.
- Information/Documentation[26]
  - Determine whether the available documentation validates CMA's compliance with regulations and conformance to procedures; and
  - Assess whether the documentation available meets the standard for records for a natural gas distribution system.[27]
- Operational Safety
  - Determine the markers of operational safety for the Renewed System;
  - Consider the number and cause of gas leaks on the Renewed System; and
  - Assess the gaps and next steps.

[25] As observed in the Statewide Assessment, a certification that an individual has a certain level of knowledge such as an Op Qual is a good first step in identifying individuals qualified to perform the tasks involved in installing, operating, and maintaining gas systems. The Op Quals are, however, merely a first step – a foundational minimum requirement. Experience and additional training are also required. In the Statewide Assessment, the Panel also found an overconfidence amongst the gas system operators in the ability of the Operator Qualification testing process to verify that an individual is qualified to perform gas work. (See Section 9.3.2, Statewide Assessment Final Report). As discussed in Section 6.1.1 herein, CMA placed significant reliance on the workforce in the Restoration Program having the appropriate Op Quals for tasks performed.

[26] Documents about pipeline assets need to contain accurate and complete information about the asset from which an operator can perform appropriate analysis, good decision-making, and effective emergency response. The quality and accessibility of good documentation directly affects the safe and reliable operations of any gas system, as well as employee and public health, and the environment.

[27] The standard for records of a gas distribution system is less clear than the one for transmission pipelines. PHMSA clarified that Records kept by operators of transmission pipelines must be traceable, verifiable and complete (TVC).

3.2.2 Initial Interviews and Information Requests

The Panel met with CMA personnel, including the Executive Sponsor, on a number of occasions. In early November, the Panel first interviewed several key individuals about the Restoration Program. CMA's key decisions about the framework of the Restoration Program[28] included establishing 8 work zones with each zone having its own command structure and workforce, using an inspector at nearly every worksite, purging the system of all live gas prior to the installation work and using 72 engineering hard-copy packages to track relevant documents.

Based on these interviews, the Panel sent several information requests on November 11, 2019. The first IR requested information to gather a broad view of the Restoration Program. The Panel asked for the Emergency Response Project Report filed with the DPU around November 1, 2018, the TRC Materials Report, maps of the 8 zones, the Purge plan, and the procedures provided to the Gas Ready team to assist in constructing the Renewed System as well as in conducting the abandonment of assets no longer active.[29]

The Panel also reviewed CMA's procedures in place at the time of the Restoration Program and compared those to the relevant Federal and State regulatory requirements.[30] To assist with this analysis, the Panel requested CMA provide its procedures in effect at the time of the Restoration Project, and to name those procedures that had changed since January 1, 2019 in a way to enable the Panel to identify those procedures that had been modified since last reviewed.[31]

The Panel was particularly interested in the information that had been provided to those individuals supporting the Restoration Program in new roles that extended beyond their routine jobs. CMA was also asked to provide the guidance they had provided to the individuals in each of these new roles they had created about the responsibilities of each role.[32] The roles included:

- Zone Commanders (Residential, Commercial, or Industrial);
- Project Manager and any project manager team members;
- Construction Coordinators (aka Inspectors);
- Dedicated Construction Manager;
- Construction Supervisors;
- Construction Contractor(s);
- Crew Chief for Construction Contractor(s);
- Dedicated Engineer(s);
- Dedicated Capital Closure person(s);
- Quality Assurance/Quality Control Inspector (by zone, if applicable);
- Incident Command for the Restoration Program; and
- House Ready work.

28 Discussed in more detail in Section 5.1.1.

29 IR 01.

30 See Appendix D, Summary of CMA procedures as evaluated with Federal and state regulation The Panel conducted a program level of CMA's procedures as part of the Statewide Assessment, but this Assessment required a more detailed review and analysis of whether the relevant CMA procedures were compliant with State and Federal regulations.

31 IR 01-02.

32 IR 3.02-3.03.

Additional IR's sent to CMA in November 2019 covered a number of other topics. These included requests for information concerning:

- Information related to the Service Line Verification Program regarding the appropriate abandonment of service lines no longer being used (IR 03);
- Information about the work performed by CMA during Q1/Q2 2019 (IR 04); and
- Information about the Panel accessing CMA electronic databases (IR 07).[33]

CMA provided responses to these IRs. The Panel and its technical team reviewed and analyzed these data. Observations about CMA's procedures are set forth in Section 6.1.7.

3.2.3 Evaluating Job Packets

In early January 2020, the Panel met again with CMA personnel to discuss, among other things, the job packets for the Restoration Project. [34] CMA's Executive Sponsor had described the job packets as containing the original engineering information as well as the completion materials related to the installation of mains and services. In essence, the job packets were the place where data and documents about each of the jobs in the 8 zones would reside. Based on these discussions and a desire to keep the review process manageable, the Panel elected to review 10 job packets that were randomly selected with some consideration for certain attributes.

To help create the random sampling, the Panel focused on selecting packets for each technique of construction and spread those out over zones to derive a list of 10 job packets to be provided to the Panel for review, as follows:

- Three in which pipe was inserted into an abandoned main (in Zones 2, 4 and 7);
- Three in which an excavation was performed and the main pipe was laid into an open cut (in Zones 2, 3 and for installation of steel pipe in Zone 8);
- Three in which the pipe being used was requalified for use at a higher pressure (Zone 1, 5 and 6); and
- One in the area where the Grade 1 leak occurred (Zone 6.06).

The Panel expected these data would provide information on the design of the Renewed System, the materials used and relevant pressure test forms for mains, services and tie-ins. As discussed in Section 6.1.3.1, the job packets became an early indication of inconsistencies and inaccuracies contained in CMA's documentation for the Restoration Program.

[33] CMA used a variety of electronic databases in which to store different types of data.

[34] IR 06, 06.01 through 06.10 provided a description of the specific Job Packets requested and reviewed.

3.2.4 Information about Gas Leaks on the Renewed System

The presence of gas leaks can be one indicator about the condition and operational safety of a natural gas distribution system.[35] Accordingly, the Panel asked CMA to provide information about gas leaks on the Renewed Assets, as well as the Legacy System as of November 22, 2019 (IR 05). Based on further discussions with CMA, the Panel determined it would be helpful to know about discovered leaks on a weekly basis throughout the Assessment. In a subsequent IR, the Panel asked CMA to provide a weekly update of discovered leaks that maps the location of the leaks and uses a specified format to provide data. CMA submitted reports about the gas leaks on the Renewed System between November 2018 and April 2020. Discussion of the leak data is set forth in Section 6.2.3.

3.2.5 Additional Efforts to Identify and Verify Pressure Testing of Mains and Services

An in-depth review of the information provided in response to the initial IRs raised additional questions. There are inconsistencies and inaccuracies in and between the documents,[36] and the data and documents did not provide the documentation from which the Panel could verify CMA had performed the work in the manner it claimed.

To fill the identified gaps and to continue to gather information required for this Assessment, in January 2020, the Project Team issued the following additional information requests to CMA:

- IR 12 Project Program Information focusing on the Key Technical Areas and the gaps identified in information from responses to IR 06 at the program level and providing a specified Excel table format for the data. This requests specifically asks for pressure test records; and
- IR 13 Project Segment Information focusing on the Key Technical Areas and the gaps identified in information from responses to IR 06, at certain named pipeline segments, level and providing a specified table format for the data.

In addition, the Panel issued an IR to the DPU to seek information it had about the work performed by CMA in the Restoration Project:

- IR 14 DPU Inspection Data: Seeking documentation and correspondence related to DPU inspections of, or correspondence with CMA about, CMA MV Restoration Project.

In late February 2020, the Panel met again with CMA and the Executive Sponsor to discuss initial observations and current gaps in information and to develop additional information requests to obtain the information needed to verify completion of the work. The Panel also met with CMA's President to express concerns about the challenges and the broader implications.

By this time, it had become apparent that CMA lacked documentation from which the Panel could verify CMA had followed its own procedures concerning the materials, joining, or installation of the Renewed Assets. Observations about the lack of these documents is set forth in Section 6.1.3.

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[35] This concept was discussed in the Statewide Assessment Final Report, See Appendix E, Relevant Portions of Statewide Assessment Final Report. Section 8.2.3.1 of the Statewide Assessment Final Report provides a general discussion about why discovered leaks on a gas system provide data about the condition of a distribution system. See also, Section B.3.4 of the Statewide Assessment Final Report for the leak analysis for CMA on its entire system for data collected between 2013 and 2018 (before the leak rates in the Renewed System would be known). In general, CMA had leak ratios that were comparatively high as compared to the average National Ratio and the Representative Gas Company, but had an overall leak trend that was downward with a recent uptick in leaks on mains. See Appendix E, Relevant Portions of the Statewide Assessment Final Report.

[36] IR 09 provided questions related to the preliminary review of documents provided in earlier information requests.

3.2.6 Review of Pressure Test Documentation Intensified

Without the documentation to verify many of the phases of construction, pressure test records for mains and services assumed a more important role in the Assessment and the level of review of pressure test documents intensified. The Panel also increased its efforts on understanding the findings from both the internal and external QA/QC efforts.

In March 2020, the Panel issued another IR in an effort to address the identified gaps and better understand the materials provided earlier by CMA. The Panel requested information to continue the analysis of pressure test records (including charts from main testing and detailed information from service line records), followed up on Operator Qualifications discrepancies, and inquired about the findings from the QA/QC efforts.[37]

CMA engaged in a substantial work effort to respond to IR 15. This included reviewing specific records and information related to the installation and uprating of over 50 miles of main, installation of nearly 5,000 services and compiling a summary of the data with the fields necessary for the Panel to verify compliance with Federal and State regulation.

The Panel's technical team reviewed CMA's summary of approximately 350 pressure tests for mains against the corresponding pressure test charts to compare the duration and level of pressure of each test. The team also reviewed whether the person that conducted the pressure test was operator qualified. This was done by comparing the signature of the person on the pressure test form against an operator qualification list provided by CMA. A similar process was followed to compare a sample of 200 individual service line records (SLRs) against CMA's summary.

Over the course of the Assessment, CMA produced over 8,000 documents containing over 40,000 pages of materials, drawings and other information. In addition, CMA provided over 100 spreadsheets. CMA also made available its in-house on-line systems to aid in data and document reviews. This included access to CMA internal electronic systems known as WMSDocs, iAuditor, Box and 3-GIS.

3.2.7 Field Visits to Service-Line Abandonment Verification Sites

In October and November 2019, the Panel observed CMA's work at 33 sites at which CMA was inspecting and verifying that the abandonment of service lines was completed and documented correctly. The Panel accompanied field crews when the Service Line Abandonment Verification program was in its kick-off phase, and some weeks later when it was at full force.[38]

3.3 DPU Inspections of CMA's Restoration Program

When the challenges in the documentation retained by CMA became clearer, the Panel elected to seek information from other sources. Since DPU inspectors conducted their own inspections at some of the work sites during the Restoration Program, the Panel asked the DPU to provide its inspection records.[39] DPU's inspection documents were more detailed and informative than the QA/QC documents received from CMA. It provided a solid view into the items the DPU inspectors found adequate and those that raised concerns. The observations flowing from this analysis are set forth in Section 6.1.4.3.

[37] IR 15.

[38] See Section 5.2 for discussion of the Abandonment Verification process.

[39] IR 14 was issued to the DPU. The Panel's analysis of IR 14 is discussed in Section 6.1.4.3.

4 Pipeline Construction and Operations Basics

4.1 Regulations for Construction of Gas System[40]

Federal and State regulations provide the minimum standards required for operators during each of the several phases of constructing, testing and operating a new pipeline system.[41] Regulations applicable to constructing new mains and services or uprating existing mains and services mains and services include:

- Materials and Design of the components and the system (49 CFR Part 192 Subparts B, C and D);
- Welding steel or joining joints of plastic pipe one to another, including tie-ins of mains and services (49 CFR Part 192 Subparts E and F);
- General Construction Requirements related to installation, including such topics as inspection of pipe, bends, depth of cover, type of fill, etc. (49 CFR Part 192 Subpart G);
- Meter and Service Line installation (49 CFR Part 192 Subpart H);
- Pressure Testing (49 CFR Part 192 Subpart J);
- Uprating of existing assets (49 CFR Part 192 Subpart K);
- Abandonment of assets no longer in service (49 CFR Part 192.727); and
- CMA's procedures generally are consistent with the requirements set forth in these Federal and State regulations.[42]

4.2 Changing Pressure Requires Several Steps

Transitioning from a low-pressure gas system to a higher-pressure gas system requires several significant changes in the infrastructure. As background, low-pressure natural gas systems typically operate with an amount of pressure that is measured in inches of water column.[43] The system pressure is regulated at district regulator stations located throughout the system to measure and regulate pressure. Gas is then delivered to homes via a house meter that are not equipped with regulators. This absence of a regulator at the house meter means that if the pressure rises on the low-pressure system, the amount of gas being delivered to the house increases. Often house meters on

[40] As discussed in the Statewide Assessment Final Report, compliance with regulatory obligations is a basic foundation for pipeline safety, but it is insufficient, in and of itself, to make operations of gas pipeline safe. While compliance can be obtained, pipeline safety requires a journey of continuous improvement. (Section 9.6.1, Statewide Assessment Final Report).

[41] While there are many similarities, regulations differ between transmission pipelines (those transporting gas into a general area) and distribution pipelines (those that deliver gas to homes and business in communities).

[42] See discussion in Section 6.1.7 for the three areas in which CMA's procedures could be improved.

[43] One psig is equal to approximately 27.68 inches of water column.

low-pressure systems are installed inside the house. Among other things, moving to a higher pressure requires the meters to be moved outside of the home.[44]

To operate the new higher-pressure system in the Affected Communities, CMA installed and requalified the Renewed Assets and tied them into the higher-pressure Legacy System.

4.3 Installation of New Mains

Installation of the new gas mains in the Renewed Assets used open cut or insertion methods:

- Using the open cut method, a new ditch is excavated, and pipe is joined together and laid into the ditch. This method involves what CMA's considers to be the hardest and often the most time-consuming part of the construction: digging a ditch through neighborhood streets. It has the benefit, however, of enabling crews to work with new materials, and to visualize the work being performed over the entire segment.
- The insertion method involves utilizing the pipe that is no longer in service[45] as a conduit, also known as a carrier pipe, through which the new plastic pipe is inserted. This method is possible because of the flexibility of plastic pipe. Generally, inserting pipe is less time-consuming than the open cut method. Inserting plastic pipe into abandoned pipe can create a risk if a gas leak occurs because the abandoned cast iron pipe may act as a conduit to transport leaked gas away from its original source. Using this type of installation method makes the proper abandonment of services from the abandoned cast iron main particularly important.

CMA also requalified certain plastic pipe that had been installed after 1991[46] to function in the Renewed Assets. The criteria for including this pipe in the Renewed Assets and the Panel's views concerning CMA's choice of this methodology is discussed in Section 6.1.6. The number of miles of each method used in establishing the Renewed Assets is set forth in Table 2.

Table 2: Miles of Main in Restoration Program, by Method[47]

Installation Method	Miles
Open Cut	37.7
Inserted	8.2
Requalified Plastic Mains	11.8
Total	57.7

[44] As discussed in the Statewide Assessment Final Report, there are many safety benefits to replacing leak prone pipe operated at low pressure with newer, more modern plastic pipe. These include reducing or eliminating reliance on regulator stations, moving meters from inside homes to outdoors, installing a pressure reducing regulator at every service, installing excess flow valves or curb valves between the gas main and the meter, providing an opportunity for operators to update records about the assets, and because of the better records, generally enhancing the ability to locate and mark the pipe to reduce the likelihood of excavation damage in the future. There is also, however, an increase in construction risks when live gas work is required.

[45] These could be cast iron pipes, as in the Restoration Program, or other types of pipe, such as steel or even larger diameter plastic pipe that is no longer being used.

[46] CMA used this date cut-off to ensure a specific type of pipe, which had been identified as having potential integrity issues due to blistering during the fusion process, was replaced rather than requalified.

[47] Provided by CMA in CMA_MV 15.32 Revision 1.

4.4 Pressure Testing

Operators conduct pressure testing as a means to verify the integrity of the pipeline. In the Restoration Program the pressure tests were performed immediately after construction and before the assets were placed into service.[48] This post-construction pressure test verifies the adequacy of the pipeline materials and the construction methods and is a foundation to confirming operational safety. In a pressure test, a test medium (e.g., air, gas or liquid) inside the pipeline is pressurized by the use of pumps or compressors to a pressure that is greater than the normal operating pressure of the pipeline. This test pressure is then held for specified duration (e.g., hours) to ensure there are no leaks in the pipeline. Any indication of leakage requires the identification and repair of the leak. Then, the pipeline is retested until successfully completed.

4.5 Pipeline Integrity Threats to Pipeline Safety[49]

Safely constructing, maintaining and operating a natural gas pipeline system is a complex endeavor. Among other things, it requires CMA to know its gas system and to proactively engage in taking steps to identify and reduce or eliminate threats to the structural integrity of the pipeline.[50] This includes proactively taking steps to understand the materials and make-up of the Renewed Assets.

Based on Federal regulations, operators must identify and manage threats to the integrity of distribution pipelines predominantly including:

- Corrosion;
- Natural forces;
- Excavation damage;
- Other outside force damage;
- Material or welds;
- Equipment failure; and
- Incorrect operations.

As part of safely operating its pipeline systems, CMA must identify which of these threats are applicable on each segment of its system, and then undertake efforts to understand, manage and mitigate these threats in an effort to prevent failures.[51]

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48 See 49 CFR Part 192, Subpart J and K, Pressure Testing and Uprating pipe. In this context, integrity means the pipeline has sufficient structural strength to contain and distribute natural gas while preventing leaks or ruptures under normal and upset operating conditions.

49 The word threats as used herein is a term specific to pipeline integrity management. It means those characteristics or actions that, if left unmitigated, could potentially represent a threat to the structural integrity of the pipeline and reduce its ability to contain the product being transported.

50 Pipeline integrity management (integrity), which is the conventional, primary method for accomplishing this goal, requires CMA to identify and manage potential threats to pipeline integrity and reduce risks on pipeline systems. Integrity management considers: physical assets, such as leak prone pipe; other risks, such as weather, dig-ins, and terrorism; threat-based analysis and mitigation efforts; and other distinct threats and risks that different asset-types face.

51 Federal regulation requires CMA to set forth its DIMP in a written procedure. The DIMP is the tool companies use to identify the specific threats and mitigation plans designed to address the threats. DIMPs are expected to continue to evolve and mature over time as more information and data are developed. In the Statewide Assessment, the Panel found CMA's DIMP met the minimum compliance requirements and had positive characteristics but was not being used to its full capacity. See Appendix E.

4.6 Importance of Records

Maintaining accurate and reliable records is the foundation for safe operation, pipeline integrity management and emergency response. If records are not readily available, are incomplete, or are unreliable, it impedes an effective, timely response.

Yet the regulatory standard applicable to gas distribution asset records remains unclear. Transmission pipeline operators [52] were advised in 2011 that Pipeline and Hazardous Materials Safety Administration (PHMSA) expected them to have records that are TVC. [53] During the rulemaking process, there were discussions about applying the TVC standard to distribution assets. [54] The expectation that transmission asset records meet the TVC standard was recently enacted into law, but in a way that suggests the standard has not yet been made a regulatory requirement for operators of distribution system. [55]

As such, the appropriate standard for distribution records also remains in flux because of the date of installation of many assets. Furthermore, quality records for assets installed before 1970 are unlikely to exist since the installation preceded the enactment of Federal pipeline safety regulations. [56]

For systems installed more recently, one would expect better records to support regular maintenance and replacement efforts, even in the absence of Federal regulations. Each time a pipe is exposed, an operator has the opportunity to inspect and update its records for accuracy.

Operators are expected to create and maintain reliable records required for operating and maintaining a distribution system. For example, typical records would include, but not be limited to:

- Material purchase records (to verify purchase of the appropriate pipe, valves, regulators, excess flow valve, etc.);
- Confirmation of proper storage and installation before the date at which pipe can become compromised;
- Showing the correct valve or regulator made it to the appropriate pressure system (or a process by which the crew verifies it confirmed the valve/reg were the appropriate one for the duty);

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52 Transmission pipelines transport gas from where it is produced to the areas in which it will be consumed. They tend to be hundreds of miles long and operate at several hundred pounds of pressure. Distribution pipelines usually move gas from the transmission lines (or other sources) to homes and businesses via mains and services.

53 In 2011, after the 2010 rupture of Pacific Gas & Electric's gas pipeline in San Bruno, California, PHMSA issued Advisory Bulletin, ADB-11-01, recommending that the records relied upon by operators calculate the MAOP of a segment must be traceable, verifiable, and complete. This Advisory Bulletin followed the NTSB's recommendations after its finding that PG&E did not have an accurate basis on which to calculate MAOP.

54 Commentators indicated that applying the TVC standard to gas distribution assets would be a monumental task (given the millions of miles of mains and services across the country), would divert limited resources away from more important endeavors, and the added detailed gained by the effort would not make the systems safer overall. Commentators asked PHMSA not to place the TVC requirement in Section 192.13 (which would have general applicability to all pipeline operators). See page 52216, et. Seq., Federal Register., Vol. 84, No. 190 (October 1, 2019) for discussion on Records.

55 See Federal Register, Vol. 84, No. 190 (October 1, 2019), Final Rule, Docket No. PHMSA-2011-0023, Amdt. Nos. 191-26; 192-125; effective July 1, 2020 (among other things, clarifying the TVC standard applies to transmission pipelines, adding/clarifying other requirements related to records, and explaining what meets the TVC requirements.)

56 For instance, as identified in the Statewide Assessment, when operators report that mains or services are of an unknown vintage this usually is due to a lack of a complete record on that asset. This suggests the asset was likely manufactured and installed prior to 1970 when Federal regulations requiring records were put into place. See Statewide Assessment Final Report, Section 8.2.6.3.

- Installation of excess flow valves (EFVs) and/or curb valves where required (by code and by company's own procedures);
- Location of all valves – both fire valves as well as operational valves (records here should also include inspection and maintenance records of the valves);
- Location of all regulators including inspection and maintenance records;
- Location of sensor lines;
- Leak surveys – including specific location, duration, findings and leak cause/repair records;
- Pressure test records for mains and services, other appurtenances, etc.; and
- OQ records for all persons involved in construction/inspection/maintenance of assets.

Another important component of accurate records is version control.[57] If a record needs to be changed to improve its accuracy, there should be a record kept of the modification. Generally, this would include the date, reason for the change and the person who made the change. In addition, the documents would be marked to indicate it was no longer valid along with appropriate revision control.

[57] This is interrelated with a robust management of change process. The phrase *Management of Change* describes a leading practice used to ensure that safety, health, and environmental risks, and hazards are properly controlled when an organization makes a change to their facilities, operations, or personnel. It involves steps that include planning and communications before the change is made, actively monitoring, managing and implementing the change (including training), and then reviewing the effectiveness of the change to continually improve the process of managing the change.

5 CMA's Post-Incident Actions

5.1 Restoration Program (3rd and 4th Quarter 2018)

5.1.1 Program Framework

The planning process for the Restoration Program required that decisions be made to restore service as expeditiously as possible and manage certain barriers that inherently exist in executing at the planned pace. These included:

- Dividing the usual workstreams in three different ways:
  - By team: one group worked on getting the gas to the house meter (Gas Ready) and another group worked on getting gas from the meter into the house, which included replacing furnaces and appliances impacted by the over-pressurization (House Ready);
  - By zone: dividing up the Affected Area into 8 different Zones, with different work teams in both Gas Ready and House Ready workflows assigned to work in each Zone; and
  - By task: dividing up the workflow so individuals were able to focus on a specific set of tasks rather than manage the entire work site as was expected in the normal workflow, which for Gas Ready, included installation of new mains, installation of new services, traffic control, customer contact, locate & mark teams, work inspectors and individuals assigned to conduct QA/QC.
- Relying on the expertise of CMA and NiSource personnel from other states in which NiSource operates (which includes Kentucky, Indiana, Ohio, Pennsylvania, Maryland and Virginia) and supplementing that NiSource expertise with contractors with whom CMA or NiSource had long-standing experience;
- Seeking, and receiving permission from the DPU, to substitute the operator qualification certifications from other states in lieu of having technicians become operator qualified in Massachusetts;[58]
- Relying on the workforce's familiarity with NiSource's procedures set forth in its Operations and Maintenance Manual, which CMA shares and were made electronically available in their entirety to the workforce;
- Developing 72 engineering job packages that would contain original engineering and completion materials but would depend on an all-paper process, rather than using electronic forms for such items as pressure test information, that would be pulled together manually and would be handed out to the crews as they were ready for the next job;
- Asking all technicians not to use the materials they had in their work trucks, but instead, to obtain materials from the CMA warehouses;

[58] CMA stated that requiring each technician to be tested to Massachusetts operator qualifications would have substantially increased the time before those individuals could begin work on the Restoration Program with little benefit given the similarity of most state pipeline safety regulatory codes which must be consistent with the Federal pipeline safety regulations. CMA reached out to the DPU Director of Pipeline Safety and have an email confirming the approval of the DPU.

- Assigning a company inspector to provide oversight of the work performed by crews, with an anticipated 1:1 or 1:2 inspector-to-crew ratios, and limited and informal reporting requirements for those inspectors;
- Utilizing both internal and external personnel to conduct additional inspections as a QA/QC measure of quality of the work being performed on a sample of work sites;
- Establishing a regimented on-boarding process for each person who would be working on the Restoration Program prior to authorizing them to report to duty;
- Conducting a daily work briefing early each morning, which provided a direct and frequent method of communication with the workforce about expectations, issues and changes in direction; and
- Electing to purge natural gas from all mains and services throughout the Affected Areas.

CMA leadership believed these decisions, taken together, provided a solid platform to successfully install the Renewed Assets and return gas service to the Affected Communities as soon as practically possible. As explained below, the manner in which CMA implemented some of these decisions affected the Panel's ability to verify the work performed.

5.1.2 By Team: Gas Ready and House Ready Portions

CMA elected to break up the work by separating workflows at the meter.[59] One group focused on Gas Ready and the other on House Ready. The Gas Ready work involved construction of the new system of gas mains and gas services, right up to the meter. House Ready started at the meter and went into the house. This work involved setting meters, installing gas piping inside customer homes or businesses and working with customers to either replace or repair their gas-fired appliances (such as furnaces, water heaters, stoves and clothes dryers). Each of these programs had its challenges.

To perform both Gas Ready and House Ready work, CMA brought in approximately 5,000 people. About 1,000 of these people were NiSource employees from other operating areas both within and outside of the Commonwealth of Massachusetts (Commonwealth). The remaining were contractor personnel comprised of 18 pipeline contractors with 231 crews from across the United States. On a typical work day during the Restoration Program, nearly 1,200 people would be working in the field on either Gas Ready or House Ready.[60]

5.1.2.1 Gas Ready

In the Restoration Program, the Gas Ready portion of the work included construction of the mains and new services that would comprise the Renewed Asset and connecting those with assets already in place to create a Renewed System.

[59] As discussed in Section 6.1.5, this disruption in the usual workflow, combined with the decision to purge the gas all at once rather than having crews working around live gas, solved some issues, but created others that went unidentified and unmanaged by CMA.

[60] See page 5, CMA_MV 15.25 (c) (Confidential PowerPoint presented by CMA to DPU on December 2, 2019, entitled Verification Summary, Service Lines, Gate Boxes, Curb Boxes). In this document, CMA stated 43.3 miles of pipe had been installed of which 8.3 miles had been inserted. In Table 1 in Section 2, however, CMA stated 45.9 miles of pipe had been installed. In this document, CMA also states 5,086 new service lines were installed. As discussed in Section 6.2.2.1, the number of service lines installed changed during this Assessment.

This process involved a number of steps.

1. Purge of gas from entire current system;
2. Selection of materials to be used;
3. Excavating the trench (or excavations required for insertions);
4. Laying the pipe (usually high density plastic pipe) in the trench (or insertion into carrier pipe); and
5. Inspecting the plastic pipe.

To be deemed Gas Ready, all components up to the meter would have been installed and pressure tested with gas introduced into that portion of the system. Generally, the Gas Ready work was performed by one of the 18 contractors. The Gas Ready portion of the work was completed by October 29, 2018.[61]

5.1.2.2 House Ready[62]

To be House Ready meant that at least one appliance in the home or business had to be available for a re-light by CMA.[63]

Getting to House Ready was complicated by a couple of factors. First, meters had to be moved outside to be ready to connect to the higher-pressure pipeline system that was being built and equipped with a regulator. Consideration for outdoor meter location was required to meet specific regulations about where gas meters can be placed (vis-a-vis windows or vents or other avenues that might allow gas from a leak at the meter to migrate indoors).[64]

The second complicating factor was replacing or repairing customer owned equipment such as furnaces and appliances. Typically, a gas distribution company's responsibility ends at the meter. But because the over-pressurization had destroyed or damaged customer-owned gas-fired appliances, CMA agreed to install the gas piping into the house and purchase or repair appliances.

Installing indoor gas piping is a task performed by a licensed plumber in Massachusetts. While CMA had a number of such plumbers on staff, the sheer numbers of homes that needed to be refitted with new gas piping and new or repaired equipment required CMA to hire non-company licensed plumbers. While the House Ready work was performed by a number of contractors and NiSource personnel,[65] CMA hired the engineering firm Gilbane as its contractor to manage the House Ready portion of the Restoration Program.

The first House Ready was completed October 3, 2018, with substantial completion achieved on December 12, 2018.[66]

61 See page 6, CMA Response CMA_MV 15.25 (c).

62 Assessment of the House Ready portion of the Restoration Program is outside the scope of this Assessment.

63 See page 6 of CMA Response CMA_MV 15.25 (c).

64 Other benefits to a high-pressure system are discussed in Footnote 44.

65 See page 6 of CMA Response CMA_MV 15.25 (c).

66 See page 6 of CMA Response CMA_MV 15.25 (c).

5.1.3 By Zone: 8 Zones in Affected Area

As mentioned in Section 5.1.1, CMA elected to break up the work in several ways. One was by dividing the Affected Area into 8 zones.[67] These were designated as:

- Zones 1 and 2 in Andover;
- Zones 3 through 6 in Lawrence; and
- Zone 7 and 8 in North Andover.

5.1.4 Reaching Substantial Completion (December 2018)

The Gas Ready and House Ready work proceeded in parallel from mid-September until mid-December. Residents returned to their homes as gas service was returned to their street or neighborhood. By mid-December, all of those customers who choose to return to their home or business were able to do so. At that time, CMA deemed the Restoration Program substantially complete. Based on that declaration, CMA began the process of closing out the Restoration Program and releasing personnel back to their normal jobs and/or locations.

5.1.5 Completing Customer Equipment Repair and Restoration

After the Restoration Program was deemed substantially complete in December 2018, there still remained some work inside customer's homes and businesses. In furtherance of the House Ready work, some furnaces or other appliances were repaired or replaced in the first and second quarter of 2019.[68]

5.2 Service Line Abandonment Verification Program

As part of the Restoration Program, CMA purged and abandoned 67.8 miles of pipe by zone.[69] CMA reported to have installed 43.3 miles of new pipe,[70] of which 8.3 miles of new plastic mains were inserted into older cast iron pipelines that were being abandoned. Additionally, CMA reported it had installed 5,086 new service lines[71] and taken 4,862 service lines out of service.

Although Gas Ready was completed by October 29, 2018 and House Ready reached substantial completion by December 12, 2018, it was not until July 2019 that a CMA service technician observed and reported observing that gas assets no longer in service had not been abandoned correctly. It was not until September 11, 2019 that CMA reported the problem to the DPU, at which time the Chairman ordered CMA to undertake an abandonment verification process.[72]

In that process, the most urgent concern was re-inspecting those portions of the new plastic pipe, both mains and services, that had been inserted into the abandoned cast iron pipe. This was because

67 See Figure 1.

68 The House Ready work is outside the scope of this Assessment.

69 Data and information for this section was provided by CMA in response CMA_MV 15.25 (c). CMA presented the information to the DPU via a PowerPoint presentation entitled, "Columbia Gas of Massachusetts Verification Summary – Service Lines, Gate Boxes, Curb Boxes, Patterns, Trends, Correlations" dated December 2, 2019.

70 The Panel notes this is not the same number of miles of pipe reported to the Panel in CMA_MV 15.03. See Table 1, in Section 2, provided by CMA on March 9, 2020.

71 See Section 6.2.2.1 regarding the variances in the actual number of service lines CMA installed during the Restoration Program.

72 See Chairman's 11th Set of Orders under G.L. c. 25, § 4B, dated September 11, 2019.

if the plastic pipe developed a gas leak, the gas could migrate from the site of the leak through the abandoned cast iron pipe (carrier pipe) to a different location, including inside of homes and buildings if services had not been properly abandoned.

5.2.1 Verifying abandonment of service lines off of inserted mains (Group 1)

CMA reported that there were 717 meters on service lines connected to inserted mains that had been abandoned in the Restoration Program and these were classified as the highest priority (Group 1).[73]

To verify the abandonment had been performed correctly, the field crew would need to verify the service line outside of the building had been physically separated and disconnected from the main. The ends of the abandoned piping must be sealed with an approved end cap, closed valve, or other approved method to prevent a path of gas migration. This means that inside the building, the service line had been plugged (with a plug through the foundation) and capped, with the cap having been painted yellow.[74]

As the Panel observed during its field work, nearly every service abandonment had a unique set of circumstances. At many sites observed by the Panel, it was necessary for the crew chief to put the pieces of a puzzle together to determine what had occurred. This was accomplished by utilizing sometimes incomplete or inaccurate paper records, reading the street,[75] and talking with owners or landlords about their gas services. If no cap or plug was in place inside the building, CMA used a remote camera that could be inserted into the service line from inside the home to see if the service had been cut. If it could be determined that it had, the crew could then insert a plug through the abandoned service far enough to be outside of the foundation wall and put a yellow cap on the service. If any one of those steps were not able to be confirmed, then the crew chief noted that further action was required (FAR) which would then be undertaken by a different crew at a different time.

The results of this effort are set forth in Table 3.[76] Of note, during this process CMA discovered 68 of the services lines that had not been abandoned properly had been taken out of service prior to the Restoration Program in 2018.

Table 3: Service Line Abandonment Verification Summary, Group 1

Meter Location	Inside Remediation Only	Outside Remediation Only	Inside & Outside Remediation	% Needing Disconnected from the Main	% Needing Some Form of Remediation	Number of No Remediation	% No Remediation	Total Number
Inside	197	22	112	31%	78%	95	22%	426
Outside	4	1	1	1%	2%	285	98%	291
Total	201	23	113	19%	47%	380	53%	717

[73] In reporting the results of the abandonment verification program to the DPU on December 2, 2019, CMA designated the different assets involved in the various phases of the abandonment verification process into four groups: inserted mains, indoor meters, all customers, and curb valves and named them as Group 1, 2, 3, and 4, respectively. For simplicity, the Panel has adopted this nomenclature.

[74] CMA GS 1740.010 (MA).

[75] *Reading the street* is a skill practiced by crews in the field. It means looking for and assessing all of the clues on-site about the location and possible condition of underground assets. It includes, among other things, examining the street and surrounding areas to identify the new and old marks indicating the presence of underground facilities, looking for evidence of water, sewers, or storm drains, noticing whether the pavement or grass has been disturbed, and judging the likely timing of that disturbance.

[76] These results were reported by CMA to the DPU on December 1, 2019. Page 8 of CMA in response CMA_MV 15.25(c). The extent of the required remediation efforts was unknown in September 2019.

5.2.2 Lawrence Grade 1 Leak

On September 27, 2019, after CMA had begun to verify the abandonment of services associated with inserted mains, a Grade 1 gas leak[77] occurred on CMA's gas system in Lawrence, Massachusetts.[78] As a result of the leak, which was detected at 3:15 a.m., over 100 people were evacuated from their homes. Electricity and gas were cut off to the area, affecting approximately 1,600 electric customers.

At first, it was unclear whether the Grade 1 leak occurred on the Renewed Assets or on the Legacy System. It soon became evident, however, that during the Restoration Program, CMA had not followed its required procedures for the abandonment of main valve.[79]

The incident occurred when a contractor working for the City of Lawrence's water department inadvertently closed CMA's main valve that was still connected to an abandoned main, which had been inserted with new 2-inch plastic pipe as part of the Restoration Program. When the contractor turned the main valve, the action sheared the inserted live gas main resulting in the Grade 1 leak. Had the gate valve been correctly abandoned from the cast iron system, the contractor would have been unable to turn the valve and shear the live gas line.

5.2.3 DPU Expands Abandonment Verification

As a result of the Grade 1 leak and the findings during the verification of the inserted mains, the DPU again acted to require CMA to expand its Service Line Abandonment Verification program.[80] In addition to requiring the insertion review to be completed on an accelerated schedule, the DPU required CMA to expand the verification process to include verification of the appropriate abandonment of all inside meters to all customers (eventually), and to all gate and curb valves.

5.2.3.1 Abandoned Indoor Meters (Group 2)

It became apparent that another group of abandoned assets required inspection and verification; those customers who had meters located inside their homes that were abandoned during the Restoration Program.[81] This included 2,234 meters. CMA followed the same process it had used for Group 1.

The results of this verification effort are set forth in Table 4.[82] In performing the inspection of the inserted mains, CMA discovered 118 service lines that had been taken out of service prior to the Restoration Program but had not been abandoned properly at the time.

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77 A Grade 1 gas leak is one that represents an existing or probable hazard to persons or property, and that required immediate and continuous action until the conditions are no longer a hazard. See M.G.L. c. 154 §144.

78 Lawrence is one of the Affected Communities. The distress caused by the Grade 1 leak in the area in which residents had already suffered was significant. CMA acknowledged this added burden in a CMA press release issued shortly after the Grade 1 leak.

79 A main valve is typically a gate valve. A curb valve is installed on a service line between the gas main and the gas meter and is typically a ¼-turn ball valve.

80 Chairman's Twelfth Set of Orders under G. L. C. 25, §4B, dated October 1, 2019.

81 In one of the first Service Line Abandonment Verification sites visited by the Panel, the crew was surprised to discover that, although the paperwork indicated the inside meter had been moved outside, the check inside the basement of the home to ensure the service had been abandoned properly revealed a clearly visible gas meter hanging on the wall connected to a piece of service line that no longer contained gas.

82 Page 9 of CMA response CMA_MV 15.25 (c).

Table 4: Service Line Abandonment Verification Summary, Group 2

Meter Location	Inside Remediation Only	Outside Remediation Only	Inside & Outside Remediation	% Needing Disconnected from the Main	% Needing Some Form of Remediation	Number of No Remediation	% No Remediation	Total Number
Inside	1259	56	443	22%	79%	472	21%	2230
Outside	2	--	--	0%	50%	2	50%	4
Total	1261	56	443	22%	78%	474	21%	2234

5.2.3.2 Remaining Customers (Group 3)

Based on the results from Group 1 and Group 2, the Service Line Abandonment Verification program was expanded to include all remaining 1,911 customers. CMA followed the same process as it had used for Group 1. In this group, there were 52 sites, or 3% of the sites that needed outside remediation. Customers were offered inside verification. CMA reported no sites needing inside remediation.[83]

5.2.3.3 Valve Verification (Group 4)

Immediately following the Grade 1 leak, from September 27 to September 29, 2019, CMA engaged in a walking survey of main line valves. This walking survey identified three main valves remained accessible after the Restoration Program. These were subsequently remediated.

CMA also expanded the valve verification to curb valves to verify proper abandonment.[84] CMA began by identifying the location of all of its curb valves using four subsets:

- Sites where curb valves were identified in active computer records (Subset 1);
- Sites identified through manual review of old tap cards off of those mains abandoned after the Incident that prior to the Restoration Program had either (a) had inside meters or (b) outside meters (Subset 2 and 3);
- Sites at which a new plastic pipe had been inserted into a cast iron main during the Restoration Program (Subset 4).[85]

This process involved a field visit to each of 4,544 sites to visually identify the existence of the curb valve abandoned as part of the Restoration program. The purpose was to verify that no new plastic pipe installed in the Restoration Program was inserted through an operable gate valve.

The two right-hand columns in Table 5 provide the breakdown of the curb valve remediation. A total of 394 curb valves needed remediation of some sort.[86]

[83] Page 10 of CMA response CMA_MV 15.25 (c). Of note, CMA did not report the number of customers who accepted the offer for an inspection of appropriate abandonment of the inside assets. Presumably, this subset of customers did not include customers who had inside meters prior to the Incident, but the presentation by CMA does not make this clear.

[84] Chairman's Twelfth Set of Orders under G. L. C 25, §4B, dated October 1, 2019.

[85] Page 12 of CMA response CMA_MV 15.25 (c).

[86] Page 12 of CMA response CMA_MV 15.25 (c). In its presentation to the DPU, CMA states "130 of 4,544 curb valves (2.9%) were inserted or tied-over. The basis for this statement is unclear from the table provided. See page 10 of presentation.

Table 5: Curb Valve Verification Summary

	Number of Verifications Performed	Curb Valve Not Present Based on Verification	Number of Curb Valves Remediated	Curb Valve Present – Hard Surface	Curb Valve Present – Soft Surface
Sub-set 1	412	351	61	44	17
Sub-set 2	1,451	1,257	194	153	41
Sub-set 3	2,358	2,221	137	83	54
Sub-set 4	323	321	2	2	--
Total	**4,544**	**4,150**	**394**	**282**	**112**

5.3 NiSource agrees to sell CMA business to Eversource Energy

On February 26, 2020, NiSource announced it had entered into a definitive agreement under which Eversource Energy would acquire substantially all of CMA's assets.[87] If the transaction closes, which is subject to DPU approval and other closing conditions, it is expected to be completed by the third quarter of 2020. Following completion of the sale, CMA will stop all gas operations in Massachusetts.[88]

[87] The sale, which fulfills part of a deferred prosecution agreement between NiSource and the US Attorney's Office to resolve any potential charges related to the Incident, includes substantially all of CMA's assets related to its natural gas business. CMA also agreed to pay a $53 million fine as part of its criminal plea agreement. See Press Release, Department of Justice, U.S. Attorney's Office, District of Massachusetts, dated Wednesday 26, 2020.

[88] See Press Release, Department of Justice, U.S. Attorney's Office, District of Massachusetts, dated Wednesday 26, 2020.

6 Observations

In 2018, CMA faced a monumental task to restore gas service to the Affected Communities before winter set in. Not only did CMA have to install and pressure test over 50 miles of mains and nearly 5,000 services in a relatively short period of time, but it also needed to do so under challenging circumstances. Decisions about how to accomplish this task were made in consideration of these circumstances. CMA accomplished the task with the implicit and at times explicit support of the DPU as well as other stakeholders.

With the benefit of hindsight, this Assessment identifies the impact of certain decisions made to expedite the work. Significant changes to normal workflow, for which the impact went unidentified at the time, created gaps and issues with pressure test records, SLRs and the abandonment of pipeline infrastructure.

In addition, CMA's predominate reliance upon people more so than processes also resulted in gaps and missed opportunities. It did not adequately document the work undertaken, perform its own real-time analysis of potential shortcomings, or conduct a critical review as part of their project close out.

These choices, combined with changes to data and information provided by CMA over the course of this Assessment, create uncertainty with operational risks and also created challenges for the Panel to verify the work performed in the Restoration Program.[89]

The observations in this section identify gaps and opportunities for CMA and its Successor in Interest to close gaps over time.[90] The new infrastructure of the Renewed Assets improve pipeline safety for the Affected Communities as compared to the low-pressure cast-iron system that it replaced. Implementing this Assessment's recommendations will further improve pipeline safety.

The Panel's observations arising from CMA's Restoration Program are set forth in this section. These observations are organized into two categories:

- The CMA Restoration Program (Section 6.1); and
- The Assets (Section 6.2).

6.1 Observations about the CMA Restoration Program

6.1.1 Heavy reliance on people without sufficient process was misplaced.

At the start of and subsequent to this Assessment, CMA has made assurances that it has confirmed its installation of the Renewed System was compliant with all applicable Federal and State regulations. Discussions revealed CMA's confidence primarily rested on four pillars on which it built the Restoration Program. These were:

- Its workforce knowing and following the appropriate CMA procedures;
- Its workforce having the appropriate Op Qual to perform the work;

[89] The same might be true if the Panel were assessing some other gas distribution company under similar circumstances. This fact provides additional support to the broader movement to improve pipeline records and implement robust pipeline safety management systems.

[90] While each observation may not be significant in isolation, they collectively become impactful.

- Having company inspectors present at each work site, with a roving team of internal and external quality assurance personnel in the field; and
- Its project close-out procedure to confirm satisfactory completion of work performed.

Initially, these pillars appeared to create a reasonable basis for concluding the Renewed Assets had been constructed appropriately and in accordance with regulations. This list is not unlike what many gas distribution companies would rely upon under normal circumstances. As the Panel looked deeper into each, however, a number of items came to light that raised concerns:

1. First, CMA chose not to provide any specific guidance to the workforce on the critical procedures to follow. This was despite the facts on the ground, including:
   - NiSource personnel came from different states and contractor personnel came from all over the United States;
   - NiSource's procedures are voluminous, available on-line, and include numerous standards that vary by State;[91] and
   - Procedures were made available on-line which required workers to retrieve them.[92]

   Given all of this, CMA's choice to forego providing specific guidance on performing key construction tasks necessary to meet Massachusetts requirements to field personnel or inspectors raised a flag to the Panel.
2. Second, there was over-reliance by CMA upon the minimum requirement of Op Qual for all workers. The fact that Op Qual were accepted, even though from a state different than Massachusetts, [93] created further complications and inherent differences in workflow and different documentation requirements.
3. Third, while the concept of having an inspector at each site was a good decision, further discussions revealed that limited processes were established to guide the inspectors. A well-established process would have set expectations to be on the job site all the time [94] and document what was inspected and what corrective actions were taken when deviations were identified. Instead of establishing that process, CMA relied solely on the people to intervene and correct work that did not meet standards.
4. Fourth, and most significantly, a review of the pressure test records and SLRs revealed gaps and inaccuracies in the documentation that had not been identified by the close-out team. These are discussed in detail in Section 6.2.

91 NiSource operates gas utilities in seven states but uses one set of Operations and Maintenance (O&M) manuals.

92 In the Statewide Assessment, the Panel observed that field crews often encountered difficulty in accessing O&M manuals in the field (difficulty recalling passwords or with the connection to the internet) and more importantly, O&M manuals were rarely helpful or relied upon in the field. See Section 9.1.2 of the Statewide Assessment Final Report.

93 CMA apparently sought and received approval by the DPU to accept out of state operator qualifications as if the operator qualifications had been issued in Massachusetts. CMA relied on this DPU approval to use out of state operator qualifications as if they had been issued under the Commonwealth's regulations. This arrangement indicates an implicit understanding that time was of the essence and accommodations would need to be made to get the gas service back to customers before winter.

94 While CMA planned to have a 1:1 ratio of inspector to job site, various factors caused the ratio to vary from 1:1 to 1:2, and on occasion to 1:3 or more sites.

6.1.2 CMA failed to proactively scrutinize its own work.

As the Panel asked questions about the four pillars and sought additional explanation about discrepancies in the documents provided by CMA, it became clear CMA had not performed a deep analysis of its data from the Restoration Program prior to others stepping in to verify its work. Despite having performed the Restoration Program under emergency conditions and intense pressures, CMA did not assess its own performance of the Restoration Program to seek and understand what gaps might have occurred until those gaps were brought to light by a field technician,[95] TRC, [96] or this Panel.

After reaching the milestone of substantial completion in December 2018, CMA dismissed those employees and contractors who had been called away from other operating areas. The next two quarters focused on completion of customer owned appliance issues. When this was completed, the organization returned to normal business. It appears that the organization did not conduct an in-depth analysis of the data produced by the Restoration Program to identify potential gaps.

This lack of proactive and critical analysis by CMA of documents and data related to the Restoration Program continued even after issues arose in July 2019 concerning the abandonment of assets. The failure continued even after TRC issued its report revealing gaps and concerns related to the materials used. When the Panel began this Assessment, CMA made strong assertions about its confidence that compliance requirements were met, and that the system could be operated safely and at a higher pressure.

As each issue was identified by the Panel, CMA worked diligently to develop an explanation as to what had occurred and to explain why it was not a problem. When further questions about the explanation arose, it often led to additional issues or discrepancies. At some point in the process, CMA would commit to undertaking new efforts to assess or mitigate the issue.[97]

6.1.3 Absence of recordkeeping hampered the ability to verify compliant construction.

Records and other documentation and reconciliation efforts during the Restoration Program proved problematic on several fronts including:

- Engineering packages;
- Construction process;
- Close-out process; and
- Management of change.

6.1.3.1 Engineering Job Packets often were incomplete.

CMA asserted that the job packets would contain the original engineering records and job completion records for each job. After reviewing a sample of the job packet records, the Panel determined this

[95] Issues with the abandonment of pipeline infrastructure were first observed and reported by a field technician in July 2019. See Section 5.2.

[96] In the fall of 2019, CMA hired TRC to conduct an analysis of the materials used in the Restoration Program in an effort to support CMA's request to the DPU to increase the operating pressure of the Renewed Assets. As discussed in Section 6.1.4.1, TRC identified a number of gaps and concerns with the materials that led CMA to undertake corrective action.

[97] For example, after the Panel's analysis of the main pressure test records found gaps, CMA undertook a significant work effort to match the information in its GIS to the pressure test records. This effort is discussed further in Section 6.2.1. The resulting work product from CMA is in Appendix F.

assertion was incomplete. Each had a similar file structure but were only partially completed. Various job packets did not have information about design, materials, joining, or installation.

6.1.3.2 Construction Process was not sufficiently documented.

CMA failed to create appropriate documentation during the construction process. Rather than having a documented tracking mechanism for the materials, field personnel were instructed to retrieve the materials from specific CMA warehouses, entrusting the technicians to not use any materials they found on their trucks (which may have been used for gas distribution work in another state). On-site inspectors did not document the work they observed being performed or the corrective actions taken, if any. The QA/QC teams were meant to bolster the ability to confirm quality.[98] This resulted in an over reliance upon people to do what they knew how to do in the manner they knew how to do it.[99]

CMA's decisions about how to conduct the work and the lack of established documentation practices at the time of construction hamper the Panel's ability to verify today the quality of the work performed at the time and whether the construction was compliant with Federal and State regulations. Documents do not exist to verify compliance with regulatory requirements related to:

- Design;
- Materials used;[100]
- Installation methods utilized; and
- Joining of pipe.

As such, the public and the DPU are left without a documentation trail to determine whether or not regulations and CMA procedures were followed with regard to these critical aspects of construction. To gain a better understanding of what occurred during the construction of the Renewed Assets, the Panel was forced to consider other data more closely.

6.1.3.3 CMA's Capital Close-out Process was not sufficiently robust to identify gaps.

CMA represented that the documentation confirmed that the Renewed System had been subjected to an appropriate pressure test. In making this representation, CMA relied heavily on its Capital Close-out Process.[101] When the Panel's technical team explored inconsistencies in the pressure test records,[102] it required CMA to undertake significant work to address those inconsistencies. For example, the Panel learned that some individuals working on the Close-Out Process had insufficient

98 As discussed in the Statewide Assessment, the reliance on an individual as the last defense to ensure safe execution is unfair to the individual and the organization. A strong positive safety culture requires systems and process in place to ensure safe execution of work. See Footnote 122 and Appendix A.5.4, Safety Culture, Statewide Assessment Final Report.

99 The Panel observed many CMA crew chiefs deserving of this trust. As discussed in Footnote 98, a strong positive safety culture requires systems and process in place to ensure safe execution of work. This is especially true in the difficult circumstances in which the Restoration Program was being executed.

100 In fall 2019, CMA hired TRC Engineering to analyze the materials used by CMA in constructing the Renewed Assets as well as a portion of the Legacy System. See Section 6.1.4.1 for a discussion of the TRC Materials Report.

101 Gas distribution operators generally utilize a process to complete and verify paperwork associated with any construction project. At CMA, this process is called the Capital Close Out Process. It is in this step that a team, often a mix of engineers and accountants, review and assess the documentation related to a project to ensure that every item in the process is accounted for and properly documented. This would include ensuring that the job order packages provide information on the design, materials, proper joining and testing, and abandonment. The more robust the process, the more reliable the results.

102 A discussion of the gaps and inconsistencies the Pressure Test records for mains and for service lines is set forth in Sections 6.2.1 and 6.2.2, respectively.

experience to be able to identify whether a tie in should have been pressure tested as part of the main pressure test (MPT) or the service line pressure test. CMA's Close-Out Process was not as robust as expected and not sufficiently robust to identify the gaps in the documents prior to this Assessment.

6.1.3.4 Management of change process related to official records appeared non-existent.

CMA failed to establish minimum version control requirements for official documents. In reviewing pressure test forms, the Panel's technical team uncovered at least 10 forms that appeared to be duplicates but had no markings or other indications indicating if it was an official record or a duplicate.

The review of the pressure test forms related to Test 136 and Test 140 uncovered several document handling irregularities.[103] CMA's investigation determined that the inspector created the pressure test form for Test 140 on October 8, 2018. Nearly a month later, on November 5, 2018 he scanned the document into the electronic records system. Subsequently on November 9, 2018, he scanned in the form for Test 136 changing some but not all fields, to correct what he had come to believe was an error in the first form. There was no marking on either form to suggest one was a revision. There was no explanation of the reason for the change. Apparently, there was no QC by any other person to check the calculations or the purpose for the change. As such, several errors were introduced into the system. Without a change management process for the pressure test forms, CMA had no information available to understand why two nearly identical documents had been created to document the same pressure test work in the field.

6.1.4 Quality Concerns were identified by several sources.

Without the documentation to verify construction of the Renewed Assets was compliant with regulation and CMA procedures, the Panel looked to several other sources of data about the quality of construction. These sources identified several quality concerns with the construction of the Renewed Assets that may, or may not, impact long-term performance of the assets.

In the Fall of 2019, the TRC Materials Report found issues with the materials utilized in the Restoration Program which CMA is in the process addressing. During the construction, CMA's own QA/QC process – utilizing both internal and external personnel – identified issues, many of which related to a failure to join pipe in accordance with the regulations.[104] The DPU's inspection results also provide insight into issues found during construction.

Each of these are discussed below, as follows:

- TRC Materials Report (Section 6.1.4.1);
- Results from CMA's QA/QC Process (Section 6.1.4.2); and
- DPU Inspections (Section 6.1.4.3).

The Panel notes that the percentage of quality issues identified in these sources is relatively small as compared to the overall volume of the work performed. There are two issues, however, with relying on the small sample to support the proposition that construction of the Renewed Assets was performed adequately and in compliance with regulations.

[103] See Appendix J.

[104] Good QA/QC processes are expected to find issues and concerns. In addition to correcting the specific issue identified on a single site, good QA/QC processes also include collecting the data, analyzing the cause of the issue, and using the process to identify potential trends and corrective actions to be applied more broadly to the project. See Appendix H, Quality Control Management.

First, each source represents just a sampling of the overall work performed. While sampling is generally considered a reasonable approach to QA/QC, it has its limitations in application to the body of work. For instance, it is not possible to know whether the quality issues found during a QA/QC audit appear throughout the population of worksites in the same way or at the same rate.

Second, it assumes that in each instance a quality issue occurred, it was both identified and appropriately corrected at the time. This may, of course, be true, but without documentation it is not possible today to verify whether it was performed correctly.

6.1.4.1 TRC report found issues with materials.

TRC's report found a number of issues with materials used in the Legacy System.[105] First, TRC identified CMA had been using the wrong maximum allowable operation pressure (MAOP) for the Legacy System.[106] TRC went on to examine 13 areas including historical information, code requirements, outside forces and operator processes. From its evaluation, TRC identified issues which it believed would impair safe operations of the Legacy System, if their recommendations were not followed. Findings included concerns with improper regulator orifices, bare steel services in the Legacy System that were not replaced as part of the Restoration Program, the use of medium density plastic fittings with a code limitation of 80 psig,[107] and pressure regulator station that were not aligned with industry best practice.[108]

CMA has committed to addressing each of the concerns identified by TRC in the November 2019 report.

6.1.4.2 QA/QC Process suggests issues with joining process.[109]

CMA instituted a QA/QC process as part of the Restoration Program.[110] CMA used both internal and external personnel to perform QA/QC. Collectively, the QA/QC findings highlighted concerns with

[105] On November 12, 2019, TRC provided CMA with its report providing TRC's evaluation of the materials and system characteristics of the Legacy System, into which the Renewed Assets had been tied as part of the Restoration Program. TRC also evaluated Legacy System assets that were not part of the Restoration Program. The scope of each individual section in the TRC report varied. For example, the comprehensive material review included what TRC referred to as the "restored area" which is equivalent to the Renewed Assets.

[106] The November TRC Report contains the following footnote 1: "In TRC's October 27 and October 31 reports, TRC concluded that "CMA has acknowledged that the MAOP of the 99 psig system is actually 98.8 psig per the calculation for 1-1/4" CTS using Equation 1 found in 49 CFR § 192.121" and "Typically, MAOP values are not listed in decimal form, so CMA might want to reconsider referring to the system as 98 psig and not 99 psig." CMA agrees with TRC's conclusion and will refer to the system as 98 psig; however, there may be references to 99 psig in some of the earlier reports provided in this Pressure Restoration Plan which were prepared prior to TRC recommendation." We note 49 CFR §192.121 provides two calculations to determine the MAOP for plastic pipe. Either one can be used. For the material specifications in the TRC report, one equation results in design pressure of 98.46 psig and one results in 98.80 psig. These are the same TRC appears to have obtained but in the report, it appears TRC mixed up which result belongs to which equation.

[107] CMA stated the fitting manufacturer and Gas Technical Institute retrospectively performed additional testing and confirmed that the medium density fittings can be used at 98 psig (see CMA response CMA MV IR 1.2 and CMA MV 15.18). CMA further stated the DPU is performing evaluations to validate those findings.

[108] The TRC Report also identified potential concerns around pressure test documentation for mains and services. The Panel's own assessment of the pressure test records is set forth in Section 6.2.

[109] Documents provided by CMA from which the information was drawn for this Section include CMA_MV 15.15, CMA_MV 15.16, and CMA_MV 15.17. In addition, information about the CMA QA/QC was drawn from CMA_MV 15.14(a) and Attachment CMA_MV 15.14(a). Additional information about the TRC QA/AC was drawn from Attachment CMA_MV 15.17 (excel spreadsheet) and Attachment CMA_MV 15.15.

[110] CMA's QA/QC processes, however, did not include actions beyond identifying (and presumably correcting) issues identified on a specific site. It generally did not include collecting the data, analyzing the cause of the issue, and using the process to identify

joining, which could lead to an increase in the likelihood of future leaks. Subsequent audit and direct examinations (via excavations) performed by CMA did not alleviate all concerns.[111]

6.1.4.2.1 CMA QA/QC visits

The CMA QA/QC team made 147 visits to work sites.[112] From those visits, the team identified 29 at-risk findings over 26 work sites. Table 6 provides a summary of the categories of the at-risk findings made by CMA personnel.[113]

Table 6: Summary of Category of At-risk Findings by CMA

At Risk Category	Number of CMA QA/QC At-risk findings	Percentage of CMA QA/QC At-risk findings by Category
Joining	12	41%
Installation	6	21%
Pressure Testing	7	24%
Construction Safety	4	14%
All Categories	**29**	

To better understand what these findings included, the Panel asked CMA to provide additional information.[114] Based on that information, the at-risk findings involved the following concerns, with the number in parenthesis indicating the number of times this reason was provided.

For Joining:

- Failure to mark area to be cleaned (4);
- Failure to mark area to be scraped (4);[115]
- Failure to recognize need to re-shave pipe after realignment for butt fusion (1);
- Failure to keep pipe clean and dry before fusion (1);
- Failure to clean scraper blades prior to each use (1); and
- Butt fusion did not pass inspection by DPU and had to be cut-out (1).

For Installation:

potential trends and corrective actions to be applied more broadly to the project. There are some instances, however, when information about potential problems were escalated and managed. See Section 6.1.4.

111 Some, but not all, concerns identified were alleviated. As discussed in Section 6.1.4.2.3, CMA did undertake 22 "Supplemental post dig audits" based on findings from TRC Audits. These digs did not identify any additional at-risk findings related to joining and no leaks were identified.

112 The CMA QA/QC audits also performed what it reports as three "random" QA/QC visits by CMA's Technical Support Group. In one of the two random visits related to the Renewed Assets, four at-risk findings were noted. One related to joining (not marking the pipe prior to cleaning or scaping as part of the Joining process, two were related to "Safety" (with no further notation) and 1 related to corrosion control. The third random QA/QC visit occurred during a leak investigation but this leakage was not on Renewed Assets.

113 See Appendix N, Summary of QA/QC observations for additional information about the CMA QA/QC visits.

114 See Attachment CMA_MV 15.14(b).

115 There is some indication, including from interviews with the Panel, that this finding was escalated from field crews to leadership as one that may have potential systemic issues.

- Failure to follow Massachusetts compaction standard (1);
- Inserted main did not have sufficient casing removed for service tee placement and lack of bridging support (1); and
- Failure to internally clean service line prior to testing (4).

For Pressure Testing:

- Failure to mark testing information on pipe being tested (5); and
- Plug left in meter stop during pressure test of service (2).

The audit reports indicated that most findings were corrected on site or were scheduled to be corrected. No further information was provided by CMA about the completion of the scheduled corrections. Unanswered questions include:

1. Was there a systemic or individual reason the inspector was not catching these items?
2. Would sites not visited by a QA/QC inspector exhibit a similar percentage of issues as found at the sites visited by the QA/QC team that went undetected and uncorrected?

A possible answer to the first question may be evident from the QA/QC documentation. At 123 of the 147 sites visited, the forms stated: No –Supervisor was not on Site which suggests that an inspector was not physically at the site during the QA/QC team visit.[116]

The answer to the second remains unknown. Although there is some evidence that CMA took some audit findings and applied them across the project,[117] it remains unclear whether the findings in the audits were more broadly integrated, in a systematic way, for quality assurance on the project.[118]

6.1.4.2.2 TRC QA/QC visits

CMA also hired TRC Engineering to conduct QA/QC during the Restoration Program.[119] TRC conducted 1,319 audits on the Renewed Assets. From these, the TRC QA/QC inspectors identified 68 Unsatisfactory[120] observations at 42 locations. Table 7 sets forth the categories of the Unsatisfactory observations.[121]

[116] Of the 24 sites where the data shows "Yes, Supervisor on Site," the name of the inspector was given at 8 sites, a name is provided in the comments without any notation indicating the named person is the inspector, and at 13 sites, no name is provided.

[117] See, for example Section 6.1.4.2.3.

[118] Potential corrective actions could include refreshed training, additional guidance at the daily job brief, assigning a different inspector to watch a crew with particular issues.

[119] This work is different and separate from work CMA hired TRC Engineering to perform in the fall of 2019 related to verifying the materials used in constructing the Renewed Assets, as well as a portion of the Legacy System. See Section 6.1.4.1 for discussion of the TRC Materials Report.

[120] It is unclear if the standards applied by the CMA QA/QC personnel and the TRC personnel differed, or if the use of "at risk" and "unsatisfactory" language (used respectively) was meant to convey the same level of findings and/or concerns.

[121] See Appendix N, Summary of QA/QC observations for additional information about the TRC QA/QC visits.

Table 7: Unsatisfactory Observations by Finding Category

TRC Unsatisfactory Observation Category	TRC Unsatisfactory Observations	Percentage of TRC Unsatisfactory Observations by Category
Joining	51	75%
Installation	11	16%
Pressure Testing	6	9%
All Categories	**68**	

Similar to the steps taken with the CMA QA/QC, the Panel asked CMA to provide additional information.[122] Based on that information, the Unsatisfactory findings involved the following concerns, with the number in parenthesis indicating the number of times this reason was provided:

For Joining:

- Pipe not marked properly before fusion (39);[123]
- Pipe not cleaned properly before fusion (7);
- Pipe not scraped to marks (2);
- Stab fitting procedure not followed (2); and
- Butt fusion bead not wide enough (1).

For Installation:

- Backfill does not provide adequate protection to pipe(6);
- Butt fusion bead does not meet CMA Gas Standard (1);
- Warning tape not installed (1);
- Inadequate depth of cover (1); and
- Pipe handling not adequate (2).[124]

For Pressure Testing:

- Testing leaks required re-test (6).

The TRC Summary states that of the 68 unsatisfactory observations, 45 were resolved during the audits, 15 were resolved by completing a successful pressure test and 7 remaining as unresolved. In March 2020, CMA confirmed to the Panel that the 7 remaining unsatisfactory observations were resolved during Company post digs.[125]

[122] See Attachment CMA_MV 15.15 and Attachment CMA_MV 15.17.

[123] The purpose of marking the pipe before joining is to help ensure a good quality fusion occurs. Failure to join properly can result in gas leaks.

[124] For example, from one TRC audit report "@redacted St - "Pipe was aggressively being inserted and being drug over asphalt and pushed through the insertion without any inspection of the pipe. The pipe actually was going over the 90° edge of the saw cut asphalt being pulled down in the hole."

[125] CMA's response CMA_MV 15.16. Neither the nature of the issue or the nature or method of resolution was provided by CMA.

6.1.4.2.3 Other quality checks performed by CMA personnel

Following the at-risk and unsatisfactory findings, CMA undertook additional checks on quality. CMA reported that it conducted 22 supplemental post dig audits based on findings from TRC Audits.[126] These digs did not identify any additional at-risk findings related to joining and no leaks were identified. Based on these results, CMA elected to put the facilities into service even though a CMA Gas Standard had not been followed (e.g., an area on the pipe that was to be scraped was not marked).[127]

In addition, CMA conducted 15 Compliance QA audits. CMA elected to perform these after suspending an individual's Op Qual following the discovery of gas leaks in locations at which the individual had worked. These audits also involved digs, with a focus on locations with tees, caps and stab fittings. No gas leak was found during these digs. Of the 15 compliance audits, there were 4 audits with findings. In those 4 audits there were 8 at-risk findings. All 8 are related to joining and pipe not being marked as required by the CMA Gas Standard.

CMA also conducted leak surveys as a method to check for quality of the construction. They report that four bar-hole audits over service tees at which no leaks were found. CMA conducted 45 leak audits using an infrared based leak detection survey instrument over service lines and found one leak at an above ground meter set.

6.1.4.3 DPU Inspections provide good window into concerns with CMA's Restoration work.

DPU inspectors conducted their own inspections of CMA's construction of the Renewed Assets from September 2018 to November 2018. DPU provided the Panel with 494 inspection forms.[128] Many of these inspections were recorded on a single form, which provided a checklist of regulations.[129] In addition, the forms provided an opportunity for an inspector to note a concern.

While each inspector provided a short summary of work activity to categorize the review that took place on these forms, there was a large variation in descriptions and activities observed by differing inspectors.[130]

To provide a more usable summary of the inspection findings, the Panel's technical team focused on those forms on which the inspector had written a concern and then grouped those into certain categories.[131] The results from this analysis are set forth in Table 8.

[126] It is unclear from the CMA response whether the seven excavations discussed in Section 6.1.4.2.3 are included in the 22 "post-dig audits" reported here.

[127] This seems like a reasonable approach to the Panel, provided the exception to meeting CMA Gas Standards is reflected in the asset records.

[128] DPU response to IR 14; the 494 inspection forms were combined into five files for submission purposes.

[129] The DPU inspection forms identified up to 96 specific code items for inspection, with the most common template having 85 items available for the inspector to check. Because of the inconsistency between forms, it was not possible to draw meaningful conclusions from the number of checkmarks. It does however, provide an insight into the DPU inspection process that leads to Recommendations to the DPU in Section 7.2.

[130] Over 123 different inspection descriptions were listed in the 494 forms.

[131] Due to the volume and format of the data, information was electronically extracted and certain decisions and assumptions were made to produce this summary.

Table 8: Categories of Concerns Identified by DPU Inspection Activities

Category	Audit	Concern
CMA Procedure review[132]	2	2
Incident Investigation	16	6
Installation	305	70
Main Inspection	13	0
Meter and Regulation Set Inspection	54	52
Misc.[133]	41	19
Ops Qual	8	1
Pressure Test and/or Purge	20	12
QA/QC	9	3
Service Inspection	21	3
Tie-In	5	2
	494	**170**

As indicated, the inspection documents collectively identified 170 concerns, meaning DPU inspectors identified a concern at over 34% of the sites (170 or 494) for which DPU inspection forms were completed.

If an on-site DPU inspector identified a concern, the Panel understood that CMA personnel on site would have corrected the issue to the inspector's satisfaction. Unfortunately, documentation is not available to verify the assumption.

6.1.5 Early decisions with lasting impacts largely went unrecognized by CMA.

CMA made a number of early decisions about the structure of the Restoration Program with lasting impacts that largely went unrecognized by CMA.[134] As the Panel discussed in the Statewide Assessment Final Report, the impacts of changes in workflow present unique challenges on the work site. If changes from typical workflows are not fully considered and addressed, errors can arise.

While CMA explained why the foundational decisions were made, it appears they did not fully consider the risk that was being introduced, or if they did have the recognition, it seems no mitigation efforts were undertaken.

For example, CMA wanted people to focus on one task, so they organized the work by team, zone and task even though a crew is used to managing all the work at one site. When CMA elected to break up the work into Gas Ready and House Ready projects, it failed to recognize that no one person was

[132] Rather than inspecting a work activity, the DPU Inspectors reviewed CMA Procedures and found them not in compliance with the Federal and State regulations. See DPU Response, IR 14, pages 2,396 and 2,673.

[133] Miscellaneous items that did not neatly fit into one of the other categories, include field, on site, pipe fitters, main and service tee replacements.

[134] There is no way to know whether or not these decisions helped accelerate the time needed to return to gas service. We do know CMA was able to execute its Restoration Program in a way sufficient to return gas service to residents and businesses before winter of 2018/19 fully set in. This outcome was welcomed not only by CMA, but also by the DPU, public officials and the Affected Communities.

accountable for ensuring the abandonment of old assets was properly completed. In a normal setting, crews who were accustomed to working at each site from main to meter, likely would have appropriately performed and verified the abandonment of the assets that would no longer be in service because doing so was part of their usual workflow.[135]

CMA opted to move to paper pressure test forms because it recognized it had crews from other states performing Gas Ready work who might struggle with the electronic forms it usually used. Yet it failed to provide specific guidance about what the form meant or how to fill it out likely leading to some of the discrepancies and issues in the pressure test forms.

As was previously discussed, the decision to purge the system of natural gas, while done with good intentions,[136] disrupted the typical workflow and introduced unintended variances. With no live gas, field crews working on Gas Ready had no need to focus on ensuring the old service lines were appropriately abandoned (e.g., cutting and capped the dead service from the main). In turn, the House Ready teams had no need to consider removing inside meters, installing a plug through the foundation and making sure it had a yellow cap. Given these workflow variances, it is not surprising, in hindsight, that no one person was accountable for ensuring the abandonment of old assets was properly completed.

CMA belatedly recognized the impact of these changes in workflow when it stated in a presentation to the DPU on December 2, 2019:

> *It appears that the structure, timing and method of restoration including different teams for each of the 9 works teams, which is substantially different than a typical construction proceed is the likely driver in the instances of not completing service line abandonment work properly.*[137]

Had CMA recognized the impacts earlier, it could have instituted certain mitigation measures to reduce risks resulting from disrupted workflows.

6.1.6 CMA's approach for establishing MAOP for Renewed Assets was insufficient.

The process CMA elected to use to establish the MAOP of the Renewed Assets was insufficient to meet regulatory requirements.[138] The Panel takes issue with two aspects of CMA's approach. First, CMA relied on pressure testing the already installed assets (calling them requalified), rather than undertaking the analysis and process required by Federal regulations for uprating those existing assets into service at a higher pressure.[139] Second, CMA relied on a 2009 MAOP Worksheet rather than undertaking a fresh analysis to establish the MAOP of the assets installed in 2018.

On the issue of uprating, CMA takes the position that conducting a pressure test was a "better regulatory and pipeline safety fit" than uprating the pipe.[140] In essence, CMA suggests that there are

135 As discussed in Section 5.2, issues with the abandonment of assets were discovered in July 2019. Efforts were undertaken to verify the appropriate abandonment of services, mains and curb valves through the Fall of 2019.

136 The Panel agrees that the purge was in the best interest of public and worker safety, the challenge was to recognize the impact of the decision on typical workflow. Had CMA identified and fully addressed the impact, appropriate mitigation strategies, including workflow hand offs, could have been implemented.

137 Page 26, Attachment CMA_MV 15.25 (c).

138 Subject to the discussion about pressure testing in Section 6.2, the fact that CMA conducted pressure tests of the newly installed and the "requalified" pipe provides indicia the pipes are safe to operate at 98 psig.

139 CMA's response to IR 15.02 (basis for requalifying existing pipe) was a reference to response to IR 15.01 (MAOP determination).

140 CMA_MV 15.01(a), page 4.

two alternative methods of increasing MAOP: 1) uprating or 2) pressure testing.[141] Moreover, CMA believes uprating is only necessary when the pipe is in service.[142] This, however, is not aligned with the code nor with PHMSA interpretations.[143]

Uprating is covered in a separate section of the Federal pipeline safety code that is dedicated to the requirements to uprate existing segments.[144] Pressure testing is not an alternative to uprating, rather it is one of several elements of uprating.[145] In addition, certain analysis has to be conducted, and based on that analysis, other steps may be required.[146]

Nonetheless, CMA provided a number of justifications for its reliance on the pressure test performed as part of the Restoration Program[147] to establish the MAOP of the requalified pipe. This includes:

- The added safety of being able to conduct the pressure test with air, rather than gas;[148]
- DPU's verbal approval of the pressure test plan[149] though it is unclear whether that approval extended to a waiver of the uprating requirements;
- Installation of the pipe being requalified[150] post-1991;[151] and
- CMA has an extensive listing of materials purchased and used by the Company post-1991.[152]

Nonetheless, before an operator can increase the operating pressure on a segment of pipe, it must perform the analysis set forth in Subpart K.

On the issue of establishing the MAOP for all of the Renewed Assets, CMA chose to tie-in the newly installed assets without undertaking a new process to establish MAOP for those assets, despite the extensive nature of the newly installed assets and the fact the MAOP worksheet[153] for the Legacy

141 As set forth in 49 CFR Subpart J. Section 192.619 is the applicable regulatory requirement for establishing MAOP, whether for new construction or uprating older assets to a higher pressure. Under 192.619, a pressure testing is one of the four ways used to establish the MAOP of a segment. Section192.619(a)(2)(i) is the provision detailing how to pressure test plastic pipe.

142 CMA_MV 15.01(a), page 4-5. CMA claims that "[u]prating is typically used in situations where facilities are not rated through pressure testing for the pressure they are intended to operate and where the line cannot be taken out of service for pressure testing as described in 49 CFR 192.619. Since these assets were already out of service, CMA reasoned uprating was not necessary.

143 See Appendix I, Interpretations of PHMSA regulations on MAOP.

144 49 CFR 192, Subpart K, Sections 192.551 -192.557. Section 192.551 states the scope of the subpart as prescribing the "minimum requirements for increasing maximum allowable operating pressures (uprating) for pipelines."

145 Section 192.557 states that no person may operate a plastic pipeline at an increased MAOP unless the requirements of that section are met.

146 Some of these include a review of the design, materials, and operating history, conducting a leak survey under certain circumstances, and making certain repairs or replacements as may be needed. See Section 192.557 (b) (1) –(7).

147 In responding to questions about these assets, CMA did not indicate that the existing pipe had been subjected to a prior pressure test when it was originally put into service. Had it been subjected to a pressure test of sufficient pressure and duration, PHMSA guidance suggests such a test could be used as support for uprating the pipe segment. See Appendix I.

148 CMA_MV 15.01(a), pages 4-5.

149 CMA appears to have relied upon an email dated September 26, 2018, in which CMA confirmed the DPU's then-Director of Pipeline Safety's verbal approval for the testing protocol on the existing plastic main.

150 The term "requalified" is not a term recognized in 49 CFR Part 192 for gas distribution systems.

151 This cut-off reflects an effort to ensure that pipe with a certain defect that had been installed prior to 1991 would not be part of the requalified assets. CMA_MV 15.01(a), page 4.

152 See CMA_MV15-01 (c), though CMA was not able to confirm which material was actually used in the Renewed Assets because it did not have a method to track which materials were used, but instead, relied on crews using materials obtained from a designated warehouse.

153 CMA's Gas Standards require an analysis and documentation on an "MAOP Worksheet" to establish MAOP in according to the requirements of 49 CFR 192.619. See CMA GS 1660.020 describing the document as Form GS 1660.020-1 "MAOP Worksheet."

System was last signed in 2009.[154] Even when CMA acknowledged a change in MAOP for the Legacy System, from 99 psig to 98 psig, CMA still elected not to update the MAOP worksheet for the Legacy System. This is despite the fact that 49 CFR 192.619(a) states that MAOP must be established for every segment not for every system. CMA's worksheet requires analysis about design, materials and other aspects of the pipe to confirm its fitness for service at the proposed MAOP.

CMA may have an argument that it technically is not required by its own Gas Standards to conduct the analysis of the appropriate MAOP for the Renewed Assets but doing so adds value.

6.1.7 CMA's Gas Standards are generally compliant with opportunities for improvement.

The Panel conducted an analysis of CMA's Gas Standards against the critical Federal and State regulations and found that CMA's Gas Standards are generally compliant. The Panel identified three areas that present an opportunity for improvement. These include removing the ambiguity in the calculation of the duration of pressure tests, clarifying when a new MAOP worksheet is required and clarifying the expected duration of a soap test.

CMA's current pressure test standard provides the minimum requirements for test pressures and duration.[155] It provides both an equation to be used to calculate the appropriate pressure and duration (Equation 1)[156] and a Table provides various test durations for given pipe size and length (Table 4).[157] It also states a multi-step process to determine the correct duration when multiple segments are pressure tested together.[158] In conducting the analysis described in Section 6.2.1, it became clear that relying on Table 4 produced test durations that were slightly longer than those under Equation 1. In evaluating the pressure test records, certain pressure tests met the test duration based upon the equation, but not the table. It was unclear whether the field technician actually calculated the test duration in the field.[159] Further clarification regarding acceptance limits is warranted as to whether the test duration needs to meet both or either the table or equation.

As discussed in Section 6.1.6, CMA suggests its current procedure related to MAOP Worksheets can be interpreted to add substantial assets, such as the Renewed Assets, to an already existing MAOP determination without undertaking the kind of analysis required under 49 CFR §619. This is contrary to the purpose of taking multiple step analysis in the CMA MAOP Worksheet to appropriately establish the MAOP for new assets.

In response to concerns raised about a duplicate pressure test form,[160] CMA reported its procedures do not provide a soap test duration for joining pipe during construction. While there is no specified

[154] When asked to provide the current MAOP worksheet for the entire pipe system, CMA stated "Based on the supporting design, material, and testing documentation, the restored system of the Merrimack Valley affected area conformed to the MAOP of system identification number 80001004 as documented by the MAOP sheet provided in CMA_MV 12.05(a). Therefore, no supplementary or replacement documentation to the original MAOP Sheet is necessary." See CMV_MV 12.05.

[155] CMA Gas Standard 1500.10 (MA), provided to the Panel in CMA_MV 2.08.

[156] Equation 1 can be found in CMA_MV 01.06(a), page 163 of 738.

[157] Table 4 can be found in CMA_MV 01.06(a), page 164 of 738.

[158] It is a somewhat complicated set of steps that hopefully is not expected to be performed in the field.

[159] If field crews are determining duration in the field, providing a table that results in slightly longer duration may have been a desired outcome.

[160] See Section 6.1.3.4.

duration for a soap test during a joint tie-in, [161] there, are, however, numerous references to leak testing in the same Gas Standard for which the test duration is at least 15 minutes. While a leak test does not necessarily mean soap test,[162] the principle of testing for leaks for a period of 15-minutes appears in several places in the Gas Standards.[163] Moreover, the field crews appear to generally use the 15-minute duration. If CMA intends not to set a standard duration for soap tests in the field, it would be well-served to clear up the inferences drawn within the same Gas Standard.

6.1.8 CMA does not appear to have integrated the Renewed Assets into its DIMP.

As discussed in Section 4.5, an operator is required to know its gas system and identify and mitigate potential threats. This is accomplished via the Distribution Integrity Management Program (DIMP). To help the Panel understand what efforts CMA had undertaken to identify threats arising from the construction of the Renewed Assets, the Panel asked for information on how the Renewed Assets were added to and reflected in its DIMP.[164]

CMA responded with a generic description about its DIMP rather than a detailed assessment of the potential threats to the Renewed Assets.[165] In a separate response, CMA noted several threats were reduced by the installation of the Renewed Assets.[166] It is unclear whether CMA has specifically updated their DIMP to adequately assess and mitigate the new threats discussed throughout this assessment (e.g., main/service inserts, GIS map updates, material).

6.1.9 Core changes to culture are required for continuous improvement.

It is the Panel's observation that when questioned as to why or how certain activities were performed, CMA's inclination was to justify why it was acceptable as presented. This appeared to create barriers to objective and critical analysis that would provide the opportunity to highlight gaps and improvements. For example, the Panel had identified numerous gaps and discrepancies related to the pressure test records that were generally explained away by CMA. It was not until the very end of this Assessment process that CMA undertook action to identify and reconcile gaps in pressure testing records. Its efforts to do so left additional gaps.[167]

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161 See Section 9.1, Tie-In Joints in GS 1500.010(MA), which states that if a tie-in joint is not included in the pressure test of the pipeline, it shall be tested for leakage by applying leak detector solution after the tie-in joint has been pressurized to operating pressure. Leak detector solution shall be applied around the entire circumference of the joint. During the test if the appearance of soap bubbles indicates a leak is present, the joint shall be repaired or replaced. Record the results in accordance with Section 11 of this standard.

162 Depending on the situation, a leak test could be a reference to a pressure test.

163 For example, see Section 9.3.1, Plastic Verification Fittings in GS 1500.010(MA) which requires a test at a pressure for duration of 15 minutes, with the text being followed by a statement to "Apply leak detector solution to all exposed joints during the test." Similarly, consider two exhibits in the Gas Standard which indicate a "Test Duration 15 minutes" in the title and the text. See Appendix F.4, which contains Exhibit A (3 of 5) and Exhibit A (5 of 5) of GS 1500.010(MA).

164 IR 15.26 (asking how the CMA DIMP and SMS programs have identified and assessed the threats to the Affected Area).

165 See CMA response to IR 15.26.

166 See CMA response in CMA_MV02.06(a)(f) (draft presentation from a Process Safety Workshop regarding the Merrimack Valley system, dated October 23, 2019). Threats reduced include replacing cast iron with plastic, better records, installation of additional main line valve, relocation of meters to outside and installation of meters with regulators. These align with the expected benefits of having replaced a low-pressure system with one operating at a higher pressure.

167 See Appendix O, CMA Reconciliation of Main Pressure Tests, dated May 13, 2020, in which the gaps identified in the pressure test records were "clearly" tested because the assets were shown on the pressure test drawings. This finding ignores the basic fact that the presence of an asset on a plan is not sufficient evidence of the execution or occurrence of a pressure test, much less evidence from which verification of duration or amount of pressure can be drawn.

6.2 Observations about the Assets

While leak rates are higher than might be expected, the Renewed Assets have been through two frost in/frost out cycles without development of a major leak or operational issue. This provides a good indication of the Renewed Assets current operational safety. While the gaps and discrepancies presented within this Assessment collectively create concern, the gaps related to the operation of the assets can largely be addressed over time.

The Panel's observations about the CMA assets are set forth in this section. These observations are organized into three categories:

- Main pressure tests (Section 6.2.1);
- Service line pressure tests (Section 6.2.2); and
- Leaks discovered (Section 6.2.3).

6.2.1 Pressure testing of mains largely provides assurances but gaps remain.

In February 2020, the Panel determined that records required to verify the construction and operational safety of the Renewed Assets were not available.[168] The Panel pivoted to verifying pressure test records to ensure every foot of the new mains installed in the Renewed Assets had been appropriately pressure tested.[169] In response to the Panel's request, CMA created and produced an extensive summary that provided information on 350 pressure tests (Summary) as well as copies of Pressure Test forms or charts for each of the pressure tests on the Renewed Assets.[170]

As the analysis progressed, the Panel's technical team determined that the actual number of pressure tests performed on the Renewed Assets was less than the Summary provided by CMA.[171] Only 319 pressure tests could be analyzed against regulatory test pressures and duration.[172]

Information discrepancies[173] as between the CMA-prepared Summary and the Pressure Test form were widespread, with 111 tests in the Summary found to have information discrepancies.[174] The Panel's technical team corrected the Summary entries (to match the corresponding Pressure Test

[168] Earlier in the Assessment, the Panel had requested a sampling of pressure test records to review. CMA provided a Pressure Test Summary in Attachment CMA_MV 12.03.xlsx and an OQ List in Attachment CMA_MV 12.01(a).xlsx. These were reviewed against a sample of Pressure Charts that could be found in the Engineering Packets that were provided as part of IR 06. The Panel's technical team observed a number of inconsistencies and potential errors in the documents.

[169] Recall CMA had assured the Panel at the start of the Assessment that it was confident it had pressure tested all the mains and services installed as part of the Restoration Program. Accordingly, the Panel expected CMA to fulfil the request with little effort, except that required to re-format some of the data into a specified Excel format.

[170] CMA provided information responding to IR 15, including a new and updated Mains Pressure Test Summary, Attachment CMA_MV 15.07(a) CONFIDENTIAL.xlsx, and all of the relevant pressure test forms and pressure charts in Attachment CMA_MV 15.07(b) CONFIDENTIAL.zip, as well as an updated Op Qual list in Attachment CMA_MV12 (Supplemental #1). As additional question arose from these materials, CMA also produced CMA_MV 15.07 (Supplemental #1).

[171] There were 340 unique tests identified by CMA in the Summary, with 10 duplicates. Another 21 of the test forms had irregularities in the documents that kept them from being evaluated. The full analysis of the difference in numbers, along with charts and additional information about the pressure tests is set forth in Appendix F.2.1.

[172] Regulatory requirements for pressure tests are set forth in Appendix F.1.

[173] Here, a "discrepancy" is defined as a mismatch between the Summary and the Pressure Test Form/Chart. These mismatches included entries about the job order, amount of pressure, the duration of the test, the length being tested, and the person named as performing the test. See Appendix F.2.2 for a summary of the number of tests that did not match each of these characteristics.

[174] The Panel's technical team identified 111 out of the Summary Tests with at least one discrepancy. See Appendix F.2.2 for more details on the discrepancies.

form) in its evaluation of the 319 tests. Ultimately, this analysis resulted in the observations in Sections 6.2.1.1-6.2.1.4.

6.2.1.1 Main pressure tests evaluated met Federal and State regulations, but two do not comply with CMA's Gas Standards.[175]

Of the 319 pressure tests that could be analyzed, each met the Federal and State regulatory requirements.[176] Two pressure tests[177] did not meet the CMA Gas Standard.[178] An additional test likely meets CMA Standards, but discrepancies in the pressure test form make it difficult to evaluate conclusively.[179]

6.2.1.2 Discrepancies in documentation suggest other gaps remain.

Discrepancies in the documentation of the MPT records remain unresolved. For example, the initial review identified a discrepancy between the Summary provided by CMA and the pressure test records for 35 pipe segments (totaled 3,489 feet).[180] In addition, the Panel discovered at least one set of duplicate pressure test records that left in question whether 487 feet had been pressure tested.[181]

CMA responded to inquiries about the duplicate records with a number of explanations[182] that failed to resolve the concern about whether the 487 feet had been pressure tested.[183]

In May 2020, CMA completed a foot by foot analysis of the pressure test records, comparing the length of the test in its GIS[184] against the length of test in the Pressure Test forms. Based on this

175 See Footnote 24. Failure to follow company standards generally is considered to be a regulatory violation.

176 This means the test was at a sufficient pressure and duration and performed by a person who held an operator qualification to perform the test.

177 Summary Test 123 and Test 124 did not meet CMA's Gas Standard 1500.010 (MA). See details in Appendix F. In addition, Summary Test 275 also may not meet the Equation 1 requirements but there is a discrepancy on the Pressure Test Form that makes it difficult to evaluate conclusively. See Appendix F.

178 This assumes the CMA Gas Standard requires the duration to meet either Equation 1 or Table 4, but not both. If the pressure tests needed to meet the duration set forth in Table 4, then at least 8, and potentially up to 94, pressure tests do not meet the Table 4 duration requirements.

179 Summary Test 275 may not meet the Equation 1 requirements but there is a discrepancy on the Pressure Test Form that makes it difficult to evaluate conclusively. The duration required by Equation 1 is 1.5 hours. The duration on the Summary is 1.83 hours but the duration stated on the pressure test form is 1.25 hours, but the calculated time using the "start/stop" times on the pressure test form equal 1.83 hours. See Appendix F.2.2 for more detail.

180 The Panel's technical team attempted to determine if these segments could be found in other tests listed in the Summary Tests but these efforts were not exhaustive in light of the propensity for the Summary to have irregularities, duplication of tests, re-use of same Pressure Test Forms for different tests listed in the Summary. See Appendix F.2.2.

181 See Appendix F for discussion of Test 136 and Test 140.

182 CMA indicated the discrepancy in the two versions of the same Pressure Test form were the result of human error in the field when the inspector inadvertently added 487 feet into the one form, then corrected it, and rescanned it. This raised concerns about CMA's document management practices (see discussion at Section 6.1.3.4), but does not resolve the issue concerning whether or not the 487 feet had been pressure tested. Even after further discussions, discrepancies remained. For instance, one pressure test covering 10 feet of pipe indicated the pipe tested was 4-inch pipe rather than the 6-inch pipe installed in the location in question.

183 See discussion in Appendix F indicating the lack of supporting documentation to demonstrate the 487 feet had been pressure tested. This analysis was based on documents made available to the Panel as mid-April 2020. It is unclear how the 487 feet fit into CMA's analysis completed by mid-May 2020.

184 Each segment of pipe in GIS is assigned a unique identifier known as an Object Identification (ObjectID). Although ObjectIDs were contained in the Summary, CMA had not previously reconciled the information from GIS on a foot-by-foot basis with the pressure test forms.

analysis, CMA was able to confirm 99.5% of 57.8 miles[185] of mains had been subjected to an appropriate pressure test. For the remainder, the sum of footage in the Pressure Test form was not equal to (or more than the sum of) the GIS length. This occurred in 36 instances totaling about 1,398 feet or 0.5% of the new mains.[186] CMA relies on a variety of supporting documents to provide it with the confidence to declare all mains had been appropriately pressure tested. Without the appropriate pressure test forms to back up the claim,[187] the Panel still views this as a gap and further highlights the inability to reconcile discrepancies.[188]

6.2.1.3 Pressure testing of tie-ins is unsupported by documentation.

The available documentation does not provide conclusive evidence the tie-ins joints were appropriately pressure tested. Federal and State regulations prescribe visual inspection of welds on steel pipe and soap tests for tie-ins of plastic pipe.[189]

For the welds on steel pipe, compliance relies upon the assumption that the welder who created sketches including the requisite tie-in also performed a visual inspection of his tie-in weld.[190] CMA identified 69 locations at which welded tie-ins occurred.[191] CMA was initially able to identify the welder and the welder's sketch at 66 of the 69 locations. Subsequently, CMA created and produced detailed sketches for the remaining 3 locations.[192]. The creation of the sketch in 2020, following the Panel's inquiry, of an inspection performed in 2018 seems to rely on the welder's assumption that he performed a visual inspection of the weld because it was his habit to do so rather than any actual memory of the weld in question.

For the soap tests performed on plastic pipe tie-ins, CMA was able to locate and provide records for 300 of the 534 locations of tie-ins of plastic pipe.[193] A review of a sample of 18 of the 300 soap test records revealed a substantial portion of them to be incomplete.[194] This evidence suggests CMA

185 See Table 2 of this Final Report in which CMA reported the total miles of main installed in the Restoration Program as 57.7 miles, not 58.8 miles.

186 CMA_MV 15-07 (Supplement #3). In this document, CMA also states it is "currently evaluating an enhanced method for capturing pressure test start and end points, allowing for improved reconciliation of the length of pipe pressure tested against the as-built drawings." It does not, apparently, recognize that relying on the presence of certain fitting detail on a pressure test layout document involves assuming that the pressure test of those fittings actually occurred at the necessary pressure and duration, even though the fittings were absent from the Pressure Test Form.

187 See CMA_MV 15.07 (Supplemental #3(a)) in Appendix F.4.

188 On May 27, 2020, CMA provided the Panel with a copy of a report from TRC, dated May 19. 2020, of its review of NiSource's pipeline pressure testing performed in Massachusetts. The executive summary states TRC found the CMA pressure test standard met regulatory requirements and four specific pressure tests "could be confirmed to be valid based on the information provided and industry standard practices." The Panel has not reviewed the content of the 85-page report in detail but notes the utilization of the word "appears" in describing what occurred in the field. This usage suggests TRC, like the Panel, was unable to verify the performance in the field based on a high level of confidence in the validity or completeness of the records. Instead, TRC was comfortable relying upon reasonable assumptions to corroborate appropriate pressure tests occurred at the four locations.

189 A soap test involves the application of a soapy liquid to be applied after the tie-in join has been pressurized to operating pressure to determine whether small amounts of gas are leaking from the joint. If gas were leaking, the soapy liquid would form visible bubbles. See Appendix H.1 for Federal and State regulations for tie-ins and Appendix H.3 for CMA Gas Standards for testing tie-in joints. See also Section 6.1.7 regarding the ambiguity in CMA Gas Standards for the duration of a soap test.

190 This relies on the Op Qual of the welder.

191 See IR 12.

192 See IR 15.

193 IR 15.13.

194 Of the 18 reviewed, 8 did not indicate the pressure at which the soap test was performed. While there is some ambiguity of the appropriate duration of the soap test (see Section 6.1.7), 15 of the 18 indicated a duration of at least 15 minutes. Two of the records in the sample did not indicate the person who conducted (and signed for) completing the soap test.

cannot confirm completion of the required soap testing of tie-ins joints of plastic pipe on the Renewed Assets.

6.2.1.4 Personnel had the operator qualifications for the tasks performed with a few exceptions.

Of the 319 MPTs in the Summary that were evaluated, two pressure test forms were performed by an individual that did not have the appropriate Op Qual to perform the test, although the person who signed the digital log appears to be a person qualified to perform pressure tests.[195] Of the sample of the main tie in soap tests that were performed, only one person appears not to have the appropriate Op Qual for the task.[196]

6.2.2 Service Line Records raise concerns.

The review of the relevant Service Line Records (SLRs) revealed significant gaps and inconsistencies.[197] Throughout the Assessment, the CMA revised the SLR data, including the number of service lines installed.[198] The review of 200 SLR Tap cards against CMA's Summary revealed many inconsistencies and errors that prevented verification of the work performed at each location. Some SLRs were missing, with the exact number diminishing over the course of this Assessment.[199] At over 1,100 locations, SLRs contained insufficient information to confirm appropriate soap tests were performed. These observations are described in more detail in Sections 6.2.2.1 to 6.2.2.3.

6.2.2.1 CMA continues to modify the number of services lines in the Renewed Assets.

The number of service lines reportedly installed during the Restoration Program continues to change.[200] The variance included:

- 4,737 (as of February 21, 2020)[201];
- 4,714 (as of March 18, 2020)[202]; and
- 4,699 (as of March 30, 2020)[203].

The changes largely occurred because, in their investigations to respond to the Panel's IRs, CMA found duplicate Service Line Records and/or service lines that were not actually part of the Restoration Program.[204]

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195 See Appendix F.4.6 for Tests 137 and 139.

196 The person named in IR 15.13 (filename 34.pdf) for Zone 3 does not appear on CMA's list of persons with Operator Qualifications. It is possible, of course, that CMA did not compile a complete list and this person does have the appropriate Op Qual. The fact that a consolidated list of those Op Qual is not available begs the question if or how Op Qual was confirmed by CMA.

197 See IR 12.

198 See Appendix G.1 (discussion of changing information about SLRs over the course of the Assessment).

199 In IR 12, CMA identified 16 SLRs missing. In 15.11 (Revision #1), the number dropped to ten. It may have dropped further since then.

200 This is despite CMA's assurances the number has been verified by its engineering department. See e.g., IR 12.04.

201 See IR-12.

202 See IR 15.09. CMA_MV 15.11, dated March 18, 2020

203 See CMA_MV 15.11 (Revision #1) and CMA_MV 15.32 (Revision #1), dated March 30,2020. While it is possible CMA may further adjust this number as it undertakes additional analysis, the Panel is using this number (4,699) as the total number of service lines for which pressure tests records should be available.

204 Id. See also IR15.32. CMA notes there are two ways for it to report "services." These are "1) the number of service lines, 2) the number of meters." This explanation, however, does not explain the changing count of service lines. In IR 12.04, the Panel asked for the number of service lines when requesting pressure test information because there is a one to one relationship between a service

6.2.2.2 Discrepancies and inconsistencies in the SLRs raise concerns.

A review of the Summary of SLRs prepared by CMA against a sample of 200 SLR Tap revealed many inconsistencies and errors that undermined confidence in the accuracy of the SLR Tap Cards.[205] CMA subsequently produced a Summary along with the Tap Cards for all SLRs. Table 9 summarizes several irregularities in the documentation that were found when evaluating this Summary.

Table 9: Irregularities in SLR Documentation[206]

Service Line Records with Documentation Problems					
Improper Documentation Soap Test	**Improper Documentation Pressure Test**	**Test Duration out of compliance**	**Missing Service line records**	**Improper Documentation of Tester**	**Unknown Tester**
1105	11	1	8	75	1

6.2.2.3 SLR improperly documented the soap test on a substantial number of services.

Over 1,100 of the SLRs did not have proper documentation of the soap test. For example, CMA's summary documented that a soap test at SiteID 045333000 was checked for both segments which is incorrect.[207] The summary also incorrectly documented test lengths and pressures.[208] Collectively, all of these error and issues undermine confidence that pressure testing of all service lines was performed correctly.

6.2.3 Discovered gas leaks on the Renewed Assets appear to be trending down.

Discovered gas leaks on the Renewed Assets are now trending downward.[209] The number of leaks on the Renewed Assets initially were higher than the Panel would expect on newly installed plastic pipe system, but this may be accounted for by the phenomenon known as the bathtub curve of construction. A more recent uptick in the number of identified leaks is likely related to using more sensitive leak survey equipment. Overall, if the leak data results in an upward trend, further action is recommended.

line and a Service Line Record. Moreover, each Service Line Record should contain the Pressure Test information for each service line (regardless of how many meters are hanging off the end of that service line).

205 See also Figure G-1 and Figure G-2 in Appendix G for examples of two SLR Tap Cards have different SiteIDs recorded on their forms (See Figure 1 (A & B) & Figure 3 (A&B))

206 The numbers in Table 9 were accurate as of April 5, 2020. The exact numbers may vary at the time of this Final Report as CMA continues to evaluate its SLRs.

207 See Figure G-4 in Appendix G.

208 See Figure G-5 and Figure G-6 in Appendix G.

209 Leak data reported here reflects CMA's leak reporting which only accounts for closed leaks on plastic mains and services and not leaks occurring on coated steel pipelines associated with tie-ins.

6.2.3.1 Gas leaks were higher early on.

CMA reported 54 gas leaks discovered on the Renewed Assets since they were put into service. [210] As can be seen in Figure 2,[211] the gas leaks on the Renewed Assets started out high, then dropped and then modestly increased. This increase correlates to CMA's increase in the number of leak surveys in the fall of 2019. The second increase appears be connected to CMA's decision to utilize a more sensitive leak survey tool, known as Picarro™ which can detect smaller leaks.

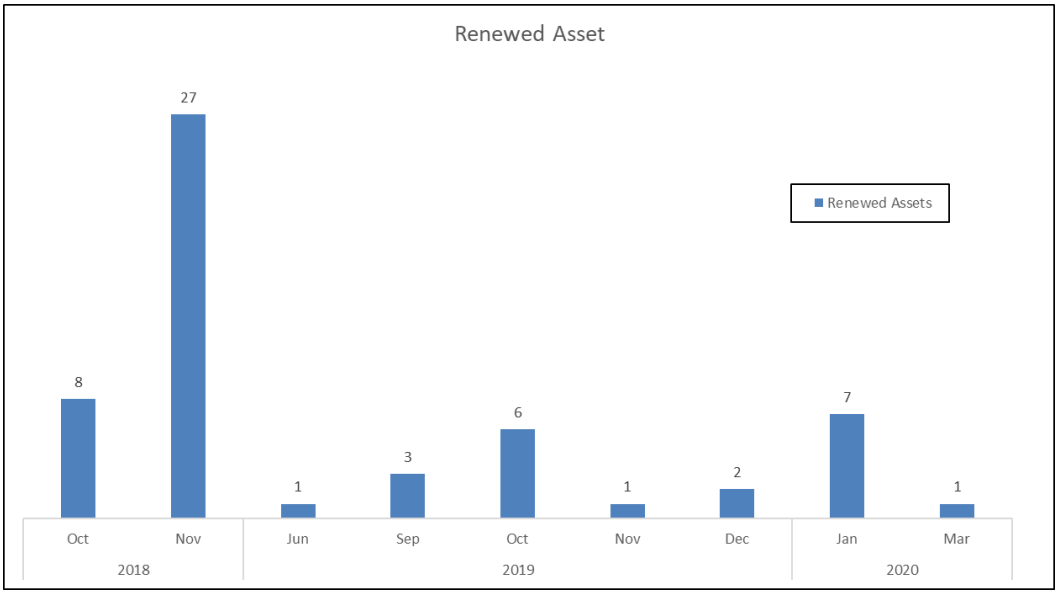

Figure 2: Gas Leaks on Renewed Assets Since In-service Date

CMA calculated its leak ratios on the Renewed Assets the first 6 months following installation and the second six months. The overall increase in leaks per 100 miles would be expected with the use of Picarro™ as shown in January 2020. See Table 10.

Table 10: Gas Leak Ratios on Renewed Assets Since In-service Date

Leak ratios for the Renewed Assets (September 2018 – June 2019)
Leaks/100 Mile = 0.00
Leaks/1000 Services= 7.6

Leak ratios for the Renewed Assets (July 2019 – February 14 2020)
Leaks/100 Mile = 1.73
Leaks/1000 Services = 2.96

[210] The discovered leaks include those already repaired and those pending repair or review. Similar to the discovered leak data in the Statewide Assessment Final Report, the data do not include 12 leaks that occurred as a result of excavation damage. Such leaks are the result of operational and maintenance activities rather than a sign of the quality of the construction of the Renewed Assets. See Appendix K for additional leak data.

[211] In addition to excluding the leaks resulting from excavation damage, other items that may have started as a reported leak have been removed from the list. These exclusions include leaks classified by CMA as a negative read, cleared as a mistake, identified as stray gas not from a gas leak, a leak from customer-owned facilities or leaks that re-classified without repair as non-leaks.

CMA initially attributed the increased leak rate resulted from an increase in supplemental leak surveys.[212] After the technical teams further reviewed how the leak leaks were discovered, only 9 out of 37 leaks in the fourth quarter of 2018 were previously discovered with a supplemental survey. See Figure 3.

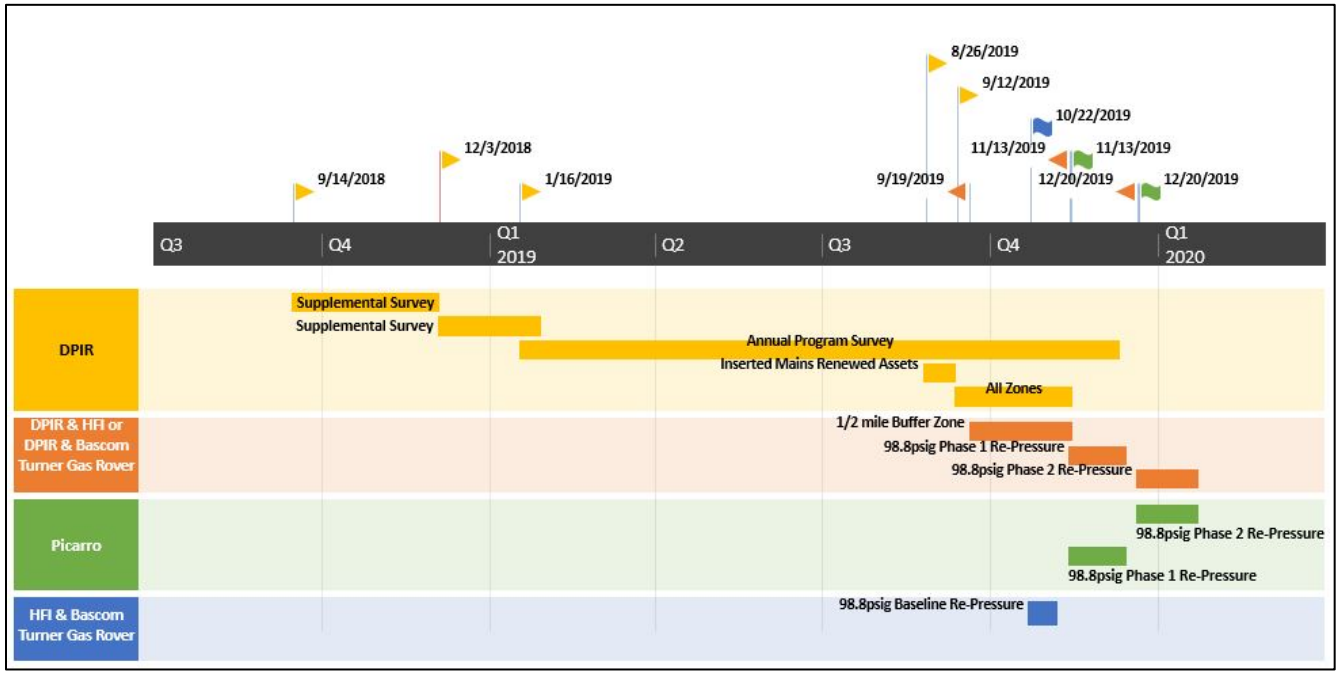

Figure 3 Timing of Leak Survey

[212] Appendix A to CMA's Leak Report (IR 15.22a) showed three surveys were from September 2018 - December 2018, but only one supplemental survey was performed during that time.

6.2.3.2 Majority of leaks caused by mechanical fittings.

The majority of the gas leaks on the Renewed Assets were caused by incorrect operations[213] as a result of issues with installing mechanical fittings[214] such as service tee caps and fittings, but other causes were also reported. For example, three leaks that occurred on saddle tees which CMA asserts were the results of issues arising from the manufacturing process. See Figure 4 and Figure 5 for more details on Leak cause and Gas Leak by Asset type, respectively.

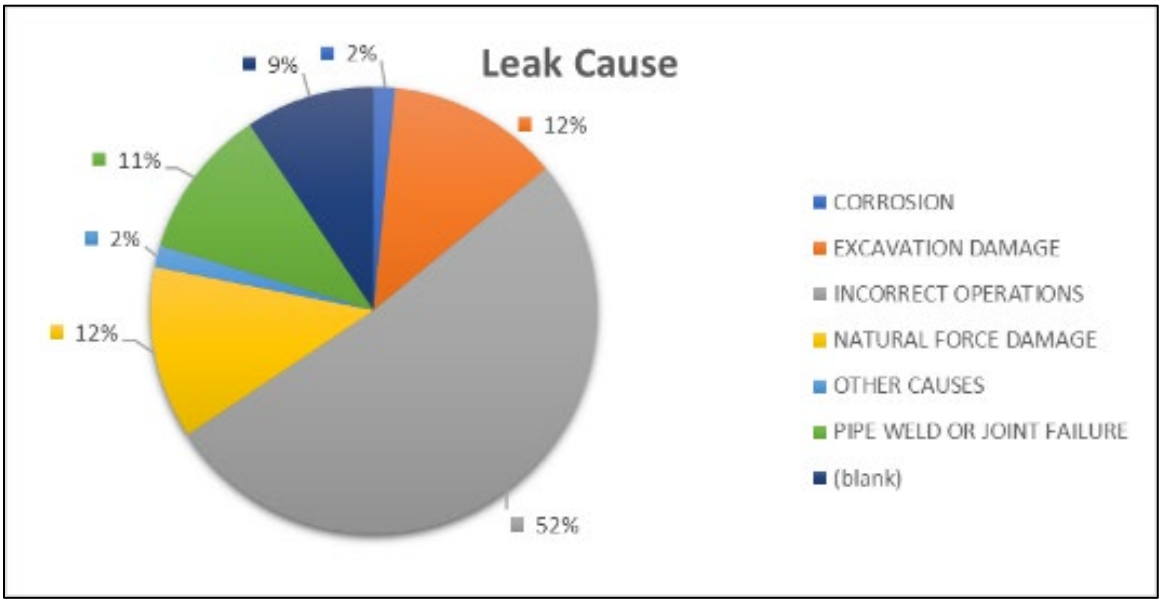

Figure 4: Gas Leaks by Cause on Renewed Assets Since In-service Date

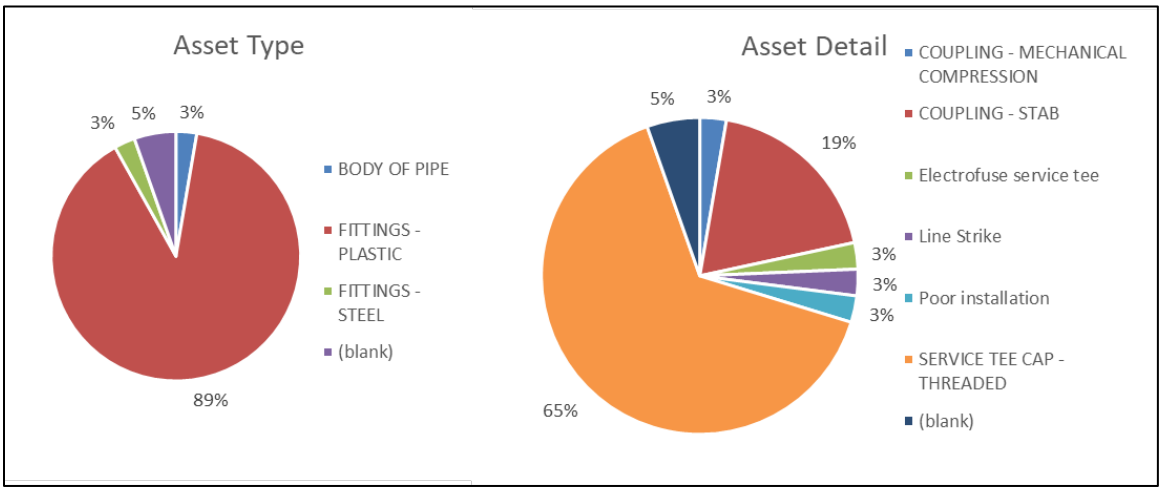

Figure 5: Gas Leaks by Asset Type

[213] Most of the leaks were related to the incorrect installation of mechanical fittings. CMA classified these leaks as incorrect operations based upon the PHMSA failure cause classification.

[214] Details about the saddle tee leaks are set forth in Appendix K, Leak Data.

These figures indicate a large percentage of leaks were related both to plastic fittings (89%), but more specifically to service tee caps (65%) and stab fittings (19%).

6.2.3.3 PHMSA Data does not fully explain the extent of CMA leaks.

While CMA presents that the leaks related to the installation of tee caps and stab fittings are an industry-wide issue,[215] the PHMSA data[216] on mechanical fitting failures[217] does not fully explain the extent of CMA leaks on the Renewed Assets.

The data set forth in Appendix L indicate that while mechanical fittings have been identified as a leading cause of leaks for the industry, it is more of an issue for CMA than its peers in Massachusetts, the Northeast, or across the United States.[218]

Moreover, the rate of mechanical fitting failures at CMA has been steadily increasing since 2017.[219] Across the United States, operators saw an increase in 2017 and 2018, but a significant decrease in 2019 in the number of gas leaks across the US due to mechanical fittings. Lastly, over the period from 2011-2019, stab fitting failures were not the leading type of mechanical fitting failure.[220] Based on this analysis, the industry issue with mechanical fittings does not fully explain the extent of the problems with tee caps and stab fittings that resulted in the leaks on the Renewed Assets. Instead, the data suggest CMA may have a systemic issue with its installation practices.

6.2.3.4 CMA missed an opportunity to proactively learn from the industry data.

CMA looks to the industry issues with tee caps and stab fittings as justification for the number of leaks on the Renewed Assets. In doing so, CMA missed an opportunity to learn from the industry's experiences. While CMA states it will include the likelihood of increased leaks on these assets in its DIMP, there was an opportunity to recognize this potential threat from using these materials before installation. By waiting to determine if the company should transition away from mechanical couplings

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215 CMA provided a report prepared by the PPDC, entitled "Plastic Piping Data Collection Initiative Status Report (August 2019)" (Attachment CMA_MV 15.24(e)). PPDC's research found that 1.3% of all fitting failures are due to stab fittings and 27% due to caps. CMA has a higher percentage of failure with these couplings.

216 The PHMSA data relied upon in this section is the PHMSA Mechanical Fittings Failure report. In that report, a hazardous leak is defined as one that involves a mechanical fitting. Note that the Mechanical Fittings Failure report is different and separate from the PHMSA Incident Report, discussed in the Statewide Assessment Final Report in Section 8.3. There is, however, a relationship between the Mechanical Fittings Failure Report and the hazardous leaks captured in the PHMSA Annual report, which enables a meaningful comparison of that data. See Table L-7 and Table L-8 in Appendix L.

217 The types of mechanical fittings tracked in the PHMSA Mechanical Fittings Report are: Bolted, Nut Follower, Other compression Type Fitting and Stab Fittings. The actual "cause" of the mechanical fitting failure identified in the Mechanical Fittings Failure Report can be any one of the PHMSA cause codes (e.g., Incorrect Operations, Equipment, Natural Forces, etc.). It was because the Annual Report did not capture data on mechanical fitting failures that PHMSA began to collect the data on such failures in a separate report.

218 See Table L-11 and Table L-12 of Appendix L, PHMSA Mechanical Fittings Data. Table L-11 shows that the mechanical fitting failure rate (failures per million services) in CMA is greater than the rates in Massachusetts, in the Northeast, and in the United States. This is the case for the single year of 2018, and the period from 2011-2019. Table 12 shows that stab fitting failure rate (failures per million services) in CMA is greater than the rates in Massachusetts, in the Northeast, and in the United States. This is the case for the single year of 2018, and the period from 2011-2019.

219 It is possible the increase of stab fitting failures in CMA during 2018 and 2019 is due, in part, to the large number of stab fittings being installed in the Renewed Assets. While data are not available to make that determination, the relative difference of the stab fitting failure rate between CMA and its peer groups is similar, whether comparing to a single year (2018) or 2011 to 2019. This may suggest the trend is independent of the installation of the Renewed Assets.

220 Over period from 2011-2019, most of the mechanical fitting failures occurred on Nut Follower type of mechanical fitting. This is true for CMA, Massachusetts, the Northeast, and the US.

made by one specific manufacturer to another,[221] CMA missed an opportunity to learn from the extent of the leaks to proactively address the issue.

6.2.3.5 It is not unusual for higher leak rates to occur following construction.

It is not unusual for certain issues to arise following construction. This period of early failures is usually followed by a long period of stability and then a period of increasing failures. This phenomenon is often described as the bathtub curve. See Figure 6. The bathtub curve is used to represent the failure frequency often experienced in systems and components. It is comprised of three (3) stages:

- Stage 1. Decreasing failure rate in early life (new);
- Stage 2. Constant failure rate that may be random or otherwise; and
- Stage 3. Increasing failure rate as it approaches end of life (old).

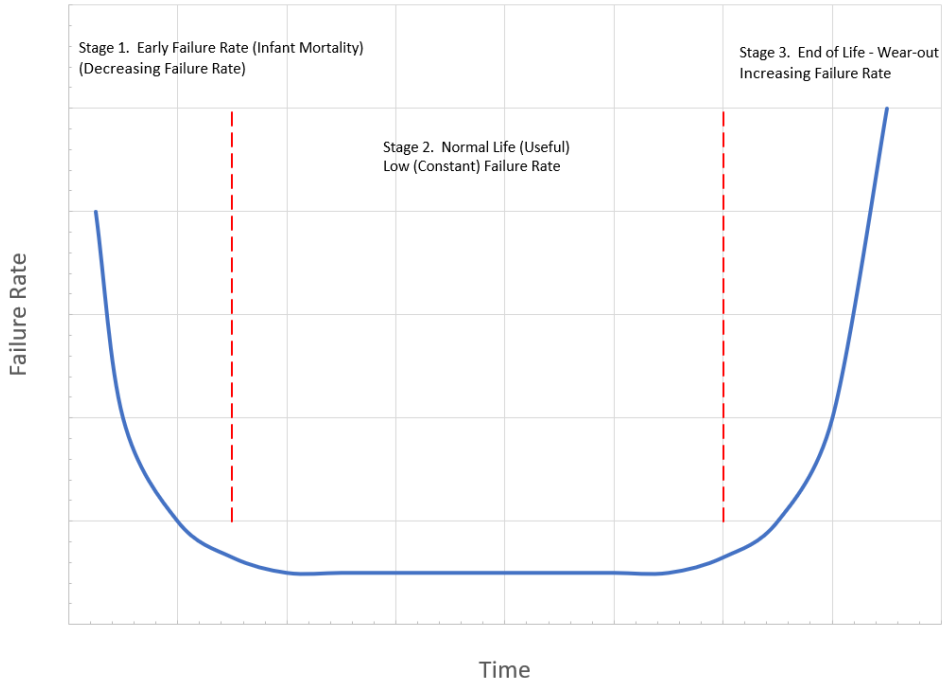

Figure 6: Bathtub Curve of Failures in Assets

The higher rate of leaks on CMA's Renewed Assets in Stage 1 are attributable to certain component failures; namely stab fittings and tee caps. As additional leak surveys are performed, leaks should continue to decrease, thereby transitioning the assets into Stage 2. Lastly, over time, the assets will enter Phase 3.[222]

6.2.3.6 Leak survey data would benefit from better documentation.

CMA's leak survey data would benefit from better and more accurate documentation. Currently, CMA collects information about leak rates, grade, location, causes and installation method. After reviewing

[221] See CMA response to IR 15.24.

[222] An example of assets in Phase 3 of the Bathtub Curve are the cast-iron mains discussed at length in the Statewide Assessment.

their data, CMA's data has errors, missing information and discrepancies that raise doubt about accuracy. CMA's leak data for some leaks is missing information that is necessary for a complete and accurate analysis such as:

- Specific asset and asset detail;
- Description of failure;
- Method of installation;
- Person responsible for installation;
- Person responsible for testing/inspection of installation;
- Investigator details; and
- Post-investigation actions taken and confirmed.

In addition, CMA was unable to precisely identify which assets had been surveyed during each leak survey. Without knowing the location and timing of leakage surveys, it is not possible to determine whether each segment has been surveyed and how many surveys were performed on each segment. This basic information should be a part of every future survey.

6.2.3.7 There is value in investigating the high rate of leaks due to excavation damage.

CMA reported 8 leaks on the Renewed Assets that resulted from excavation damage between when the assets were put into service until April 17, 2020. This seems to be a high rate of leaks in a relatively short period of time. The Panel did not investigate the reasons for such a high rate during this Assessment but notes there would be value in doing so.

6.2.4 The abandonment verification process appears to have been successful.

The efforts of CMA to identify and mitigate issues associated with the abandonment of service lines, and gate and curb valves during the Restoration Program appear to have been successful. Details of the verification process are discussed in detail in Section 5.2.

6.2.5 Renewed Assets enhance safety when compared to the cast iron system.

The new infrastructure of the Renewed Assets has improved pipeline safety for the Affected Communities as compared to the low-pressure cast-iron system that was replaced. Benefits include newer, more modern plastic pipe which will reduce gas leaks. It also includes reducing the reliance on district regulator stations, moving meters from inside homes outdoors, installing a pressure regulator at every service and installing excess flow valves or curb valves between the gas main and the meter. All of these contribute to improving pipeline safety.

7 Recommendations

The Panel's recommendations set forth this section are designed to address the uncertainties introduced by issues described in Section 6. In addition, because of the upcoming change in ownership, the Panel has organized the recommendation into three categories:

1. Recommendations for the Successor in Interest (Section 7.1);
2. Recommendations for the DPU (Section 7.2); and
3. Recommendations for CMA/NiSource (Section 7.3).

7.1 Recommendations for Successor in Interest

The Panel recommends the Successor in Interest undertake efforts to accomplish the following:

1. Continue leak surveys with Picarro or other similar technology on a regular schedule;[223]
2. Improve the leak survey process to ensure full coverage, documentation of conditions found and traceability of where surveys were performed;
3. Introduce and use survey to survey comparisons to better understand the history of discovered leaks;
4. Conduct and complete leak failure investigations in a timely manner, to develop and implement appropriate mitigation efforts to address causes;
5. Investigate the reasons for the high rate of gas leaks on the Renewed Assets resulting from excavation damages and institute an appropriate program to address findings;
6. Proactively utilize each opportunity when the Renewed Assets are exposed for any reason to validate or create records as to the material used, the equipment installed and the condition of the assets;
7. Reconcile records for the Renewed Assets and Legacy System to the highest confidence possible (with documentation of rationale, basis for changes, reconciliations and change management);
8. Confirm TRC recommendations related to materials have been implemented and documented;
9. Develop and implement programs to address and close gaps associated with:
    a. Findings of cap tee and stab fitting leaks including whether these leaks are more systemic than perceived;
    b. Missing service line pressure tests, potential leaks on saddles where they tie into the main and where service lines tie into the riser and the absence of soap test records;
    c. Main pressure tests; and
    d. Any potentially systemic issues identified through the exposure of assets over time.
10. Review the DIMP to ensure the Renewed Assets have been added to the assets covered by the DIMP and have been assessed appropriately.

[223] Timing of surveys should be driven by findings. At the outset, 2 times per quarter for a period of 3-5 years may be an appropriate beginning. Timing may also vary if PHMSA regulatory changes provides specific guidance for the number of years survey must continue.

7.2 Recommendations for DPU

The Panel recommends the DPU undertake efforts to accomplish the following:

11. Continue to improve focus of DPU inspectors' field activities to ensure their analysis goes beyond regulatory compliance topics;
12. Continue to update inspection forms to drive more consistent reporting formats that provide an opportunity to comment on the larger issues;
13. With respect to CMA, consider maintaining the prohibition of undertaking work unless it is essential; and if essential, develop a plan to have steps in the workflow supervised;
14. Consider adopting TVC (or similar) requirements for asset record-keeping for gas distribution operators in Massachusetts.

7.3 Recommendations for CMA

The Panel recommends that CMA undertake efforts to accomplish the following while still operating these assets:

15. Develop a document change management process for asset records to mark and track documents that are revised to correct earlier errors, without waiting for implementation of a Pipeline Safety Management System (PSMS);
16. Limit maintenance and construction activities related to CMA assets to only those that are essential pending hand-over of the assets to the Successor in Interest;[224]
17. Revisit the Project Close-Out Process for the Restoration Program to document and reconcile discrepancies identified;
18. Modify Gas Standards to take advantage of improvement opportunities discussed in Section 6.1.7;
19. Revise construction inspector and QA/QC roles to not only correct findings real time, but also create accurate and complete documentation of tasks inspected, findings and resolutions; and
20. Embrace professional challenges and critical thinking as a means for continuous improvement.

[224] The Panel notes that despite all of the opportunities for improvement since the Incident, a CMA technician performing necessary but routine work on regulator station in March 2020 resulted in a pressure drop on the pipeline system and 200 people losing gas service on a cold day. Fortunately, no one was injured, but this suggests the workforce, which has been under tremendous and nearly unrelenting work demands since the Incident, and the public they serve may benefit from a period of only necessary work being performed until the transfer of assets to a new owner.

8 CMA Response

CMA was provided the opportunity to review this Final Report prior to its completion. Any factual errors identified by CMA during this review period have been corrected. CMA's response to the substantive contents of the report is set forth in Appendix P.

Appendix A The Incident and Emergency Response

A.1 CMA's Incident in the Merrimack Valley

On September 13, 2018, at about 4 pm Eastern Daylight time, the public became aware of the incident when a series of explosions and fires started occurring in homes and business across various parts of the City of Lawrence, and the towns of Andover and North Andover (the Affected Communities) located in the northeast region of the Merrimack Valley.[225]

The construction project at the heart of the incident was part of CMA's Gas System Enhancement Plan (GSEP).[226] The replacement program calls for replacing leak prone low-pressure cast iron pipelines (both mains and services) with higher-pressure modern plastic pipe. As part of that process, many of the older cast-iron pipes would be abandoned in place.[227]

On this particular day, when the crew tied in the new plastic distribution main pipe at Salem and Union Streets in Lawrence, they took action to abandon the older cast iron main.[228] Unfortunately, at the Winthrop Avenue regulator station about ½ mile away, the abandoned cast iron main was still connected to the regulator sensing lines.[229] When the crew shut off the pipe to be abandoned, the sensing lines detected the pressure was dropping and called for the regulator to open. This increased the pressure within the distribution system. As the sensors detected no pressure in the line, the regulators opened fully which pushed higher pressure gas through the low-pressure system and, then into the appliances in the buildings.

Tragically, one person was killed and 22 individuals were injured. [230]Over 131 structures, including at least 5 homes were damaged or destroyed. Much of the structural damage resulted from fires ignited and fueled by customer-owned gas appliances inside the homes and businesses.

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225 Because the Incident and the Emergency Response are outside the scope of this Assessment, the description of the incident and the subsequent emergency response relies heavily on the facts set forth in the National Transportation Safety Board Pipeline Accident Report: *Overpressurization of National Gas Distribution System, Explosions, and Fires in Merrimack Valley, Massachusetts, September 13, 2018*, NSTB/PAR-19-02, PB2019-101365, adopted September 24, 2019. Section 3.1 and 3.2 are provided for context for the Restoration Program.

226 GSEP is a Massachusetts program intended to encourage natural gas companies to replace leak prone pipes by providing a mechanism for an accelerated rate recovery of the costs associated with such work. GSEP work is intended to improve pipeline safety by decreasing the amount of leak prone pipe in Massachusetts. As reported in the Statewide Assessment, the natural gas mains operated in Massachusetts as of 2018 represent a disproportionately higher percentage of the leak prone mains operating in the US and have a leak ration that is 4 times higher than the national average. The benefits and risks associated with pipe replacement work are discussed in some detail in the Statewide Assessment Final Report.

227 Abandoning in place pipeline segments that are no longer in service has been a pipeline industry practice for many years. Federal pipeline safety regulations set forth the process by which such abandonment is permitted. Decisions about abandoning in place versus removing the abandoned assets involve a balancing of the benefits and costs of each approach. Reasons for leaving an abandoned pipeline in the ground can include minimizing the disruption caused by excavating on streets.

228 As described in the NTSB report, 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 pm, by closing valves on a 2-inch plastic bypass pipe between the cast iron and the polyethylene mains. The crew then cut the bypass pipe to abandon the cast iron main." (NTSB Report, page 7-8).

229 Sensing lines are appurtenances to district regulator stations on low-pressure natural gas distribution systems. The sensing lines, which sometimes are also called control lines, detect the amount of pressure in the distribution system and provide input to the regulators to control the pressure in the system.

230 An 18-year old male was killed when a home exploded and the chimney fell onto the vehicle where he was sitting. Another person in the vehicle at the time was severely injured as was someone on the second floor of the house. The 22 people transported to the hospital, including 3 firefighters, generally suffered from respiratory injuries related to smoke inhalation from fires or musculoskeletal injuries from evacuation.

A.2 Emergency Response

The over-pressurization of the low-pressure gas system in the Affected Communities sent gas into home appliances at a rate for which they were not designed to handle. This had the effect of creating explosions and fires in homes and business. As such, the fire departments in the Affected Communities were the first to receive notification of the start of the incident via 9-1-1 calls, and shortly after 4 pm, were inundated with calls.[231]

While the CMA supervisory control and data acquisition (SCADA) system showed a pressure drop in the system at 4:04 pm, it was approximately 4:30 pm before a CMA gas technician, who had been dispatched to the field to investigate, recognized a large amount of gas was flowing through the Winthrop regulator. Measurements shortly thereafter at a nearby home indicated the pressure was at 2.5 psi. This is substantially higher than the maximum allowable operating pressure of approximately 7 inches of water column.[232] CMA began taking actions to shut down the low-pressure natural gas distribution system which occurred by about 7:25 pm.

In the meantime, National Grid, which was the electricity provider in the area, turned off electricity in the Affected Communities. The Affected Communities undertook evacuations. In total, over 50,000 people residents were asked to evacuate following the over-pressurization. At 6:30 am on September 14, 2018, CMA was able to confirm the shut-off of the natural gas system for 8,447 customers in the Affected Communities. An additional, nearly 2,500 customers outside the immediate area also had their gas shut off as a precaution.

In the afternoon of September 14, 2019, the Massachusetts Governor authorized Eversource Energy[233] to assume the Incident Command. Between September 14 and 16, 2018, Eversource, CMA and National Grid coordinated to make sure homes were gas safe before turning on the electricity.

While some residents were able to return to their homes by September 16, 2018, many residents who remained without heat, hot water and the use of gas-fired appliances were unable to return home. CMA, with its parent NiSource, established an alternative housing program, relocating about 2,300 families to hotels, apartment and trailers. They would remain in these alternative housing arrangements until gas service could be restored to their homes.

231 Like the description of the incident, the description of the emergency response in this Summary Report draws heavily upon the findings and descriptions set forth in the National Transportation Safety Board Pipeline Accident Report: Over pressurization of National Gas Distribution System, Explosions, and Fires in Merrimack Valley, Massachusetts, September 13, 2018, NSTB/PAR-19-02, PB2019-101365, adopted September 24, 2019.

232 Pipeline pressures for medium or high-pressure distribution systems are generally expressed as pounds per square inch (psig). High pressure is generally 60 psig or higher. For low-pressure systems, the pressures are expressed as "inches of water column." A measurement of 1 inch of water column is equal to 0.0361 psig.

233 NSTAR Gas Company d/b/a Eversource Energy (Eversource) is one of the eleven gas companies operating in Massachusetts. Eversource provides both gas and electric service to customers in Eastern and Western Massachusetts. It is also part of a larger Investor-owned utility with operations in Connecticut, and New Hampshire.

Appendix B Abbreviations

Table B-1 lists and provides the meanings for abbreviations used in this Final Report.

Table B-1: Abbreviations

Abbreviation	Meaning
ANSI	American National Standards Institute
CEII	Critical energy infrastructure information
CFR	Code of Federal Regulations
CGM	Columbia Gas of Massachusetts (as Referenced in the Statewide Report); see CMA
CMA	Columbia Gas of Massachusetts (Bay State Gas Company)
CMR	Code of Massachusetts Regulations
Commonwealth	Commonwealth of Massachusetts
CV	Curb valve
DIMP	Distribution Integrity Management Program
DPU	Department of Public Utilities (Commonwealth of Massachusetts)
Dynamic Risk	Dynamic Risk Assessment Systems, Inc.
EFV	Excess flow valve
FFR	Facility Failure Report
Gas	Natural gas
GIS	Geographical information system
GS	Gas standard
GSEP	Gas System Enhancement Plan
ICS	Incident Command System
ID	Identification
IR	Information request
LNG	Liquid natural gas
MAOP	Maximum allowable operating pressure
MD	Maryland
MDPE	Medium-density polyethylene
MFS	Minimum Federal Safety (Standards)
MPT	Main pressure test
MTR	Material test report
MV	Merrimack Valley
NE	Northeast
NSTAR	NSTAR gas utility, doing business as Eversource Energy
O&M	Operations and Maintenance
ObjectID	Object Identification

Abbreviation	Meaning
OD	Outside diameter
OID	Object identification; typically, a reference within GIS
Op Qual	Operator Qualification
OQ	Operator Qualification
PE	Professional engineer
PHMSA	Pipeline and Hazardous Materials Safety Administration (part of the U.S. Department of Transportation)
PL	Property line
PPDC	Plastic Pipe Database Committee
PSMS	Pipeline Safety Management System
PT	Pressure test (form)
QA/QC	Quality assurance and quality control
SCADA	Supervisory control and data acquisition
SLR	Service line record
SMS	Safety Management System
SMYS	Specified minimum yield strength
Statewide Final Report	The Final Report from the Statewide Assessment, February 3, 2020 (Rev 1)
TRC	TRC Companies, Inc.
TVC	Traceable, verifiable, and complete

Appendix C Panel and Technical Team

This appendix lists personnel and organizations that supported the assessment.

C.1 Independent Review Panel

These individuals comprise the Independent Review Panel:

- Patrick H. Vieth, Executive Vice President, Dynamic Risk (Project Lead);
- Elizabeth Herdes, Contractor to Dynamic Risk (Project Co-Lead); and
- Cheryl Campbell, Contractor to Dynamic Risk (Technical Lead).

C.2 Project Technical Team

These individuals comprise the Project Technical Team:

- Curtis Parker, Technical Director, Dynamic Risk;
- Derrick Daniels, Integrity Specialist, Dynamic Risk;
- David Klatchuk, Contractor to Dynamic Risk;
- Adrian Day, Project Manager, Dynamic Risk;
- Benjamin Mittelstadt, Director – Technical Services, Dynamic Risk; and
- Trevor MacFarlane, President and CEO, Dynamic Risk.

Appendix D Summary of CMA Procedures as Evaluated against Federal and State Regulation

Dynamic Risk conducted a review which compared the key elements of the following codes to CMA procedures:

- 49 CFR Part 192 - TRANSPORTATION OF NATURAL AND OTHER GAS BY PIPELINE: MINIMUM FEDERAL SAFETY STANDARD:
  - Subpart B Materials §192.59;
  - Subpart F Joining of Materials Other Than by Welding §192.283, §192.285, §192.287, §192.307;
  - Subpart G General Construction Requirements for Transmission Lines and Mains §192.361, §192.383, §192.385;
  - Subpart J Test Requirements §192.501, §192.503, §192.509, §192.511, §192.513, §192.515, §192.517; and,
  - Subpart K Uprating §192.551, §192.553, §192.557.
- 220 CMR 101.00: Massachusetts natural gas pipeline safety code 101.06.

There were no significant areas of concern found when comparing the Federal or State regulations to the CMA Gas Standard GS 5500.200, except in 49 CFR Part 192 Subpart K Uprating. An excerpt from CMA Gas Standard GS 5500.200 is shown below:

> *Standard Series 5500 shall be followed whenever necessary to increase the Maximum Allowable Operating Pressure (MAOP) of an existing distribution system. This series provides a method for increasing the MAOP without taking the distribution system out of service. However, a system having its MAOP increased should be examined to determine if it can be economically taken out of service and pressure tested. If so, all uprating steps must be followed except the incremental pressure increases and leakage inspections.*

Related to the underlined sentence above, there is no specific exemption in the 49 CFR Part 192 Subpart K indicating that certain sections of §192.557 do not need to be followed when an existing distribution system is uprated, taken out of service and pressure tested.

Appendix E Relevant Portions of the Statewide Assessment Final Report

E.1 Columbia Gas of Massachusetts – CGM[234]

E.1.1 System Overview

Columbia Gas of Massachusetts (CGM)[235] is part of NiSource (an investor-owned utility) and provides service to customers in 3 operating areas within the state (Springfield, Brockton and Lawrence areas). As shown in Table E-1, about 13% each of the main mileage and services are characterized as leak prone pipe. Over 44% of the main and almost 16% of the services are pre-code vintage.

The system also includes 28 low-pressure service areas, which have no regulation protection at the house or EFVs on the service laterals – these low-pressure systems are protected by the over-pressure protection at the district regulator station. They have about 66,000 inside meters, the majority of which will be moved outside as part of the GSEP program.

Table E-1: Columbia System per 2018 PHMSA Data[236]

	Total System Miles/Number	Leak Prone Miles/Number	% of System	Pre-70's Vintage Miles/Number	% of System
Mains	4,989.5	623.3	12.5%	2,220.8	44.5%
Services	273,847	34,613	12.6%	42,571	15.6%

Natural gas is delivered to CGMs systems via two gas transmission companies: Algonquin Gas Transmission (AGT) and Tennessee Gas Pipeline (TGP). TGP is the only transmission company supplying gas to the Springfield and the Lawrence operating areas. TGP and AGT supply gas to the Brockton operating area. There are four liquid natural gas (LNG) plants that are self-reported as "aging." The Panel did not assess the split on meeting peak load as between pipeline capacity and LNG plant.

CGM reported a number of over-pressure events during the time period requested. Other than the tragedy in the Merrimack Valley Region in September 2018, the majority of low-pressure system overages were minor excursions.

Many of the NiSource companies operate under the same O&M Manual. As such, certain learnings from across the organization are relevant to CGM. Columbia Gas of Ohio experienced a significant over-pressure event in Zanesville, Ohio in May 2019.[237] Columbia Gas of Massachusetts and Columbia Gas of Ohio are sister companies. In this incident, hundreds of customers were out-of-service for days,

[234] This appendix contains the Snapshot information about Columbia Gas of Massachusetts that appeared in the Statewide Final Report, except those cross-references to materials in the Statewide Final Report which have been deleted. The acronym used to describe to Columbia Gas of Massachusetts in the Statewide Final Report was CGM, rather than CMA which is used throughout this report.

[235] Bay State Gas Company d/b/a Columbia Gas of Massachusetts.

[236] Mains or services that were reported as "unknown" vintage are considered in the pre-1970 cohort. Generally, when an operator reports the vintage as unknown, it is due to a lack of a complete record on that asset. This suggests the asset was likely manufactured and installed prior to 1970 when Federal regulations requiring records were put into place.

[237] As discussed in Fn. 16 of the *Final Report*, Columbia Gas of Massachusetts and Columbia Gas of Ohio are sister companies. They share a parent company and operate under the same *O&M Manual*. The Panel collected information about the organization's response to the Zanesville incident to better understand Columbia Gas of Massachusetts' processes concerning investigating incidents, learning from incidents, and reporting incidents to PHMSA.

electricity was shut-off, and an emergency incident command center was set up to address the issues resulting from over-pressurization.[238] Despite the deleterious impacts of this event, Columbia Gas of Ohio determined it was not a significant event in the eyes of the operator[239] for which a PHMSA incident report should be filed.[240]

Columbia Gas of Pennsylvania also experienced a significant event on a low-pressure system in Washington County, PA. Work was being performed on an ongoing project in the area when a home on a different street exploded. Columbia reported that a necessary pressure regulator was never added to the home during the process of upgrading from a low- to a higher-pressure system. When the pressure was raised in the newer higher-pressure system, the gas filled the house and ignited. The explosion destroyed the house and five people were injured, including three firefighters and the homeowner. With the consequences meeting the necessary PHMSA threshold of damages to require a PHMSA incident report to be filed, the company did so.[241]

E.1.2 Construction and Maintenance Work (Execution)

The Panel visited 39 works sites and observed construction and maintenance work including review/remediation of abandoned service lines, leak repairs, new services, installed and ties-in of a plastic line.

(1) Because of the DPU work stoppage and concerns that arose around the abandoned assets following the Merrimack Valley incident, the Panel observed 33 sites at which Columbia was inspecting and verifying the abandonment was completed and documented correctly.

(2) The Panel visited 6 sites to observe construction and maintenance work including installation of new main as part of GSEP, installation of a new service line and a response to Grade 1 leak.

238 See public reporting on the gas over-pressurization event on a distribution system in Zanesville, Ohio on a gas distribution system operated by Columbia Gas of Ohio:
https://www.zanesvilletimesrecorder.com/story/news/2019/05/09/columbia-gas-shutting-off-service-south-side-zanesville/1156699001/

239 PHMSA requires reporting of incidents within a certain time frame. An incident is defined as (1) a release of gas (and other hazardous materials) that results in (i) A death, or personal injury necessitating in-patient hospitalization; (ii) Estimated property damage of $50,000 or more, including loss to the operator and others, or both, but excluding cost of gas lost; or (iii) Unintentional estimated gas loss of three million cubic feet or more; or (2) an emergency shutdown of an LNG facility or an underground natural gas storage facility, or (3) An event that is significant in the judgment of the operator, even though it did not meet the criteria in (1) or (2). 49 CFR §191.3 (3).

240 Columbia Gas of Ohio informed the Public Utility Commission of Ohio.

241 See PHMSA Report ID: 20190095.

E.1.3 General Observations

The Panel observed the following, which was specifically related to Columbia Gas of Massachusetts:

- Strengths:
  - New training facility in 2017 to provide training for employees;
  - A number of strong effective Company and contractor crew leads;
  - The *O&M Manual* explicitly includes documenting conversations between excavators and company staff in the Dig Safe Program, which appears to be beyond the positive identification requirement from DPU when no company buried assets are present in the area; and
  - Developing a company inspector program with the intent of having company inspectors present on job sites at the ratio of 1:1.
- Opportunities:
  - Evaluate how to become more of a learning organization, including how to utilize learnings from affiliates;
  - Consider the role of overconfidence as a barrier to becoming more of a learning organization. For example, the Panel observed in the field the belief that it was acceptable to do the work *the way it has always been done* rather than engaging in critical thinking and not accepting accountability for an individual's role;
  - Enhance QC of company provided inspectors, review training, and clarify expectations for Inspectors onsite;[242]
  - Improve QC of engineering process, especially to ensure that professional engineers (PEs) have all necessary information (and visit the field, as necessary);[243]
  - Conduct a root cause analysis of the Allen Street Tie In to specifically consider the:
    - Allen Street Tie-In Plan (Versions 1-7) to understand the reasons and practices for each revision, and understand the potential gaps between the records and the information relied upon by the PE;
    - Role and qualifications of the inspector;
    - Earlier line strike that occurred; and
    - Process, methods and limits to overcome misaligned pipe ends at tie-in locations.

[242] At one work site, the company supplied a detailed checklist to the crew, but rather than checking off the items as each step was completed, the inspector indicated he would check off all of the items at the end of the day, thereby defeating the purpose of the checklist. In addition, he briefed the crew on a purge plan that the inspector had reason to know, via an email the night before that he acknowledged reading, was in the process of being modified by engineering.

[243] At the same work site, the purge procedure and PE-stamped drawings (Version 6) being used by the crew to start the day, were inaccurate and missing critical buried infrastructure for the purge being set up to occur that day or the next. Review of the prior versions indicated some PE-stamped drawings being corrected on the same day. This suggests the engineer stamping the drawings was not in possession of sufficient information to accurately prepare the drawing.

- Re-visit the construction procedures related to misalignment of pipe to provide clear guidance on methods and limits for pipe alignment practices;
- Enhance tracking of critical gas events, like over-pressurizations on low-pressure systems; [244]
- Conduct more robust RCAs as means to learn from events;
- Develop and implement a plan to lower the number of over-pressure events;[245]
- Review requirements for documentation related to traceability of steel pipe being installed (e.g., MTR and test records for all pipe being installed);
- Ensure check lists are being completed, step by step, at the time of the work being completed (in progress);
- Improve training on the Incident Command System (ICS). Perform emergency drills regularly, including black swan events, to improve knowledge and execution;
- Ensure that use of spotters for backhoes while excavating;
- Ensure that guidelines are developed and/or followed regarding the requirement for Project Restart Memos, specifically designed for projects with disrupted workflow;
- DIMP generally used more data, rather than the relying solely on the opinions of its SMEs, and considered external information about the potential risks to their systems; however, the organizational view of the program as, basically, a leak management program, keeps it from being grouped as one of the exceptions to treating the DIMP as a compliance requirement; and
- Use discovered leaks to inform selection of leak prone pipe replacements.

CGM's strength are the many dedicated, talented, committed crew chiefs the Panel encountered throughout this Assessment. In the interactions with management, however, the Panel consistently observed a concerted effort to assert that the Company's performance of the work was done right. This viewpoint contrasts with the basic tenets of becoming a learning organization in which asking questions is valued (i.e., *What do I see? How can we be better? What are we missing?*). This lack of openness to learning and looking for what may have been missed is especially striking in the aftermath of the recent incidents at Columbia.[246]

[244] During the Snapshot Review Process, Columbia indicated it has a tracking system of critical gas events. The Panel did not confirm the existence of the tracking system.

[245] The three large Gas Companies (which includes Eversource) collectively experienced just under 40 over-pressure events on their low-pressure systems and over 85 over-pressure events on their medium- and high-pressure systems (with the vast majority being slight variances above MAOP) since 2013.

[246] This includes the tragic incident in the Merrimack Valley, and incidents at Columbia Gas of Ohio and Columbia Gas of Pennsylvania.

One set of field site visits epitomized the strengths and opportunities in this organization. There, the Panel observed:

- The only lesson learned by the field crews about an earlier line strike in the area was that the crew who struck the line would no longer be working for Columbia Gas;
- A PE-stamped set of drawings and step-by-step procedure that failed to include 300 feet of pipe that would be involved in the purge. Also, the incorrect procedure was used to brief the crew on the work to be performed;[247]
- A company inspector who not only failed to use the checklist as intended while work progressed, but also briefed the crew using a Version 6 document that the inspector had reason to know, via an email the night before that he acknowledged reading, was in the process of being modified by engineering. When asked to explain the situation, the inspector asserted it was not his responsibility and that he was only doing what he was told;
- A field crew chief who identified the missing 300 feet of pipe that would be affected during the purge process refused to sign off on the plan without a revision to correct the missing assets;
- Efforts undertaken by the inspector to have engineering deliver a PE-stamped plan (Version 7) that would include the previously missing 300 feet of pipe, while the crew prepped the site on a very busy street;
- Insistence that the complex misalignment facing the crew was just *the way it was always done* demonstrating both a determination to get the work done under the circumstances presented and a lack of critical thinking about the potential impacts of the changed circumstances presented to the crew;
- When presented by the concerns of the Panel, an insistence by management that the work performed was safe despite the Panel's concerns about the adequacy of the investigative analysis and/or implementation of any corrective actions, and without any explanation of whether such actions were under consideration. While a calculation was provided to demonstrate that the process was acceptable, it did not consider all of the available information; and
- Each of these observations provide an opportunity for learning and improving the organization.

E.1.4 Leak Analysis

A high-level analysis of leak ratios can help determine if renewal is staying ahead of overall system deterioration. This ratio should be viewed as a trend over time since there are a number of variables that can impact the number of leaks discovered in any one year.

[247] In response to IR 08, issued by the Panel on November 7, 2019, Columbia provided the earlier versions. When reviewing the prior six versions, it became evident that – between Revision 5 and Revision 6 – all of the prior tie-in locations in this complex project were deleted. This likely provides an explanation as to how the 300 feet of pipe, that needed to be part of the purge plan, were deleted from Version 6; the same version used to brief the crew. Some revisions were made on the same day to address errors that had been inadvertently included in the immediately prior version.

The leak ratio of the Columbia system is set forth in Table E-2, along with the comparisons to the average national leak ratio and the Representative Gas Company leak ratio.

Table E-2: Leak Ratios for Mains and Services (2013 and 2018)

Company	2013		2018	
	Main	Services	Main	Services
Columbia Gas MA	29.72	11.17	30.40	5.53
Average National Ratio	9.85	4.27	8.00	5.00
Representative Gas Company	1.35	0.11	0.69	0.14

Observations about Columbia's system and renewal programs based on this leak analysis are as follows:

- Overall leak ratio trend is downward, with a recent uptick in main ratios;
- Ratios are comparatively high;
- Causes include corrosion, joint failure, natural force damage and other – supporting continuing strong renewal programs for GSEP and pre-70's vintage assets;
- Analyze why progress in reducing leaks through GSEP appears have reversed course in 2017; and
- Monitor leak ratios and consider pipe replacement selection to ensure remediation remains ahead of general system deterioration.

See Figure E-1.

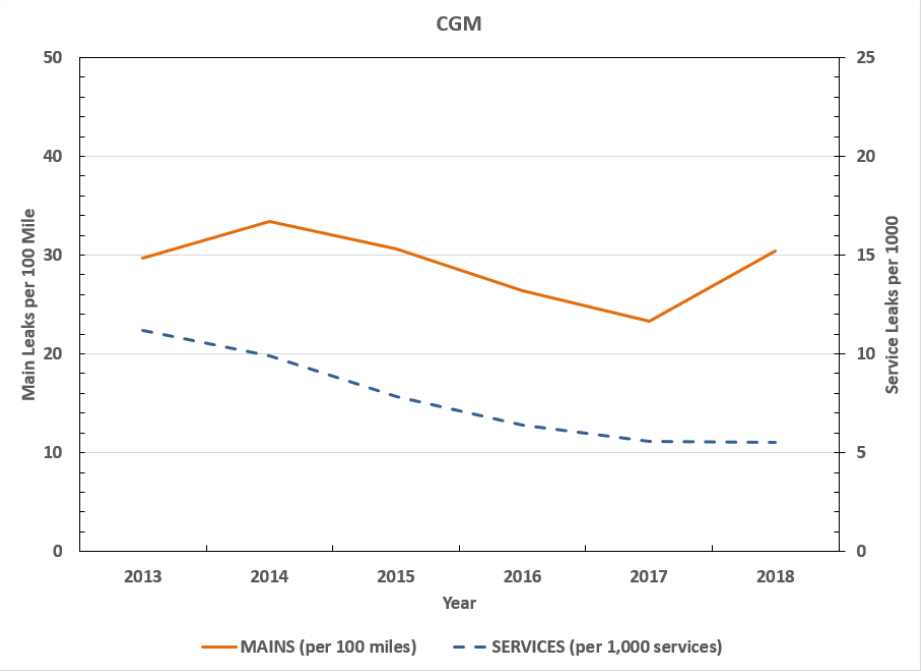


Figure E-1: Columbia Leak Ratio (Mains and Services)

E.1.5 Review of Written Procedures and Program

The Panel reviewed certain procedures and programs and highlighted the following observations:

1. Operations and Maintenance:
    a. There are a lot of drawings/diagrams of typical installations and practices, clearly identifying expectations;
    b. Responsibilities are clearly delineated in the *O&M Manual*, including which department is responsible for execution, which records to collect, etc.;
    c. Not all higher risk activities have drawings/diagrams to help provide clarity and reduce risk;
    d. Procedures in the O&M manuals are generic and it is not always clear when unique, written procedures are required nor who is responsible to develop and execute;
    e. The *O&M Manual* is primarily code focused with no deficiencies noted against minimum requirements. Typical processes and procedures do not appear to incorporate company risk and integrity management priorities;
    f. While record requirements are outlined, there does not appear to be a quality management program around records;
    g. The *O&M Manual* is very thorough, which makes it large and potentially overwhelming. It is available in electronic searchable format, which helps ameliorate its size;
    h. The *O&M Manual* explicitly includes documenting conversations between excavators and company staff (Dig Safe Program). This is a best practice and appears to go beyond the recently adopted DPU regulation requiring gas companies to positively respond to excavators to indicate the company has no underground facilities within the safety zone; and
    i. Consider clarifying/setting policy for regulator station tear down as opposed to "as needed upon inspection".
2. Construction Practices:
    a. A number of typical installation drawings/diagrams are included, which is very helpful for employees and contractors. However, it is not clear when there is a unique installation who writes the procedure and how that procedure is executed; and
    b. Written procedures are required for all main tie-ins.
3. Distribution Integrity Management Program:
    a. Records are key to a robust integrity management program. While record requirements are outlined in the *O&M Manual* for various maintenance and construction activities, there does not appear to be a quality management program (data quality, data management) around records;
    b. DIMP appears to be actively managed;
    c. Threat identification is more comprehensive and considers some external information;
    d. Calculated risk assessment at the segment level;
    e. Risk model includes pipes and regulator stations;

f. Program is reviewed annually, which exceeds minimum requirements; and

g. Link between risk mitigation plans and specific risk results for lower threshold risks could be more clearly defined.

4. Risk Management Program:

   a. The CGM management team believes GSEP is moving at an appropriate pace, with about 80% of the work planned to be complete within 15 years. The Panel questions if the right pipe is being replaced given the increasing leak ratios;

   b. The LNG plant is aging and adds operational and reliability risk to the system;

   c. The current SCADA system provides monitoring with limited control capability in portions of the system; and

   d. The CGM management team did not appear to think about risk in a holistic manner, nor did it appear to consider company and community risk tolerance it integrates into overall processes and systems.

5. Incident and Crisis Management:

   a. Emergency plan generally written for compliance;

   b. Limited emergency exercises. No full-scale exercises noted;

   c. Just starting to learn about root cause analysis – how to, follow up, etc.; and

   d. Includes provision requiring investigation of each PHMSA reportable and with development of lessons learned. This appears to be a limited process that could be enhanced with a review of effectiveness of changes implemented to address lessons learned. The determination of concerning what constitutes a "significant event" in the eyes of the operator does not include items the Panel (and likely the public) would consider significant. CGM may wish to recalibrate reporting activity to be more forthcoming.

6. Management Systems:

   a. Some experience with Safety Management System (SMS) in Virginia (VA) – corporate;

   b. Some learning outside industry in process (Westinghouse Nuclear); and

   c. Infancy stages.

E.1.6 Field Visit Summary[248]

[248] Not included for this Assessment.

Appendix F Pressure Tests of Mains

F.1 Federal and State regulations regarding pressure testing of mains and tie-ins.

F.1.1 Federal and State Regulations for duration of tests

Table F-1 sets forth the requirements set forth in the Federal pipeline safety laws related to test pressures and durations for gas distribution pipelines that operate at less than 100 psig, which is applicable to the Renewed Assets. Table F-2 sets forth the requirements in the Massachusetts natural gas pipeline safety code.[249]

Table F-1: Requirements for Test Pressure and Duration in Federal Regulation 49 CFR 192

	Minimum Test Pressure	Minimum Test Duration	Regulatory Reference
Steel Mains	90 psig	Not specified	§192.503, §192.509(b)
Plastic Mains	1.5 x MAOP or 50psig whichever is greater	Not specified	§192.503, §192.513

Table F-2: Requirements for Test Pressure and Duration in Massachusetts Regulation 220 CMR 101.06

	Minimum Test Pressure	Minimum Test Duration	Regulatory Reference
Steel Mains	90 psig	1 hour	220 CMR 101.06(16)(b)
Plastic Mains	150% of MAOP or 90 psig, whichever is greater	1 hour	220 CMR 101.06(18)(b)

F.1.2 Other Federal Regulations related to Pressure Tests

Textual excerpts from Relevant Sections of 49 CFR 192, Subpart J, Test Requirements, include:

49 CFR §192.503 General requirements.

(a) No person may operate a new segment of pipeline, or return to service a segment of pipeline that has been relocated or replaced, until—

(1) It has been tested in accordance with this subpart and §192.619 to substantiate the maximum allowable operating pressure; and

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

…

(d) Each joint used to tie in a test segment of pipeline is excepted from the specific test requirements of this subpart, but each non-welded joint must be leak tested at not less than its operating pressure.

[249] 220 CMR 101 et. Seq.

49 §192.509 Test requirements for pipelines to operate below 100 p.s.i. (689 kPa) gage.

Except for service lines and plastic pipelines, each segment of a pipeline that is to be operated below 100 p.s.i. (689 kPa) gage must be leak tested in accordance with the following:

(a) The test procedure used must ensure discovery of all potentially hazardous leaks in the segment being tested.

(b) Each main that is to be operated at less than 1 p.s.i. (6.9 kPa) gage must be tested to at least 10 p.s.i. (69 kPa) gage and each main to be operated at or above 1 p.s.i. (6.9 kPa) gage must be tested to at least 90 p.s.i. (621 kPa) gage.

49 CFR §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% of the maximum operating pressure or 50 psi (345 kPa) gauge, whichever is greater. However, the maximum test pressure may not be more than 2.5 times the pressure determined under §192.121 at a temperature not less than the pipe temperature during the test.

(d) During the test, the temperature of thermoplastic material may not be more than 100 °F (38°C), or the temperature at which the material's long-term hydrostatic strength has been determined under the listed specification, whichever is greater.

F.1.3 Other Massachusetts Regulations for pressure tests

Relevant excerpts from Relevant Sections of **220 CMR 101.06**, include:

101.06(16) Test Requirements for Pipelines to Operate at or below 100 psig. (Section 192.509 MFS Standards.)

Except for service lines and plastic pipelines, each segment of a pipeline that is to be operated at or below 100 psig must be leak tested in accordance with the following:

(a) The pipeline operator must use a test procedure that will ensure discovery of all potentially hazardous leaks in the segment being tested. However, loss of pressure due to leakage during the test period is not permitted.

(b) At a test pressure of at least 90 psig for at least one hour.

(c) The tie-in joints to the live gas main, cast iron or steel, shall be tested using the soap bubble test.

101.06(18) Test Requirements for Plastic Mains and Services. (Section 192.513 MFS Standards.)

(a) The test procedure must ensure discovery of all potentially hazardous leaks in the segment being tested. However, loss of pressure due to leakage during the test period is not permitted.

(b) The test pressure shall be at least 150% of the maximum operating pressure or 90 psig whichever is the greater, for at least 15 minutes for services, or one hour for mains. However, the maximum test pressure may not be more than three times the design pressure of the pipe.

101.06(16) provides:

> Except for service lines and plastic pipelines, each segment of a pipeline that is to be operated at or below 100 psig must be leak tested in accordance with the following: …
>
> (c) The tie-in joints to the live gas main, cast iron or steel, shall be tested using the soap bubble test.

F.2 CMA Gas Standards for Pressure Testing

F.2.1 Gas Standard 1500.010 (MA) for pressure tests.

In CMA Standard GS 1500.010(MA)[250], the minimum requirements for test pressure and duration are shown in Section 7[251]. "Table 2" as summarized in Table F-3 and Table F-4.

Table F-3: Table 2 in CMA Standard: Minimum Requirements for Test Pressure and Duration[252]

	Minimum Test Pressure	Minimum Test Duration	CMA Standard Reference
Steel Mains	Greater of 1.5 x MAOP or 90psig	1 hour	GS 1500.010(MA) Section 7, Table 2
Plastic Mains	150psig	1 hour	GS 1500.010(MA) Section 7, Table 2

In addition to the minimum requirements, the CMA Gas Standard GS 1500.010(MA), Section 7.2.2[253], there are further requirements for test duration, to ensure that all potentially hazardous leaks are discovered (and to meet the regulatory requirements of 49 CFR 192.509(a), 49 CFR 192.513(a), 220 CMR 101.06(16)(a) and 220 CMR 101.06(18)(a)).

CMA provides two methods in the Standard to determine the test duration - "Equation 1" (Equation F-1) and "Table 4" (Table F-4) - which are described below:

Equation F-1: Equation 1

1. $T = L \times D2 / 8000$

Where:

T = test duration, in hours

L = length of test segment, in feet

D = nominal pipe size, in inches

250 GS 1500.010(MA) can be found in Attachment CMA_MV 01.06(a), page 154-187 of 738.

251 Attachment CMA_MV 01.06(a), page 159 of 738.

252 Table 2 can be found in Attachment CMA_MV 01.06(a), page 160 of 738.

253 Attachment CMA_MV 01.06(a), page 163 of 738.

Table F-4: Table 4 in CMA Standard: Pressure Test Durations for Given Pipe Size and Length[254]

Nominal Pipe Diameter	Length of Pipe Test Section in Feet												
	50	100	200	300	500	750	1000	1500	2000	2500	3000	3500	4000
2	1	1	1	1	1	1	1	1	1	1.25	1.5	1.75	2
3	1	1	1	1	1	1	1.25	1.75	2.25	3	3.5	4	4.5
4	1	1	1	1	1	1.5	2	3	4	5	6	7	8
6	1	1	1	1.5	2.25	3.5	4.5	6.75	9	11.25	13.5	15.75	16
8	1	1	1.75	2.5	4	6	8	12	16	16	16	16	16
10	1	1.25	2.5	3.75	6.25	9.5	12.5	16	16	16	16	16	16
12	1	2	3.75	5.5	9	13.5	16	16	16	16	16	16	16

In the case of multiple segments that are tested together, the notes to Table 4 indicate that "To determine the required test duration for multiple segments tested together; sum the required test duration calculated in Equation 1 for each segment (or sum the required test duration for each segment found in Table 4) to determine the total test duration and check Table 2 to make sure the total is greater than or equal to the required minimum pressure test duration.

F.2.2 Relevant Section of Gas Standard 1500.010 (MA) for pressure tests of tie-ins.

In CMA Standard GS 1500.010(MA) provides the following with regard to pressure testing of tie-ins:

- 9.1 Tie-In Joints:

  If a tie-in joint is not included in the pressure test of the pipeline it shall be tested for leakage by applying leak detector solution after the tie-in joint has been pressurized to operating pressure. Leak detector solution shall be applied around the entire circumference of the joint.

  The "leak detector solution" is usually referred to as a soap test.

[254] Table 4 can be found in Attachment CMA_MV 01.06(a), page 164 of 738.

F.3 Requirements Review

There were 350 numbered pressure tests identified by CMA, however due to documentation discrepancies, only 319 have been reviewed for this analysis.[255] Of the 319 pressure tests identified by CMA that are included in this evaluation of compliance to regulations and conformance to CMA Gas Standard, the results are summarized in Table F-5.

Table F-5: Compliance To Regulations And Conformance To CMA Gas Standard

		Compliance with Regulations (CFR 192 and 220 CMR)		Conformance to CMA Gas Standard GS 1500.010(MA)	
Total Number of Tests Identified by CMA	Number of Tests Reviewed (see Note 1)	Test Pressure	Test Duration	Test Pressure	Test Duration
350	319	319	319	319	Some tests did not meet requirements. See below for detail.

The 319 pressure tests evaluated met the Federal and Massachusetts regulatory requirements for test pressure and test duration. The test pressure also met the requirements of CMA Gas Standard. However, a few tests did not meet the requirements of the CMA Gas Standard for test duration.

Tests listed in Table F-6 did not meet test duration requirements in the CMA Gas Standard for either Equation 1 or Table 4.

Table F-6: Pressure Tests Did Not Meet Test Duration Requirements In The CMA Gas Standard

Pressure Test	Diameter(s)	Length	Test Duration	Equation 1 Duration Requirement	Table 4 Duration Requirement	CMA Document Reference
123	6	2012	9.00	9.05	11.25	18-0843174-00_123 PDF
124	6 2	491 19	2.00	2.22	3.25	18-0843274-00_124 PDF
275	4 2	400 1402	1.25	1.50	2.00	18-0843226-00_275 PDF

[255] As discussed in Section 6.2.1.1, there were 340 unique tests identified by CMA in the Summary, with 10 duplicates. Another 21 tests had irregularities in the documents that prevented them from being evaluated.

The following eight (8) tests (see Table F-7) are examples of pressure test records that met the test duration requirements for Equation 1, however they did not meet requirements based on Table 4.

Table F-7: Examples That Met Test Duration Requirements For Equation 1

Pressure Test	Diameter	Length	Test Duration	Equation 1 Duration Requirement	Table 4 Duration Requirement	CMA Document Reference
35	4	1326	2.67	2.65	3.00	18-0843263-00_35 PDF
39	6	513	3.17	2.31	3.50	18-0843352-00_39 PDF
41	6	512	2.50	2.31	3.50	18-0843138-00_41 PDF
129	4	1150	2.83	2.30	3.00	18-0843176-00_129 PDF
256	6	525	3.00	2.36	3.50	18-0843218-00_256 PDF
306	6	365	2.00	1.64	2.25	18-0843236-00_306 PDF
315	4	635	1.33	1.27	1.50	18-0843412-00_315 PDF
332	6	320	1.5	1.44	2.25	18-0843242-00_332 PDF

While both methodologies are acceptable under the CMA standard for determining the test duration, Table 4 provides more conservative (longer test duration) results than Equation 1. There may be opportunity for CMA to provide more clarity in the Standard to eliminate the opportunity for confusion about the acceptability of the duration on a given test.

There may be other tests that did not meet the requirements of Table 4 and Equation 1. However, this was not fully investigated since the CMA Standards allows for either of these methods to be used in determining test duration.

F.4 CMA's Pressure Test Forms and Charts

F.4.1 Summary Tables of Review of CMA Pressure Tests

Table F-8 to Table F-10 summarize the key metrics from review of the CMA Summary as compared to the actual Pressure Test Forms and Charts.

Table F-8: Total Number of Tests in Summary

Total Number of Summary Tests	**350**	
Duplicate Summary Tests	10	3%
Summary Tests with Document Irregularities	21	3%
Summary Tests that can be evaluated against test pressure and duration requirements	319	91%

Table F-9: Summary of Evaluation of 319 Tests

Summary Tests Evaluated (out of 350 Total)	**319**	
Summary Tests compliant with Federal regulations for test pressure and test duration	319	100%
Summary Tests compliant with Massachusetts regulations for test pressure and test duration	319	100%
Summary Tests conforming to CMA Gas Standard requirements for test pressure	319	100%
Summary Tests conforming to CMA Gas Standard requirements for test duration	317	99%
Summary Tests performed by persons qualified in pressure testing	317	99%
Summary Tests without any information discrepancies between Summary information and Pressure Test Form/Chart	208	65%

Table F-10: Tie-ins not Pressure Tested

Number of Welded Tie-ins	**69**	
Welded Tie-ins performed by persons qualified in welding	69	100%
Number of Plastic Tie-in Locations	**534**	
Plastic Tie-in Locations with documentation of soap tests	300	56%
Number of Sampled Plastic Tie-in Locations checked for personnel qualifications	**16**	
Number of Sampled Plastic Tie-ins performed by persons qualified in pressure testing	15	94%
Number of Sampled Plastic Tie-ins with documentation including test pressure and duration and person performing the soap test	13	81%

F.4.2 Irregularities that Limited Review to 319 Summary Tests

There are 11 Summary Tests that have irregularities with documentation that prevented including these in the evaluation of MPTs for this Assessment. These include:

- 6 Summary Tests where Support Documents referenced in the Summary were not found in the files provided by CMA;
- 2 Summary Tests where *Support Documents were found but information in the Support Document is incomplete* to determine if it matches the information in the Summary;[256] and
- 3 Summary Tests where Support Documents were found in the files provided by CMA but information in the Support Document does appear to match the information in the Summary.

There are 111 tests in the Summary with information discrepancies[257] for which the information discrepancies have been corrected (to match the corresponding Pressure Test Form) in the evaluation of the 319 tests. A discrepancy is defined as a mismatch between the Summary and the Pressure Test Form/Chart.

Discrepancies occurred in the following information types in the Pressure Test Form or Chart:

- Job Order;
- Pressure;
- Duration;
- Length; and
- Person Performing Test.

The Summary Tests that have discrepancies with the Pressure Test Form by individual information type are as follows:[258]

- Job Order for 29 Tests did not match the Pressure Test Form or Chart;
- Pressure for 2 Tests did not match the Pressure Test Form or Chart;
- Duration for 4 Tests did not match the Pressure Test Form or Chart;
- Length for 10 Tests did not match the Pressure Test Form or Chart; and
- Person that Performed the Pressure Test for 77 Tests did not match the person who signed the Pressure Test Form or Chart.

[256] An example is if a pressure chart does not identify the pipe size and/or material at minimum, then it cannot be traced with any certainty back to the Summary.

[257] Overall, out of the 319 Summary Tests evaluated, only 208 Tests in the Summary have no discrepancies. In other words, only 65% of Summary Tests (208 of 319) had no data entry errors.

[258] Some tests have multiple information mismatches which is why the sum of the discrepancies below is 122, versus the overall number of tests with discrepancies above of 111.

Below is a more detailed description of the document irregularities and information discrepancies.

Document Irregularities include:

- Support Document could not be found in files provided by CMA;
- Support Document cannot be traced back to the information in the Summary; and
- Information in the Summary does not match Support Document.

Note that not all Summary Tests with Document Irregularities were excluded from the evaluation. Some Summary Tests had multiple Support Documents associated with them and only some of the Support Documents (for that Summary Test) had irregularities.

Information Discrepancies include:

- Information in the Summary does not match information in the corresponding Pressure Test Form/Chart (e.g., for Pressure, Duration, Length, Job Order, Person Performing the Test); and
- Information appears to have been modified/changed without clear management of change.

Note that Summary Tests with Information Discrepancies were included in evaluation after correcting the information based on the Pressure Test Form/Chart (i.e. the Pressure Test Form/Chart is assumed to be the source of truth for the respective test).

Table F-11 provides more detailed descriptions of the Document Discrepancies by MPT.

Table F-11: Details of Irregularities or Information Discrepancies

Test No.	Duplicate Test, Document Irregularities, or Information Discrepancies	Summary Test No.
MPT-01	• Same Pressure Test Form for multiple Test Numbers • Duplicate information in the Summary	193, 194, 214, 215
MPT-02	• Same Pressure Test Form for multiple Test Numbers • Duplicate information in the Summary • Information in the Summary does not match Support Document	283, 284, 285
MPT-03	• Support Document could not be found in files provided by CMA • Duplicate information in the Summary • Person in Summary does not match person who signed Pressure Test Form	212
MPT-04	• Support Document could not be found in files provided by CMA • Information in the Summary does not match Support Document • Other Support Documents found in files provided by CMA are not referenced on the Summary • Duplicate information in the Summary • Pipe tested in Pressure Test Form is not included in Summary	90
MPT-05	• Duplicate information in the Summary • Information in the Summary does not match Support Document	18
MPT-06	• Duplicate information in the Summary • Information in the Summary does not match Support Document • Person in Summary does not match person who signed Pressure Test Form	19

Test No.	Duplicate Test, Document Irregularities, or Information Discrepancies	Summary Test No.
MPT-07	• Duplicate information in the Summary • Information in the Summary does not match Support Document	20
MPT-08	• Support Document could not be found in files provided by CMA	22
MPT-09	• Support Document could not be found in files provided by CMA	206
MPT-10	• Support Document could not be found in files provided by CMA • Support Document cannot be traced to the data in Summary • Information in the Summary does not match Support Document	6
MPT-11	• Support Document cannot be traced to the data in Summary	348
MPT-12	• Information in the Summary does not match Support Document • Pipe tested in Pressure Test Form is not in the test data in the Summary	311, 327
MPT-13	• Information in the Summary does not match Support Document	275
MPT-14	• Information in the Summary does not match Support Document	44
MPT-15	• Information in the Summary does not match Support Document	344
MPT-16	• Person in Summary does not match person who signed Pressure Test Form	251
MPT-17	• Person in Summary does not match person who signed Pressure Test Form	261
MPT-18	• Person in Summary does not match person who signed Pressure Test Form	250
MPT-19	• Person in Summary does not match person who signed Pressure Test Form	137
MPT-20	• Pressure Test Form appears to have been modified	193, 194
MPT-21	• Pressure Test Form appears to have been modified • Person in Summary does not match person who signed Pressure Test Form	226
MPT-22	• Pipe tested in Pressure Test Form is not in the test data in the Summary	64
MPT-23	• Pipe tested in Pressure Test Form is not in the test data in the Summary • Pressure Test Form appears to have been modified	16

To provide a deeper dive into each of the MPT items in the Table, see Tables with Examples MPT-01, MPT-02 and MPT-03 (Table F-12, Table F-13 and Table F-14, respectively), with a detailed explanation below each table.

Table F-12: Example MPT-01[259] (Redacted)

Unique Identifier	Pressure Test #	Support Document	Zone	Project Area	Job Order	Job Type	Start Test Pressure	End Test Pressure	Test Duration (hh:mm)	Pipe Length (feet)	Pipe Material	Pipe Size	Test Medium	OIDs of Main Segments in Test	Person Performing Test
193	124	18-0843274-00_124 PDF	3	3.2	18-0843274-00	0001	153	153	02:00	491	PE	6"	AIR	842963,842961, 843121,842227, 842226,842225,	[redacted]
194	124	18-0843274-00_124 PDF	3	3.2	18-0843274-00	0001	153	153	02:00	19	PE	2"	AIR	842965,842971, 842231,842229,	[redacted]
214	138	18-0843270-00_138 PDF	3	3.5	18-0843270-00	557	153	153	02:00	19	Plastic	2"	Air	842229, 842231, 842965	[redacted]
215	138	18-0843270-00_138 PDF	3	3.5	18-0843270-00	557	153	153	02:00	491	Plastic	6"	Air	842227, 842963	[redacted]

[259] The names of the individuals performing the test have been redacted for privacy.

- Same Pressure Test Form for multiple Test Numbers
  - The Pressure Test Form in the Support Document shown (in the Summary) for each of these respective tests appear to be identical.
- Duplicate information in the Summary
  - The data in the Summary for Pressure, Duration, Length, Diameter and Person Performing Test for each of the pressure tests are identical.
    - Note: A difference between the test data in the Summary is that the Job Type is different for the two tests (0001 for Test 124 and 557 for Test 138).
      - If this single test was repeated in the Summary to show it applied to different Job Types, then the Summary cannot be used to validate length for each Job Type.
      - There are some OIDs repeated across Job Types (e.g., OID 842963 is in the row with Unique Identifier 193 and 215, for Job Type 0001 and 557, respectively). Since OIDs are supposed to have unique pipe attribute information, it does not make sense that the same OID could be in both Job Types because they would have different installation dates.

Table F-13: Example MPT-02 (Redacted)

Unique Identifier	Pressure Test #	Support Document	Zone	Project Area	Job Order	Job Type	Start Test Pressure	End Test Pressure	Test Duration (hh:mm)	Pipe Length (feet)	Pipe Material	Pipe Size	Test Medium	OIDs of Main Segments in Test	Person Performing Test
441	283	18-0843230-00_283 PDF	7	7.4	18-0843230-00	557	153	153	03:05	1216	Plastic	4"	Air	56343, 846327, 846164, 846833	[redacted]
442	284	18-0843230-00_284 PDF	7	7.4	18-0843230-00	557	153	153	13:05	1813	Plastic	6"	Air	846161, 56355, 56393, 56365, 56364, 56386, 56358, 56395, 56404	[redacted]
443	284	18-0843230-00_284 PDF	7	7.4	18-0843230-00	557	153	153	13:05	73	Plastic	4"	Air	846161, 56360, 56353, 846166, 846167, 846165	[redacted]
444	284	18-0843230-00_284 PDF	7	7.4	18-0843230-00	557	153	153	13:05	36	Plastic	2"	Air	846163, 846162	[redacted]
445	285	18-0843406-00_285.1	7	7.4	18-0843406-00	0001	153	153	03:05	1216	Plastic	4"	Air	846834, 846833, 846173, 846327, 846165, 846329, 56353, 56399, 846164, 56343, 846166, 56360	[redacted]
446	285	18-0843406-00_285.2	7	7.4	18-0843406-00	0001	153	153	03:05	1813	Plastic	6"	Air	56403, 56358, 56365, 56404, 56386, 56369, 56395, 56364, 56405, 56394, 56366, 56351, 56400, 56355, 56393, 846172	[redacted]

- Same Pressure Test Form for multiple Test Numbers
  - There appears to be only two Pressure Test Forms in the Support Documents
  - The pressure test chart in the Support Document 18-0843230-00_283 PDF appears to be identical to the pressure test chart in the Support Document 18-0843406-00_285.1.pdf.
  - The pressure test chart in the Support Document 18-0843230-00_284 PDF appears to be identical to the pressure test chart in the Support Document 18-0843406-00_285.2.pdf.

- Duplicate information in the Summary
  - The data in the Summary for Pressure, Duration, Length, Diameter and Person Performing Test are identical for rows with Unique Identifier 441 and 445.
  - The data in the Summary for Pressure, Duration, Length, Diameter and Person Performing Test are identical for rows with Unique Identifier 442 and 446.
  - Note: A difference between the test data in the Summary is that the Job Type is different for the two tests (0001 for Test 283 and Test 284 and 557 for Test 285).
    - It is understood that it is possible that a pressure test could have covered both Job Types. The Test Form in 18-0843230-00_284 PDF (or 18-0843406-00_285.2) does indicate that the test may have been for both "Retest + New Installation".
    - However, if the test information was repeated in the Summary to show it applied to different Job Types, then the Summary cannot be used to validate length for each Job Type.
    - There are some OIDs repeated across Job Types (e.g., OID 56343 is in the row with Unique Identifier 441 and 445, for Job Type 557 and 0001, respectively). Since OIDs are supposed to have unique pipe attribute information, it does not make sense that the same OID could be in both Job Types because they would have different installation dates.
- Information in the Summary does not match Support Document
  - For Pressure Test 285, the Pressure Test Form in Support Documents 18-0843406-00_285.1.pdf and 18-0843406-00_285.1.pdf refer to Job Order 18-0843230-00 however, the Summary indicates this is Job Order 18-0843406-00. This discrepancy would call into question the traceability of the Pressure Test Form back to the pipe associated with Job Order 18-0843406-00.

Table F-14: Example MPT-03 (Redacted)

Unique Identifier	Pressure Test #	Support Document	Zone	Project Area	Job Order	Job Type	Start Test Pressure	End Test Pressure	Test Duration (hh:mm)	Pipe Length (feet)	Pipe Material	Pipe Size	Test Medium	OIDs of Main Segments in Test	Person Performing Test
327	212	18-0843200-00_212 PDF	5	5.2	18-0843200-00	557	155	155	15:15	944	Plastic	8"	Air	843368, 843369, 690212, 843366, 840737, 843365, 842830, 840738, 690143	[redacted]
328	212	18-0843200-00_212APDF	5	5.2	18-0843200-00	557	155	155	15:15	193	Plastic	4"	Air	843,041	[redacted]
329	212	18-0843200-00_212 PDF	5	5.2	18-0843200-00	557	155	155	15:15	193	Plastic	4"	Air	690219, 843056, 842835, 690142, 690141	[redacted]
330	212	18-0843200-00_212 PDF	5	5.2	18-0843200-00	557	155	155	15:15	40	Plastic	2"	Air	851613, 851612, 851616	[redacted]

- Support Document could not be found in files provided by CMA.
    - There was only one Pressure Test Form found for one of the Support Documents
    - The Pressure Test Form in the Support Document 18-0843200-00_212 PDF was found and matches the data in rows with Unique Identifiers 327, 329 and 330.
    - The Support Document 18-0843200-00_212A PDF could not be found in the files provided by CMA.
- Duplicate information in the Summary
    - The data in the Summary for Pressure, Duration, Length, Diameter and Person Performing Test and Job Type are identical for rows with Unique Identifier 328 and 329.
    - Note: the row with Unique Identifier 328 has an OID 843041 that does not appear in any of the other rows for Pressure Test 212. It is not known whether the missing Support Document 18-0843200-00_212A PDF should apply, at least in part, to OID 843041 or whether this row is just a duplicate and should be voided. It is further noted that OID 843041 is included in Pressure Test 203 so it is covered by a different test.
- Person in Summary does not match person who signed the Pressure Test Form
    - In Support Document 18-0843200-00_212 PDF, the person who signed the Pressure Test Form is different from the person on the Summary.

F.4.3 Two Tests Do Not Meet CMA standards

As discussed in Section 6.2.1.1, there are two MPTs that do not comply with CMA's Gas Standards. The details are set forth below:

1. Summary Test 123
    - See Figure 1
    - Duration on the Summary is 9.00 hours
    - Duration according to Equation 1 is 9.05 hours

    Summary Test 124
    - See Figure 2
    - Duration on the Summary is 2.00 hours
    - Duration according to Equation 1 is 2.22 hours

See Table F-15 and Table F-16 for summary tests 123 and 124, respectively.

Table F-15: Summary Test 123 (Redacted)

Unique Identifier	Pressure Test #	Support Document	Zone	Project Area	Job Order	Job Type	Start Test Pressure	End Test Pressure	Test Duration (hh:mm)	Pipe Length (feet)	Pipe Material	Pipe Size	Test Medium	OIDs of Main Segments in Test	Person Performing Test
192	123	18-0843174-00_123.PDF	3	3.2	18-0843174-00	557	154	154	09:00	2012	Plastic	6"	Air	842465, 842468, 842470, 842481, 842482	[redacted]

Table F-16: Summary Test 124 (Redacted)

Unique Identifier	Pressure Test #	Support Document	Zone	Project Area	Job Order	Job Type	Start Test Pressure	End Test Pressure	Test Duration (hh:mm)	Pipe Length (feet)	Pipe Material	Pipe Size	Test Medium	OIDs of Main Segments in Test	Person Performing Test
193	124	18-0843274-00_124.PDF	3	3.2	18-0843274-00	0001	153	153	02:00	491	PE	6"	AIR	842963,842961, 843121,842227, 842226,842225,	[redacted]
194	124	18-0843274-00_124.PDF	3	3.2	18-0843274-00	0001	153	153	02:00	19	PE	2"	AIR	842965,842971, 842231,842229,	[redacted]

F.4.4 One Test May Not Meet the Standards

Summary Test 275 also may not meet the Equation 1 requirements but there is a discrepancy on the Pressure Test Form that makes it difficult to evaluate conclusively. See Table F-17. The documents show:

- Duration according to Equation 1 is 90 minutes or 1.5 hours;
- Duration on the Summary is 110 minutes or 1.83 hours;
- The Test Duration on the Pressure Test Form is 75 minutes or 1.25 hours. Using this, the duration does not meet the requirements of Equation 1; and
- Based on the Start and End Times on the Pressure Test Form (13:15 to 15:05), the duration is 110 minutes or 1.83 hours. Using this, the duration meets the requirements of Equation 1.

Table F-17: Summary of Test 275 (Redacted)

Unique Identifier	Pressure Test #	Support Document	Zone	Project Area	Job Order	Job Type	Start Test Pressure	End Test Pressure	Test Duration (hh:mm)	Pipe Length (feet)	Pipe Material	Pipe Size	Test Medium	OIDs of Main Segments in Test	Person Performing Test
425	275	18-0843226-00_275.PDF	7	7.2	18-0843226-00	557	158	158	01:50	1402	Plastic	2"	Air	845531, 845535, 845596, 845530, 845529, 845589, 844908, 845524, 845526, 845528, 844909, 845527, 61543, 61544, 844906, 844904, 844905, 845533, 845586, 845534, 845594, 845590, 845591	[redacted]
426	275	18-0843226-00_275.PDF	7	7.2	18-0843226-00	557	158	158	01:50	400	Plastic	4"	Air	853255, 853252, 853257	[redacted]

Tests listed in Table F-18 did not meet test duration requirements in the CMA Gas Standard for either Equation 1 or Table 4.

Table F-18: Summary of Tests 123, 124 and 275

Pressure Test	Diameter(s)	Length	Test Duration	Equation 1 Duration Requirement	Table 4 Duration Requirement	CMA Document Reference
123	6	2012	9.00	9.05	11.25	18-0843174-00_123 PDF
124	6 2	491 19	2.00	2.22	3.25	18-0843274-00_124 PDF
275	4 2	400 1402	1.25	1.50	2.00	18-0843226-00_275 PDF

F.4.5 Pressure Duration set forth in Table 4

Table F-19 describes the eight tests as a sample of tests meet the pressure test duration requirements for Equation 1, but not the requirements for Table 4 in CMA Gas Standards.

Table F-19: Examples of Tests that do not Meet Table 4

Pressure Test	Diameter	Length	Test Duration	Equation 1 Duration Requirement	Table 4 Duration Requirement	CMA Document Reference
35	4	1326	2.67	2.65	3.00	18-0843263-00_35 PDF
39	6	513	3.17	2.31	3.50	18-0843352-00_39 PDF
41	6	512	2.50	2.30	3.50	18-0843138-00_41 PDF
129	4	1150	2.83	2.30	3.00	18-0843176-00_129 PDF
256	6	525	3.00	2.36	3.50	18-0843218-00_256 PDF
306	6	365	2.00	1.64	2.25	18-0843236-00_306 PDF
315	4	635	1.33	1.27	1.50	18-0843412-00_315 PDF
332	6	320	1.5	1.44	2.25	18-0843242-00_332 PDF

F.4.6 Lack of Op Qual for Pressure Tests

Of the 319 Summary Tests evaluated, there are 2 where the person performing the test did not have qualifications for pressure testing. Test 137 and 139 contained the name and signature of the same person who did not have the qualifications for pressure testing. [260] See Table F-20 for the qualifications used as basis for determining if a person performing the pressure test was qualified for pressure testing.[261]

[260] The Summary shows the person that performed the pressure test was qualified to perform it. The same person's name also appears in the soap test portion of the pressure test form and on a digital log of the test. But the name on the pressure test portion of pressure test form is a different individual who was not qualified to perform the pressure testing.

[261] Based on the original OQ List provided by CMA in IR 12, there were additional tests identified with persons performing the test that were not qualified for pressure testing. CMA then revised its response to IR 15, and pressure testing qualifications were added for persons on the OQ List that covered two individuals not previously named.

Table F-20: Operator Qualifications

NGA-WE-34-Performing Pressure Test on a Pipeline – 13830
NGA-WE-CT34 - Performing Pressure Test on a Pipeline EXAM
OQ M-3 Pressure Testing
OQ M3 Pressure Testing Pipelines
VGOA0014E - Performing a Pressure Test on a Pipeline – Exam
VGOA 14 EXAM - Performing a Pressure Test on a Pipeline
NS.M03.0561 Pressure Test: Nonliquid Medium – MAOP Less Than 100 psi (IN, KY, MD, OH, PA, VA) SOC 1:2
192-1301 - Leak & Strength Test - Service Lines, Mains, and Transmission Lines (Span of Control: 1 to 1)
192-1301 - Leak & Strength Test - Service Lines, Mains, and Transmission Lines
MEA - MEA1156 - KNT192-1301.00 Leak & Strength Test - Service Lines, Mains, and Transmission Lines
MEA - MEA1434 - TNG192-1301 Leak & Strength Test - Service Lines, Mains, and Transmission Lines
KNT 192-1301 Leak & Strength Test - Service Lines, Mains, and Transmission Lines (MEA1156)
TNG 192-1301 Leak & Strength Test - Service Lines, Mains, and Transmission Lines (MEA1434)
KNT192-1301.00 Leak & Strength Test - Service Lines, Mains, and Transmission Lines
TNG192-1301 Leak & Strength Test - Service Lines, Mains, and Transmission Lines
PEF192-1301.01 Leak/Strength Test - Service/Main/Trans. Line: Gas pressure <=100 psi
192-1301 - Leak & Strength Test - Service Lines, Mains, and Transmission Lines
KNT 192-1301 Leak & Strength Test - Service Lines, Mains, and Transmission Lines - KNT
192-1301 - Leak & Strength Test - Service Lines, Mains, and Transmission Lines

F.4.7 Test 136 and Test 140

A significant document irregularity was discovered during the review of Pressure Test Forms related to Test 136 and Test 140. (See Appendix J to view the documents).

The Pressure Test Forms in these Support Documents look very similar but with a few notable differences

- The Support Document referenced for Test 136 was 18-0843250-00_136 PDF:
  - For the Pressure Test, the length for 4 inch pipe is shown as 1,129 feet; and
  - For the Soap Test, the Stop Time is 2:36 and Test Duration is 16 min.
- The Support Document referenced for Test 140 was 18-0843270-00_140 PDF:
  - For the Pressure Test, the length for 4 inch pipe is shown as 1,606 feet; and,
  - For the Soap Test, the Stop Time is 2:23 and Test Duration is 3 min.

It appears that the Pressure Test Form in Support Document 18-0843250-00_136 PDF for Test 136 may be an alteration of the Pressure Test Form in Support Document 18-0843270-00_140 PDF.

In response to a request for clarification from CMA, they provided CMA_MV 15.07 Supp. 1 COMBINED CONFIDENTIAL.pdf which states:

- These documents are two versions of the same Pressure Test Form;
- The discrepancy was caused by human error in the field when the Inspector inadvertently included an extra 487' of pipe; and
- "[W]hen the Inspector realized the error in footage, he corrected the document and scanned in the updated version of the pressure test".

Note 1 Because of this explanation, the version in 18-0843250-00_136 PDF for Test 136 is the version that was included in the evaluation (included with the 319 Summary Tests evaluated).

F.4.8 Pressure Testing of the 487 feet of 4 inch Pipe

The pipe segment associated with ObjectID 842126 (487 feet of 4 inch pipe) does not appear to have supporting test documentation to verify that a pressure test was performed (see Table F-21):

- ObjectID 842126 is the pipe segment identified by CMA to be part of Summary Test 140. ObjectID 842126 does not appear anywhere else in the Summary;
- According to the CMA GIS system (as determined using 3-GIS software which was provided to Dynamic Risk by CMA), ObjectID 842126 is 4 inch pipe with a segment length of 487 feet and geospatially, is a pipe segment along [named roads];
- This is the segment referred to in the section above –Document Irregularity - Test 136 / Test 140 - which CMA clarified is not part of the Pressure Test Form for Summary Test 136. CMA clarified that the Support Document referenced for Summary Test 140, and associated with ObjectID 842126, is not applicable; and
- In CMA_MV 15.07 Supp. 1 COMBINED CONFIDENTIAL.pdf, CMA states, "The footages data for each street for both job orders, detailed on the *attached map*, when compared to the pressure test forms for each job order, demonstrates that the pressure testing documentation covers all of the gas mains included in these projects." ("these projects" refers to Job Orders 18-0843270-00 and 18-0843250-00).

To assess whether the footages data for each street for both job orders covers all of the gas mains when compared to the pressure test forms, the lengths were compared between GIS (using ObjectIDs from the Summary), the Summary data and the Pressure Test Form data.

Note 2 Job Orders 18-0843270-00, 18-0843250-00 and 18-0843274-00 were reviewed (see Figure 4 for Summary information for these Job Orders), that cover Tests 124 (and Test 138 because it is duplicate data), 136, 137, 139 and 140.

Observations from the Review for each Summary Test are as follows:

- **Summary Test 137** appears to closely match the Pressure Test Form for 18-0843270-00_137 PDF.pdf, for 2 inch pipe on redacted Street;
- **Summary Test 139** appears to closely match the Pressure Test Form for 18-0843270-00_139 PDF.pdf, for2 inch pipe on redacted Street;

- **Summary Test 138** has same test information as Test 124 in the Summary and the Pressure Test Forms in the respective Support Documents appear to be identical (18-0843270-00_138 PDF and 18-0843274-00_124 PDF, respectively). In reviewing GIS and looking at the ObjectIDs for both Test 124 and 138, it appears that Pressure Test Form covers the portion of redacted Rd south of redacted Street. Note that the ObjectIDs for Test 124 are for existing pipe (installed prior to 2018) and this aligns to the Job Type of 0001 for requalified pipe;
- **Summary Test 136** appears to match the test chart that was edited for length in Support Document 18-0843250-00_136 PDF. If that is the correct Pressure Test Form for Test 136 and Job Order 18-0843250-00, then the summary is incorrect because it says 1,662 feet of 4" (should be 1,185 feet in total of 4"); and
- **Summary Test 140.** Effectively, CMA is saying that the Support Document for Test 140 is not applicable (i.e., 18-0843270-00_140 PDF). Test 140 references ObjectID 842126, which is 487 feet of 4" in GIS. This ObjectID is not shown anywhere else in the entire summary. If it is not part of the test chart(s) in question, then there is no documentation for that 487 feet. It does not correlate with tests charts for any of these Job Orders.

Some other observations related to this review of lengths of segments:

ObjectID 842971 appears to be included in Test 124 in error. ObjectID 842971 is listed in the Summary for Test 124 and Test 137. However, since the length in GIS for ObjectID 842971 is 459 feet for 2 inch pipe, it appears to be an error to add it into Test 124. Particularly, because the date of installation for ObjectID 842971 is 10/16/2018 so it cannot be part of Job Type 0001. Also, without this ObjectID being included in Test 124, the length of 2 inch pipe would be 24 feet which is a closer match to the Pressure Test Form. Including the full length of ObjectID 842971 only in Test 137 makes sense because the length matches the Pressure Test Form.

It appears that the Summary is missing ObjectIDs for 6 inch pipe in Test 124. The length of pipe from all ObjectIDs in Test 124 and Test 138 is 338 feet of 6 inch pipe, not the 491 feet of 6 inch pipe that is in the corresponding Pressure Test Form. It appears there should be additional ObjectIDs that should be associated to this Pressure Test Form. Some additional concerns ab out Test 124 include:

- It appears that the Job Type for Test 124 is incorrect;
- Test 124 includes both Installed pipe and Uprated pipe, based on the installation dates in GIS for the ObjectIDs;
- The Job Type covering these ObjectIDs should be 0001 and 557;
- Note: The Installed portion of pipe in Test 124 are the same ObjectIDs as in Test 138;
- ObjectID 842228 was part of Renewed Assets and does not appear anywhere in the Summary;
- In GIS, ObjectID 842228 is part of Job Order 18-0843270-00;
- In GIS, ObjectID 842228 is 2 feet of 4 inch pipe;
- All of the ObjectIDs for Job Order 18-0843250-00 are included in the Summary; and
- The ObjectIDs are all listed in Test 136.

ObjectIDs associated with Job Order 18-0843274-00 in the Summary cannot be checked in GIS.

Table F-21: Pressure Testing of the 487 feet of 4 inch (Redacted)

Test	OD	Length from GIS related to ObjectIDs for Each Summary Test (feet)	Summary Length (feet)	Pressure Test Form Length (feet)	Description
Test 136	2	4	8	8	redacted 8'
	4	1182	1662	1185	redacted 1129' redacted 48' redacted 8'
Test 137	2	1454	1454	1454	redacted 1314' redacted 140'
	4	2	3	3	redacted 3'
Test 124/138	2	483	19	19	redacted 11' redacted 8'
	6	338.714	491	491	redacted 491'
Test 139	2	1325	1334	1334	redacted 1334'
Test 140	4	487	1606	-	-

F.4.9 Segments in Pressure Test Forms but Not in Summary

There are potentially 35 pipe segments[262] that were found on Pressure Test Forms but they do not appear to be in the Summary:

- The sum of the length for these segments is 3,489 feet and is potentially not accounted for in the Summary; and
- These segments were identified it appeared that a segment on a single Pressure Test Form/Chart did not appear to be in the Summary for that Summary Test.

An exhaustive effort was not made to try to reconcile with the entire Summary or conclusively determine if these were already included in the Summary under a different Summary Test.

F.4.10 Pressure Testing of Tie-ins

Welders were qualified for 69 welded tie-ins.

- CMA provided 69 locations of welded tie-ins;
- In IR 12, weld sketches with welder names were provided for 66 of 69 welded tie-ins and the welders on the sketches were qualified for welding as per the OQ List; and
- In IR 15, new welded sketches for the other 3 of 69 welded tie-ins, dated in 2020, were prepared and signed by the welder that CMA says was the welder for those 3 welded tie-ins.

[262] A segment is defined as having a unique pipe size and material.

The welder was qualified for welding on the OQ List. (Note: the particular welder was already on some of the weld sketches for the original 66 of 69 weld sketches).

Soap Test records were found by CMA for 300 of 534 plastic tie-ins.

- According to CMA in their response to IR 15.13, records of soap tests for 300 of 534 Plastic Tie-in Locations were found;
- A spot check of 18 files provided by CMA with soap test records for the plastic tie-in locations was performed;
- 10 of 18 files have soap test records that indicate pressure;
- 15 of 18 files have soap test records that indicate duration; and
- 16 of 18 files have soap test records that indicate the person who signed the soap test.

F.4.11 One soap test record did not have a qualified person perform the test.

- Of the persons associated with the soap test records in these 16 files with a person indicated that performed the soap test, 15 of them are qualified in pressure testing.[263]

[263] See IR 15.13 (filename 34.pdf) for Zone 3.

F.5 Examples of Tie-In Joint Forms from CMA GS 1500.010 (MA)

Figure F-1 and Figure F-2 are examples of tie-in joint forms.

Full Size Test Record Form with Tie-in Joint Example
Test Duration 15 Minutes
Test Pressure 50 psig

Pressure Test Form (Retain Permanently)

Company: ☐CGV ☐CKY ☐CMA ☐CMD ■COH ☐CPA ☐NIPSCO
LOA/TCC: 0822-Columbus Pressure System No. 34100165 WO/JO: 16-0086655-00
Recording Chart: ☐Yes* ■No Recorder Serial No._____ Required MAOP: _____

Pipeline or Station Pressure Test **Test Acceptable: ☐Yes ☐No**

Station Number: _____
Description of Station: _____
Location of Station: _____

Pipeline Description

Location of Pipeline(s)	City, Town, County, etc.	Length	Size	PE or Steel

Start Date: _____ Start Time: _____ ☐AM ☐PM Test Pressure: _____ Test Medium: ☐Air ☐Nitrogen
Stop Date: _____ Stop Time: _____ ☐AM ☐PM Test Duration: _____ ☐Natural Gas
Describe any leaks or failures that occurred and explain their disposition: _____
Additional Comments: _____
Print Name: _____ Signature: _____ Contractor (if applicable): _____

Leak or Pressure Test (tie-in joint, pressure control fitting, etc.) **Test Acceptable: ■Yes ☐No**

Description (tie-in joint, end cap, control fitting, etc.): 6" electrofusion coupling tie-in for 6" main extension
Location: West side of [redacted] St. 145 feet north centerline of [redacted] St.
Start Date: 04-06-17 Test Medium: ☐Air ☐Nitrogen ■Natural Gas System or Test Pressure: 50 psig
Start Time: 3:00 ☐AM ■PM Stop Time: 3:15 ☐AM ■PM Test Duration: 15 minutes
Describe Leak(s) and Disposition of Leak(s): None
Additional Comments: _____
Print Name: [redacted] Signature: [redacted] Contractor (if applicable): [redacted]

* Write WO/JO number, test medium, test pressure and date on back of recording chart, if used, and attach to this form before submittal.
Note: Record data for additional tie-in joint or pressure control fitting tests on reverse side.

GS 1500.010-3 (05/2016)

Figure F-1: Examples of Tie-In Joint Forms from CMA GS 1500.010 (MA) – Form 1 of 2 (Redacted)

EXHIBIT A
(5 of 5)

Full Size Test Record Form with Pipeline and Tie-in Joint Example

Pressure Test Form (Retain Permanently)

Company: ☐CGV ☐CKY ☐CMA ☐CMD ☐COH ■CPA ☐NIPSCO

LOA/TCC: 2421-York Pressure System No. 37001025 WO/JO: 17-0231325-02

Recording Chart: ☐Yes* ■No Recorder Serial No. _____ Required MAOP: 60 psig

Pipeline or Station Pressure Test **Test Acceptable: ■Yes ☐No**

Station Number: _____

Description of Station: _____

Location of Station: _____

Pipeline Description

Location of Pipeline(s)	City, Town, County, etc.	Length	Size	PE or Steel
[redacted] Dr.	Dover	354 ft.	2"	PE
[redacted] Dr.	Dover	404 ft.	2"	PE

Start Date: 02-15-17 Start Time: 3:50 ☐AM ■PM Test Pressure: 95 psig Test Medium: ■Air ☐Nitrogen

Stop Date: 02-15-17 Stop Time: 4:50 ☐AM ■PM Test Duration: 1 hour ☐Natural Gas

Describe any leaks or failures that occurred and explain their disposition: None

Additional Comments: _____

Print Name: [redacted] Signature: [redacted] Contractor (if applicable): _____

Leak or Pressure Test (tie-in joint, pressure control fitting, etc.) **Test Acceptable: ■Yes ☐No**

Description (tie-in joint, end cap, control fitting, etc.): 2" electrofusion coupling tie-in for 2" main extension

Location: Northeast side of [redacted] Dr. 45 ft. southeast centerline of [redacted] Dr.

Start Date: 02-17-17 Test Medium: ☐Air ☐Nitrogen ■Natural Gas System or Test Pressure: 45 psig

Start Time: 9:00 ■AM ☐PM Stop Time: 09:15 ■AM ☐PM Test Duration: 15 minutes

Describe Leak(s) and Disposition of Leak(s): None

Additional Comments: _____

Print Name: [redacted] Signature: [redacted] Contractor (if applicable): _____

* Write WO/JO number, test medium, test pressure and date on back of recording chart, if used, and attach to this form before submittal.

Note: Record data for additional tie-in joint or pressure control fitting tests on reverse side.

GS 1500.010-3 (05/2016)

Figure F-2: Examples of Tie-In Joint Forms from CMA GS 1500.010 (MA) – Form 2 of 2 (Redacted)

Appendix G Service Line Records

G.1 Changes in SLR information During the Assessment

The following provides supplemental analysis of the changing information provided by CMA about the SLRs over the course of this Assessment.

1. SLR Summary based on information provided in response to IR 12:
    - Data set includes Project IDs for 72 job packets;
    - Data includes Subzones, SiteIDs, construction and testing information;
    - Pressure test data for 4,721 service lines that were installed or requalified for reuse at the 98 psig system as part of CMA's Merrimack Valley restoration program;
    - This total includes 13 duplicate PSIDs, which had unique job order numbers. These were cases where the original service line was either moved or retested; and
    - 16 service lines that are still being investigated for original service line installation records.

    SLR Summary based on information provide in response to IR 15.11 (in CMA_MV15.11):

    - CMA provided Pressure test data is now for 4,714 service lines instead of 4,721:
        - CMA identified 17 services as duplicate references;
        - CMA updated their summary to include if a pressure test, soap test and OQ test was documented on the SLR form; and
        - 174 service lines where the 'pressure tested by' information was not filled out or legible on either the SLR or Survey123.
    - CMA updated Summary showed:
        - 1,283 out of 4,714 (~27%) did not have required information documented (i.e. Pressure Test, Soap Test, Tester still being investigated);
        - 9 SiteIDs were identified by CMA that require a retest:
            - 8 did not have any test records; and
            - 1 had a test duration of 5 min.
        - 7 SiteIDs from CMA's updated summary were not consistent with the sampling review:
            - SiteID 531033005 & 605923000:
                - Sampling review found that the wrong SLR card or SiteID is associated for these locations; and
                - CMA used the information from the wrong SLR card or SiteID.
            - SiteID 916133000:
                - Information on card does not match CMA's summary

- SiteID 768723003 & 535333000:
  - Could not find an SLR card; and
  - CMA found the SLR card during the summary update.
- SiteID 45333000:
  - No documentation of a Soap test during sampling review;
  - CMA documented soap test was performed; and
  - Still no indication a soap test was performed on SLR.
- SiteID 338825005:
  - No SLR card was found during sampling review; and
  - CMA uploaded the missing SLR on 3/30/2020 for the 10/15/2018 installation.

SLR Summary based on information provide in response to IR 15.11 (in CMA_MV15.11 Revision #1):

- CMA provided CMA_MV 12.01 (Supplemental #2) to correct any errors and additional names on the OQ List;
- After investigating the 174 lines:
  - The total number of services lines was reduced to 4699 from 4714;
  - Duplicates and non-impacted assets were identified;
  - 7 instances in which the SLR cards could not be found;
  - 5 instances in which the SLR cards were found but illegible signature did not permit identifying the person who performed the pressure test (CMA used the name in WMS for verification of OQ);
  - 25 instances in which SLR on have a company name for the person who performed the pressure test (CMA used the name in WMS was verified for OQ);
  - 32 instances in which the name was blank, and WMS was verified for OQ and WMS was used to id the OQ tester;
  - 10 instances in which the name was blank, and Survey 123 was used to identify the OQ tester; and
  - Remaining 95 services had sufficient information to identify the person who sign the pressure test info.
- CMA updated Summary showed:
  - 1,165 out of 4699 (~25%) did not have required information documented (i.e. Pressure Test, Soap Test, Tester);
  - 1,097 of the 1,165 did not have proper documentation of a soap test;
  - 9 SiteIDs were identified by CMA that require a retest; and
  - 8 did not have any test records
  - 1 had a test duration of 5 min.
  - 7 SiteIDs from CMA's updated summary were not consistent with the sampling review.

G.2 SLR Random Sample Review by Panel

Using the SLR summary, "Attachment CMA_MV 12.04.xls," provided by CMA, 200 SiteIDs were selected using a random generator. Each SLR was reviewed in OpenText SLR against specific criteria to determine if documentation was adequate. Criteria for adequacy was documentation on SLR Card for Both Main-PL/CV & PL/CV-Meter in three areas:

- Pressure Test;
- Soap Test; and
- Operator Qualification of tester (using CMA provided list "Attachment CMA_MV 12.01(a).xls").

Each SLR Tap Card has a space to list both the pressure test from the main to the plastic line or curb valve, and a pressure test from the plastic line or curb valve to the meter. The Tap Cards also provide spaces to collect information for:

- Length of time for pressure test;
- Testing pressure;
- Check box indicating a soap test was performed; and
- Signature and printed name of person performing the test.

The results of reviewing the random Tap Cards against the information in the Summary include:

- Using the criteria described, 115 (~58%) SLR cards sampled did not have adequate documentation;
- 22 SLR cards had a combination of issues (missing pressure test, soap test, or Test no on OQ list). See Table G-1;
- 39 testers were not on the OQ List;
- 7 SLR cards had issues (SLR could not be found, different SiteID on the card, or conflicting information);
- 16 SLR cards did not have a soap test on both segments of service lines; and
- 31 SLR cards had tester names that were not legible or blank (Unknown Tester).

In summary, see Table G-1, Summary of issues in Sample of SLR Tap Cards.

Table G-1: Summary of issues in Sample of SLR Tap Cards

Inadequate	***SLR Number***
Combination of Issues	22
OQ	39
SLR Card Issue	7
Soap Test	16
Unknown Tester	31
Grand Total	115

G.3 Examples of Discrepancies in SLRs

Figure G-1 is a completed SLR card. Figure G-2 is a CMA summary of the same tap card.

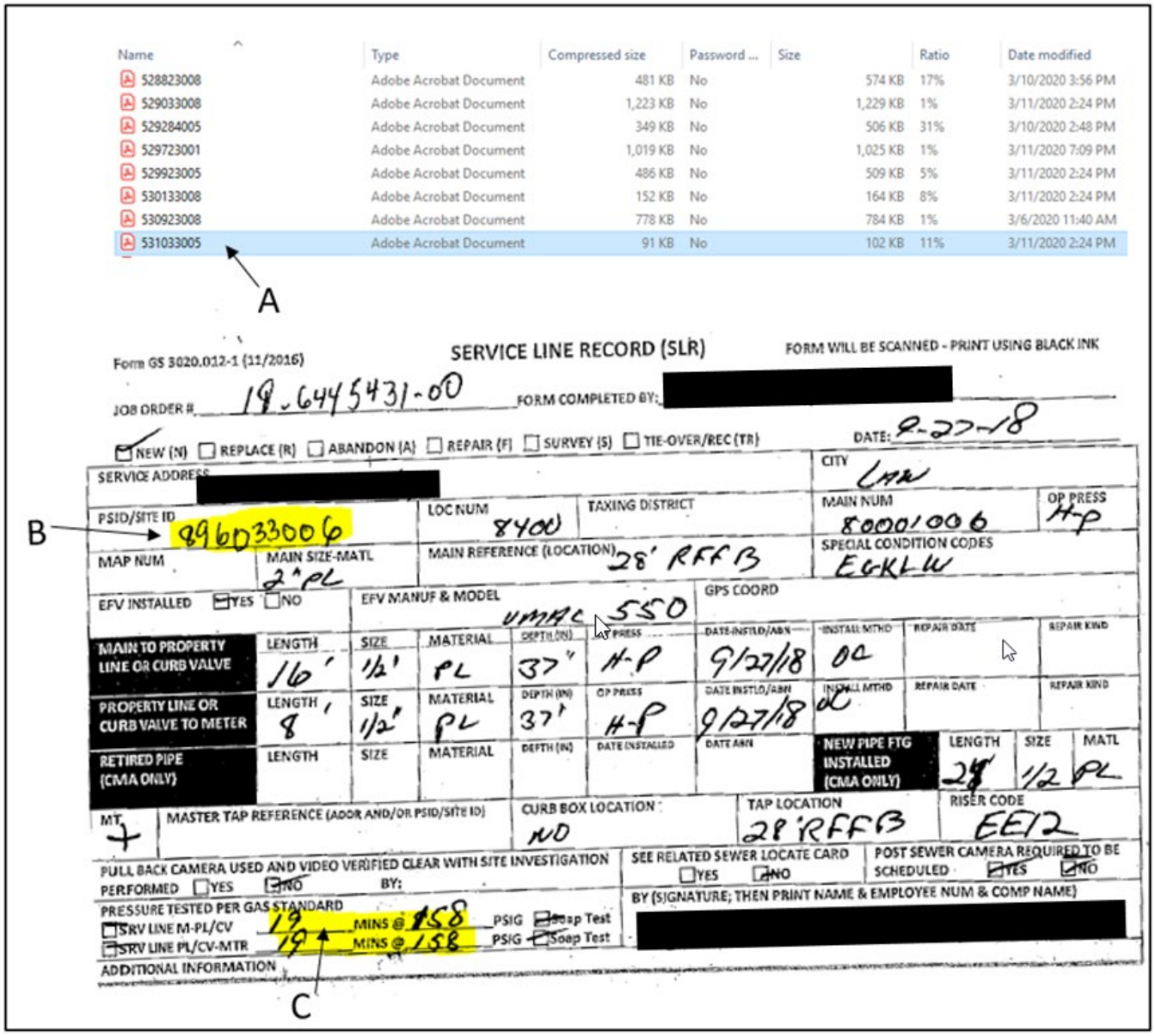
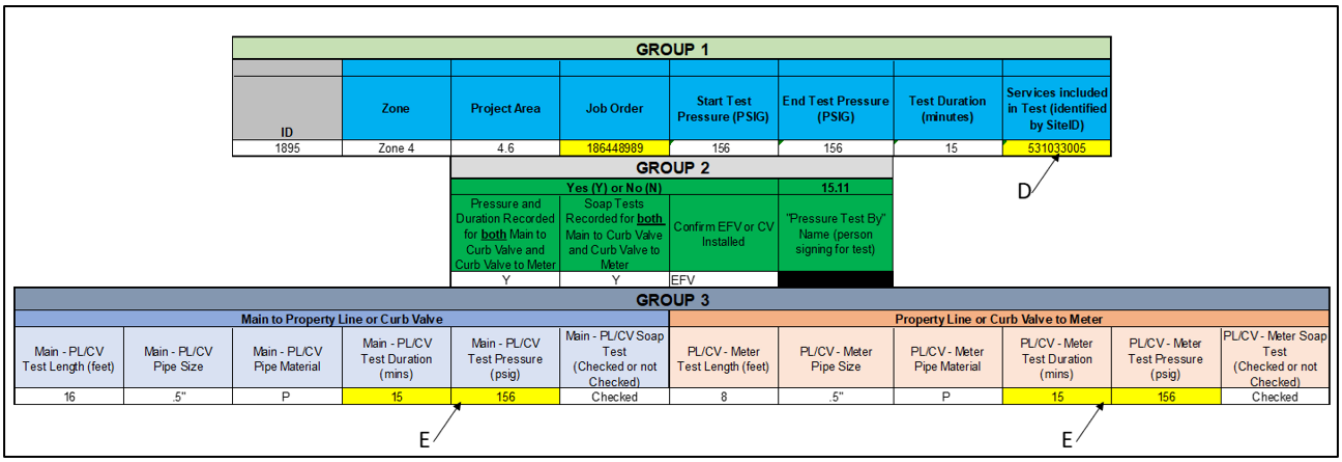


Figure G-1: SLR Tap Card (Redacted)



GROUP 1							
ID	Zone	Project Area	Job Order	Start Test Pressure (PSIG)	End Test Pressure (PSIG)	Test Duration (minutes)	Services included in Test (Identified by SiteID)
1895	Zone 4	4.6	186448989	156	156	15	531033005

D

GROUP 2				
Yes (Y) or No (N)			15.11	
Pressure and Duration Recorded for both Main to Curb Valve and Curb Valve to Meter	Soap Tests Recorded for both Main to Curb Valve and Curb Valve to Meter	Confirm EFV or CV Installed	"Pressure Test By" Name (person signing for test)	
Y	Y	EFV	[redacted]	

GROUP 3											
Main to Property Line or Curb Valve						Property Line or Curb Valve to Meter					
Main - PL/CV Test Length (feet)	Main - PL/CV Pipe Size	Main - PL/CV Pipe Material	Main - PL/CV Test Duration (mins)	Main - PL/CV Test Pressure (psig)	Main - PL/CV Soap Test (Checked or not Checked)	PL/CV - Meter Test Length (feet)	PL/CV - Meter Pipe Size	PL/CV - Meter Pipe Material	PL/CV - Meter Test Duration (mins)	PL/CV - Meter Test Pressure (psig)	PL/CV - Meter Soap Test (Checked or not Checked)
16	.5"	P	15	156	Checked	8	.5"	P	15	156	Checked

E E

Figure G-2: CMA Summary of Tap Card in Figure G-1

Figure G-3 is a completed SLR tap card with a mismatched Site identification (ID) and Document Name. Figure G-4 is a completed SLR tap card with an unchecked soap text box.

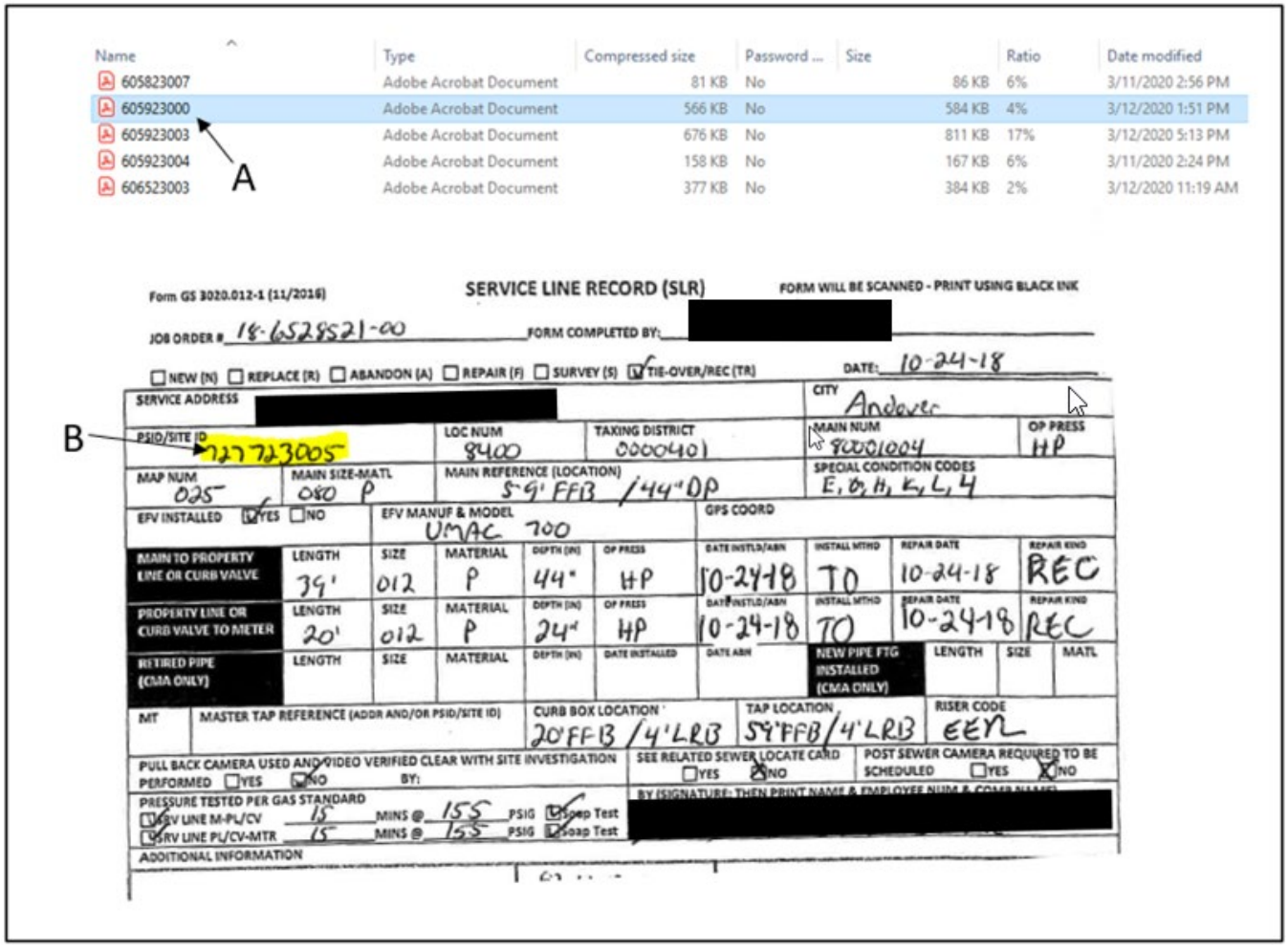
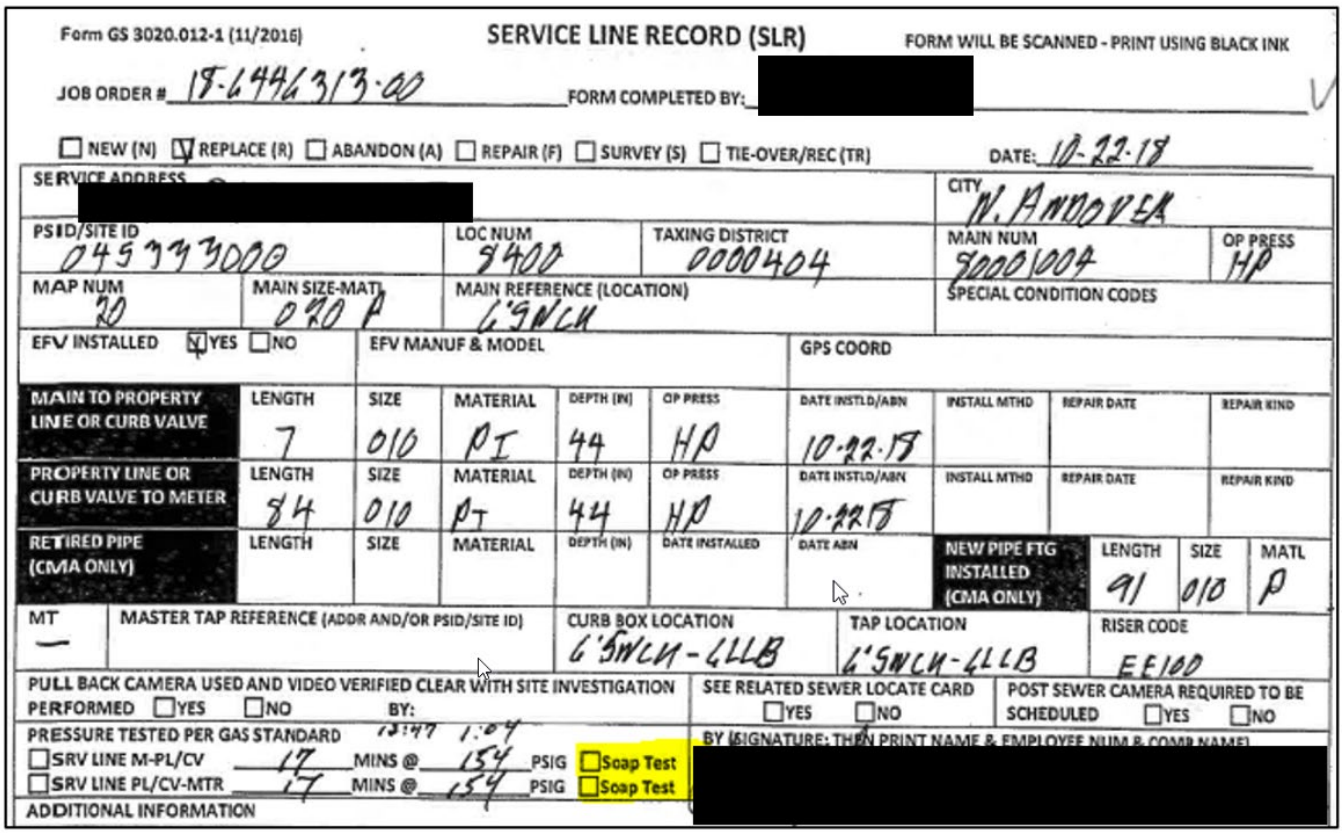


Figure G-3: SLR Tap Card, Site Identification and Document Name are Mismatched (Redacted)



Form GS 3020.012-1 (11/2016) **SERVICE LINE RECORD (SLR)** FORM WILL BE SCANNED - PRINT USING BLACK INK

JOB ORDER # 18-6446313-00 FORM COMPLETED BY: [redacted]

☐ NEW (N) ☑ REPLACE (R) ☐ ABANDON (A) ☐ REPAIR (F) ☐ SURVEY (S) ☐ TIE-OVER/REC (TR) DATE: 10-22-18

SERVICE ADDRESS [redacted] CITY N. ANDOVER

PSID/SITE ID	LOC NUM	TAXING DISTRICT	MAIN NUM	OP PRESS
045773000	8400	0000404	80001004	HP

MAP NUM	MAIN SIZE-MATL	MAIN REFERENCE (LOCATION)	SPECIAL CONDITION CODES
20	020 P	6'SWCH	

EFV INSTALLED ☑ YES ☐ NO | EFV MANUF & MODEL | GPS COORD

	LENGTH	SIZE	MATERIAL	DEPTH (IN)	OP PRESS	DATE INSTLD/ABN	INSTALL MTHD	REPAIR DATE	REPAIR KIND
MAIN TO PROPERTY LINE OR CURB VALVE	7	010	PI	44	HP	10-22-18			
PROPERTY LINE OR CURB VALVE TO METER	84	010	PT	44	HP	10-22-18			

RETIRED PIPE (CMA ONLY)	LENGTH	SIZE	MATERIAL	DEPTH (IN)	DATE INSTALLED	DATE ABN	NEW PIPE FTG INSTALLED (CMA ONLY)	LENGTH	SIZE	MATL
								91	010	P

MT	MASTER TAP REFERENCE (ADDR AND/OR PSID/SITE ID)	CURB BOX LOCATION	TAP LOCATION	RISER CODE
—		6'SWCH-4LLB	6'SWCH-4LLB	EE100

PULL BACK CAMERA USED AND VIDEO VERIFIED CLEAR WITH SITE INVESTIGATION PERFORMED ☐ YES ☐ NO BY:

SEE RELATED SEWER LOCATE CARD ☐ YES ☐ NO

POST SEWER CAMERA REQUIRED TO BE SCHEDULED ☐ YES ☐ NO

PRESSURE TESTED PER GAS STANDARD 15:47 1:04

☐ SRV LINE M-PL/CV 17 MINS @ 154 PSIG ☐ Soap Test

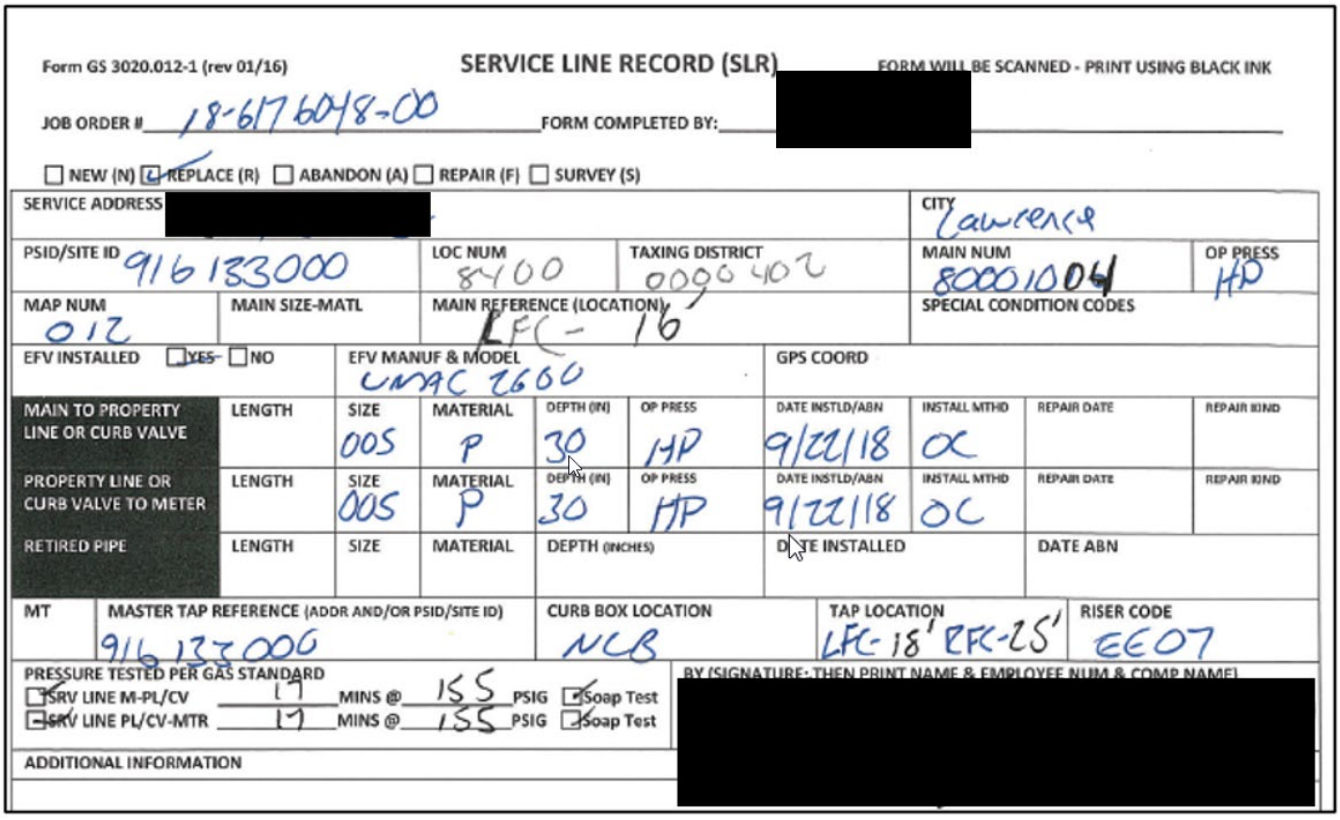
☐ SRV LINE PL/CV-MTR 17 MINS @ 154 PSIG ☐ Soap Test

BY (SIGNATURE; THEN PRINT NAME & EMPLOYEE NUM & COMP NAME) [redacted]

ADDITIONAL INFORMATION

Figure G-4: SLR Tap Card, Where Soap Test Box Unchecked (Redacted)

Figure G-5 is a completed SLR tap card with handwritten changes. Figure G-6 is a CMA summary of the same tap card.



Form GS 3020.012-1 (rev 01/16) **SERVICE LINE RECORD (SLR)** FORM WILL BE SCANNED - PRINT USING BLACK INK

JOB ORDER # 18-6176048-00 FORM COMPLETED BY: [redacted]

☐ NEW (N) ☑ REPLACE (R) ☐ ABANDON (A) ☐ REPAIR (F) ☐ SURVEY (S)

SERVICE ADDRESS [redacted]						CITY Lawrence			
PSID/SITE ID 916133000		LOC NUM 8400		TAXING DISTRICT 0090402		MAIN NUM 80001004		OP PRESS HP	
MAP NUM 012	MAIN SIZE-MATL	MAIN REFERENCE (LOCATION) LFC - 16				SPECIAL CONDITION CODES			
EFV INSTALLED ☐YES ☐NO		EFV MANUF & MODEL UMAC 2600				GPS COORD			
	LENGTH	SIZE	MATERIAL	DEPTH (IN)	OP PRESS	DATE INSTLD/ABN	INSTALL MTHD	REPAIR DATE	REPAIR IOND
MAIN TO PROPERTY LINE OR CURB VALVE		005	P	30	HP	9/22/18	OC		
PROPERTY LINE OR CURB VALVE TO METER		005	P	30	HP	9/22/18	OC		
RETIRED PIPE	LENGTH	SIZE	MATERIAL	DEPTH (INCHES)		DATE INSTALLED		DATE ABN	

MT MASTER TAP REFERENCE (ADDR AND/OR PSID/SITE ID) 916133000	CURB BOX LOCATION NCB	TAP LOCATION LFC-18' RFC-25'	RISER CODE EE07

PRESSURE TESTED PER GAS STANDARD
☑ SRV LINE M-PL/CV 17 MINS @ 155 PSIG ☑ Soap Test
☑ SRV LINE PL/CV-MTR 17 MINS @ 155 PSIG ☐ Soap Test

BY (SIGNATURE, THEN PRINT NAME & EMPLOYEE NUM & COMP NAME) [redacted]

ADDITIONAL INFORMATION

Figure G-5: SLR Tap Card, With Handwritten Changes on Card (Redacted)

GROUP 1

ID	Zone	Project Area	Job Order	Start Test Pressure (PSIG)	End Test Pressure (PSIG)	Test Duration (minutes)	Services included in Test (identified by SiteID)
2955	Zone 5	5.2	186176048	150	150	15	916133000

GROUP 2

Yes (Y) or No (N)			15.11
Pressure and Duration Recorded for both Main to Curb Valve and Curb Valve to Meter	Soap Tests Recorded for both Main to Curb Valve and Curb Valve to Meter	Confirm EFV or CV Installed	"Pressure Test By" Name (person signing for test)
Y	Y	EFV	[redacted]

GROUP 3

Main to Property Line or Curb Valve						Property Line or Curb Valve to Meter					
Main - PL/CV Test Length (feet)	Main - PL/CV Pipe Size	Main - PL/CV Pipe Material	Main - PL/CV Test Duration (mins)	Main - PL/CV Test Pressure (psig)	Main - PL/CV Soap Test (Checked or not Checked)	PL/CV - Meter Test Length (feet)	PL/CV - Meter Pipe Size	PL/CV - Meter Pipe Material	PL/CV - Meter Test Duration (mins)	PL/CV - Meter Test Pressure (psig)	PL/CV - Meter Soap Test (Checked or not Checked)
19	.5"	P	15	150	Checked	34	.5"	P	15	150	Checked

Figure G-6: CMA Summary with Mismatches in Pressure and Duration

Figure G-7 is an example of the signature block that is completed by someone writing in the letters "CMA" rather than having an individual sign the tap card. There were approximately 75 such Tap Cards.

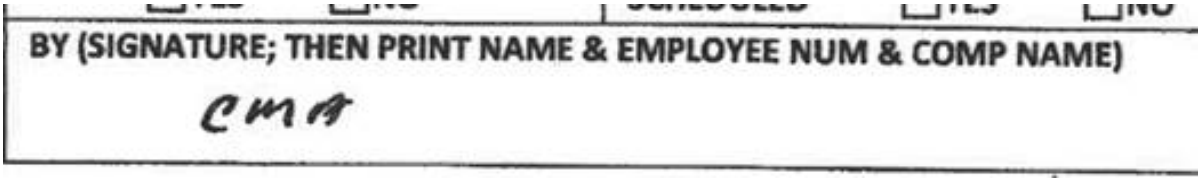


Figure G-7: CMA Tap Card Signature

Appendix H Quality Control Management

Best practices in quality management are about implementing quality management *systems*. It involves using what you learn to continuously improve systemically. It is similar to implementing another aspect of a SMSs. Except on a project, if done well, the intent of quality management is to find issues early and often to apply corrective actions, equally early, but more broadly to the project.

Using both internal and external personnel to conduct the audits is a good practice. From a quality management perspective, finding issues is a good thing provided there is learnings from the finding and that learnings are applied broadly. There is a saying in the industry – *you cannot inspect-in quality*. Inspecting, in and of itself, is just finding individual defects and correcting them. Instead, the goal is to build-in quality. That is, using findings from individual defects to learn how to correct the system.

A Quality Management System must have certain requirements to be effective. Below are some of the Guiding Principles of an effective Quality Management System:[264]

Defined project quality objectives and personnel accountabilities;

- Processes to establish and maintain the appropriate project organizational structure;
- Processes to establish and maintain the appropriate training and qualification of internal and contracted personnel;
- Processes to facilitate and verify quality throughout project design, contracting, procurement, manufacturing, fabrication and construction;
- Processes to prevent, detect, mitigate and eliminate potential and actual non-conformances with project procedures, specifications and referenced standards or non-compliances with regulations, and verification and documentation of actions taken and the outcome;
- Assessment of the achievement of quality objectives throughout the construction project; and
- Methods to measure the effectiveness of each process and to enact continuous improvement of the Quality Management System.

[264] See Quality Management for pipeline construction (which supports operators in implementing Pipeline Safety Management systems under API 1173 at: https://pipelinesms.org/get-started/more-pipeline-safety-resources/construction-quality-management-system/.

Appendix I PHMSA Interpretations Regarding Uprating

In Federal regulations, 49 CFR 192 requires that when the maximum allowable operating pressure is increased, Uprating, as per Subpart K, is required. Pressure testing is not an alternative to uprating but is a requirement of Uprating. Nothing in the Subpart K indicates that it is only applicable when the pressure testing medium is natural gas.

I.1 Whenever MAOP is increased, Uprating (Subpart K) is applicable

The scope of 49 CFR §192.551 is that when MAOP is increased, Uprating (Subpart K) is applicable. PHMSA Interpretation PI-94-019 reinforces that even when a pipeline has originally met the requirements for a higher MAOP, Uprating is still required. While PHMSA Interpretation PI-94-019 is referring to a specific scenario in which MAOP is being raised above 125psig, it clarifies that 49 CFR §192.551 is applicable to all MAOP increases.

I.1.1 49 CFR §192.551

This subpart prescribes minimum requirements for increasing maximum allowable operating pressures (uprating) for pipelines.

I.1.2 PHMSA Interpretation PI-94-019 (excerpt)

However, any increase in MAOP above 125 psig must comply with the uprating requirements of Subpart K of Part 192 (§ 192.551). Subpart K would still have to be met even if the system has been tested after construction to at least 218 psig (1.5 time 145 psig).

I.2 Pressure Testing is not an alternative to Uprating, it is a requirement of Uprating

According to 49 CFR §192.553(d), when Uprating, all of the requirements of §192.619 must be followed to establish the new MAOP, including a pressure test (which, for plastic pipelines, is a pressure test to 1.5 times MAOP). Interpretation PI-18-0007 reinforces that all of the requirements of §192.619 must be met, including pressure testing.

I.2.1 49 CFR §192.553(d)

(d) Limitation on increase in maximum allowable operating pressure. Except as provided in §192.555(c), a new maximum allowable operating pressure established under this subpart may not exceed the maximum that would be allowed under §§192.619 and 192.621 for a new segment of pipeline constructed of the same materials in the same location. However, when uprating a steel pipeline, if any variable necessary to determine the design pressure under the design formula (§192.105) is unknown, the MAOP may be increased as provided in §192.619(a)(1).

I.2.2 PHMSA Interpretation PI-18-0007 (excerpt)

Section 192.553(d) has a limitation on uprating. The uprated MAOP may not exceed the MAOP that would be allowed under §§ 192.619 and 192.621 for a new segment of pipeline constructed of the

same materials in the same location. Thus, the operator would have to ensure that an uprated MAOP does not exceed the lowest of the four pressures determined in accordance with §192.619(a)(1), (a)(2), (a)(3) and (a)(4). The pressure test itself would satisfy paragraph (a)(2). Paragraph (a)(3) is not applicable because the pipeline was constructed after 1970. Paragraph (a)(4) could be satisfied by the review required in §192.557(b).

I.3 There is no limitation of scope of Subpart K to pressure testing with natural gas while in service.

A requirement of Uprating is pressure testing. A pressure test with natural gas is permitted by Subpart J (49 CFR §192.503(c)) provided the maximum hoop stress does not exceed 30% SMYS, which should be the case for distribution pipelines. However, nothing in Subpart K indicates that it only applies to pressure testing with natural gas. The incremental pressure increases prescribed in 49 CFR §192.553(a) and 49 CFR §192.557(b) are referencing the gradual increase in pressure from lower MAOP to higher pressure, including up to the test pressure. While it was in response to a scenario related a steel pipeline, PHMSA Interpretation PI-74-017 reinforces that any increase, including to the test pressure, should be done in increments (but there is no limitation on applicability of these increments to only testing with a natural gas medium).

I.3.1 49 CFR §192.553(a)

(a) Pressure increases. Whenever the requirements of this subpart require that an increase in operating pressure be made in increments, the pressure must be increased gradually, at a rate that can be controlled and in accordance with the following:

(1) At the end of each incremental increase, the pressure must be held constant while the entire segment of pipeline that is affected is checked for leaks.

(2) Each leak detected must be repaired before a further pressure increase is made, except that a leak determined not to be potentially hazardous need not be repaired, if it is monitored during the pressure increase and it does not become potentially hazardous.

I.3.2 PHMSA Interpretation PI-74-017 (Excerpt)

The increments prescribed by section 192.557(c) apply to the increase in pressure between the existing MAOP and the test pressure or the desired MAOP multiplied by the appropriate factor in section 192.619(a)(2)(ii).

Appendix J Duplicate Pressure Test Forms

A significant document irregularity was discovered during the review of Pressure Test Forms related to Test 136 and Test 140. Each is set forth in L-1, an excerpt of the Summary provided by CMA is in L-2 and an April 2020 analysis by the Panel is at L-3.

The Pressure Test Forms in L-1 look very similar but with a few notable differences

- The Support Document referenced for Test 136 was 18-0843250-00_136 PDF:
  - For the Pressure Test, the length for 4 inch pipe on redacted Rd is shown as 1,129 feet; and
  - For the Soap Test, the Stop Time is 2:36 and Test Duration is 16 min.
- The Support Document referenced for Test 140 was 18-0843270-00_140 PDF:
  - For the Pressure Test, the length for 4 inch pipe on redacted Rd is shown as 1,606 feet;
  - For the Soap Test, the Stop Time is 2:23 and Test Duration is 3 min.

It appears that the Pressure Test Form in Support Document 18-0843250-00_136 PDF for Test 136 may be an alteration of the Pressure Test Form in Support Document 18-0843270-00_140 PDF.

In response to a request for clarification from CMA, they provided CMA_MV 15.07 Supp. 1 COMBINED CONFIDENTIAL.pdf which states:[265]

- These documents are two versions of the same Pressure Test Form;
- And "the discrepancy was caused by human error in the field when the Inspector inadvertently included an extra 487' of pipe on redacted St. between redacted Ave. and redacted St … The pressure test form was scanned into WMSDocs";
- And "when the Inspector realized the error in footage, he corrected the document and scanned in the updated version of the pressure test" (into WMSDocs); and
- Effectively, CMA is saying that 18-0843250-00_136 PDF is the correct version and supersedes the version 18-0843270-00_140 PDF.

J.1 Pressure Test Forms from CMA

Figure J-1 and Figure J-2 are completed pressure test forms from CMA.

[265] Because of this explanation, the version in 18-0843250-00_136 PDF for Test 136 is the version that was included in the evaluation of the 319 pressure test forms that were evaluated.

Pressure Test Form (Retain Permanently)

Company: ☐CGV ☐CKY ☑CMA ☐CMD ☐COH ☐CPA ☐NIPSCO 1808432 70-00

LOA/TCC: 8400 Pressure System No. 80001004 WO/JO: 1808432 50-00

Recording Chart: ■Yes* ☐No Recorder Serial No. 10041679 Required MAOP: 99

Pipeline or Station Pressure Test Test Acceptable: ☑Yes ☐No

Station Number: _____

Description of Station: _____

Location of Station: _____

Pipeline Description

Location of Pipeline(s)	City, Town, County, etc.	Length	Size	PE or Steel
[redacted]	Lawrence	1606	4"	PE
	Lawrence	8'	4"	PE
	Lawrence	8'	4"	PE
	Lawrence	48'	4"	PE

Start Date: 10-7-18 Start Time: 10:38 ☑AM ☐PM Test Pressure: 154 Test Medium: ☑Air ☐Nitrogen

Stop Date: 10-7-18 Stop Time: 14:38 ☐AM ☑PM Test Duration: 4 hrs ■Natural Gas

Describe any leaks or failures that occurred and explain their disposition: none

Additional Comments: _____

Print Name: [redacted] Signature: [redacted] Contractor (if applicable): _____

Leak or Pressure Test (tie-in joint, pressure control fitting, etc.) Test Acceptable: ☑Yes ☐No

Description (tie-in joint, end cap, control fitting, etc.): 4" EFC SOAP Test

Location: [redacted]

Start Date: 10-8-18 Test Medium: ☐Air ☐Nitrogen ☑Natural Gas System or Test Pressure: 99

Start Time: 2:20 ☐AM ☑PM Stop Time: 2:23 ☐AM ☐PM Test Duration: 3 mins

Describe Leak(s) and Disposition of Leak(s): _____

Additional Comments: _____

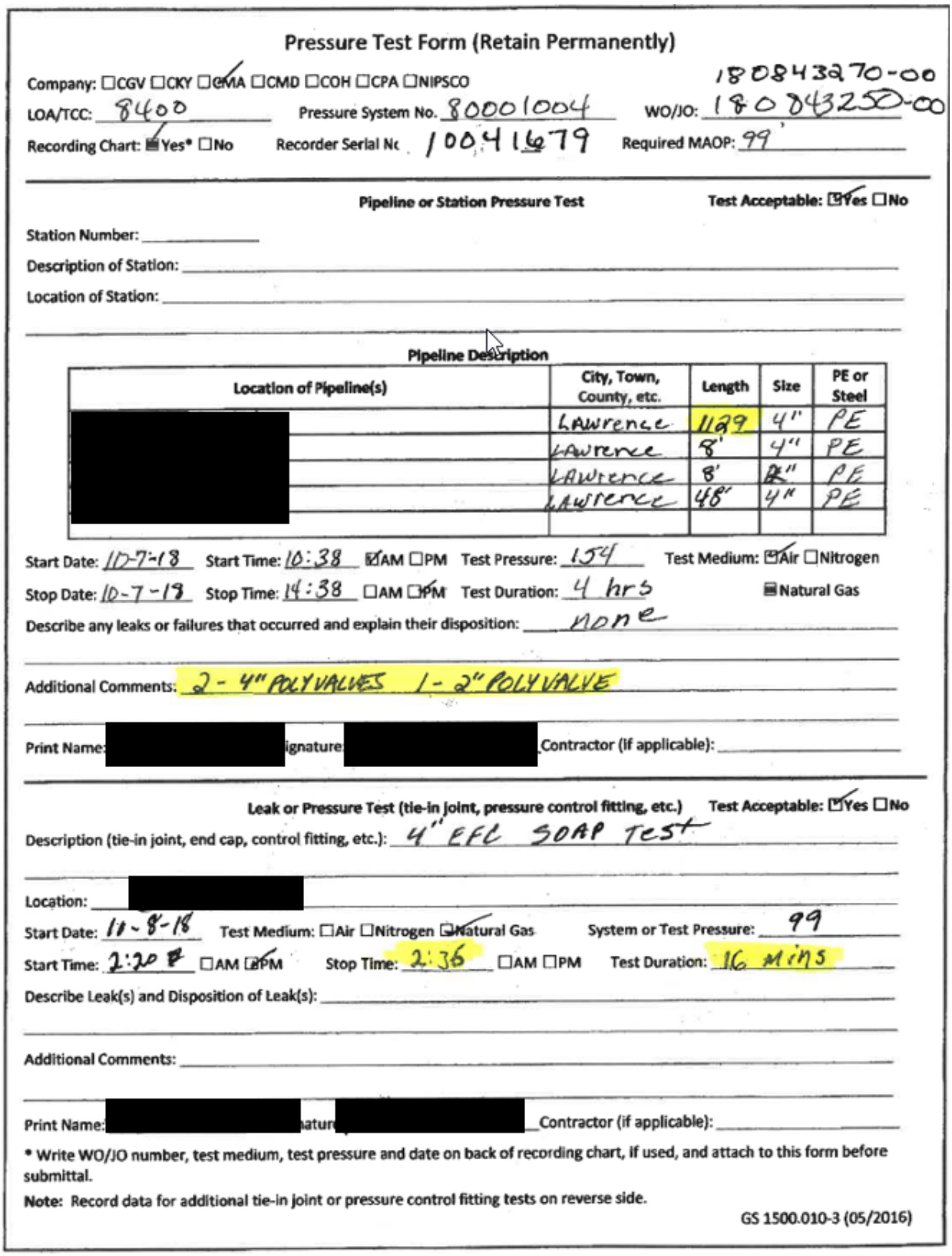
Print Name: [redacted] Signature: [redacted] Contractor (if applicable): _____

* Write WO/JO number, test medium, test pressure and date on back of recording chart, if used, and attach to this form before submittal.

Note: Record data for additional tie-in joint or pressure control fitting tests on reverse side.

GS 1500.010-3 (05/2016)

Figure J-1: Completed Pressure Test Form from CMA (1 of 2) – Redacted



Pressure Test Form (Retain Permanently)

Company: ☐CGV ☐CKY ☑CMA ☐CMD ☐COH ☐CPA ☐NIPSCO 18084327O-00

LOA/TCC: 8400 Pressure System No. 80001004 WO/JO: 180843250-00

Recording Chart: ■Yes* ☐No Recorder Serial No. 10041679 Required MAOP: 99

Pipeline or Station Pressure Test Test Acceptable: ☑Yes ☐No

Station Number: _____

Description of Station: _____

Location of Station: _____

Pipeline Description

Location of Pipeline(s)	City, Town, County, etc.	Length	Size	PE or Steel
[redacted]	Lawrence	1129	4"	PE
	Lawrence	8'	4"	PE
	Lawrence	8'	4"	PE
	Lawrence	48'	4"	PE

Start Date: 10-7-18 Start Time: 10:38 ☑AM ☐PM Test Pressure: 154 Test Medium: ☑Air ☐Nitrogen

Stop Date: 10-7-18 Stop Time: 14:38 ☐AM ☑PM Test Duration: 4 hrs ■Natural Gas

Describe any leaks or failures that occurred and explain their disposition: none

Additional Comments: 2 - 4" POLY VALVES 1 - 2" POLY VALVE

Print Name: [redacted] Signature: [redacted] Contractor (if applicable): _____

Leak or Pressure Test (tie-in joint, pressure control fitting, etc.) Test Acceptable: ☑Yes ☐No

Description (tie-in joint, end cap, control fitting, etc.): 4" EFC SOAP TEST

Location: [redacted]

Start Date: 11-8-18 Test Medium: ☐Air ☐Nitrogen ☑Natural Gas System or Test Pressure: 99

Start Time: 2:20 ☐AM ☑PM Stop Time: 2:36 ☐AM ☐PM Test Duration: 16 MINS

Describe Leak(s) and Disposition of Leak(s): _____

Additional Comments: _____

Print Name: [redacted] Contractor (if applicable): _____

* Write WO/JO number, test medium, test pressure and date on back of recording chart, if used, and attach to this form before submittal.

Note: Record data for additional tie-in joint or pressure control fitting tests on reverse side.

GS 1500.010-3 (05/2016)

Figure J-2: Completed Pressure Test Form from CMA (2 of 2) – Redacted

J.2 Pressure Test Summary Excerpt

Table J-1 is a pressure test summary excerpt.

Table J-1: Pressure Test Summary Excerpt

Unique Identifier	Pressure Test #	Support Document	Zone	Project Area	Job Order	Job Type	Start Test Pressure	End Test Pressure	Test Duration (hh:mm)	Pipe Length (feet)	Pipe Material	Pipe Size	Test Medium	OIDs of Main Segments in Test
199	129	18-0843176-00_129 PDF	3	3.3	18-0843176-00	557	155	155	02:50	1150	Plastic	4"	Air	844519, 844518, 844517
200	130	18-0843176-00_130 PDF Note: 1949 = 1945 + 2 + 2	3	3.3	18-0843176-00	557	154	154	04:30	1949	Plastic	4"	Air	844320, 844417, 844515, 844516
201	130	18-0843176-00_130 PDF Note 12 = 6 + 6	3	3.3	18-0843176-00	557	154	154	04:30	12	Plastic	2"	Air	843345, 844418, 844419
202	131	18-0843176-00_131 PDF	3	3.3	18-0843176-00	557	159	159	01:00	633	Plastic	2"	Air	844419, 844424, 844425, 844513, 859315, 859316
203	132	18-0843178-00_132	3	3.4	18-0843178-00	557	150	150	05:00	1175	Plastic	4	Air	841112, 841087, 841085, 841063
204	132	18-0843178-00_132	3	3.4	18-0843178-00	557	150	150	05:00	1177	Plastic	2	Air	841072, 841073, 841074, 841075, 841107, 841078, 841079,841080, 841106
205	133	18-0843178-00_133	3	3.4	18-0843178-00	557	153	153	01:00	40	Plastic	4	Air	841063
206	134	18-0843178-00_134	3	3.4	18-0843178-00	557	157	157	02:30	512	Plastic	2	Air	841088,841105,841065
207	134	18-0843178-00_134	3	3.4	18-0843178-00	557	157	157	02:30	422	Plastic	4	Air	841061
208	134	18-0843178-00_134	3	3.4	18-0843178-00	557	157	157	02:30	1	ST	4	Air	841059
209	135	18-0843180-00_135 PDF	3	3.4	18-0843180-00	557	154	154	01:00	1268	Plastic	2"	Air	841082, 841083, 841084
210	136	18-0843250-00_136 PDF	3	3.5	18-0843250-00	557	154	154	04:00	8	Plastic	2"	Air	842118, 842117
211	136	18-0843250-00_136 PDF	3	3.5	18-0843250-00	557	154	154	04:00	1662	Plastic	4"	Air	843651, 842119, 842114, 843349, 842123, 842120, 842115, 843652, 842122, 842116
212	137	18-0843270-00_137 PDF	3	3.5	18-0843270-00	557	156	156	01:00	1454	Plastic	2"	Air	842971, 842974, 842972, 842973
213	137	18-0843270-00_137 PDF	3	3.5	18-0843270-00	557	156	156	01:00	3	Plastic	4"	Air	842964
214	138	18-0843270-00_138 PDF	3	3.5	18-0843270-00	557	153	153	02:00	19	Plastic	2"	Air	842229, 842231, 842965
215	138	18-0843270-00_138 PDF	3	3.5	18-0843270-00	557	153	153	02:00	491	Plastic	6"	Air	842227, 842963
216	139	18-0843270-00_139 PDF	3	3.5	18-0843270-00	557	156	156	01:00	1334	Plastic	2"	Air	842231, 842232, 842233
217	140	18-0843270-00_140 PDF	3	3.5	18-0843270-00	557	154	154	04:00	1606	Plastic	4"	Air	842126

J.3 Pressure Test from Mark Up

Figure J-3 is the pressure test from mark up.

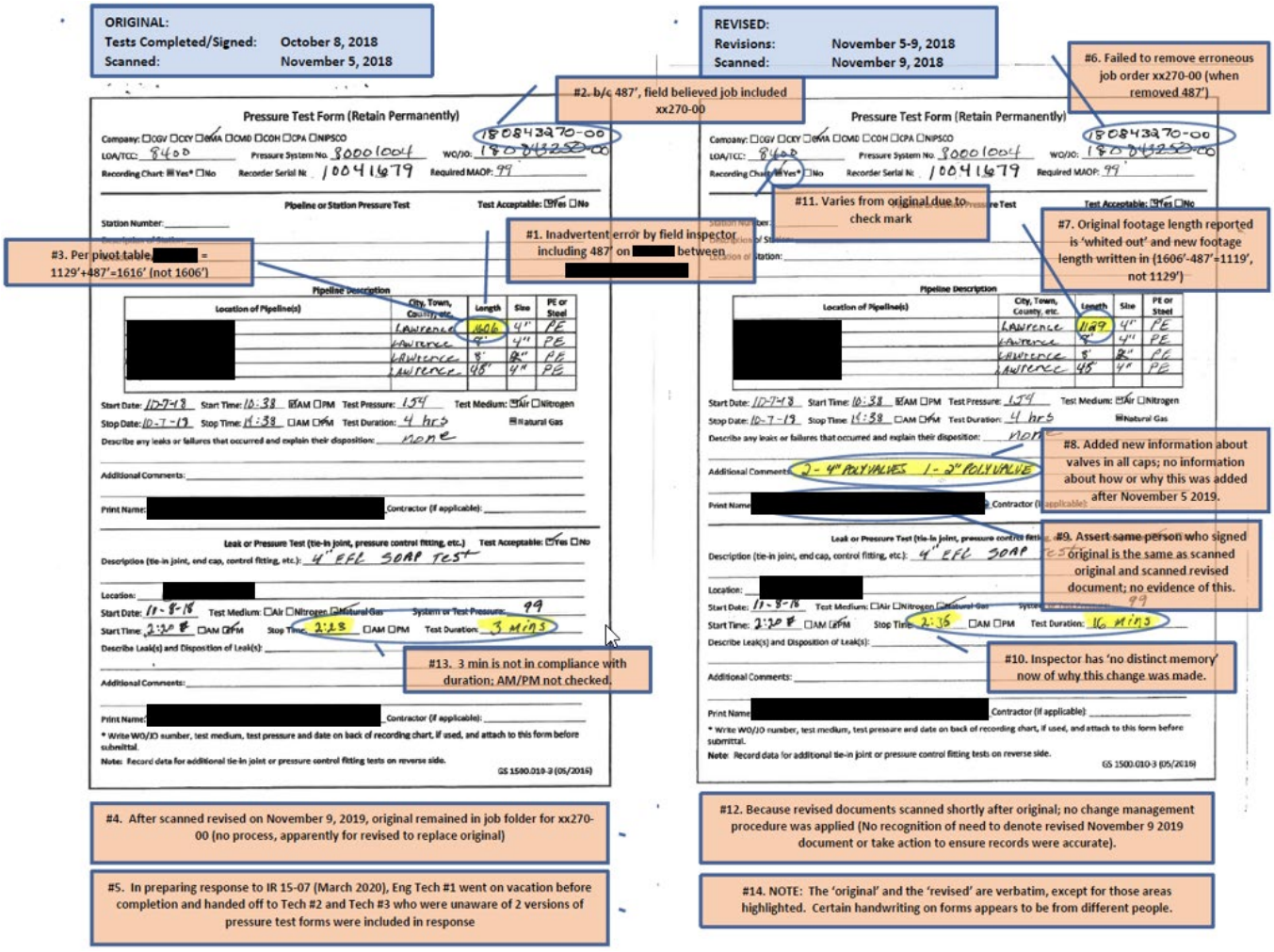


Figure J-3: Pressure Test from Mark Up (Redacted)

Appendix K Leak Data

This appendix provides additional information about the gas leaks on the Renewed Assets from the time the assets were put into service until March 22, 2017.[266]

K.1 Saddle Tee Leaks

Three gas leaks have occurred on saddle tees on the Renewed Assets since September 2018. Below, CMA provided more information about each of the leaks.[267]

1. FFR 54270
    - Cold slug in the underside;
    - Still investigating the potential quantity that may have been purchased;
    - From March 2018 to March 2020 there were a total of 7914 parts produced;
    - CMA brought 707 pieces into inventory;
    - About 90 pieces remaining in its Wrentham, Massachusetts a Construction facility; and
    - The Company will continue to assess the system through leakage surveys.
2. FFR 38455
    - Destructive testing of the fusion joint showed there was incomplete fusion of the two mating surfaces;
    - Attributed to inadequate pipe surface preparation;
    - Operator installation error;
    - Suspended the OQs for person who performed the electrofusion and inspector who was overseeing the electrofusion; and
    - QA/QC visits at three sample sites where they worked for spot check.
3. FFR 54215
    - Tee was fused to the bottom of the gas main and used as a drip;
    - Tee cap was not installed concentrically with the service tee chimney;
    - Installed exhibiting 5-6 threads exposed on the tee chimney;
    - Found the top five threads of the service tee chimney to be stripped;
    - Cap was found to have marks indicative that a tool for tightening; and
    - Investigation concluded that the leak occurred as a result of operator installation error.

[266] This is the date of CMA's submission responding to IR 15. On April 17, 2020, the Panel informed CMA that it no longer had to report leak data to the Panel pursuant to IR 08.01, except for any Grade 1 leaks which the Panel asked it be informed about until the completion of this Final Report.

[267] See response to IRs 15.21(a), 15.21 (b) and 15.21, respectively.

K.2 Leaks Remaining in the Renewed Assets and related Legacy System

CMA has resurveyed the remaining open leaks to confirm there has been no change in criteria.[268] Based on follow-up surveys, the following probable leak sources are noted below:[269]

- D404384 – Leak appears to be on the service tee cap;
- D401940 – A duplicate to D404384 and has been cleared;
- D402025 – Leak appears to be on the service tee cap;
- D404386 – Leak appears to be on the service tee cap;
- D401938 – No leak was detected and the leak was cleared as a negative read;
- D401936 – Leak appears to be on the service tee cap;
- D404380 – Leak was reclassified (D308216) to a grade 2 and appears to be on the service tee cap;
- D401935 – A duplicate to D404380 and has been cleared; and
- D405455 – No leak was detected and the leak was cleared as a negative read.

CMA also indicated it will submit a formal request to the DPU and cities to excavate and repair the remaining five leaks on the Renewed Assets when the winter moratorium has ended.

Based on CMA's Facility Failure 2019 year-end report, CMA provided this additional update about Gas Leaks on the Renewed Assets:[270]

- Mechanical fittings are and have been the top threat since 2016;
- The number of failures continue to increase;
- Stab fittings and cap tees are on a steady incline; and
- Leaks attributed to not following procedures.

Based on CMA's *Plastic Piping Data Collection Initiative Status Report*, research found that 1.3% of all fitting failures are due to stab fittings and 27% due to caps .[271]

K.3 Leak Survey Methodology

CMA indicated its modification of leak survey methodology resulted in an increased discovery of leaks over time. It is unclear whether this is true. While CMA did not collect data to indicate the precise location of each of the surveys. As such, it is unclear whether each survey covered 100% of the Renewed Assets or only a portion thereof. Without knowing the distribution of leakage surveys, additional surveys and tools cannot demonstrate that all leaks are being found.

CMA's leak report attempts to justify their large number of leaks shortly after construction by stating that the majority of CMA's leaks were found during their initial supplemental surveys. Appendix A of

[268] These were the gas leaks remaining on the Renewed Assets as of April 17, 2020.

[269] These data were provided in response to IR 15.32.

[270] In response to IR 15.24 (d).

[271] In response to IR 15.24 (e) (CMA references this report to talk about the number of leaks for stab fitting and cap tees.)

this report showed three surveys dated between September 2018 and December 2018, but only one supplemental survey was performed that could have increased the number of leaks. After reviewing the leak data for how leaks were discovered, 9 out of 37 leaks were discovered with a supplemental survey.

K.4 Leak Cause

From the time the Renewed Asset was put into service to March 22, 2020, the majority of leaks on the Renewed Asset were caused by incorrect operations which is a term that is defined by PHMSA. CMA uses this term to include issues with installation and construction. These leaks are also attributed to service tee caps and stab fittings. See Figure K-1 and Figure K-2.

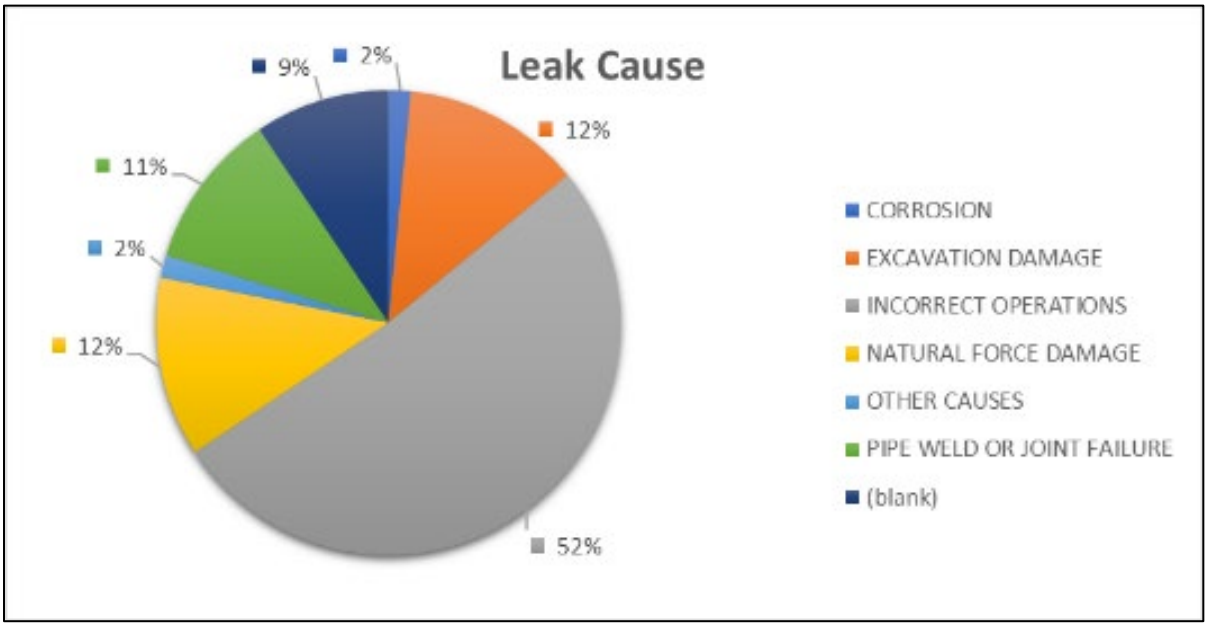


Figure K-1: Leak Cause by Asset

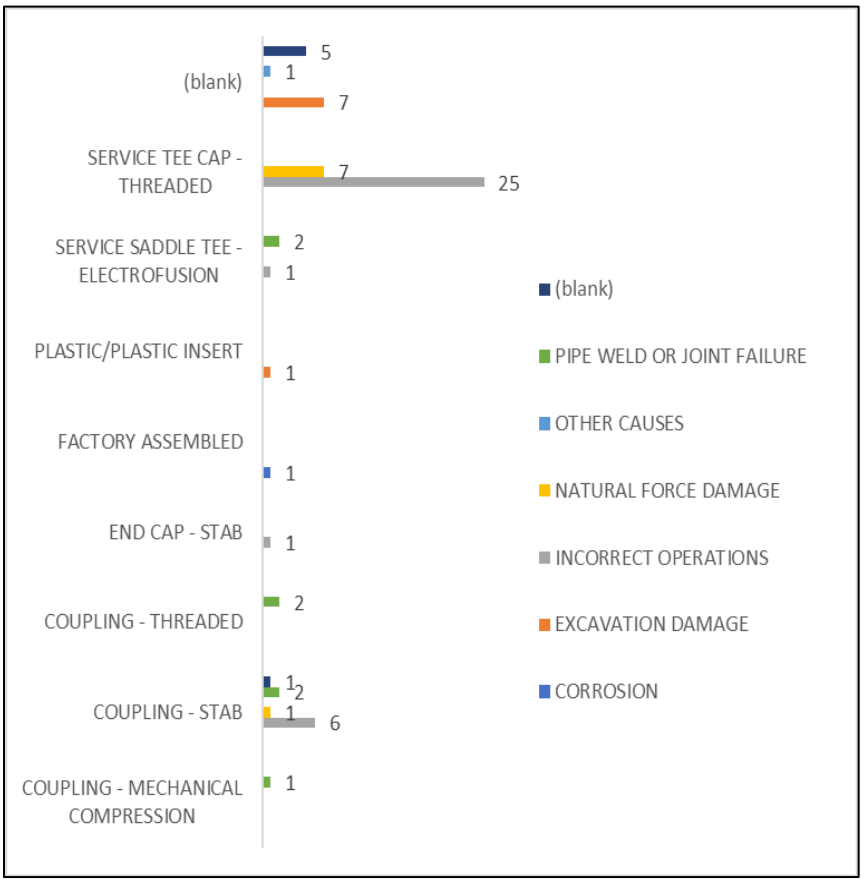


Figure K-2: Leak Cause

CMA compared their failure causes (Attachment CMA_MV 15.24(d)) over the last five years, which revealed an upward trend in their incorrect operations. In the 4th quarter of 2018, 28 of their leaks were caused by incorrect operations. This means that more than half of CMA's leaks were caused by incorrect operations in 2018. See Figure K-3.

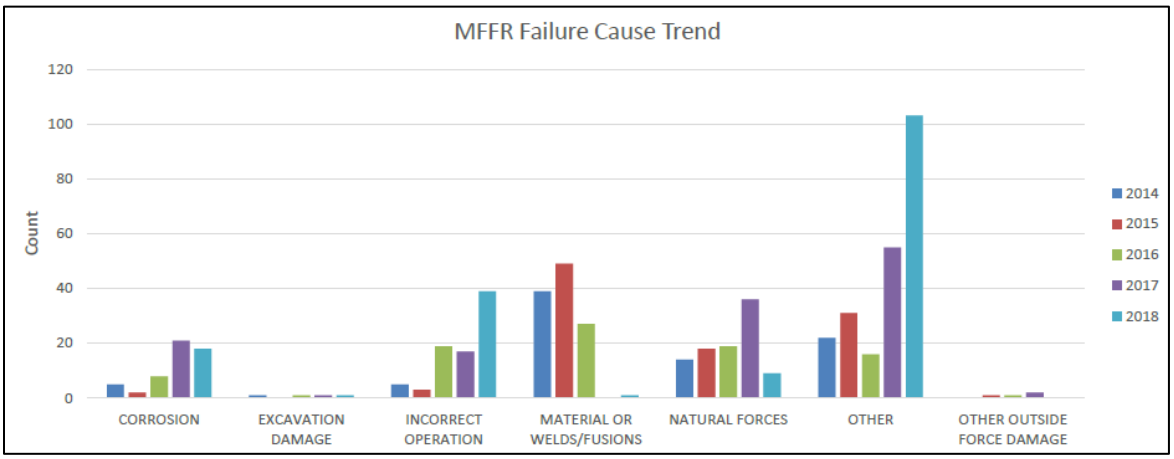


Figure K-3: Materials Facility Failure Report Failure Cause Trend (Attachment CMA_MV 15.24(d))

Out of 37 leaks on the Renewed Assets in the 4th quarter of 2018, a majority (94%) of the leaks were attributed to Service Tee Caps (see Figure 6). Their report claimed these surveys were performed for QC and that they are not a typical practice for new construction. If QC were a point of focus, their leak analysis could have been performed sooner than 2/3/2020. Further, these surveys could have raised concern immediately about quality and the success of the Restoration Project for the renewed asset. A new system that has many leaks immediately after a system is put into service does not provide confidence in CMA's quality of work or QC and inspection programs. CMA could have completed a review in material selection, construction and inspection. Lastly, testing could have been performed based on their findings. See Figure K-4.

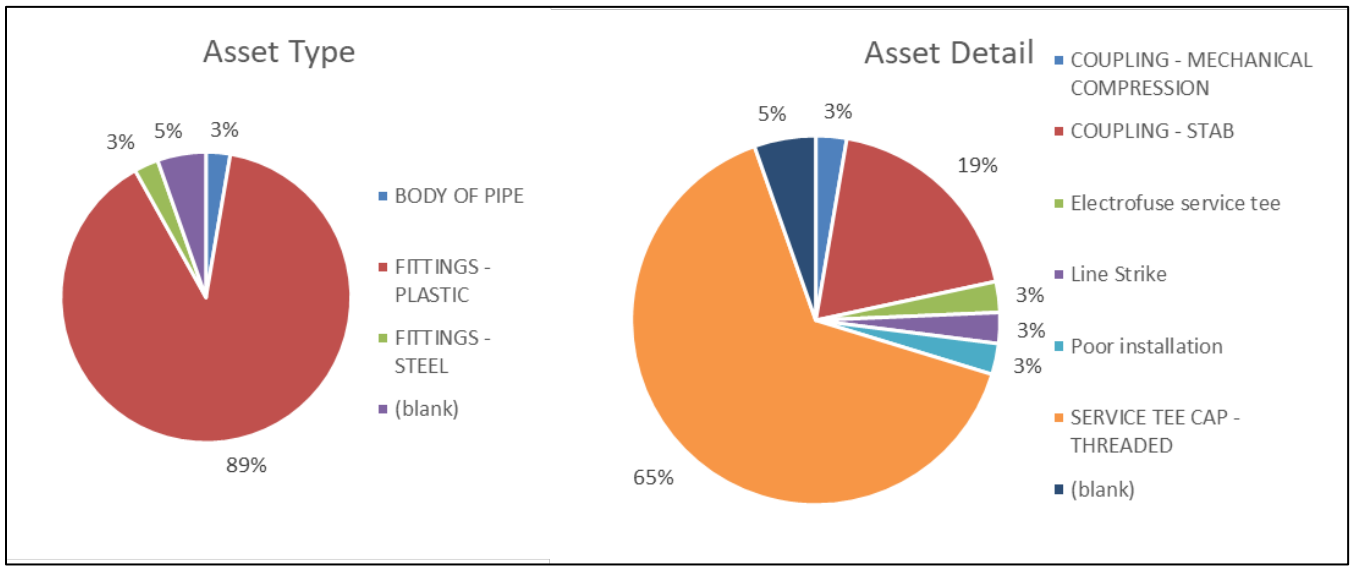


Figure K-4: Leaks by Asset Type and Asset Detail

K.5 Industry Issue

CMA asserts that stab fittings and caps are the leading source of leaks industry wide.[272] CMA provided a report prepared by the Plastic Pipe Database Committee (PPDC), entitled "Plastic Piping Data Collection Initiative Status Report (August 2019)"[273]. PPDC's research found that 1.3% of all fitting failures are due to stab fittings and 27% due to caps. CMA has a higher percentage of failure with these couplings.

K.6 Errors in CMA Leak Data

CMA's leak report states they analyzed leak rates, grade, location, causes and installation method. However, after reviewing their data, CMA's data have errors, missing information and discrepancies. Missing data includes:

- Leak grade;
- Method of installation;

[272] But see, Appendix L, PHMSA data on Mechanical Fitting Failures.
[273] See Attachment CMA_MV 15.24(e).

- Person responsible for installation;
- Person responsible for testing/inspecting installation;
- Asset name;
- Asset detail;
- Description of failure; and
- Investigator details.

Appendix L PHMSA Data on Mechanical Fittings

L.1 Summary of PHMSA Data

As discussed in Section 6.2.3.3, the review of post-construction leaks in the Renewed Assets indicates that many of the leaks were related to stab fittings installed on services. Stab fittings are mechanical couplings known to be associated with leaks in the industry. In 2011, PHMSA began collecting data on hazardous leaks associated with mechanical fittings. Based on an analysis of that data, it appears that mechanical fitting failures in general and stab fitting failures specifically have been historically more of an issue in CMA than for their peers in Massachusetts, the Northeast and the United States.

L.2 Tables of PHMSA Data on Mechanical Fittings

The tables below are based on PHMSA Mechanical Fitting Failure data from 2011 to 2019,[274] and where applicable, in conjunction with the value for the Number of Services from PHMSA Annual Report data.[275],

See tables below:

- Table L-1 - Columbia Gas of Massachusetts - Mechanical Fitting Failures on Services;
- Table L-2 - United States - Mechanical Fitting Failures on Services;
- Table L-3 - Massachusetts Companies – All Mechanical Fitting Failures on Services (2011-2019);[276]
- Table L-4 - Massachusetts Companies – All Stab Fitting Failures on Services (2011-2019);
- Table L-5 - Mechanical Fitting Failures on Services Relative to Number of Services (in 2018);
- Table L-6 - Stab Fitting Failures on Services Relative to Number of Services (in 2018);
- Table L-7 - Percentage of Mechanical Fitting Failures on Services Relative to Total Number of Hazardous Leaks (in 2018);
- Table L-8 - Percentage of Stab Fitting Failures on Services Relative to Total Number of Hazardous Leaks (in 2018);
- Table L-9 – Columbia Gas of Massachusetts - Mechanical Fitting Failures on Services by Material;
- Table L-10 – United States - Mechanical Fitting Failures on Services by Material;
- Table L-11 – Comparison of Mechanical Fitting Failure Rates per Million Services in CMA, MA, NE and US; and
- Table L-12 – Comparison of Stab Fitting Failure Rates per Million Services in CMA, MA, NE and US.

[274] Data for PHMSA Mechanical Fitting Failure data may be found at: https://www.phmsa.dot.gov/data-and-statistics/pipeline/mechanical-fitting-failure-data-gas-distribution-operators.

[275] Data for PHMSA Annual Report data may be found at: https://www.phmsa.dot.gov/data-and-statistics/pipeline/gas-distribution-gas-gathering-gas-transmission-hazardous-liquids

[276] Company references in Table L-3 and Table L-4 are from PHMSA database.

Table L-1: Columbia Gas of Massachusetts - Mechanical Fitting Failures on Services

Report Year	Bolted	Nut Follower	Other Compression-type Fitting	Stab Fitting	Grand Total
2011	1	71	-	10	82
2012	1	35	-	4	40
2013	7	67	-	15	89
2014		63	-	5	68
2015		83	1	10	94
2016		58	3	17	78
2017	1	89	4	18	112
2018	2	85	1	40	128
2019	4	67	47	32	150
Grand Total	**16**	**618**	**56**	**151**	**841**

Table L-2: United States - Mechanical Fitting Failures on Services

Report Year	Bolted	Nut Follower	Other Compression-type Fitting	Stab Fitting	Grand Total
2011	369	4029	1721	785	6904
2012	443	3929	1189	1043	6604
2013	488	5480	1042	1217	8227
2014	580	6038	1562	1132	9312
2015	718	7725	2264	1121	11828
2016	549	10186	2190	1566	14491
2017	548	6882	2646	1353	11429
2018	637	8046	3137	1624	13444
2019	229	2048	2148	558	4983
Grand Total	**4,561**	**54,363**	**17,899**	**10,399**	**87,222**

Table L-3: Massachusetts Companies – All Mechanical Fitting Failures on Services (2011-2019)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	Grand Total
Berkshire Gas Co	2	3	11	16	25	17	6	3	9	92
Blackstone Gas Co		1	2		1					4
Boston Gas Co	3		2			1	1			7
Columbia Gas of Massachusetts	82	40	89	68	94	78	112	128	150	841
Essex County Gas Co		2					1			3
Fitchburg Gas & Electric Light Co	2	9	16	10	8	5	3		3	56
Holyoke Gas & Electric Dept, City Of		1	7	14	9				1	32
Liberty Utilities (New England Natural Gas Company) Corp						1	2	2	1	6

	2011	2012	2013	2014	2015	2016	2017	2018	2019	Grand Total
Liberty Utilities Massachusetts			2	4	6	7				19
Middleborough Gas & Electric Dept				1	70	1		3	2	77
Middleborough Gas & Electric Dept	2									2
New England Gas Company	3	2								5
NSTAR Gas Company				3	5			1	5	14
Grand Total	**94**	**58**	**129**	**116**	**218**	**110**	**125**	**137**	**171**	**1,158**

Table L-4: Massachusetts Companies – All Stab Fitting Failures on Services (2011-2019)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	Grand Total
Berkshire Gas Co	1	3	4	10	5	12	1	3	8	47
Blackstone Gas Co			1							1
Boston Gas Co	1		2			1	1			5
Columbia Gas of Massachusetts	10	4	15	5	10	17	18	40	32	151
Fitchburg Gas & Electric Light Co						1	2		3	6
Liberty Utilities Massachusetts			2							2
Middleborough Gas & Electric Dept				1		1		2	1	5
Middleborough Gas & Electric Dept	1									1
NSTAR Gas Company				1	1				2	4
Grand Total	**13**	**7**	**24**	**17**	**16**	**32**	**22**	**45**	**46**	**222**

Table L-5: Mechanical Fitting Failures on Services Relative to Number of Services (in 2018)

	Number of Services (2018)	Mechanical Fitting Failures (2018)	Mechanical Fitting Failures per Million Services (2018)
Columbia Gas of Massachusetts	273,847	128	467
United States	69,343,726	13,444	193

Table L-6: Stab Fitting Failures on Services Relative to Number of Services (in 2018)

	Number of Services (2018)	Stab Fitting Failures (2018)	Mechanical Fitting Failures per Million Services (2018)
Columbia Gas of Massachusetts	273,847	40	146
United States	69,343,726	1,624	23

Table L-7: Percentage of Mechanical Fitting Failures on Services Relative to Total Number of Hazardous Leaks (in 2018)

	Total Number of Hazardous Leaks (2018)	Mechanical Fitting Hazardous Leaks (2018)	Percentage of Mechanical Fitting Leaks to Total Leaks (2018)
Columbia Gas of Massachusetts	1,035	128	12%
United States	173,820	13,444	8%

Table L-8: Percentage of Stab Fitting Failures on Services Relative to Total Number of Hazardous Leaks (in 2018)

	Total Number of Hazardous Leaks (2018)	Stab Fitting Hazardous Leaks (2018)	Percentage of Stab Fitting Leaks to Total Leaks (2018)
Columbia Gas of Massachusetts	1,035	40	4%
United States	173,820	1,624	1%

Table L-9: Columbia Gas of Massachusetts - Mechanical Fitting Failures on Services by Material

Report Year	PLASTIC	STEEL	Grand Total
2011	73	9	82
2012	33	7	40
2013	63	26	89
2014	58	10	68
2015	78	16	94
2016	45	33	78
2017	60	52	112
2018	82	46	128
2019	68	82	150
Grand Total	**560**	**281**	**841**

Table L-10: United States - Mechanical Fitting Failures on Services by Material

Report Year	BRASS	COMBINATION PLASTIC AND STEEL	OTHER	PLASTIC	STEEL	UNKNOWN	Grand Total
2011	73	423	72	1984	4075	277	6904
2012	156	437	72	2030	3823	86	6604
2013	173	530	66	2408	4958	92	8227
2014	205	545	107	2657	5574	224	9312
2015	476	630	215	3151	7236	120	11828
2016	1008	456	66	2825	9440	696	14491
2017	247	348	55	2727	7419	633	11429

Report Year	BRASS	COMBINATION PLASTIC AND STEEL	OTHER	PLASTIC	STEEL	UNKNOWN	Grand Total
2018	289	453	89	3609	8491	513	13444
2019	13	243	43	1067	3588	29	4983
Grand Total	**2640**	**4065**	**785**	**22458**	**54604**	**2670**	**87222**

Table L-11: Comparison of Mechanical Fitting Failure Rates per Million Services in CMA, MA, NE and US

	Mechanical Fitting Failures on Services per Million Services (2018)	Mechanical Fitting Failures on Services per Million Services (2011-2019)*
Columbia Gas of Massachusetts	467	3,071
Massachusetts	102	859
Northeast	248	1,533
United States	194	1,258

* Failure rate based on number of services in PHMSA Annual Report for 2018 Report Year.

Table L-12: Comparison of Stab Fitting Failure Rates per Million Services in CMA, MA, NE and US

	Stab Fitting Failures on Services per Million Services (2018)	Stab Fitting Failures on Services per Million Services (2011-2019)*
Columbia Gas of Massachusetts	146	551
Massachusetts	33	165
Northeast	41	255
United States	23	150

* Failure rate based on number of services in PHMSA Annual Report for 2018 Report Year.

* Failure rate based on number of services for 2018 Report Year.

Appendix M Analysis of TRC Materials Report

M.1 TRC November 2019 Report Review

TRC evaluated CMA's Legacy System in 13 areas of focus with factors ranging from historical, code requirements, outside forces and operator process. These are discussed below.

The 13 areas of focus include:

1. Improper regulator orifices
   - Additional efforts to ensure overpressure protection due to specifications of the 1813B service regulators.
     - CMA could not locate the regulators
     - Per the report, "field review of all customer accounts to determine which customer would require a regulator equivalent in size to an 1813B in question".
     - 751 sites evaluated with 5 improper regulator orifices. Four were remediation with one pending.
2. Plastic Failure Data Review
   - Review of CMA plastic failure data from 2009-2019 for entire 99 psig system in MV.
     - "No plastic fittings failures were experienced due to improper pressure rating."
     - "Remaining plastic failures were consistent with industry norms"
3. Yellow 80 psig Fittings on 99 psig system
   - Specific type of 80 psig yellow medium-density polyethylene (MDPE) fittings used in CMA's 99 psig system and the SDR11 MDPE pipe was limited to 80 psig by code prior to January.
   - Manufacturer provided updated documentation and testing showing their fittings were acceptable for a 99 psig system
4. Bare Steel Services
   - Risk of bare steel services and concerns with CMAs documentation of bare steel services. Recommendations:
     - Field verify all services for proper designation as inside or outside [meter] sets.
     - Before pressure restoration of the Lawrence 99 psig system,
     - An effort to increase confidence of inside bare steel service should be made to better evaluate the bare steel services.
     - Inside service inspection of wall penetration for corrosion and leak check where records indicate bare steel or unknown material.
     - Replace any remaining outside bare steel service be the end of 2020 4th quarter and any main to property bare steel service lines when the bare steel main is replaced.
5. Leak Analysis
   - CMA's leak history on plastic and coated steel mains in the 99 psig system is consistent with the industry, but they have a higher number of leaks and severity on bare steel mains and services than their plastic lines. Recommendation:
     - Accelerate replacement of all bare steel lines
     - Increased leak survey intervals until segments are replaced.
6. Pressure Test review (Services in restored are of 99 psig system)
   - Adequate satisfactory (ANSI Quality Standard Z 1.4 and CMA standards) pressure test records exist for a statistical sampling of 210 SLR out of 4,606 services installed.
   - Inadequate records for sampling documenting leak test of tie-ins were observed.
7. Pressure Test review (Services outside restored are of 99 psig system)
   - Sampling from post 1998 population of service of 200 services resulted in data quality due to age of records. Report and findings not completed.

TRC evaluated CMA's Legacy System in 13 areas of focus with factors ranging from historical, code requirements, outside forces and operator process. These are discussed below.

The 13 areas of focus include:

8. Pressure Test Review (Mains in restored area of 99 psig system)
   - Sampling of 20 workorders out of 104 with adequate records for pressure test with 1 missing in-service leak testing a tie-in joint record missing. Additional 20 workorders were randomly selected with no deficiencies.
9. Pressure Test Review (Mains outside restored area of 99 psig system)
   - "Less than 1% of the total population of 312.4 miles of pipeline records could not be found." CMA's capital close-out process ensures compliance.
10. Regulator Station Review
    - Station are adequate but TRC noted deficiencies and recommendations for industry best practice.
11. Service Regulators Review
    - Review and report not complete as of date of Review.
12. LNG/Propane-air/ Regulator station analysis
    - Adequate design for 99 psig system with no concerns
13. Hydraulic Model Validation
    - To meet peak demands CMA needs to return system to at least 84 psig as soon as possible after recommendations are followed.

Appendix N Review of QA/QC and TRC Audits

N.1 CMA QA/QC Audits

Table N-1 to Table N-3 contain CMA QA/QC Audit data.

Table N-1: Number of Site Audits with Findings by Finding Category

Finding Category	CMA QA/QC Site Audits with At-risk Findings	Percentage of CMA QA/QC Site Audits with At-risk Findings
Joining	10	7%
Installation	6	4%
Pressure Testing	6	4%
Construction Safety	4	3%
All Categories	**26**	**18%**
Total Audits	**147**	**-**

Table N-2: Total Findings by Finding Category

At Risk Finding Category	CMA QA/QC At-risk Findings	Percentage of CMA QA/QC At-risk Findings by Category
Joining	12	41%
Installation	6	21%
Pressure Testing	7	24%
Construction Safety	4	14%
All Categories	**29**	**-**

Table N-3: Audits and Findings by Construction Zone

Construction Zone	Number of CMA QA/QC Site Audits	Percentage of Site Audits in Zone	At-risk Findings in Zone
1	33	22%	2
2	11	7%	3
3	23	16%	10
4	15	10%	6
5	16	11%	2
6	23	16%	1
7	21	14%	4
8	5	3%	1
Total	**147**	**-**	**29**

N.2 TRC QA/QC Audits

Table N-4 to Table N-6 contain TRC QA/QC Audit data.

Table N-4: TRC Audits and Observations by Construction Zone

Construction Zone	Number of TRC Audits	Percentage of TRC Audits in Zone	Unsatisfactory Observations in Zone
1	160	12%	0
2	170	13%	19
3	120	9%	2
4	152	12%	4
5	182	14%	11
6	231	18%	22
7	193	15%	9
8	111	8%	1
Total	**1,319**	**-**	**68**

Table N-5: Unsatisfactory Observations by Finding Category

TRC Unsatisfactory Observation Category	TRC Unsatisfactory Observations	Percentage of TRC Unsatisfactory Observations by Category
Joining	51	75%
Installation	11	16%
Pressure Testing	6	9%
All Categories	**68**	**-**

Table N-6: Unsatisfactory Observations by Finding Category

TRC Unsatisfactory Observation Category	TRC Unsatisfactory Observations	Percentage of TRC Unsatisfactory Observations by Category
Joining	51	75%
Installation	11	16%
Pressure Testing	6	9%
All Categories	**68**	**-**

Appendix O CMA Reconciliation of Main Pressure Tests

As presented in Section 6.2.1.2, CMA provided the Panel with an update (May 13, 2020) on its own pressure test analysis, which is presented below. CMA subsequently provided additional analysis in a report prepared by TRC (May 19, 2020) related to the MPTs.

Columbia Gas of Massachusetts
A NiSource Company

Columbia Gas of Massachusetts High Level Overview of Additional Pressure Testing Analysis:

Pursuant to requests for more detailed pressure testing information than Columbia's current processes or system of record provides, Columbia conducted additional work to match its electronic mapping system against its as-built drawings and corresponding pressure test records. Columbia has done this for each of the 63 project areas associated with the Merrimack Valley Restoration Project, and cross referenced these processes to produce a foot-by-foot analysis. 99.5% of the system was able to be fully confirmed via tracking and traceability verification. The remaining 0.5% was verified via other records, as described below. Based on this analysis, Columbia remains confident that 100% of the mains in the Merrimack Valley Restoration project were tested at the appropriate pressure and duration.
At a high level, this tracking and traceability analysis included:

1) Added all 2,495 unique Merrimack Valley restoration Object IDs (OID's) from Columbia's electronic mapping system to an Excel document, so that the document reflected electronic mapping footage for the total 57.8 miles of tested mains.

2) Reviewed all Merrimack Valley restoration pressure test record documents to align them with each OID and populate relevant information on pressure tests in the Excel document. If a particular OID was covered by multiple pressure tests, that record was split and properly allocated to each test.

3) Summed the footage for each pressure test document and compared to the sum of the footages for the associated OIDs.

4) Recorded and investigated any exceptions. All mains were determined to have an acceptable pressure test based on available pressure test forms combined with pressure test maps.

    a. A separate pivot table (labeled Exceptions on Attachment CMA_MV 15.07 Supplemental #3 (a)) was prepared in order to identify by pressure test (Column A) where the sum of the footage listed on the Pressure Test form (Column E) is not equal to or more than the sum of the GIS length (Column D). In 36 instances, totaling 0.5% of the project footage or 1,398 feet, the pressure test form had a noted exception. A list of these exceptions and a reference to the supporting documents used to support the pressure test are provided in Attachment CMA_MV 15.07 Supplemental #3 (a).

5) Gathered supporting pressure test documents into file folders for reference.

6) Updated a Geographic Information System (GIS) shapefile to model the associations made between the pressure tests and OIDs in the excel document

Dynamic Risk's assessment has indicated an opportunity for Columbia to enhance its processes and procedures around documenting and recording pressure testing information. Columbia is currently evaluating an enhanced method for capturing pressure test start and end points, allowing for improved reconciliation of the length of pipe pressure tested against the as-built drawings.

Table O-1: Table from CMA

Pressure Test Document	Sum of GIS (OIDs) Length	Sum of PT Form Pipe Length	Difference Footage	Confidence Statement	Supporting Document
18-0842474-00_21 PDF	1151	1147	-4	Fittings detail not included in PT form, but included in pressure test	Pressure Test Layout
18-0843146-00_62 PDF	316	314	-2	Pressure Test form omits short segments but shows as tested	Pressure Test Layout
18-0843154-00_78 PDF	1152	1131	-21	Fittings detail not included in PT form, but included in pressure test	Tie In Document
18-0843164-00_89 PDF	30	20	-10	Conflicting footage between Pressure test form and as built sketch but pressure test layout shows as tested	Pressure Test Layout
18-0843166-00_93 PDF	838	834	-4	Fittings detail not included in PT form, but included in pressure test as per pressure test layout	Pressure Test Layout
18-0843174-00_120 PDF	1458	1451	-7	Fittings detail not included in PT form, but included in pressure test as per pressure test layout	Pressure Test Layout
18-0843176-00_129 PDF	1225	1150	-75	Segment of pipe omitted from pressure test form	Detail Sketch
18-0843178-00_132	2385	2352	-33	Conflicting footage between Pressure test form and as built sketch but pressure test layout shows as tested	Pressure Test Layout
18-0843186-00_152	2329	2328	-1	Fittings detail not included in PT form, but included in pressure test as per pressure test layout	Pressure Test Layout
18-0843188-00_156 1	4689	4683	-6	Fittings detail not included in PT form, but included in pressure test as per pressure test layout	Pressure Test Layout
18-0843190-00_157 PDF	934	900	-34	Conflicting footage between Pressure test form and as built sketch but pressure test layout shows as tested	Pressure Test Layout
18-0843192-00_254_255	1881	1767	-114	Conflicting footage between Pressure test form and as built sketch but pressure test layout shows as tested	Pressure Test Layout
18-0843192-00_256	507	500	-7	Conflicting footage between Pressure test form and as built sketch but pressure test layout shows as tested	Pressure Test Layout

Pressure Test Document	Sum of GIS (OIDs) Length	Sum of PT Form Pipe Length	Difference Footage	Confidence Statement	Supporting Document
18-0843192-00_259_260	1642	1637	-5	Pressure Test form short footage, but pressure test layout shows full extent of pipe tested	Pressure Test Layout
18-0843194-01_265	33	30	-3	Pressure Test form short footage, but pressure test layout shows full extent of pipe tested	Pressure Test Layout
18-0843194-01_267	1566	1563	-3	Pressure Test form short footage, but pressure test layout shows full extent of pipe tested	Pressure Test Layout and Tie-In document
18-0843194-01_274	536	500	-36	Pressure Test form short footage, but pressure test layout shows full extent of pipe tested	Pressure Test Layout
18-0843196-00_284_285	445	443	-2	Fittings detail not included in PT form, but included in pressure test as per pressure test layout	Pressure Test Layout
18-0843200-00_212 PDF	1186	1177	-9	Fittings detail not included in PT form, but included in pressure test as per pressure test layout	Pressure Test Layout
18-0843212-00_237	2098	1992	-106	Pressure Test form short footage, but pressure test layout shows full extent of pipe tested	Pressure Test Layout
18-0843212-00_240	946	939	-7	Fittings detail not included in PT form, but included in pressure test as per pressure test layout	Pressure Test Layout
18-0843214-00_248 PDF	460	455	-5	Pressure Test form short footage, but pressure test layout shows full extent of pipe tested	Pressure Test Layout
18-0843218-00_252 PDF	1813	1767	-46	Pressure Test form short footage, but pressure test layout shows full extent of pipe tested	Pressure Test Layout
18-0843218-00_256 PDF	527	525	-2	Fittings detail not included in PT form, but clearly included in pressure test, as per pressure test layout document	Pressure Test Layout
18-0843220-00_267 PDF	1058	1055	-3	Fittings detail not included in PT form, but clearly included in pressure test, as per pressure test layout document	Pressure Test Layout and Valve Sheet
18-0843228-00_276	1147	847	-300	Pressure Test form short footage, but pressure test layout shows full extent of pipe tested	Pressure Test Layout

Pressure Test Document	Sum of GIS (OIDs) Length	Sum of PT Form Pipe Length	Difference Footage	Confidence Statement	Supporting Document
18-0843236-00_299.1 PDF	119	115	-4	Fittings detail not included in PT form, but clearly included in pressure test, as per pressure test layout document	Pressure Test Layout
18-0843236-00_306 PDF	366	365	-1	Fittings detail not included in PT form, but clearly included in pressure test, as per pressure test layout document	Pressure Test Layout
18-0843242-00_336 PDF	902	901	-1	Pressure Test form short footage, but pressure test layout shows full extent of pipe tested	Pressure Test Layout
18-0843244-00_347	529	509	-20	Pressure Test form short footage, but pressure test layout shows full extent of pipe tested	Pressure Test Layout
18-0843244-00_354	466	0	-466	Pressure Test form missing footage, but pressure test layout shows extent of pipe tested	Pressure Test Layout
18-0843246-00_320 PDF	2177	2167	-10	Pressure Test form short footage, but pressure test layout shows full extent of pipe tested	Pressure Test Layout
18-0843283-00_360 PDF	999	993	-6	Fittings detail not included in PT form, but clearly included in pressure test.	Pressure Test Layout
18-0843415-00_19 PDF	566	560	-6	Fittings detail not included in PT form, but clearly included in pressure test.	Pressure Test Layout
18-0843803-00_260 PDF	925	894	-31	Fittings detail not included in PT form, but clearly included in pressure test.	Pressure Test Layout
18-0843170-00_104 PDF	798	790	-8	Fittings detail not included in PT form, but included in pressure test as per pressure test layout	Pressure Test Layout
36 Test Discrepancies			**(1,398)**		

Appendix P CMA's Response to the Final Report

CMA was provided the opportunity to review this Final Report prior to its completion. Any factual errors identified by CMA during this review period have been corrected.

This appendix contains CMA's response to the substantive contents of this report, which was limited to no more than four pages by the Guidelines for Engagement.

Columbia Gas of Massachusetts
A NiSource Company

Columbia Gas Response to Dynamic Risk Construction Assessment

Columbia Gas of Massachusetts ("CMA" or "the Company") appreciates the learning opportunities provided by this in-depth construction assessment completed by Dynamic Risk and its pipeline safety experts. Throughout the process, CMA has worked hard to engage and cooperate with this effort, recognizing that this post-incident review is a critical, invaluable step in restoring confidence in the safety of the system affected by the over-pressurization event that occurred on September 13, 2018. The Dynamic Risk Construction Assessment presents a thorough examination of the Company's work to restore gas service to the Merrimack Valley after the incident. CMA recognizes that this is a necessary step to raise the confidence of customers and communities, who deserve to receive safe and reliable gas service. To that end, the independent review of the Company's work during construction in the fall of 2018 has yielded a number of discrete recommendations that will heighten the safety of the system and provide a basis for ongoing improvement to the benefit of customers.

As the Construction Assessment suggests, the restoration work in the Merrimack Valley was a "monumental task" for the Company. CMA accepts full responsibility for the work performed during the restoration and takes the deficiencies identified by Dynamic Risk very seriously. Process rigor and recordkeeping were challenges during the restoration project and CMA recognizes that there are areas where it must improve, particularly on tracking and traceability, pressure testing and internal evaluation of its own work.

Since the incident and associated restoration, the Company has worked hard to improve its operating capabilities and safety culture to instill confidence in customers and communities that the gas service they are now receiving is safe and reliable. This objective is of paramount importance to the Company. In February 2020, NiSource announced its agreement to sell CMA to Eversource Energy. The transaction is expected to close by the end of the third quarter of 2020, following review and approval of the sale by the Department of Public Utilities. NiSource and CMA know that this is the right decision for their valued customers and the communities in which these customers live and work. As part of the transition, NiSource and CMA are working closely with Eversource to address the deficiencies identified through the Dynamic Risk Construction Assessment.

NiSource also plans to incorporate the lessons learned from the Dynamic Risk Construction Assessment into its pipeline safety program supporting all of the NiSource companies. That, along with a self-initiated independent assessment of the enterprise-wide safety culture and the implementation of the NiSource Safety Management System, will continue to advance public safety for all customers, including CMA customers in Massachusetts.

Mark Kempic
President and Chief Operating Officer – Columbia Gas of Massachusetts

Appendix Z Confidential Unredacted Information (Redacted)