nationalgrid

Raquel J. Webster
Senior Counsel

October 23, 2015

VIA HAND DELIVERY AND ELECTRONIC MAIL

Luly E. Massaro, Clerk
Rhode Island Public Utilities Commission
89 Jefferson Boulevard
Warwick, RI 02888

RE: Docket 4540 – National Grid's FY 2016 Gas Infrastructure, Safety, and Reliability Plan
<u>Risk Assessment Compliance Filing</u>

Dear Ms. Massaro:

I have enclosed ten copies of National Grid's[1] Risk Assessment Compliance Filing in compliance with the PUC's Order No. 22046 in the above-referenced docket.

Thank you for your attention to this transmittal. If you have any questions, please contact me at 781-907-2121.

Very truly yours,

Raquel J. Webster

Enclosures

cc: Docket 4540 Service List
Steve Scialabba
Leo Wold, Esq.
Jim Lanni
Don Ledversis

[1] The Narragansett Electric Company d/b/a National Grid (National Grid or the Company).

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The Narragansett Electric Company
d/b/a National Grid

Gas Infrastructure, Safety and Reliability Plan FY 2016

Risk Assessment Compliance Filing

Docket No. 4540

October 23, 2015

Submitted to:
Rhode Island Public Utilities Commission

nationalgrid

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I. Company Response

In Order No. 2046 in Docket No. 4540 (dated August 24, 2015) (Order), the Rhode Island Public Utilities Commission (PUC) instructed National Grid[1] to "provide a report to the Commission and the Division detailing its methodology of assessing risk and quantifying the reduction of risk resulting from its replacement efforts . . . ."[2] . In compliance with the Order, this report details National Grid's methodology of assessing risk and quantifying the reduction of risk.

National Grid serves approximately 260,000 customers in Rhode Island through its gas distribution network. National Grid's primary focus is on the safe and reliable delivery of natural gas throughout Rhode Island. The gas distribution system is a broad network of facilities and piping installed, operated, and maintained for more than 150 years. This network consists of 3,188 miles of gas distribution mains, 193,615 customer services, and approximately 200 custody transfer stations, pressure regulating facilities, and peak shaving plants in Rhode Island.

National Grid has developed and implemented a comprehensive set of plans, programs, policies, procedures, standards, and practices to ensure the safe and reliable operation of the gas network. The primary elements that support assessing and quantifying risk across the distribution system include the following:

1) Distribution Integrity Management Plan (DIMP) Revision 4 09-01-15 - Attachment 1-1.

2) Identification, Evaluation and Prioritization of Distribution Main Segments for Replacement (ENG04030) Procedure Revision 2 – 09/04/15 - Attachment 1-2.

3) 2014 System Integrity Report Gas Distribution Systems Trend-Based Integrity Report – Rhode Island - Attachment 1-3.

These plans, procedures, and reports form the central elements for the Company's identification and mitigation of risk associated with the gas network. These plans, procedures, and reports also provide for the identification, development and/or modification and implementation of plans and programs that are focused on further mitigating risks. Included in this process is input into the Company's financial and operating plans.

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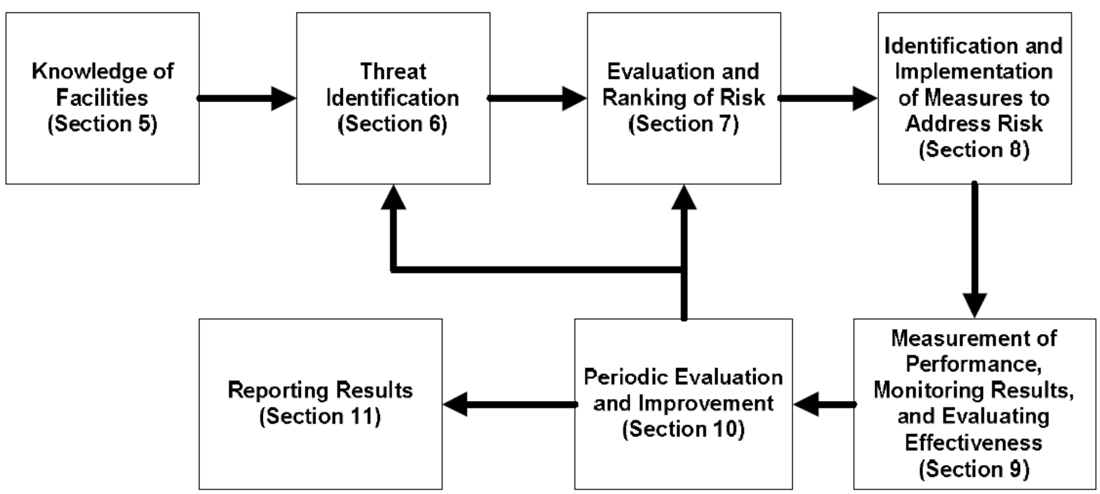
[1] The Narragansett Electric Company d/b/a National Grid (National Grid or Company).
[2] Order at p. 18, paragraph 3.

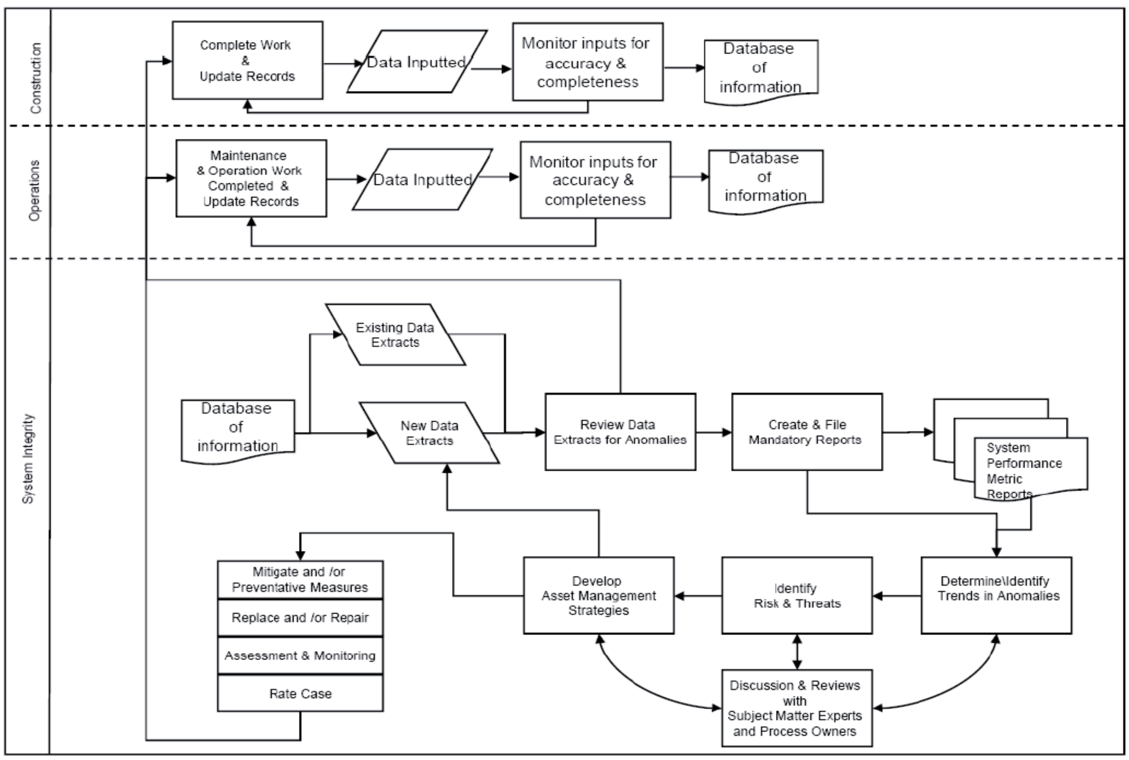
A. Distribution Integrity Management Plan (DIMP)

The Company's Distribution Integrity Management Plan (DIMP), implemented in August 2011, serves as the central component of the processes that focus on enhancing safety. The DIMP specifies the requirements for the identification and prioritization of gas distribution pipeline integrity risks. The DIMP also serves as the process for implementing measures to reduce risk and evaluate the effectiveness of the enacted measures. The Company's DIMP was developed in response to the 2009 Pipeline and Hazardous Material Safety Administration (PHMSA) rule.

The PHMSA rule requires operators of gas systems to address seven (7) areas, which are outlined in the graphic below. Each of these areas are further defined and addressed in the DIMP.



The program work flow outlined below reflect the tasks and activities that the Company carries out in support of implementation and execution of the DIMP along with the areas of responsibility for particular activities:



The DIMP identifies the system risk at the asset class level as part of the Evaluation and Ranking of Risks. Asset classes are defined, in part, by asset type (e.g., mains, services), system pressure, pipe material, and size. Details regarding the delineation of asset classing and established risk ratings may be found in the DIMP Appendices on pages RI-20 through RI-28.

Section 8 of the DIMP includes “Identification and Implementation of Measure to Address Risk”. Among other things, section 8 of the DIMP recognizes the importance of the pro-active main and service program in reducing risk and the prioritization of gas main and service replacements through incorporation of “Identification, Evaluation and Prioritization of Distribution Main Segments for Replacement” procedure (ENG0430).

B. Identification, Evaluation, and Prioritization of Distribution Main Segments for Replacement Procedure (ENG04030).

The purpose of this procedure is to identify, evaluate, and prioritize specific distribution main segments and associated services for replacement. In prioritizing the replacement segments, the Company takes into account the deterioration of the main and services, the risk to public safety, and the DIMP factor for the asset. The procedure is used by National Grid engineers for the identification of main replacement candidates that are in the Company's pro-active main replacement program in the Gas Infrastructure Safety & Reliability (ISR) Plan.

Specifically, the deterioration factor is determined by taking the following into account: main and service leak repair data for the prior 10 years, condition of main, open leaks on the main segment, and the length of main exhibiting leak activity. In addition, the risk to public safety component is developed by taking into account the population of leak classes and the types of buildings in the area (e.g., none, single family houses, small buildings, public buildings). The resulting factor is then combined with the DIMP risk score associated with that selected main segment's asset type to develop the prioritization factor. Finally, additional adjustments may be applied based upon final expert review and judgment.

One significant change in procedure associated with main and service replacement prioritization has been the recent integration of service leak data into the prioritization algorithm. National Grid has recognized the need to enhance the targeting of areas where leak prone services are prevalent to provide for further service leak reduction. This has been incorporated in the most recent procedure revision (Attachment 1-2) and is scheduled for implementation on 12/15/2015.

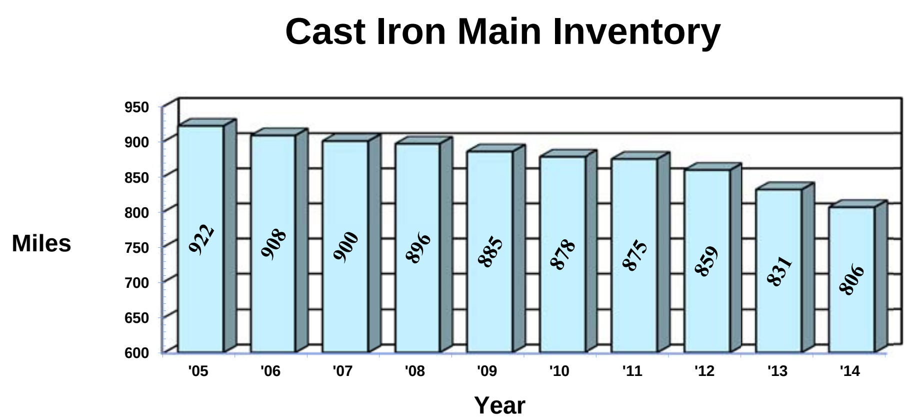
C. System Integrity Report Gas Distribution Systems Trend-Based Integrity Report

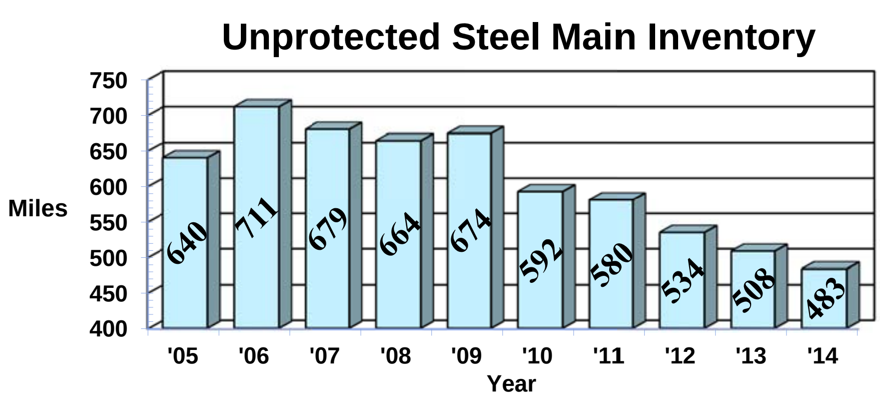
The Company's System Integrity Report also plays a key role in the DIMP with details of the report outlined in Section 5, "Knowledge of Facilities", and further expounded on in Section 9, "Measurement of Performance, Monitoring Results and Evaluating Effectiveness" of the DIMP.

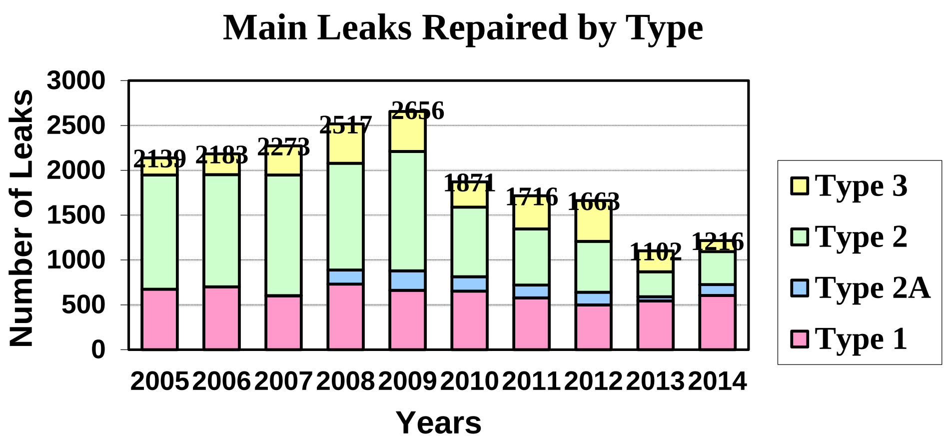
The System Integrity Report is updated and reviewed annually. The report evaluates and compares ten (10) prior years of key performance data. Trending analysis is developed around these key performance indicators to assess the effectiveness of the integrity and replacement programs. A key measure used to assess system safety and integrity is the change in system leaks and leak rates.

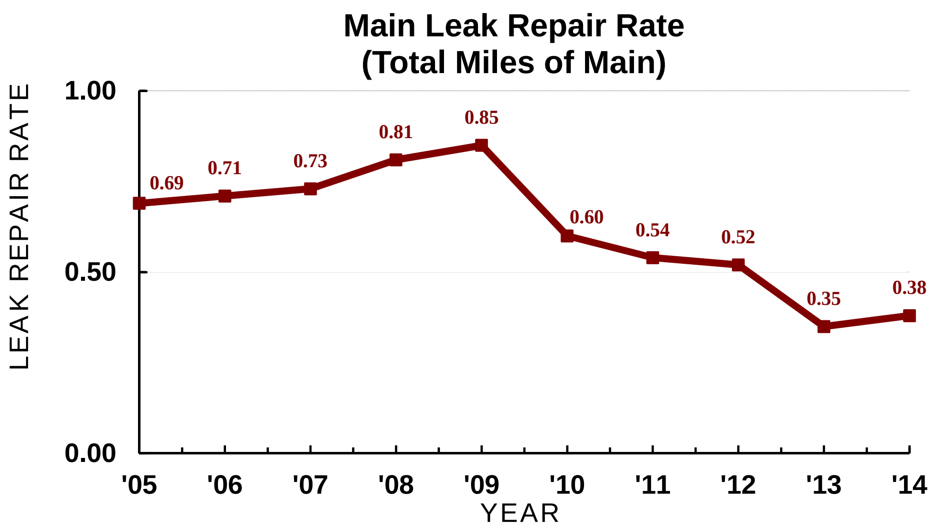
a. Gas Mains

The following graphs, which are included in the System Integrity Report, provide cast iron and unprotected steel gas main inventory and leak trends by leak type and main leak repair rate for all distribution mains in Rhode Island. These trends show a clear reduction in leak repairs and leak rates over the past six years during which accelerated main and service replacement programs have been in place. Notably, long term trending is a key component to assessing and responding to risks given the annual impact resulting from variations in weather conditions, as was evident over the past two winters. A broad set of trends are available for further review in the attached System Integrity Report.



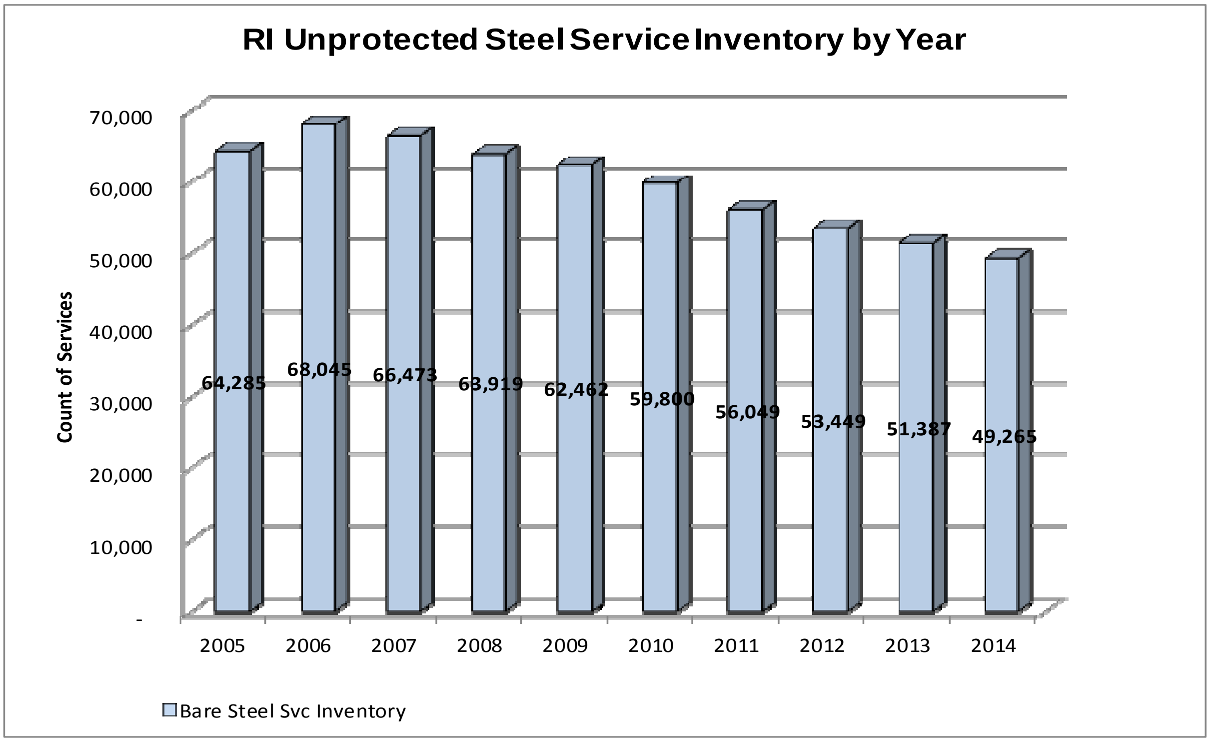


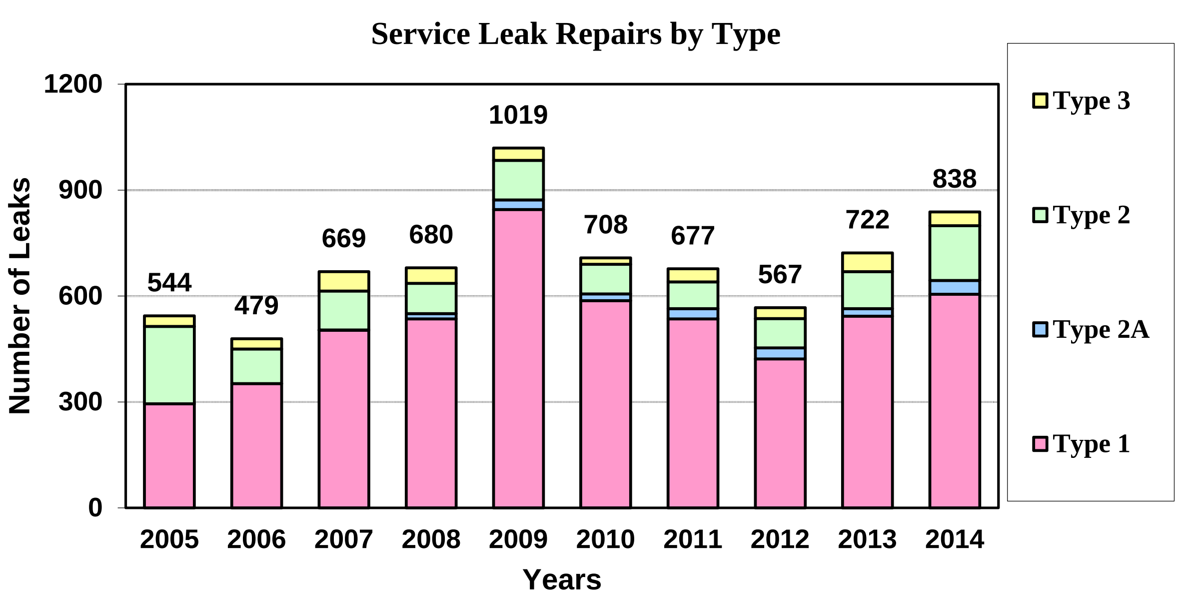


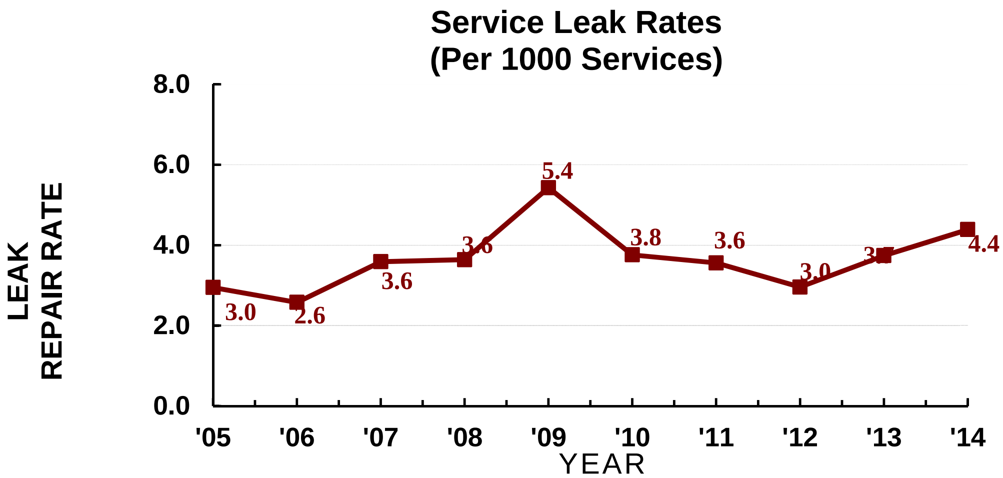


b. Gas Services

The following graphs provide the unprotected steel service inventory and leak trends by leak type and service leak repair rate of all distribution services in Rhode Island. These trends show a reduction of leak repairs and leak rates since 2009 that have been relatively stable over the past five years during which the accelerated main and service replacement programs have been in place. Long term trending is a key component to assessing and responding to risks given the annual impact resulting from variations in weather conditions, as was evident over the past two winters. A broad set of trends are available for further review in the attached report.


RI Unprotected Steel Service Inventory by Year
Count of Services
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
64,285
68,045
66,473
63,919
62,462
59,800
56,049
53,449
51,387
49,265
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Bare Steel Svc Inventory


Service Leak Repairs by Type
Number of Leaks
1200
900
600
300
0
544
479
669
680
1019
708
677
567
722
838
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Years
Type 3
Type 2
Type 2A
Type 1



The listed plans, procedures, and reports identified above provide a structured approach to risk identification and mitigation associated with the distribution network. These processes also aid in developing and refining the near and long term financial and operational programs, plans, and procedures.

National Grid currently operates 1,289 miles of cast/wrought iron and unprotected steel gas mains and 49,265 unprotected steel services in its Rhode Island gas distribution network. The Company, working in conjunction with key stakeholders, has established a replacement rate of 20 years for replacement of all cast/wrought iron and unprotected steel pipe. The DIMP, along with the numerous practices, procedures and reports, provides for continuous assessment of risks and guidance in providing mitigation strategies and efforts on the gas distribution system.

National Grid remains committed to operation of a safe and reliable gas network.

Attachments

National Grid Corporation

Gas Distribution
Integrity Management Plan

Preface

The development of this Distribution Integrity Management program was initiated in 2009 as a project involving the Northeast Gas Association, the Southern Gas Association, forty seven utilities (including National Grid), and Structural Integrity Associates. These parties collaborated to develop a best-in-class framework. Subsequent to the initial development, National Grid retained Structural Integrity to assist in the customization of the National Grid specific DIM Plan. Departments within National Grid that were directly involved in the Plan development included Operations Regulatory Compliance and Distribution Engineering. A team with representatives from these two groups was assigned the task of creating the National Grid DIM Plan by August 2011 for the U.S. gas operations.

REVISION CONTROL SHEET

Title: National Grid Corporation Distribution Integrity Management Plan

Section	Pages	Revision	Date	Comments
1-12	All	0	8/2/2011	INITIAL RELEASE
1-12	All	1	2/17/2012	REVISION 1 (Complete Re-evaluation)
1-12 & All Appendices	All	2	8/29/2013	REVISION 2 (Complete Re-evaluation)
1-12 & All Appendices	All	3	9/12/2014	REVISION 3 (Complete Re-evaluation)
1-12 & All Appendices	All	4	09/01/2015	REVISION 4 (Complete Re-evaluation)

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Section Page

1.0 COMPANY OVERVIEW

National Grid Corporation ("NGrid") is one of the largest investor-owned utilities in the world and is the largest distributor of natural gas in the Northeastern US, serving approximately 3.5 million customers in Massachusetts, New York and Rhode Island (See Figure 1-1).

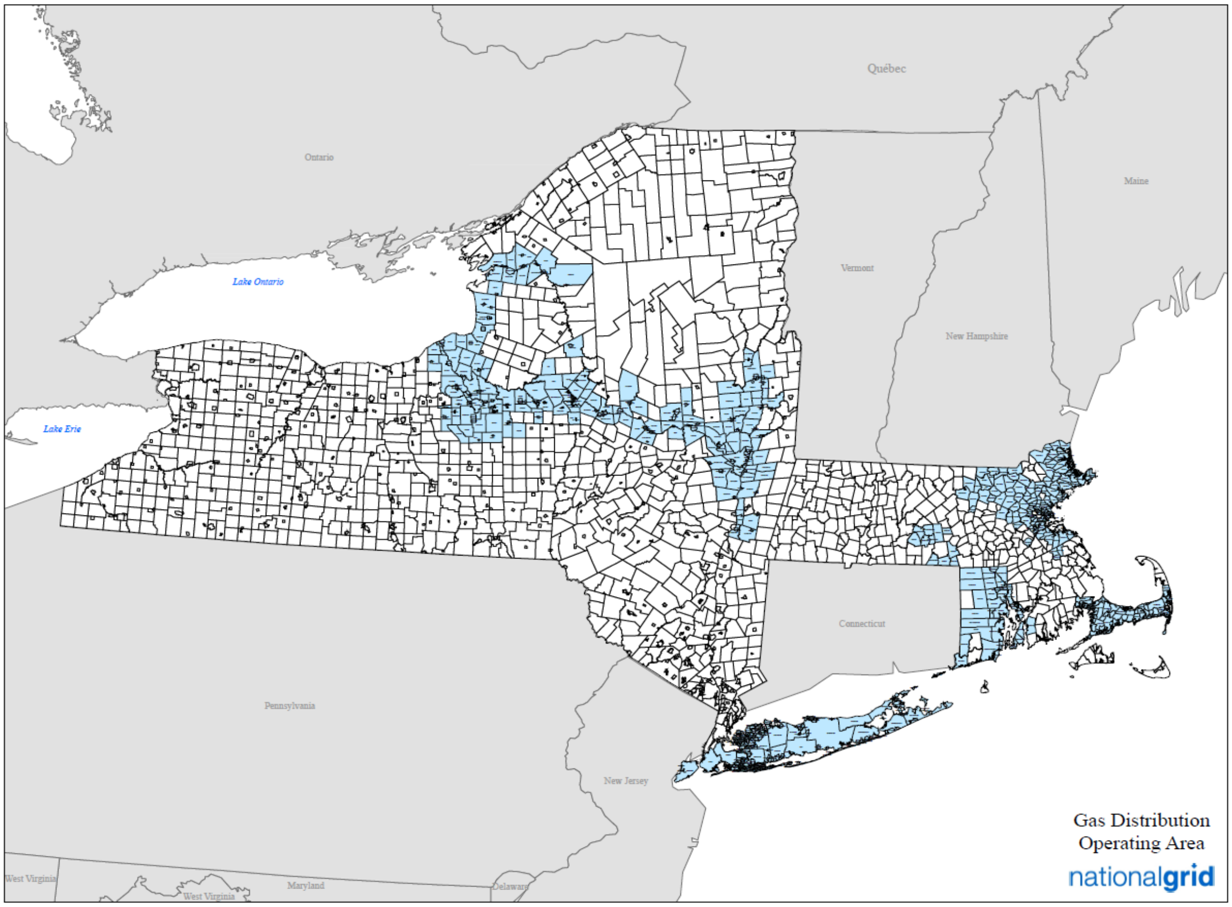


Figure 1-1

At this time, NGrid makes annual reports to The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) under the following Operator IDs:

Operator ID 4547 – Massachusetts (MA), Essex
Operator ID 11856 – Massachusetts (MA), Colonial Lowell
Operator ID 2066 – Massachusetts (MA), Colonial Cape
Operator ID 1640 – Massachusetts (MA), Boston
Operator ID 13480 – New York, Upstate (UNY)
Operator ID 1800 – New York City (NYC)
Operator ID 11713 – New York, Long Island (LI)
Operator ID 13480 – Rhode Island (RI)

2.0 SCOPE

The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) amended the Federal Pipeline Safety Regulations on December 4, 2009 to require operators of gas distribution pipelines to develop and implement a distribution integrity management (DIM) program that includes a written integrity management plan. NGrid's written integrity management plan will also comply with Code of Massachusetts Regulations 220 CMR 99 (Dig Safe Rules), 220 CMR 100.00 through 113.00 (Gas Distribution Code), New York Code, Rules and Regulations 16 NYCRR§ 255 (Transmission and Distribution of Gas), and Rhode Island Division of Public Utilities Rules and Regulations Prescribing Standards for Gas Utilities, Master Meter Systems and Jurisdictional Propane Systems.

The purpose of the DIM program is to enhance safety by identifying and reducing gas distribution pipeline integrity risks. Operators must integrate reasonably available information about their pipelines to inform their risk decisions. The DIM approach was designed to promote improvement in pipeline safety by identifying and implementing risk control measures beyond those previously established in PHMSA regulatory requirements, when warranted.

This written DIM Plan addresses the DIM Rule which requires operators to develop and implement a DIM program that addresses the following elements:

- Knowledge
- Identify Threats
- Evaluate and Rank Risks
- Identify and Implement Measures to Address Risks
- Measure Performance, Monitor Results, and Evaluate Effectiveness
- Periodic Evaluation and Improvement
- Report results

Because of the significant diversity among distribution pipeline operators and pipelines, the requirements in the DIM Rule are high-level and performance-based. The DIM Rule specifies the required program elements but does not prescribe specific methods of implementation.

This written Integrity Management Plan applies to gas distribution pipelines operated by NGrid Corporation. Gas distribution pipelines include the mains, services, service regulators, customer meters, valves, regulator stations, and other gas carrying appurtenance attached to the pipe. This Integrity Management Plan also applies to transmission pipelines that are not covered by the NGrid Transmission Integrity Management Program (IMP). Figure 2-1 below summarizes which NGrid piping systems (mains) are covered by the Transmission Integrity Management Program and which are covered by the DIM program.

Pipeline System	Approximate Miles of Mains as of 2014 PHMSA Report*	Asset Family	Integrity Program	Pipeline Attributes	NGrid Management Plans
Covered DOT Transmission	290 miles	Transmission	IMP	= or >20% SMYS and in HCA	Assessment, Preventive & Mitigative Measures
Non Covered DOT Transmission**	195 miles	Transmission	DIMP	= or >20% SMYS and NOT in HCA	Preventive, Mitigative & *Performance Measures*
Local Transmission (Distribution per §192.3)	493 miles	Transmission	DIMP	<20% SMYS >124 psi NYS > 200 psi NE	Preventive, Mitigative & *Performance Measures*
Distribution	About 35,000 miles	Distribution	DIMP	< or = 124 psi NYS < or = 200 psi NE	Preventive, Mitigative & *Performance Measures*

* *Provided for illustrative purposes, see Annual PHMSA Report for current mileage.*

** *Managed as Local Transmission under DIMP.*

Figure 2-1

This Plan also acknowledges NGrid's responsibilities relative to Oxbow Farm's master meter system in Middletown, RI in accordance with its Agreement with RI on Oxbow Farms Apartments (Docket# D-06-54). NGrid recognizes its ownership, operation and maintenance of the natural gas pipelines downstream of the Oxbow Farms master meter system. This includes performing walking leak survey on a 3 year cycle and the cathodic protection of steel facilities.

All piping was included in its respective asset category for threat identification, risk ranking, risk mitigation, and all other requirements as identified in 49CFR, Part 192.1015.

This plan does not cover:

Customer owned lines – piping downstream of the service line (as defined in Section 4.0).

Gathering lines –NGrid does not currently own or operate gas gathering lines.

Transmission lines covered under the NGrid IMP

Liquefied Natural Gas (LNG) Plant Facilities – the pipe, vessels, tanks, valves and appurtenances used in liquefied natural gas peak shaving facilities are designed, constructed, operated and maintained in accordance with the requirements established in 49CFR, Part 193.

3.0 PURPOSE AND OBJECTIVES

The purpose of the DIM program is to enhance safety by identifying and reducing gas distribution pipeline integrity risks. Managing the integrity and reliability of the gas distribution pipeline has always been a primary goal for NGrid; with design, construction, operations and maintenance activities performed in compliance with or exceeding the requirements of the Code of Federal Regulations (CFR) and as well as the following where applicable: Code of Massachusetts Regulations 220 CMR 99 and 100.00 through 113.00, New York Code, Rules and Regulations 16 NYCRR§ 255 (Transmission and Distribution of Gas), and Rhode Island Division of Public Utilities Rules and Regulations Prescribing Standards for Gas Utilities, Master Meter Systems and Jurisdictional Propane Systems.

The objective of this DIM Plan is to establish the requirements to comply with 49CFR § 192.1005, 192.1007, 192.1009, 192.1011, and 192.1013 (and 192.1015 for the master meter system in Middletown, RI) pertaining to integrity management for gas distribution pipelines. NGrid does not currently propose to reduce the frequency of periodic inspections and tests as allowed by 192.1013, but may submit such proposals for consideration and concurrence by regulators in the future.

The DIM Plan is comprised of seven elements depicted in Figure 3-1 (DIM Plan Section reference also provided).

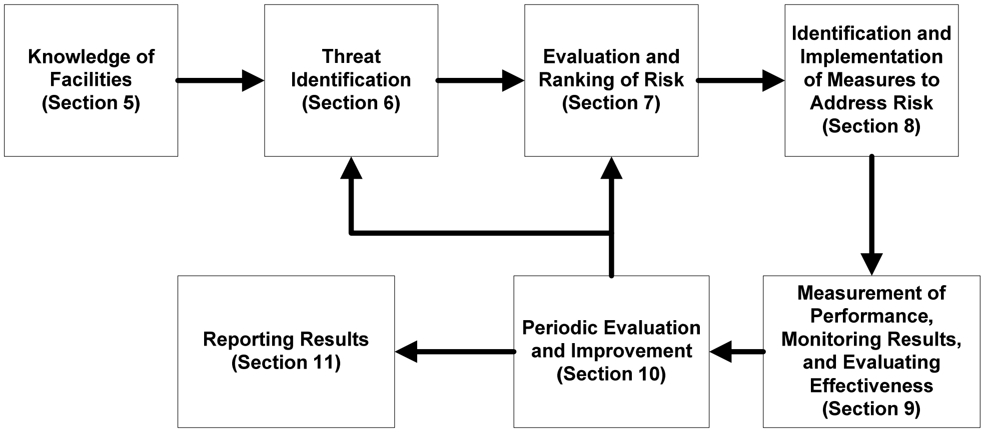


Figure 3-1 DIM Plan Elements

In addition to the key elements shown in Figure 3-1, the DIM Plan also establishes requirements for reporting of mechanical fitting failures (Section 11.2) and maintaining records (Section 12).

All elements of this DIM Plan shall be implemented by no later than August 2, 2011.

3.1 Company Roles

The purpose of this section is to describe key roles within the organization.

3.1.1 Vice President, Gas Asset Management

The Vice President of Gas Asset Management has overall responsibility to assure that the DIM Plan processes are implemented by the organization in accordance with this DIM Plan and associated regulatory requirements. The Vice President of Gas Asset Management may delegate, in writing, some or all of these responsibilities to others within the organization.

3.1.2 Manager, Distribution Engineering

The Manager of Distribution Engineering has the responsibility for day-to-day program oversight, integrity policy, facility replacement priorities, and responsibility to assure that the plan is implemented effectively and is integrated with the Company's operating procedures. This Plan assigns authority to the Manager of Distribution Engineering for approval of the DIM

Plans. The Manager of Distribution Engineering may delegate some or all of these responsibilities.

3.2 DIM Program Administration

Table 3-1 provides an overview of the actions that may be necessary to administer the DIM Program.

Table 3-1: DIM Program Administration

Plan Section	Role / Responsibility	Responsible Position *
3.1	Overall Program Implementation and Oversight	Vice President, Gas Asset Management
5.1, 5.2, 5.3 Appendix A	Updates to Appendix A	Manager, Distribution Engineering
5.4	Update Action Plans for Gaining Additional Knowledge	Manager, Distribution Engineering
5.6, Appendix A Appendix B	Conduct and Record SME Interviews as necessary for input into Appendix A (Knowledge) and Appendix B (Threat Identification)	Manager, Distribution Engineering
6.0, 6.1, Appendix B	Update Threat Identification (Appendix B) as new or modified threats are known or recognized	Manager, Distribution Engineering
7.1	Update the Risk Assessment and Ranking process and/or algorithms	Manager, Distribution Engineering
Appendix C	Perform and document updates to the Risk Assessment & Ranking Results.	Manager, Distribution Engineering
8.1, 8.2, Appendix D	Ongoing updates to Mitigation Measures to Address Risks	Manager, Distribution Engineering
9.1 thru 9.6, Appendix E	Maintain Performance Measures (updates to actual performance as well as the associated baselines)	Manager, Distribution Engineering
10.1, Appendix F	Periodic Updates to the Plan	Manager, Distribution Engineering
10.2, Appendix F	Conduct and document the Annual Effectiveness Review	Manager, Distribution Engineering
10.1, Appendix F	Conduct the Program Re-evaluation	Manager, Distribution Engineering
11.1	Prepare and submit the annual report to PHMSA and the State Pipeline Safety Authority	Manager, Distribution Engineering
12.0	Maintain DIM Program Records and Files as required by Retention Policy	Manager, Distribution Engineering

* or designee

3.3 How to Use this Plan

This DIM Plan is intended to be a resource and decision making guide for implementing the DIM Program at NGrid. The 12-section general Plan applies to all NGrid jurisdictions. There is also a state-specific Appendix for each of the three states in which NGrid operates. The general IMP and DIM Program workflow is outlined in Figure 3-2.

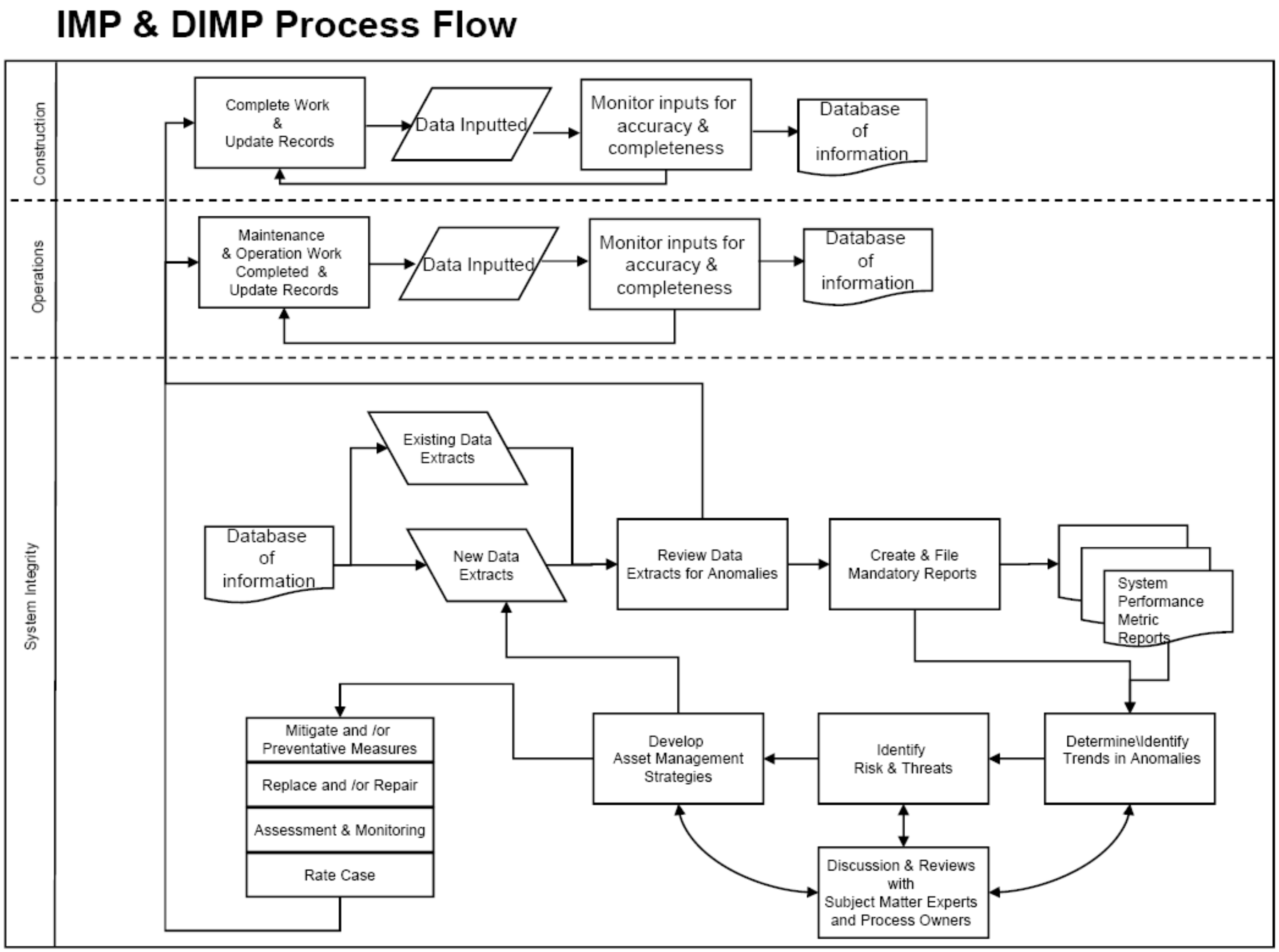


Figure 3-2 IMP & DIM Program Process Flow

4.0 DEFINITIONS AND ACRONYMS

The definitions provided in 49 CFR, §192.3 and §192.1001 shall apply to this DIM Plan. The following definitions and acronyms shall apply to this DIM Plan.

Baseline: A value established for the purposes of evaluating the ongoing results of a performance measure. Baselines are established as a matter of judgment and can change and evolve over time.

COF: Consequence of Failure

D.I.R.T.: Damage Information Reporting Tool – a secure, national web application for the collection, analysis and reporting of underground facility damage information for all stakeholders. More information on D.I.R.T. may be found at the Common Ground Alliance’s (CGA’s) website at www.cga-dirt.com.

Distribution Integrity Management Plan (DIM Plan): a written explanation of the mechanisms or procedures the operator will use to implement its integrity management program and to ensure compliance with subpart P of 49 CFR Part 192 (reference §192.1001)

Distribution Integrity Management Program (DIM Program): an overall approach used by an operator to ensure the integrity of its gas distribution system (reference §192.1001)

Distribution Integrity Management Program Files: Operator records, databases, and/or files that contain either material incorporated by reference in the Appendices of the DIM Plan or outdated material that was once contained in the DIM Plan Appendices but is being retained in order to comply with record keeping requirements.

DIM Rule: 49 CFR, Part 192, Subpart P

Distribution Line: a pipeline other than a gathering or transmission line (reference §192.3)

EFV: Excess Flow Valve. An Excess Flow Valve is a safety device that is designed to shut off flow of natural gas automatically if the service line breaks

Excavation damage: a physical impact that results in the need to repair or replace an underground facility due to a weakening, or the partial or complete destruction of the facility including, but not limited to, the protective coating, lateral support, cathodic protection, or the housing for the line device or facility (reference §192.1001)

Hazardous Leak: a leak that represents an existing or probable hazard to persons or property, and requires immediate repair or continuous action until the conditions are no longer hazardous (reference §192.1001)

HDPE: High Density Polyethylene

FOF: Frequency of Failure; synonymous with Likelihood of Failure

Integrity Management Program (IMP): A program used to manage gas transmission pipeline integrity in compliance with Subpart O of 49CFR, Part 192.

Main: a distribution line that serves as a common source of supply for more than one service line (reference §192.3)

MDPE: Medium Density Polyethylene

Mechanical fitting – As defined in the instructions for completing Form PHMSA F7100.1-1; includes Stab Type Mechanical Fittings, Nut Follower Type Mechanical Fittings, Bolted Type Mechanical Fittings and other types as may be specified by PHMSA.

NTSB: The National Transportation Safety Board

PHMSA: The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration

Pipeline: all parts of those physical facilities through which gas moves in transportation, including pipe, valves, and other appurtenances attached to pipe, compressor units, metering stations, regulator stations, delivery stations, holders, and fabricated assemblies (reference §192.3)

Region: areas within a distribution system consisting of mains, services, and other appurtenances with similar characteristics and reasonably consistent risk. The term Region may also apply to a geographic area within the operator’s system.

Risk: a relative measure of the likelihood of a failure associated with a threat and the potential consequences of such a failure

Risk Model: the integration of facility data, operational data, SME input, and established algorithms to estimate the relative risk associated with a gas distribution system threat

Service Line: a distribution line that transports gas, or is designed to transport gas, from a common source of supply to an individual customer, to two adjacent or adjoining residential or small commercial customers, or to multiple residential or small commercial customers served through a meter header or manifold. A service line ends at the outlet of the customer meter or at the connection to a customer's piping, whichever is furthest downstream, or at the connection to customer piping if there is no meter. In New York State, under 16 NYCRR § 255.3, a service line ends at the first accessible fitting inside a wall of the customer's building where a meter is located within the building, or at the building wall if the meter is located outside the building.

SME: Subject Matter Expert. An SME is an individual who is judged by the operator to have specialized knowledge based on their expertise or training.

Sub-Threat: a threat type within one of the primary threat categories specified in §192.1007(b)

Ticket: a notification from the one-call notification center to the operator providing information of pending excavation activity for which the operator is to locate and mark its facilities

5.0 KNOWLEDGE OF FACILITIES

The objective of this section is to assemble and demonstrate as complete of an understanding of the company's infrastructure as possible using reasonably available information from past and ongoing design, operations and maintenance activities. In addition, this plan identifies what additional information is being sought for the program and provides a plan for gaining that information over time through normal activities.

NGrid has a long history of systematically managing its distribution systems. The Company actively participates in committees of the American Gas Association (AGA), the Northeast Gas Association (NGA), the American Society of Mechanical Engineers (ASME), and the National Association of Corrosion Engineers (NACE).

The NGrid Distribution Engineering Department is responsible for the development and implementation of Integrity Management Programs for Gas Distribution facilities and pipelines. Data analysis is an important component of Integrity Management. The department compiles and analyzes system and operating data, files annual reports to the Department of Transportation (DOT) and State regulators, generates periodic bulletins, and prepares various Integrity Reports and Analyses. System performance, analysis, risk, threats, asset management, replacement strategies and rate case support are all performed. These engineering and operational activities require knowledge of the system inventory, age, and annual performance, as well as performance trends over time.

5.1 Policy & Procedures

NGrid has a number of existing policies and procedures that are related to integrity management and asset management of its gas distribution system. Table 5.1 below has been prepared to summarize which procedures exist to cover the elements as outlined in §192.1007. Procedures that are local to specific regions or are pending will be developed into enterprise wide documents over time.

For example: NGrid follows the nine (9) elements contained within the published PHMSA Damage Prevention Assistance Program (DPAP). The Company has been actively involved in mark outs and damage prevention for over 25 years and these processes are covered under numerous legacy operating procedures and test instructions. Mark out and damage prevention statistics are tracked and the company expects to develop a single enterprise wide policy document to include all the data elements required under the rule.

Section 10, Periodic Evaluation and Improvement, will identify any areas, policy or procedures that will require changes to comply with the rule or to improve the process over time.

Table 5-1: Policy Documents Related to Integrity Management for Distribution

Category	192.1007	Procedure	Procedure Title	Element
Asset Information	Elements A1	NA	Miscellaneous Legacy Records	Demonstrating Knowledge
Asset Information	Elements A1 & A5	NA	Miscellaneous Legacy Records	Demonstrating Knowledge
Annual SI Gas Distribution Report	Elements A1, A2, A4, B, C, & F	NA	Miscellaneous Legacy Records	Demonstrating Knowledge, Identified Threats & Periodic Evaluation
Improving Knowledge	Element A3	NA	IM Plan	Identify Additional information
Asset Information	Elements A1 & A5	GEN03002	Processing Gas Main Work Packages	Demonstrating Knowledge
Asset Information	Elements A1 & A5	CNST06020	Completion and Processing of Gas Service Record Cards	Demonstrating Knowledge
Asset Information	Elements A1 & A5	CNST01005	Preparation of Gas Facility Historical Records	Demonstrating Knowledge
Risk Scoring Procedure	Element C	GEN 01002	Risk Scoring Procedure	Ranking Risk
Annual DOT Reports	Element B & G	GEN 01020	Preparation and Filing of the DOT Annual Report for the Gas Transmission and Distribution Systems	Identify Threats & Reporting Results
Problematic Materials	Elements A & B	GEN 01009	Reporting Non-Conforming Materials	Demonstrating Knowledge & Identifying Threats
Damage Prevention Policy	Element D	DAM01011	Damage Prevention Policy	Mitigate Risk
System Operation Procedures	Element D	GCON02001	System Operating Procedure (SOP)	Mitigate Risk
Welding Policy	Element D	CNST05002	Welding Policy	Mitigate Risk
Operator Qualification Plan	Element D	GEN01100	Operator Qualification Plan	Mitigate Risk
Asset Information	Elements A1, A2, A3 & A5	ENG01001	Design of Gas Regulator Stations	Mitigate Risk
Corrosion Design Criteria	Element D	COR01100	Corrosion Design Criteria	Mitigate Risk
Leakage Survey	Element D	CNST02001	Leakage Survey Policy	Mitigate Risk
Leakage Survey	Element D	CNST02002	Leakage Surveys	Mitigate Risk
Leakage Survey	Element D	CNST 02003	Building of Public Assembly Inspections/Leakage Surveys	Mitigate Risk

Category	192.1007	Procedure	Procedure Title	Element
Special Winter Operations	Element D	CNST 02004	Winter Leak Operations	Mitigate Risk
Corrosion Control	Element D	COR 02100	Corrosion Inspection, Testing and Repair	Mitigate Risk
Atmospheric Corrosion Inspections	Element D	COR 02010	Atmospheric Corrosion Inspection of Services	Mitigate Risk
Corrosion Control	Element D	COR 03002	Measuring Pipe-To-Soil Potential	Mitigate Risk
Valve Inspection Policy	Element D	CNST 04009	Valve Inspection Policy	Mitigate Risk
Classifying Gas Leaks	Element D	CNST 02009	Classifying Gas Leaks	Evaluating Risk
Eliminating Gas Leaks	Element D	CNST 02010	Leak Response and Repair	Mitigate Risk
Surveillance of Gas Leaks	Element D	CNST 02011	Surveillance of Classified Leaks	Mitigate Risk
First Responder	Element D	CNST02013	First Responder	Evaluating Risk
Odorization Monitoring	Element D	INR 06001	Odorization Monitoring and Control	Mitigate Risk
Regulator Station Inspection	Element D	INR 03001	Regulator Station Monthly Inspection Policy	Mitigate Risk
Regulator Station Inspection	Element D	INR 03003	Regulator Station Annual Inspection Policy - NE	Mitigate Risk
Asset Management Strategy	Element D	ENG04030	Identification, Evaluation and Prioritization of Distribution Main Segments for Replacement	Mitigate Risk
Survey & Inspection	Element D	CNST 02005	Patrolling Transmission Pipelines	Mitigate Risk
Asset Management Strategy	Element D	CNST06001	Inactive Gas Services – all areas	Mitigate Risk
Asset Management Strategy	Element D	CNST 06005	Inspection and Abandonment of Inactive Services – all areas	Mitigate Risk
Regulators	Element D	ENG02001	Farm Taps	Mitigate Risk
Purging Operations	Element D	CNST03006	Direct Displacement	Mitigate Risk
Purging Operations	Element D	CNST03007	Complete Inert Gas Fill	Mitigate Risk
Purging Operations	Element D	CNST03008	Slug Method	Mitigate Risk
Cast Iron Management	Element D	DAM01007-UNY-LI	Cast Iron Encroachment Policy	Mitigate Risk
Cast Iron Management	Element D	DAM01008-MA-RI	Cast Iron Encroachment Policy	Mitigate Risk

Category	192.1007	Procedure	Procedure Title	Element
Cast Iron Management	Element D	DAM01009-NYC	Cast Iron Encroachment Policy	Mitigate Risk

These documents are subject to revision or replacement at any time. It is not practical to issue DIM Plan revisions for every policy/procedure change or update. Table 5-1 will be updated whenever a full Plan revision occurs. See current documents available on the Standards and Policies Gas Procedures intranet site for the most current information. Some procedures may not have been in effect in all NGrid regions at the time of this publication. In those cases, the enterprise-wide procedure(s) should list any currently active state-specific policies and the date(s) that the enterprise-wide procedure(s) are expected to take effect. Also, during the transition to enterprise-wide procedures, some aspects of the Rhode Island Operations and Maintenance Manual (including specifications and procedures for Construction and Maintenance (CM documents) and Customer Field Services (CFS documents)) will continue to be in effect.

5.2 Overview of Past Design, Operating, Maintenance and Environmental Factors

NGrid owns and operates approximately 35,000 miles of cast iron, steel (non IMP Transmission) and plastic distribution mains at various pressures from low to high throughout its service territory, as well as the associated services, connection equipment, instrumentation and regulation, and other appurtenances. The Company has sought and obtained regulatory approval to upgrade, replace and maintain the distribution systems needed to reduce risk and to address threats to its system and the customers it serves. Since annual system performance statistics can easily vary due to external conditions (e.g. weather), programs and plans must be based on the performance of the system over time. Identifying trends and evaluating data requires an understanding of the science of past designs, operating and maintenance histories. NGrid's knowledge of its gas distribution system is supported by the Company's gas industry experience and data.

NGrid separates its gas distribution system into two primary asset classes; Mains & Services which includes associated connection equipment, and Instrumentation & Regulation. NGrid also divides assets into sub-classes (regions) which include distinctions by factors such as material, size, vintage, pressure, construction method, and location.

5.2.1 Bare and Coated Steel Mains & Services

The modes and mechanisms of failure associated with bare-steel corrosion are well understood by corrosion experts and documented in a number of texts on the topic. It is a known fact that non-cathodically protected bare steel pipe, buried in the earth where there is moisture in the soil and without cathodic protection, will corrode over time. This corrosion may occur over the entire surface of the pipe and it may take many years before the first corrosion leak occurs. However, once the first leak on a pipeline segment occurs, there are other points on the pipe where the pipe is losing metal and where corrosion pits are becoming deeper. As the corrosion pitting continues and the pipes continue to lose metal, these pipes will increasingly experience additional leaks. Eventually many additional points of corrosion may result in an unmanageable leak rate.

The deterioration mentioned above is a function of time in the ground and is also influenced by the particular environment. This fact is evidenced by the fact that the USDOT has not allowed the installation of unprotected or bare steel for gas service since 1971. Furthermore, an early scientific reference regarding the failure rate of buried steel pipe was given in the book “Soil Corrosion and Pipe Line Protection” by Scott Ewing Ph.D., published in 1938. In the text, the performance of the service pipes in the Philadelphia Gas Works System was plotted and showed that corrosion leak occurrences over time on bare steel pipe increased at an exponential rate. This graph is shown below in Figure 5-1. When this text was written the natural gas industry was still in its infancy and high performance materials such as plastic and well-coated and cathodically protected steel were not available or well understood.

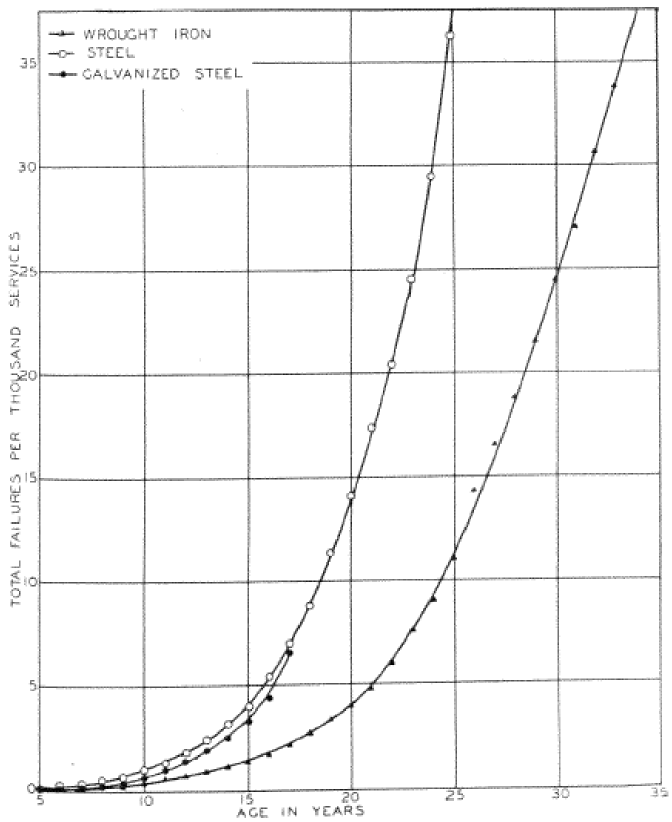


Fig. 7. Failure curves of house services in the Philadelphia Gas Works System.

Figure 5-1 - Chart from 1938 text showing exponential leak rates for bare steel pipe in gas service

This very same finding is corroborated today in more modern texts. One such text that is considered by many to be a foundational book for the study of corrosion is: “Peabody’s Control of Pipeline Corrosion” by A.W. Peabody, published by the National Association of Corrosion Engineers International, the Corrosion Society (Second Edition 2001). This text, published more than 60 years after the Ewing text, reaffirms the fact that leak incidents on unprotected bare pipe will occur at an exponentially increasing rate. In the Peabody text, this is shown as an example plotted on semi log paper. A copy of the graph used to describe this in the Peabody text (Figure 15.1 in Peabody) is shown in Figure 5-2 below.

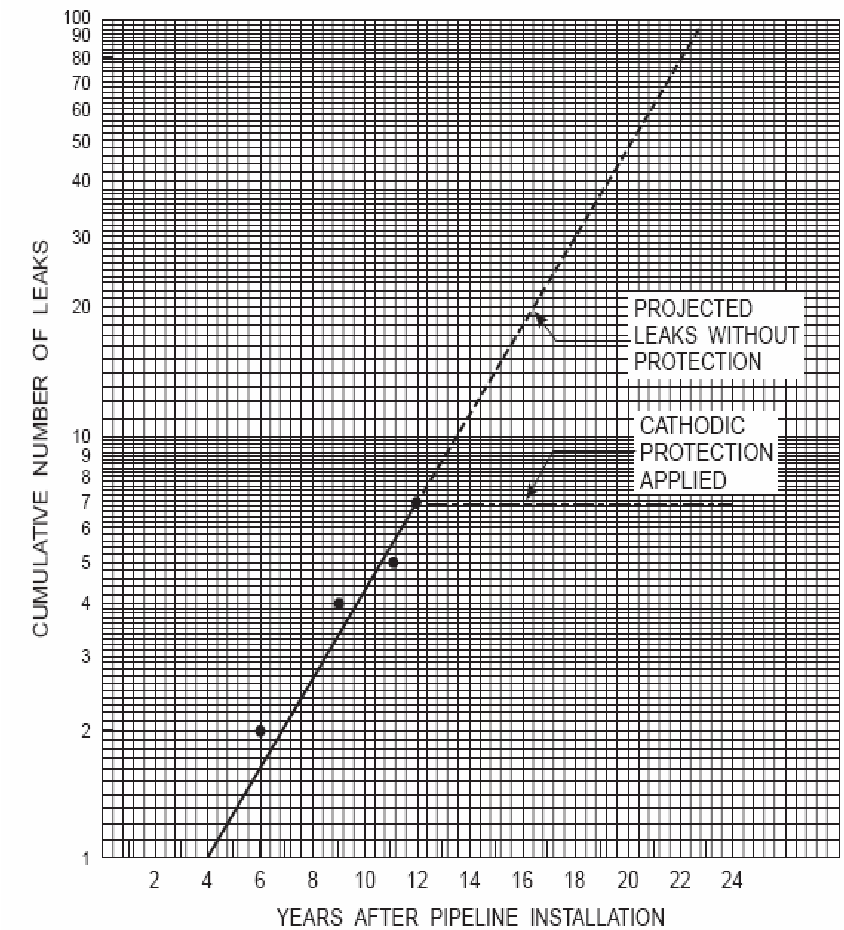


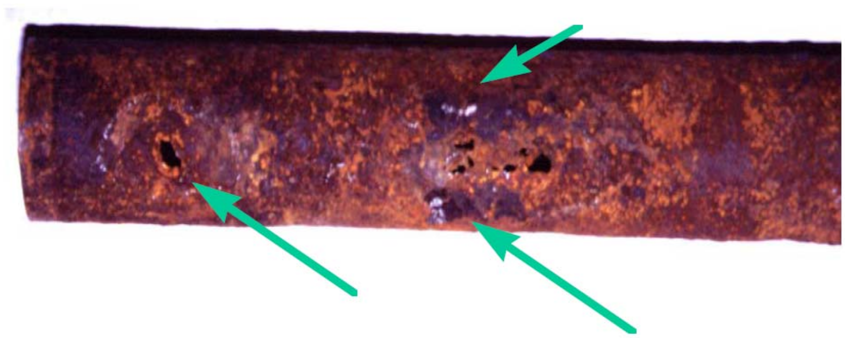
Figure 15.1 Cumulative number of leaks without CP.

Figure 5-2 - Chart from 2001 text showing exponential leak rates for bare-steel pipe in gas service.

As shown on this graph, no leakage occurs during the initial life of the pipe (first leak occurred 4 years after placing the piping in service). Then, in the next 4 years, 1.5 new leaks occurred. Then, in the next 4 years, 4.5 new leaks occurred. Then, in the next 4 years, 11 new leaks occurred. This accelerating occurrence of leaks continues at a rate that places the cumulative leak count off the scale, past the 23rd year, with more than 100 cumulative leaks occurring. What is important to note is not that the leaks are occurring, but that they are occurring at an ever increasing frequency as a function of time (once the corrosion process has reached the point to produce the initial leak). Although NGrid's inventory of main and services contains many pipes that have exceeded the 23 years noted, not all of these pipes have begun to leak at the same initial time.

This exponential growth of leak occurrences on bare-steel pipe is scientifically documented as indicated in the text above. This exponential growth of leak occurrences on bare steel pipe is also well known by experienced gas system operators who perform bare-steel repairs and find themselves installing multiple leak repair sleeves on sections of corroding pipe.

This ever increasing frequency of leak incidents is evident based on the corrosion mechanisms. Bare steel pipe is undergoing continuous deterioration by corrosion. In some locations, the deterioration is more aggressive than in other locations. In many cases, although the wall thickness is penetrated at only a single point, it can be seen that the entire pipe may have been degraded to the point where future leaks will occur at an ever increasing rate. This is visually obvious by viewing the piece of corroded pipe shown from the USDOT website in Figure 5-3. In this picture, there may be only a few points of actual leakage, but the pipe shows apparent signs of distress along the entire wall thickness.



An example of bare steel pipe installed for gas service. Note the deep corrosion pits that have formed. Operators should never install bare steel pipe underground. Operators should use either polyethylene pipe manufactured according to ASTM D2513 or coated steel pipe as new or replacement pipe. If steel pipe is installed, that pipe must be coated and cathodically protected.

Figure 5-3 - Illustration from U.S. Department of Transportation Website[1]

Wrought iron pipes, while less brittle than cast-iron mains and service lines, are subject to corrosion. The corrosion of wrought iron is similar to bare steel in its exponential leak rate growth.

[1] http://www.phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Files/3%20-%20Guidance%20Manual%20for%20Operators%20of%20Small%20Natural%20Gas%20Systems-2002.pdf

Coated steel mains and services, when cathodically protected against corrosion, are an excellent and well-performing gas distribution material. They resist corrosion and have significantly higher strength than plastic. All underground steel pipe installed after July 31, 1971 is required by federal code (per 49 CFR 192, Subpart I) to be coated and cathodically protected and is regularly tested to ensure an adequate level of protection and compliance. In many cases, steel pipe installed before 1971 is also coated, cathodically protected, and regularly tested. However, coated steel mains and services that are unprotected can undergo accelerated corrosion if the coating is breached – either by damage or disbonding. Such mains are currently viewed by NGrid as not protectable and are considered to be ineffectively coated and subject to the same risks as bare unprotected steel.

5.2.2 Cast Iron Mains

The natural gas industry considers cast-iron mains and non-cathodically protected steel mains and services to be higher risk materials. Cast Iron mains are among the oldest materials remaining in gas distribution systems, often pre-dating the 1900's. Gas facilities in most large older cities (particularly in the Northeast) account for the largest amounts of cast iron dating back before the turn of the 20th century. The cast iron system in NGrid's Boston Gas region is the second oldest in the United States (after Philadelphia Gas Works). The changeover from the use of cast iron to steel started slowly in the 1920s. During the 1940s, following the discovery of electric arc welding which provided a tight joint, steel pipe gradually replaced cast iron entirely. The industry has since replaced steel pipe with plastic pipe and cathodically protected coated steel pipe as the primary materials for distribution systems. Similar to unprotected or bare steel mains, the USDOT no longer permits installations of cast iron mains or service lines.

There are over 29,000 miles of buried cast iron pipe still in service in the United States distributing natural gas as of 2014 . Much of this pipe has provided excellent service over its life. However, aging cast-iron mains have experienced gradual deterioration and are susceptible[2] to breaks, cracks, and other failures such as joint leaks.

As the owner and operator of nearly 20 percent of all the cast iron distribution main in the United States, NGrid has unparalleled experience in dealing with cast iron mains in a safe and reliable manner. Extensive research has been done throughout the years by NGrid's legacy companies and NGrid's cast iron replacement programs have been carefully designed to continue cost-effective operation in the safest and most reliable way possible.

In 2013, National Grid also participated in the development of an AGA white paper to Congress entitled "Managing the Reduction of the Nation's Cast Iron Inventory", which is incorporated here by reference.

Experience from companies[3] that operate greater mileage of cast iron has identified certain parameters associated with higher leak and failure rates. Many of these parameters are useful to evaluate in identifying pipe segments more prone to failure. The predominant among these are:

- Pipe graphitization history
- Manufacture and original wall thicknesses, sometimes associated with vintage pipe diameter size and flexural resistance
- Loading and stresses associated with:
    - Operating pressures
    - Weather induced loads such as depth of winter frost penetration and frost action
    - Traffic loads
    - Construction impacts
    - Block supports

[2] Other environmental effects, including methods used to support the pipe, frost, and vehicle loads that impose additional stress on the pipe, thus further reducing its useful life, exacerbate the deterioration caused by graphitization.

[3] A number of studies of cast-iron and factors affecting their service life have been made. A number of these studies and evaluations were made by ZEI, Inc. (formerly Zinder Eng Inc) Ann Arbor Michigan, including articles written; see Gas Industries, February 1986. The Department referred to this report in its February 28, 1991 Order concerning its investigation into proposed rules for cast iron.

- Settlement
- Undermining
- Washouts
- Direct impact

Under research contracts with Cornell University that started in the early 1980's, the former Brooklyn Union (now part of NGrid) and other NY Gas Group companies sponsored research that has developed a library of technical papers on CI main condition, performance and evaluation. NGrid's Cast Iron related policies are informed by those studies, the most recent of which was prepared in 2008. NGrid's New York City Cast Iron system (the former Brooklyn Union Gas - which accounts for nearly 30% of all the Cast Iron in NGrid) dates from before 1895 through approximately 1950. After approximately 1930, centrifugally cast pipe predominates over pit-cast cast iron. Pit cast pipe was less uniform than later pipe, though out-of-spec wall thickness is rare. French cast iron piping of approximately WWI vintage has been reported to be overly brittle. Centrifugally cast pipe is theoretically more prone to stress crack corrosion according to UK studies, but that has not been recognized on the New York City system.

5.2.2.1 Cast Iron Graphitization

NACE[4], in its Introduction to Corrosion Basics, 1984, pg. 216, states that the corrosion rate of cast iron is comparable to that of steel in a soil. The iron is removed from the metal, leaving a network of carbon particles by the de-alloying phenomenon termed graphitization. The residual carbon retains the form of the pipe, and unless the weakened pipe is fractured, the graphitized pipe will continue to transport gas. Once the cast-iron is graphitized, the exterior becomes an extremely noble electrode in any galvanic couple. Thus uncoated or unprotected cast-iron or steel will act as the anode in contact with this "noble" pipe.

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[4] National Association of Corrosion Engineers.

It should be noted that graphitization is still relatively infrequent within NGrid and only included here to demonstrate the Company's knowledge base. Experience shows that the soils in New York City and Long Island are the most benign with respect to graphitization. Upstate and New England soils appear to be somewhat more aggressive, though there does not appear to be much of a difference in the resulting frequency of graphitization.

Graphitization occurs when cast iron is exposed to certain types of corrosive environments over time. The resultant graphitization causes the beam strength to weaken and the pipe to become brittle and contributes to rates of broken mains. In its 1971-72 study of cast iron, the New York Gas Operations Advisory Committee report stated that its experience indicated graphitization was limited to certain specific localized environments. These were areas where there were localized salt water exposures or extreme stray current discharges (such as at substations and electrified rail transit systems).

Cast iron contains carbon, in the form of graphite, in its molecular structure. It is composed of a crystalline structure as are all metals (i.e., it is a heterogeneous mass of crystals of its major elements iron, manganese, carbon, sulfur and silicon). In the presence of acid rain and/or seawater, the stable graphite crystals remain in place, but the less stable iron becomes converted to insoluble iron oxide (rust). The result is that the cast iron piece retains its shape and appearance but becomes weaker mechanically because of the loss of iron.

Graphitization is not a common problem. It generally will occur only after bare metal is left exposed for extended periods, or where joints allow the penetration of acidic rainwater to internal surfaces. Therefore there is a time dependency for graphitization to occur, and excluding other factors, the expectation would be that older pipes will have experienced deeper graphitic penetration and disintegration. Soil moisture is normally enough to provide a conducting solution. This corrosion process is galvanic, with the carbon present acting as the noblest (least corrosive) element and the iron acting as the least noble (most corrosive) element. The composition or microstructure of the iron affects the durability of the object because the rate of corrosion is dependent upon the amount and structure of the graphite present in the iron.

Graphitic corrosion or graphitization[5] is a form of de-alloying or parting caused by selective dissolution of iron from cast iron (usually gray cast iron). It proceeds uniformly inward from the surface, leaving a porous matrix of the remaining alloying element, carbon. Graphitization occurs in salt water, acidic mine water, dilute acids, and soils, especially those containing sulfates and sulfate reducing bacteria. There is no outward appearance of damage, but the affected metal loses weight, and becomes porous and brittle. The porous residue may retain appreciable tensile strength and have moderate resistance to erosion. For example, a completely buried cast-iron pipe may hold gas under pressure until jarred by a worker's shovel. Sulfates and sulfate-reducing bacteria in soil stimulate this form of attack.

5.2.2.2 Cast Iron Pipe Support

A number of methods were used to install cast iron pipe sections. The most common method involved support of individual lengths of pipe with wooden or concrete blocks near each end. The blocks served to both support the main during construction and slope the pipe for proper drainage of manufactured gas liquids. Some installations included support near the center, placing pipe on mounds of earth instead of blocks, and still others directly on the trench bottom. Placing pipe on the trench bottom actually provides the greatest life expectancy as it minimized unsupported lengths of pipe, increased ability to withstand superimposed loads, and reduced beam action. Installation on wooden blocks has been seen to cause increased instances of graphitization at the point of contact between the cast iron and wood. There are no records indicating the method of installation; though at times, it can be inferred from the condition of the pipe. Block supports may also be detrimental when they cause pipe sections to behave as beams. All of these factors result in regionally higher break rates, which are used for identifying system replacement.

[5] NACE defines graphitic corrosion in its Introduction to Corrosion Basics 1984, at page 107.

5.2.2.3 Cast Iron Pipe Size – Diameter and Flexural Resistance

Cast iron is more brittle and relatively weak as compared to steel. Sections of cast iron pipe supported at their ends on blocks experience loading and act as a beam. Flexural stress is created by the weight of the soil overburden, by the weight of the pipe itself, and by forces such as frost heave and other loads. Results of one study[6] to identify those main sizes that experience the highest failure rates revealed that 4”, 6” and 8” diameter pipe accounted for 90% of the incidences of breaking and cracking. Said another way, the beam strength is much less for smaller diameters of cast iron pipe than for larger diameter pipe. There is an increase in relative beam strength for cast iron pipe with diameters equal to or greater than 10”, providing some higher relative safety. In its system integrity analyses, NGrid regularly tracks the cast iron breakage “rates” on all of its systems and has found similar results.

While NGrid has not experienced extensive cast iron graphitization, it should be noted that cast iron pipe was installed bare and cannot be adequately protected by cathodic protection. Graphitization reduces wall thickness and thus reduces flexural resistance. An evaluation of flexural resistance (which is directly related to the “section modulus”[7]) demonstrates that a wall loss of 0.2 inch will result in a change in the relative section modulus of 4” through 8” diameter cast iron of between 52% and 45%. This reduced flexural resistance demonstrates that the smaller size pipes are far more susceptible to breakage than the larger size pipes.

Research performed by Cornell University identified 2000 microstrain as a critical level for cast iron pipe. For the purposes of replacement decisions related to parallel trench construction, 600-800 microstrain (0.06-0.08%) was selected as the replacement criteria. The condition of the cast iron pipe tested supported those levels as a proper margin of safety, which has been proven out by field experience under New York State PSC waiver and Massachusetts regulation.

When cast-iron main was originally installed as low pressure piping, its bell and spigot joints were filled with compacted jute backing and sealed with molten lead and lead caulking or

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[6] 2007 Final Report on Peoples Gas Light and Coke Cast Iron Main Replacement – Kiefner and Associates, Inc.

[7] Section Modulus is a function of outside diameter, inside diameter, and wall thickness.

cement. After years of service and switching from wet manufactured gas to natural gas, the jute has dried out and reduced in volume, weakening the seal within the joint. Additionally, exterior loads impact and flex the pipe and disturbing the seal. Loads adversely impacting cast iron mains result from traffic, seasonal weather, vibration and soil movements due to nearby construction activities; causing these joints to leak. Cornell observed that depending upon the diameter of the pipe, the joint contributed more or less to the flexibility of the pipe. Lead and jute joints were found to flex more than cement jointed pipe, which is common on Staten Island in New York City. Lead joints were also seen to leak when flexed, and later creep and seal again in low pressure applications.

5.2.2.4 Cast Iron Bell Joints

Cast Iron and Ductile Iron gas mains are constructed with bell and spigot joints. These joints were most often sealed with jute and lead, cement, or encased in concrete in order to make the joint leak free and rigid. In many cases, bell joints have been retrofitted with mechanical bell joint clamps or bell joint encapsulation as a means of addressing bell joint leaks. In the New York City operating area (formerly Brooklyn Union), all joints on cast iron pipe operating at a 15 psig MAOP have been sealed with mechanical clamps or elastomers. A majority of the low pressure joints are sealed as well.

NGrid has used a number of methods to seal cast iron joints in past years. These methods fall into five broad categories and are listed below:

- Metallic Joint Clamps – A two-part clamp secured by bolts and designed to force a steel ring over the bell and spigot joint. Pressure from a rubber gasket presses on the circumferential lead face of the bell joint. One problem caused by this method of repair is that the steel clamp can become anodic to the cast iron, resulting in corrosion.
- Shrink Sleeves – Rubber/plastic materials used have varied as have the shrinking methods (electrical or thermal). A sleeve is fitted over a cleaned bell and spigot joint as well as a short section of pipe beyond the joint. The material is then essentially shrink fit to seal the joint. Extensive cleaning of the joint area is required and if performed incorrectly it can cause these to fail over time.

- Anaerobic Seals - These have had the advantage of exposing only the top part of the joint. A hole is drilled into the bell and an anaerobic sealant injected into the jute backing. The sealant material wicks into the jute and joint surfaces sealing the joint.
- Encapsulants - Also commonly called boots or muffs, encapsulate the face of the joint. This method is more effective than shrink sleeves and not subject to corrosion or gasket failure as is common with metallic clamps, nor are they as susceptible to improper installation.
- Internal sealing methods - There have been a few approaches used over the years, including internal clamping of the joint, fogging of the main, spraying the inside of the joint with an atomized sealer, mechanically applying a sealant of the joint and the internal pipe surface from within the pipe as well as pipe lining with a type of “innertube”.

Metallic Joint Clamps and Shrink Sleeves are no longer used, though metallic clamps that were properly coated are often found to be in good condition. Anaerobic seals are often selected when a large excavation is undesirable, exposing the entire joint is difficult or impossible, or in high water tables where it is difficult or disruptive to effectively encapsulate the joint. The current internal sealing method used is known as "CISBOT" and it has diameter, length and other limitations. Internal Lining is an expensive process, but adds other benefits. The best application for internal liners is on stretches of main without tie-ins or large numbers of services. Encapsulating bell joints is generally the most effective of the methods and the most commonly used. Many thousands of cast-iron joints are sealed every year in response to leaks. While this creates a high cost of operating and maintaining this class of asset material, leaking joints have rarely led to incidents.

5.2.2.5 Cast Iron Loading and Impact

Cast-iron is much more brittle than steel and is susceptible to cracks or breaks due to loading and impact. Main breaks are a major concern due to the large amount of gas that may be released in such instances. This is made worse when the driving force behind the cast-iron main leak is the operating pressure. Medium or high pressure cast iron aggravates the safety threat posed by cast-iron mains.

Cast iron breaks are often more severe than the typical corrosion leak. A cracked main may leak at a high rate, quickly saturating the area around the break with natural gas, migrating and entering conduits and following the path of other utilities to homes or other confined spaces such as utility vaults and sewers. Cast iron main breaks are of particular concern during periods of cold temperatures when frost actions may cause additional stresses on these mains and when frost caps create an impermeable barrier of the earth's surface, preventing leaking gas from safely venting to the atmosphere. Such leaks may be difficult to pinpoint as they can cause high gas readings at appreciable distances from the actual leak site. The difficulty of leak investigation is aggravated under frost conditions and with depth of frost penetration. The inability of the gas to safely escape increases the risk to near-by residents, as gas follows the path of least resistance, often to nearby habitable structures.

The inventory of small diameter cast iron in NGrid's service territory varies. Small diameter cast iron (8" and less) is most susceptible to bending stress and impact. NGrid policies define the replacement criteria for sound cast iron adjacent to parallel trenches or exposed due to crossing excavations. Additional consideration is given to conditions such as system performance and removal of pavement over shallow cast iron mains during road reconstruction.

5.2.3 Plastic Pipe

Plastic pipe has a more recent but yet almost 50 year history. Various plastic piping materials were developed and introduced into the gas industry in the late 1960's and early 1970's. The industry became more focused on the corrosion and performance concerns with unprotected piping following the 1968 "National Gas Pipeline Safety Act". This required Federal regulations on Gas Transmission & Distribution systems in the U.S. and placed them under the jurisdiction of the Department of Transportation. Table 5-2 below is a summary of the plastic pipe materials that have been manufactured and marketed to the gas industry with a notation as to whether or not they are known to exist on the NGrid system.

Table 5-2 Plastic Pipe Material Summary

Plastic Material Type	Known to Exist in the NGrid Gas System?
PVC – Polyvinyl Chloride	No
ABS – Acrylonitrile Butadiene Styrene	No
CAB – Cellulose Acetate Butyrate*	No
PB – Polybutylene**	Yes
PP – Polypropylene	No
PA – Polyamide	No
Century MDPE 2306	No
Aldyl-A (1972 and Prior) PE 2306	Yes
Aldyl-A (Post 1972) PE 2306	Yes
Aldyl-A (1973 and After) PE 2406	Yes
Aldyl 4A (green) PE 2306	Yes
MDPE 2406	Yes
MDPE 2708	Yes
HDPE 3306	Yes
HDPE 3406	Yes
HDPE 3308	No
HDPE 3408	Yes
HDPE 4710	Yes

* A limited number of 1-inch clear CAB services were installed in Upstate New York but have been reported to have been removed.
** Rhode Island only
NOTE: Fiberglass main was once used in MA, but has been completely removed to the best of our knowledge.

Table 5-3 below provides a summary of the currently approved plastic material types.

Table 5-3 Currently Approved Plastic Pipe Material Summary

Current Approved Plastic Material Type	Region(s)
PE 2708/PE 2406	NYC/LI
PE 4710	LI
PE 4710	UNY
PE 4710	RI
PE 2708/PE 2406	MA
PE 4710	MA

Details for plastic pipe by Company, Material designation, description, and Region are provided below in Table 5-4.Table 5-4 Summary of Plastic Pipe by Region

Common Name	Company	Material Designation	Physical Description	Region(s)
Aldyl A*	Dupont Pipe	PE 2306 (pre-1973)	Pink, but can turn grey	LI, MA, NYC*, RI, UNY
Aldyl A*	Dupont Pipe	PE 2306 (1973 & later)	Pink, but can turn grey	LI, MA
Aldyl A*	Dupont Pipe	PE 2406 (1973 & later)	Pink, but can turn grey	LI, MA, NYC*, RI
Aldyl 4A	Dupont Pipe	PE 2306	Green	LI
CAB	Unknown	Unknown	Clear tubing	UNY***
PB	Unknown	Unknown	Tan	RI
Red Thread	Inner-tite	Epoxy-Fiberglass	Orange/red	NYC****, UNY
Inner-tite	Inner-tite	PE3306	Glossy Black	NYC,LI
Barrett	Barrett	PE3306	Glossy Black	NYC,LI
Orangeburgh	Orangeburgh	PE3306	Glossy Black	NYC,LI
Allied	Allied	PE3306	Glossy Black	NYC
Celanese Ultrablue	Celanese	PE 3306	Glossy Black	NYC
Crestline HD	Crestline	PE 3306	Glossy Black	UNY
Dupont HD	Dupont	PE 3406	Dull Solid Black	NYC**
Drisco 6500	Phillips Driscopipe	PE 2406	Orange	LI,MA,UNY
Drisco 6500	Phillips Driscopipe	PE 2406	Yellow	LI,MA,UNY
Driscoplex 6500	Performance Pipe	PE 2406/PE 2708	Yellow	LI,MA, RI
Drisco 7000	Driscopipe / Phillips	PE 3406	Solid Black	NYC, RI, UNY
Drisco 8000	Driscopipe / Phillips	PE3406/PE3408	Solid Black	NYC, MA,RI, UNY
Plexco	Plexco Pipe	PE2306	Orange	RI
Plexco	Plexco Pipe	PE2406	Orange	LI,MA
Plexco	Plexco Pipe	PE 2406	Yellow	LI,MA,RI
Plexco Yellowstripe	Plexco Pipe	PE 3406/3408	Black pipe with 4 yellow stripes	LI, MA, NYC,RI, UNY
Plexco Plexstripe II	Plexco Pipe	PE 3408	Black pipe with 2yellow stripes	UNY
CSR Polypipe 4810	CSR Poly	PE 3408	Black pipe with 6 yellow stripes	UNY
Extron TR 418	Extron	PE 2306	Orange	UNY
Drisco/Performance Pipe 6800	Driscopipe / Phillips	PE 3408	Black with 3 yellow stripes	LI, NYC, UNY, RI
Drisco/Performance	Driscopipe /	PE 3408/4710	Yellow exterior	NYC, RI, UNY

Pipe 8100	Phillips		black pipe	
Performance Pipe 8300	Performance Pipe	PE 3408/4710	Black with 4 yellow stripes	LI, RI, UNY
US Poly UAC 3600 (formerly DuPont)	US Poly	PE 3408/ PE 3710	Black with 3 yellow stripes	LI, MA, NYC, RI, UNY,
US Poly UAC 3700 (formerly DuPont)	US Poly	PE 3408/4710	Black with 3 yellow stripes	LI, MA, NYC, RI, UNY,
JM Eagle UAC 3700 (formerly US Poly)	JM Eagle	PE3408/PE4710	Black with yellow stripes	LI, MA, NYC**, RI, UNY
UPONOR UAC 2000	DuPont	PE 2406	Yellow	LI, MA, NYC**, UNY
US Poly UAC 2000 -Formerly UPONOR	US Poly	PE 2406/PE 2708	Yellow	LI, MA, NYC, UNY
JM Eagle UAC 2000 (formerly US Poly)	JM Eagle	PE 2406/PE 2708	Yellow	LI, MA, NYC, UNY
Charter Plastics Inc	Charter Plastics Inc	PE 2406/PE 2708	Yellow	LI, MA, NYC
Charter Plastics Inc	Charter Plastics Inc	PE 3408/ PE 3608/ PE 4710	Black with 3 Yellow stripes	LI, MA, NYC, RI, UNY
Endot Bi-modal MDPE	Endot	PE 2406/PE 2708	Yellow	LI, MA, NYC,
Endot	Endot	PE 3408/ PE 4710	Black with 3 Yellow stripes	LI, MA, NYC, RI, UNY

* A very limited amount of Aldyl A exists due to a trial installation in New York City.
** limited to Staten Island
*** A limited number of 1-inch clear CAB services were installed in Upstate New York but have been reported to have been removed
**** Limited to Greenpoint Area Only - RETIRED

5.2.4 Copper Piping

Copper pipe was used for gas service lines in many service territories throughout the United States. Within NGrid's service territory, copper was predominantly used for service renewal by inserting copper inside of deteriorated steel services. In a much more limited manner, copper services were occasionally direct buried.

Copper services may be subject to leakage caused by corrosion. In particular, direct buried copper services may be subject to advanced rates of corrosion in the presence of dissolved salts in the soil (e.g., deicing salts to melt ice and snow on road surfaces).

Copper tubing is far less of a corrosion risk than steel. NGrid's corrosion experience with over 161,000 copper services indicates that approximately 1% of all corrosion leaks are associated with copper. When inserted in older steel services, the steel provides corrosion protection since the steel is more anodic than the copper. The older steel also protects the copper pipe from excavation, natural forces, and other damage. Corrosion on NGrid's copper services has been limited to locations where it was connected to dissimilar metal without insulating joints to provide isolation between the two dissimilar metals. The dissimilar metal is anodic to the copper and corrodes. The most common situation for this exists where copper is joined to an iron or bronze service tee (the iron tees are the most susceptible). Records of where and when these dissimilar metals were installed do not exist.

5.2.5 Instrumentation & Regulating Facilities

The Instrumentation & regulating assets family includes regulating stations, transfer stations, heaters, control lines and all ancillary equipment. NGrid has over 1,800 instrumentation & regulating facilities within its service territory. Over the years there have been various designs, manufacturers and styles of stations. These include single stage with relief, double stage with either a working or open monitor. In addition, they may be above grade, below grade, in the same vault, or in separate vaults. Stations may have one single run or multiple runs. Each station is specifically designed for the upstream and downstream pressures and the intended capacity.

The regulating facilities have been designed for continuity of supply and peak performance during normal and critical gas demand periods. They have been designed for specific load and pressure requirements. The following design philosophy has been utilized:

- Stations are designed using corporate engineering guidelines for flow capacity and pressure control with consideration given to other factors such as the required footprint, security, noise, operation, maintenance, community impact and the potential for third-party damage.
- Stations are designed in accordance with applicable state and federal codes to help ensure safe and continuous supply of natural gas to our customers and the community we serve.

During the annual performance test, any minor maintenance issues are corrected. Any major repairs requiring parts replacement and calibrations are rescheduled. By the time all work is completed and the station is ready for the next season, the operating condition of that particular regulating station will be back to 100%.

A good asset management program consists of systematic and coordinated activities and practices through which NGrid optimally manages its assets, performance, risks and expenditure. The evaluation process will identify two key questions, what we expect the asset to do and what are we actually doing to maintain it.

NGrid is committed to managing and investing in our system to protect the future of our business. This is done through proactively managing existing and future risks as well as contributing to the economic growth of the region in which we operate through the provision of safe, high quality and dependable services.

NGrid achieved PAS-55 accreditation on February 11, 2009. The PAS-55 asset management certification program has been designed to enable organizations to demonstrate, by a certification process, that its asset management program is robust. It indicates to stakeholders and investors that the organization has a method of protecting and maximizing benefits from its assets and investment. NGrid's certification was valid through February 28, 2012, and may be refreshed in the future at the discretion of senior management.

5.2.6 Construction Methods

The existing NGrid system is one of the oldest in the country and various methods of construction may have been utilized from time to time. Table 5-5 summarizes the types of construction Practices that have been used or practiced within the company's service territory.

Table 5-5 Construction Practices Summary

Construction Practice	Comment
Open trench installation	Yes
Support and Blocking	Yes
Service Replacement via insertion of Copper	Yes
Replacement of mains and services via Insertion of Plastic	Yes
Main Replacement via insertion and pipe splitting via PIM (Pipe Insertion Method)	Yes
Main Replacement via insertion and pipe splitting (static pipe bursting)	Yes
Internal lining / swage-lining / roll-down	Yes
Joint Trench with other utilities	Yes
Unguided Bore (e.g. Hole Hog)	Yes
Guided Directional Bore / Drill	Yes
Blasting	Yes
Plow-in	Yes

5.2.7 Excess Flow Valves

NGrid has been installing excess flow valves for new and replacement high pressure residential service lines in all areas since the early 1990's and since the late 1970's in NYC. Ball type EFVs installed in the 1970's have been found to be unreliable, but there have not been issues with the spring & plunger type. NGrid uses EFVs of various capacities, including some multifamily residence and small businesses where they are compatible with load patterns and volumes.

Since NGrid and its legacy companies were dedicated early on to the installation of EFVs, tracking of the quantity was not viewed as necessary or required and was not done consistently in all regions (e.g. – RI records are considered good). In order to comply with new reporting requirements, some jurisdictions needed to estimate the existing quantity and annual installations on the 2010 Annual Distribution Report, as allowed by PHMSA. See Table 5-7 for additional information

5.2.8 Mechanical Fittings

A summary of the known mechanical fittings currently in service is detailed below in Table 5-6.

Table 5-6 Mechanical Fittings

Mechanical Fitting Manufacturer	Type	Region
Perfection	Stab Fitting	All
Lyco	Stab Fitting	LI, RI
AMP Fittings	Stab Fitting	All
Reynolds	Nut-Follower	RI
ContinentalFittings	Stab Fitting	MA
Chicago Fittings	Nut-Follower	MA
ContinentalFittings	Nut-Follower	MA
Mueller w/ Dresser End	Nut-Follower	All
Normac	Nut-Follower	All
Dresser	Nut-Follower	All
Dresser	Bolted	All
Eastern	Bolted	All
Plidco	Bolted	LI, NYC, MA
Mueller	Bolted	All
Smith Blair	Bolted	All
CSI	Bolted	All
Dresser Posi-Hold	Hydraulic	All

5.3 Characteristics of Design, Operations and Environmental Factors

The characteristics of the pipeline's design, operations and environmental factors that are necessary to assess the applicable threats and risks are summarized in the following sections as well as Appendix A.

5.3.1 Operating Pressures and Gas Quality

The NGrid gas distribution pipeline system operates at various pressures from low to high throughout its service territory. Sources of gas include LNG and gas produced from natural underground reservoirs. Gas Quality is monitored and managed via NGrid's Transmission Integrity Management Program.

5.3.2 Reportable/Significant Gas Incidents

Detailed summaries of recent DOT reportable gas incidents are provided in Appendix A, Section-1 and were given the highest influence in the risk evaluation and prioritization. Table A-1 summarizes incidents by year for the past 30 years – with consequences. Table A-2 summarizes incidents by year for the past 30 years – by cause. Additionally, details of last 10 years reportable incidents are provided in Table A-3 and the asset-threat combinations of all integrity-related incidents in that table were given a superseding influence in the risk ranking and prioritizations for that region.

5.3.3 Gas Distribution Inventory and Repair Data

NGrid's Distribution Engineering Department is responsible for the development and implementation of Integrity Management Programs for Gas Transmission & Distribution facilities pipelines. The department compiles and analyzes system and operating data, files annual reports to the Department of Transportation (DOT) and State regulators, generates periodic bulletins, and prepares various Integrity Reports and Analyses. System performance, analysis, risk, threats, asset management, replacement strategies and rate case support are all performed. The former Brooklyn Union committed to continuing to perform these sorts of analyses in an MOU issued to the New York State PSC in 1989 (although they were already a well established routine by that time). These engineering and operational activities require knowledge of the system inventory, age, annual performance as well as performance trends over time.

A complete system inventory by material and size as well as leak repair data by cause is updated annually and submitted on the Annual DOT reports. Copies of the reports are available on the Distribution Engineering web page along with comparisons reports for each region over time. Annual DOT reports are publicly available on PHMSA's website. NGrid Operator IDs are provided in Section 1.0.

5.3.4 Environmental Factors

NGrid operates gas distribution piping in some of the most populated regions of the country and where extremes of all four seasons are experienced. As such, all these factors are considered in the design, operation and maintenance of the gas system. As previously noted in this section (Knowledge of Facilities) there are many different policies, piping materials and construction methods utilized. NGrid utilizes, where appropriate, the characteristics of the distribution system, design, operating, environmental, performance and physical testing and inspections to assess the applicable threats and risk to its gas distribution assets. The actual performance, testing and observed condition of the asset is directly related to the environmental conditions encountered. Other attributes that are considered in the risk can include asset class (main, service or I&R facility), material, size, pressure, construction method, or meter location (sub-classes). Environmental factors that have been considered in threat identification (see Appendix B) include seismic activity, earth movement, frost heave, heat sources, and flooding. Population density and other location-specific conditions are considered in NGrid's secondary, more detailed, risk ranking efforts at the segment level via the estimate of potential human exposure (in the building types and usage), following the preliminary assessment by asset class and subclass (region). NGrid's leak survey and surveillance practices take into account environmental factors such as susceptibility to leak migration (wall-to-wall paving or seasonal frost cap) and proximity to buildings of public assembly. Valves are located in a variety of environments, including areas of paved streets. Valves are operated and maintained in accordance with Policy CNST04009.

5.3.5 Gas Distribution Mains and Services Assets Analysis

Gas mains and services comprise the bulk of the NGrid gas distribution system and were constructed with the materials and methods described above. The company reduces risk and threats by replacing the riskiest leak prone piping where appropriate and through prudent operating and maintenance that includes a number of Preventative and Mitigative measures as noted in Table 5-1

The NGrid annual System Integrity Report is incorporated by reference into the DIM Plan and typically provides the following:

- Overall Regional Distribution Integrity Assessment Summary
- Total Leak Receipts – Current Year and Previous 5 Years
- Leak Receipts as a Function of Total System Pipe Mileage – Current Year
- Leak Receipts by Discovery Source (Excluding Damages) - Current Year and Previous 5 Years
- Leak Receipts by Original Classification (Excluding Damages) - Current Year and Previous 5 Years
- Year-End Workable (excludes Type 3) Leak Backlogs - Current Year and Previous 5 Years
- Year-End Open Type 3 Leak Inventories - Current Year and Previous 5 Years
- Performance Measure (Workable Backlog / Miles of System Pipe) - Current Year and Previous 5 Years
- Performance Measure (Type 3 Inventory / Mile of System Pipe) - Current Year and Previous 5 Years
- Main Inventory by regional Company- Current Year and Previous 5 Years
- Main age analysis by region - Current Year and Previous 5 Years
- Leak-prone pipe and Main replacement program - Current Year and Previous 5 Years
- Percentage of Leak-Prone Pipe - Current Year and Previous 5 Years
- Rate Case Supported Leak-Prone Main Replacement Levels
- Total Main Leak Repairs (Including Damages) - Current Year and Previous 5 Years
- Total Main Inventory by Material vs. Total Main Leak Repairs (incl. damages) by Material – Current Year
- All Main Leak Repairs by Material (Excluding Damages) - Current Year and Previous 5 Years
- All Main Leak Repairs (Including Damages) by Cause – Current Year
- Total Main Leak Rates (repairs per total mile of main) Including Damages - Current Year and Previous 5 Years
- Total Main Leak Rates (repairs per mile of total main) Including Damages - Current Year
- Main Leak Rates (Excluding Damages) by Material - Current Year and Previous 5 Years
- Current Year Main Leak Rates (Excluding Damages) – All Region Comparison by Material
- Main Leak Repairs – Material-Cause Matrix – Current Year
- 10-Year Cast Iron Main Inventory and Attrition Rate – All Region Comparison
- Total Cast Iron Main Breaks - Current Year and Previous 5 Years
- Cast Iron Main Break Rates – All Region Comparison by Diameter – Current Year
- 10-Year Bare/Unprotected Steel Main Inventory and Attrition Rate– All Region Comparison
- Main Corrosion Leak Rates - Current Year and Previous 5 Years
- Service Inventory by regional Company- Current Year and Previous 5 Years
- Total Service Leak Repairs (Including Damages) - Current Year and Previous 5 Years
- Total Service Inventory by Material vs. Total Service Leak Repairs by Material – Current Year
- All Service Leak Repairs (Excluding Damages) by Material - Current Year and Previous 5 Years
- All Service Leak Repairs (Including Damages) by Cause – Current Year

- Total Service Leak Rates (Including Damages) - Current Year and Previous 5 Years
- Total Service Leak Rates (Excluding Damages) by Material - Current Year and Previous 5 Years
- All Region Service Leak Rates (Excluding Damages) Comparison by Material – Current Year
- Service Leak Repairs Material-Cause Matrix – Current Year
- Distribution DOT Report data Comparisons – Current Year & Previous Year.
- System Integrity Report Analysis (Findings and Explanations)

The company has developed a procedure for selecting main segments for replacement. ENG04030: Identification, Evaluation, and Prioritization of Distribution Main Segments for Replacement. This procedure details the attributes that are considered and utilized and they include but are not limited to Design, Operations and Environmental factors.

NGrid Damage Prevention metrics are also incorporated by reference into the DIM Plan and provide the following:

- Total Damages per 1000 Tickets
- Excavator Error Damages per 1000 Tickets
- Damages due to No-Calls per 1000 Tickets
- Damages due to Mismarks per 1000 Tickets
- Damages due to Company & Company Contractors per 1000 Tickets

(Note that “tickets” refers to all “one-call” requests, and not actual mark outs performed)

5.3.6 Gas Distribution Instrumentation & Regulation (I&R) Facilities Asset Analysis

As previously noted above, I&R facilities are inspected annually and immediate or scheduled repairs are made to ensure continued operation. Observed conditions are noted and used to assess and risk rank the facilities. The risk ranking methodology is viewed as a high level assessment that goes beyond the annual PT to capture overall residual risks. The assessment process guides and validates the organization’s activities.

The I&R risk ranking method consists of four primary factors: impact to the Company, effectiveness of technical controls, effectiveness of location specific controls, and the likelihood of an asset failure. These factors are weighted, averaged, and multiplied to make up the risk score. This risk score is utilized to risk rank and capture the overall condition of the station and compare it to the other stations.

The company has several programs related to integrity of I&R facilities:

- Reactive program – for operations to handle immediate parts & equipment changes
- Proactive Station Program - for planned station upgrades / replacements based on assessment, risk and threats
- Proactive Heater Program - for planned heater upgrades / replacements based on assessment, risk and threats
- Proactive Control Line Program - for planned control line upgrades / replacements based on assessment, risk and threats

Inspection data is collected and stored locally within operations and some regions have migrated to electronic data collection and storage. The risk ranking data is stored electronically and maintained by Pressure Regulating Engineering.

5.4 Additional Data Needed

Additional information needed that will be obtained over time through normal activities conducted on the pipeline is described in Table 5-7.

Table 5-7 Additional Information

Area of incomplete records or Knowledge	Can it be acquired over time through normal activities?	Does Action Plan Exist? Y / N	Scope	Schedule	Responsible Departments
Estimate number of EFVs • In system at CY end • Installed during the year on residential services only	Yes	Yes	• Interim - Estimate annual based on usage and totals calculations based on other available / reasonable data • Long term - through Electronic Reporting and GIS	• Interim for annual 2010 – 2012 DOT reporting estimates • Long term 3-5 years	• Distribution Engineering
Above grade hazardous leak repair data on services	Yes	Yes	Not previously included in DOT reporting. These leaks now need to be reported per latest OPS ruling	• Completed (2012 Annual DOT reporting)	• Distribution Engineering
Above grade leak repair data on I&R facilities	Yes	Yes	Not previously included in DOT reporting unless leak tickets and leak numbers are generated. These leaks now need to be reported per latest OPS ruling	• Completed (2012 Annual DOT reporting)	• Distribution Engineering
Leak repair data on Mechanical fittings	Yes	Yes	• Interim - Issued forms and bulletins • Long Term- Electronic Reporting	• Interim – Regulatory & Technical Bulletins issued 12/12/2010 • Long Term – 3-5 years	• Distribution Engineering
Incorrect or Incomplete Facilities Records – Maps and	Yes	Yes	• Employees may submit corrections to the AMMS system via Field Data Capture unit or the Maps &	• Continuous	• Maps and Records

Scanned Records – MA			Records Data Correction Form. • Appropriate changes are made in ArcFM & SPIPE. Sketches are added to the Scanned Records system		
Incorrect or Incomplete Facilities Records – Maps and Scanned Records – LI and NYC	Yes	Yes	• Employees may submit change requests through the Feedback tool in NRG. • Appropriate changes are made in NRG and Fortis. Sketches are added to the Fortis system.	• Continuous	• Maps and Records
Incorrect or Incomplete Facilities Records – Maps and Scanned Records – UPSTATE NY	Yes	Yes	• Employees may submit a corrected service card or GFDR. • Appropriate changes are made in Smallworld. Sketches are added to the GasCar system.	• Continuous	• Work Support • Asset Replacement
Incorrect or Incomplete Facilities Records – Maps and Scanned Records – RI	Yes	Yes	• Employees may submit corrections when inconsistencies are found. • Appropriate changes are made in Smallworld. Sketches are added to the Scanned Records system.	• Continuous	• Damage Prevention • Maps and Records

5.5 Data Capture for New Construction

The requirement for data capture for the location where any new pipeline is installed and the material of which it is constructed is contained in various standards as summarized in Table 5-8 below. The legacy procedures that exist are expected to be replaced by an updated enterprise wide procedure over time.

Table 5-8 Data Capture Requirements

STANDARD	NYC	UNY	LI	MA	RI
GEN03002 Processing Gas Main and New Service Work Packages	x	x	x	x	x
CNST06020 Completion and Processing of Gas Service Record Cards	x	x	x	x	x
CNST01005 Preparation of Gas Facility Historical Records	x	x	x	x	x
Construction Documentation Specifications					x

5.6 Knowledge Capture – Subject Matter Experts

In addition to existing enterprise wide data, information, and reporting, NGrid has conducted additional interviews and discussions with process owners and regional groups of Subject Matter Experts (SME's) to determine if there are undocumented risks that could impact system performance. SME's are individuals who have specialized knowledge based on their experience or training. SME's were used to supplement existing, incomplete, or missing records and may be the only or best source of information in subjects such as historical operations, maintenance, and construction practices. SME interviews were also utilized to ensure that all threats have been identified. All SME interviews have been documented and stored in the Distribution Integrity Management Program files.

It should be noted that, due to the extent of NGrid's gas delivery systems over eight (8) legacy companies, SME interviews needed to be limited in order to accomplish implementation of the Plan within the necessary time frame. SMEs were selected based on experience and knowledge of general regions. It was not possible to include operations personnel from all geographic locations in each legacy company. To ensure that all reasonable threats were identified and evaluated, the summary SME data was carefully reviewed after the first issuance of the Plan. If anything was believed to be incorrect by the engineering SME panel or any regulator, that information was corrected in the current revision. Furthermore, after the Plan is audited by regulators in all states, a more detailed rollout will be conducted with Operations and feedback will be solicited and incorporated into a future revision, as appropriate.

6.0 THREAT IDENTIFICATION

The objective of this section of the plan is to identify existing and potential threats to the gas distribution pipeline. The following categories of threats shall be considered for each gas distribution pipeline:

- Corrosion
- Natural Forces
- Excavation Damage
- Other Outside Force
- Material, Weld or Joint Failure
- Equipment Failure
- Incorrect Operation
- Other concerns that could threaten the integrity of the pipeline.

In addition to the above categories established by §192.1007(b), NGrid may collect and assess threats by other additional categories to evaluate the system, trends and risk. NGrid Leak Cause categories and definitions are summarized below.

Corrosion

Only to be used when gas is leaking from a hole, crack or porosity in the pipe or other gas-carrying member AND that condition was caused by corrosion (or graphitization for cast iron). [NOTES: Corrosion of valves and couplings (not the pipe) or metallic risers are "Equipment" leaks. Corrosion of metallic CI joint clamps is "Other" leaks.]

Excavation

To be used when the leak is directly caused by physical damage (impact) that can be attributed to someone. It can be Company personnel, contractors working for the Company or a third party.

Equipment

To be used for leaks caused by malfunction of control/relief equipment (including valves, regulators or other instrumentation); stripped threads or broken pipe, couplings on nipples, valves or mechanical couplings; or seal failures on gaskets, O-rings or seal/pump packing, etc. [Corrosion of valves and couplings (not the pipe) or metallic risers are "Equipment" leaks. Failures of previous cast iron joint sealing methods are "Other"leaks]

Materials and Welds/Fuses (All Materials, Including Plastic)

To be used for leaks occurring on faulty material (such as faulty bends, faulty field welds/fuses or material damaged in transportation or during installation); on originally sound material that was subjected to dents, gouges, excessive stress, etc.; or for leaks resulting from a defect in pipe material, component, fabrication or faulty weld seams. Do not use this for material that was fine but has deteriorated.

Other

To be used ONLY for leaks that are the result of deterioration (NOT corrosion) such as exceeding the normal service life or any other cause not covered above. USE THIS CAUSE FOR ALL CAST IRON JOINT LEAKS – Including those which re-occurred because a failed joint clamp or seal.

Natural Forces

To be used when the leak is directly caused by undermining, earth movement, lightning, floods, washouts, frost heave, frozen components, etc. It is a damage that was caused by nature rather than by a person. All broken mains that were not damaged by anyone and were not the direct result of corrosion/graphitization should be scored as Natural Forces.

Other Outside Force

To be used only when the leak is directly caused by fire, explosion, or a deliberate/willful act such as vandalism. USE THIS CAUSE FOR ALL ELECTRIC BURN-THROUGHS.

Operations (RARELY USED)

To be used for a leak caused by operator error, inadequate safety practices/procedures or failure to follow procedures.

6.1 Means of Threat Identification

NGrid's legacy records and employees provide the basis of information regarding the system assets and material. The cause categories noted above are the threats for gas distribution pipelines. The 5 year summary of the annual DOT reports by operator identification is incorporated by reference into this DIM Plan.

In an effort to gain additional information about the gas system and to identify potential unknown threats, Subject Matter Expert (SME) interviews were conducted and are summarized in Appendix B. Subsequent threats shall be identified as they are discovered or identified and reviewed by Integrity Engineering for inclusion in the program.

A review of information gathered for Section 5 shall be conducted periodically to identify existing and potential threats. Threats (including material performance concerns) shall subsequently be identified by personnel who are knowledgeable of the NGrid system, operations and the Distribution Integrity Management Program. This is accomplished through the annual system integrity report that is prepared and issued by Distribution Engineering and is incorporated by reference into the DIM Plan. An annual review of the system performance combined with knowledge of the facilities, design, materials science, engineering, operation and maintenance histories, construction methods, environmental factors and an understanding of reportable/significant gas incidents provides NGrid with a sound indication of the threats to its system.

6.2 Monitoring Potential Threats

Potential Threats include those that are not currently evident based on NGrid gas distribution system failures, leak, or incident data. NGrid routinely monitors information from sources that may include:

- National Transportation and Safety Board (NTSB) Reports and Recommendations applicable to Pipeline Accidents.
    - Reports may be found at: http://www.ntsb.gov/investigations/reports_pipeline.html
    - Recommendation Letters may be found at: http://www.ntsb.gov/recsletters/
- Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) Advisory Bulletins: http://www.phmsa.dot.gov/pipeline/regs/advisory-bulletin
- Membership in a local, regional, or national gas association (e.g. American Gas Association, Northeast Gas Association, NACE, ASME, etc.) and involvement in Association workshops and forums that share knowledge regarding distribution pipeline threats
- Review of trade journals and magazines that publish material regarding gas distribution
- Incident Analysis (IA's) or Near Miss Reviews
- Leak Repair Data
- Mechanical Coupling / Fitting failure reports
- Process Safety Reporting
- All Failure Analysis Reports from the Materials, Standards and Testing Group (MS&T - which includes the Materials Testing Lab) are reviewed by Distribution Engineering and key failure data is entered into a Failure Analysis Database, which is used to identify any potential systemic integrity issues. Whenever an

issue is discovered, even if it is not attributable to any asset subclass in the risk ranking (eg – common substandard conditions, fittings, etc.), appropriate mitigative measures are developed and implemented regionally or organizationally (depending on the nature of the issue). To further enhance the accuracy of the Failure Analysis Database, details of plastic leak data from all regions are scanned quarterly to identify any failures that may not have been sent in for analysis.

For Mechanical Fitting Failures resulting in hazardous leaks, the following requirements have been incorporated into the gas operating procedure GEN01009, Reporting Nonconforming Material:

- Operations and Construction will complete the "Mechanical Fitting Field Failure – US DOT Report" and send it, with the fitting (if removed from service), to MS&T for evaluation.
- Operations and Construction will notify Distribution Engineering immediately if the failure is potentially systemic in nature, requiring immediate follow-up.
- MS&T will review the form, examine the material, perform any necessary testing, notify manufacturers and/or vendors when applicable, issue any necessary technical bulletins, product advisories or reports containing their findings, recommendations and required follow-up actions.
- MS&T will make all necessary filings with the AGA, PPDC and Public Service Commission.
- MS&T will forward the form and report to Distribution Engineering for appropriate filing with PHMSA and advise Distribution Engineering if the investigation deems that immediate or scheduled removal of in-service material is warranted.

- Also under "Reporting Nonconforming Material GEN01009 ", other potential threats (beyond mechanical fitting failures) are reported to and investigated by MS&T and the follow-up is similar.

7.0 EVALUATION AND RANKING OF RISK

7.1 Objective

Risk analysis is an ongoing process of understanding what factors affect the risk posed by threats to the gas distribution system and where they are relatively more important than others. The primary objectives of the evaluation and ranking of gas distribution risk are:

- Consider each applicable current and potential threat
- Consider the likelihood of failure associated with each threat
- Consider the potential consequences of such a failure
- Estimate and rank the risks (i.e. determine the relative importance) posed to the system
- Consider the differences in the relevance of threats in areas among the various regions

For the purposes of risk assessment, NGrid has separated its gas distribution system into two broad (and very different) asset categories; Mains & Services and Instrumentation & Regulation Facilities. Separate models have been developed to estimate and relatively rank the risks for each of the assets (by sub-category). The models are different and completely independent of one another. The models and the results of these models are maintained by Distribution Engineering and Pressure Regulation Engineering and are used to develop NGrid's Asset Management Strategies by State and by Operator ID.

7.2 Mains & Services

For mains and services (with service lines including all equipment upstream of customer-owned piping, with "service line" as defined in Section 4.0), because of their sheer volume and non-homogenous nature, NGrid has elected to divide these assets into "regions" (segments of the system with similar characteristics and reasonably consistent risk for which similar actions would be effective in reducing risk). For purposes of the mains and services model, the "regions" will be the asset subclasses. The asset is first broken into two general facilities – mains or services. Each facility is further broken down by such factors as material (including active/inactive status, pipe coating, and cathodic protection status), inside vs. outside meter set (for services), pressure and diameter (for mains).

Diameters for pipe are classified by the following diameter ranges: up to 4-inch (small fractional wall thickness), over 4-inch and up to 8-inch (nominally ¼-inch wall), and over 8-inch (0.375-inch wall). For iron pipe (cast and wrought), diameters are classified by the following diameter ranges: less than 4-inch (with a higher break rate), 4-inch to 8-inch, and greater than 8-inch (with a lower break rate).

All plastic pipe evaluated in the model is assumed to be Polyethylene. As covered in Section 5.2.3, there may be small quantities of CAB in Upstate NY and PB in RI. To address any potential risk associated with these materials, company policy requires that all integrity-related plastic pipe failures be reported to the MS&T lab for evaluation and monitoring for possible systemic issues.

A relative risk score is calculated for each asset subclass (with the main and service facilities ranked independently) for each of the eight defined threat categories. The risk ranking method for each asset subclass and threat consists of 4 parts: likelihood of failure and release of gas, likelihood of the release resulting in ignition, reduction controls and the potential consequences of such an event.

A separate score is calculated for each asset subclass and threat category. The highest scores (separately for mains and services) are identified for each region and then reviewed by an engineering SME panel in order to validate/adjust the model results. Some asset subclass/threat category scores were removed if the panel concluded that the high scores were the result of known data anomalies. Additionally, some asset subclass/threat categories with lower scores were added if the SME panel felt that the potential risk or exposure was not adequately represented by the calculations. Further, any asset subclass/threat category that experienced a reportable integrity-related incident within the prior ten (10) calendar years had its score changed in its respective region to “Known Incident”. (If the asset subclass/threat was not among the top risks listed, it was added to the list with a score of “Known Incident”.) All scores labeled “Known Incident” were then accelerated to the top of the risk rankings. The resulting final main and service lists of the highest risks for each region appear in Appendix C. The model and these lists will be updated annually based on the inventory and performance data for the previous calendar year.

It is not possible for NGrid to utilize operating environment factors such as known soil conditions, frost heave susceptibility, depth of cover, potential "other outside force damage" sources, potential "natural force damage" sources, geological conditions, paving, population density, building types, substandard conditions, etc. in its primary risk rankings (beyond the overall asset subclass general susceptibilities to "natural force" and "other outside force" damages); as these are very specific to geographic areas and can vary widely within even a small geographic region. As a result, NGrid's DIM Plan ranks risk by dividing it's mains and services into "regions" with similar characteristics (as previously described), These types of factors, when known, are all considered when evaluating and prioritizing assets for proactive replacement as a mitigative measure. NGrid utilizes a secondary methodology for replacement qualification and prioritization (ENG04030) (see Section 5.3.4) that is risk-based and applied on a segment-by-segment level. Wherever possible, this methodology allows for accounting of environmental and other location-specific factors in the qualification and prioritization algorithms. These algorithms also include a “DIMP Factor” (which is based on the highest risk scores for that region in the DIM Plan) to increase the scoring for those asset subclasses and subsequently accelerate their attrition.

The parts (or “factors”) used for risk ranking have been carefully designed to take advantage of known differences in the asset subclasses, extensive experience in failure modes and subsequent events, actual current performance data for the asset subclasses and threat categories, subject matter expert opinion on assets and failures experienced throughout the history of the company, existing system operational procedures, and populations affected by each threat. Some of these factors are variable (and will be updated on an annual basis), while others are relatively fixed. The factors and their components are detailed as follows:

- Likelihood of Failure and Release of Gas – There are two components to this. The first is the actual failure frequency (or leak repair rate) for the most recent calendar year. This is a variable factor that will be updated annually. The second is a rating applied from the results of subject matter expert interviews. This strengthens the likelihood calculation because it accounts for infrequent failures that may not occur on a consistent basis. It also was derived from extensive questioning on not only each threat category, but of all the known sub-threats for each category. This is a comparatively fixed factor.
- Likelihood of the Release Resulting in an Ignition – There are 2 components to this factor as well. The first involves the hazardous nature of all failures. This will be determined by the percentage of all leak discoveries that are Type 1 (hazardous). This varies widely within NGrid's companies. This will be a variable factor and will be updated on an annual basis. The second component will be a failure mode factor, which will be a fixed score assigned based on the most common mode of asset failure.
- Separate failure mode factor scores were identified by an engineering SME panel and will be assigned based on the asset and threat category.
    - Additionally, reduction factors were included to this category for "controls" that are in place to reduce the likelihood of a release resulting in ignition. Extreme care was utilized not to include any controls that would have already been accounted for by the actual failure frequencies (leak rates). There was one control reduction factor applied to select services and one to select mains:
        - SERVICES – A reduction factor was applied to all non-LP services to account for the likelihood reduction due to the presence

of excess flow valves (EFVs). The factor was different for each region, based on the percentage of those services which had been equipped with an EFV.

- MAINS – A set of reduction factors was also applied to all Local Transmission mains. These factors are the same for each region, but vary by threat category. They were applied to account for the fact that these mains were designed and constructed as Transmission mains and are operated, maintained and monitored as Transmission mains as well; thereby reducing the likelihood.

- Potential Consequences – The Health & Safety consequence is given a weight of 60% of the total consequence score, while Customer Interruption is given a weight of 20% and Regulatory & Reputational Impact and Asset Impact consequences are weighted at 10% each.

The data used in the mains & services risk assessment is consistent with the data reported to PHMSA in NGrid’s Annual Gas Distribution Reports.

7.3 Instrumentation & Regulation

NGrid utilizes a risk model to evaluate and risk rank the 1,892 Take and Regulating Stations across the service territory. Using data from the annual Performance Test, Cathodic Protection testing, and on-site inspections technical assessments are conducted for each station taking into account pipe and equipment condition, regulator performance, corrosion data, heater, and scrubber performance. This information, combined with the potential customer impact resulting from a station outage, is used to prioritize mitigation. Data to support the risk assessment and ranking was gathered throughout 2012 during routine testing and analysis of that data was used to prioritize the work for the 2013/2014 work plan.

Initial data analysis for each station asset has been completed and will be updated as necessary. An updated listing of the highest risk-ranked facilities is maintained by Pressure Regulation Engineering and is available at all times. This listing is not being physically incorporated into Appendix C of the Plan, as it is very dynamic – changing whenever retirements or replacements occur; but is incorporated by reference in its most updated form.

8.0 IDENTIFICATION AND IMPLEMENTATION OF MEASURES TO ADDRESS RISKS

The objective of this section of the DIM Plan is to describe existing and proposed measures to address the risks that have been evaluated and prioritized in section 7. NGrid has a number of Corporate and Gas Business programs and initiatives to minimize risk to the company, the customers and the public.

8.1 Corporate Culture Philosophy and Programs

NGrid recognizes that the energy it provides is essential to today's society, but that it has inherent risk which cannot be completely eliminated. The risk can however be managed and kept as low as reasonably possible. These programs and initiatives, in most cases, exceed existing gas safety regulations and position NGrid to be a premier energy company. These programs and initiatives include but are not limited to the following:

- *Asset Management* – NGrid has obtained independent asset management certification to Publicly Available Standard 55 (PAS 55). An Audit was conducted by Lloyds Register to certify NGrid's compliance with this standard for managing its gas assets.

- *Damage Prevention* - NGrid follows the nine (9) elements contained within the published PHMSA Damage Prevention Assistance Program (DPAP). The Company has been actively involved in mark outs and damage prevention for over 25 years. NGrid also participates in the Common Ground Alliance DIRT program.

- *Gas Emergency Procedure Manual – A* Gas US manual that includes plans specifically developed to provide for a rapid emergency response. The program is designed to minimize the extent of an emergency.

- *Incident Analysis* – this is the process necessary to ensure that injuries and serious incidents are analyzed thoroughly and promptly to avoid reoccurrence. This is a NGrid Safety Procedure J-1001.

- *Leak Management Program* – NGrid's leak management program (see Table 5-1 for specific procedures) adheres to the following principles:
    - *Locate the leaks (leak response and leak survey)*
    - *Evaluate the actual or potential hazards associated with these leaks*
    - *Act appropriately to mitigate these hazards (including leak surveillance)*
    - *Keep records; and*
    - *Self-assess to determine if additional actions are necessary to keep people and property safe*

- *Material Standards & Testing (MS&T)* - NGrid maintains its own materials lab that tests gas materials for compliance with standards and for suitability for its gas system. The lab also performs root cause analysis of materials failures and investigates issues with materials and tools. Findings often generate changes in manufacturers' products and QA/QC procedures. MS&T's role in investigating mechanical fitting failures and other non-conforming materials is described in Section 6.2.

- *Operator Qualifications (OQ)* – Representatives of The New England Gas Association, the regional trade association for 26 distribution companies operating in the 6 New England states, and the New York Gas Group, a regional trade association for 10 distribution companies operating in the state of New York, formed a consortium in 1999 to develop a operator qualification written plan. Those trade associations merged, and are now the Northeast Gas Association. The NGrid OQ committee has met monthly to ensure the effectiveness of the OQ program. NGrid participates in meetings with all State Commission Staffs through the Northeast Gas Association's OQ Working Group (offspring of the two organizations mentioned previously).

- *Personnel and Job Site Safety* – This includes a core belief and commitment to Believe in Zero accidents, Employee Safety Handbooks, Trusted to Work Responsibly Documents, the Golden Rules of Safety, and Safe and Unsafe Acts (SUSA) Program.

- *Plastic Pipe Data Collection (PPDC) Initiative* – NGrid participates in the national effort to track plastic material failures and use that information to assess risk on plastic systems.

- *Proactive Main and Service Replacement Programs* – NGrid recognizes that over 31% of the mains and 21% of the services are made up of leak prone materials. Significant replacement plans are in place to reduce the inventory and thus the risk associated with leaks and cast iron breaks.

    - Additionally, ENG04030 has been revised (Revision 1, effective 9/15/2013) to better address systemic issues on vintage plastic pipe, and the extent of replacement under such conditions:

        - When Distribution Engineering determines that a systemic issue exists in a specific main segment due to improper fusion or other construction defects, the entire affected section of main will be qualified as an automatic prioritization calculation of 12 and scheduled for replacement within two/three years (based on region).

        - When Distribution Engineering determines that a systemic issue exists in a specific main segment due to slow crack growth resulting from prior squeeze offs, point loading failures, material deterioration, etc.; the entire affected section of main will be qualified as an automatic prioritization calculation of 12 and scheduled for replacement within two/three years (based on region).

- *Process Safety* – This program is based upon practices of the chemical industry and the Baker Panel investigation of the BP Texas City incident. It seeks to understand and manage the risk of low frequency high consequence events (i.e. fires and explosions). In addition to internal measures and the review of incidents and near misses, events external to the company are also reviewed (e.g., sewer cross-bore incidents, compression coupling failures, etc.). Over 100 Process Safety Key Performance Indicators (KPIs) are tracked and reported to the Board of Directors, covering the following twelve Elements of Process Safety.
  - Process Safety Leadership
  - Plant design and modifications
  - Operational procedures
  - Workforce competence
  - Human factors
  - Emergency arrangements
  - Protective devices, instrumentation and alarms
  - Inspection and maintenance
  - Permit to work
  - Asset records and data quality
  - Third party activities
  - Audit, review and closeout

- *Flooding* – National Grid has begun identifying its vulnerable facilities in flood-prone regions on both 100-year and 500-year flood surge maps, and will consider any appropriate safety and reliability improvements to those facilities.

- *Storm Hardening* – National Grid is currently evaluating various potential storm hardening measures.

- *Process Ownership* - NGrid has established process owners for various safety and management tasks to reduce risk by ensuring that best practices are reviewed and there is consistent reporting and tracking across all territories.

- *QA/QC* – NGrid has a Quality Assurance and Quality Control (QA/QC) group which monitors compliance with all gas regulatory requirements, as well as applicable NGrid construction, maintenance, service and safety policies. This effort involves:

    - Field inspection and assessment of NGrid personnel and contractors who routinely perform gas construction, maintenance and service activities;

    - Performing process audits involving Federal and State gas regulations;

    - Conducting additional audits for gas related activities on a regional basis, as well as those identified by the PAS 55 Steering Committee for having potential adverse risk to the Company's gas assets;

    - Utilize the Six Sigma process methodology to address companywide projects that require a detailed focus for inter related departmental issues;

    - Re-Dig program - this program targets post inspection results of completed gas facility installation and repair activities across NGrid's U.S. Gas Operations.

- *System Integrity Reporting* – Distribution Engineering tracks and produces regulatory reports for compliance with annual DOT and State reporting requirements. In addition, various in-depth reports on the system's performance are created to provide trending data. These reports are also used to measure and monitor the performance of existing programs.

- *Corrosion Control* – NGrid has established enterprise wide corrosion control standards, test instructions and policies covering the design, installation, surveys inspections, testing and monitoring of the cathodic protection on its gas system. These provide the preventative and mitigative actions necessary to address the threat of corrosion.

- *Special Patrols* – The local and non-IMP transmission lines are covered under this DIM plan. NGrid has established enterprise wide patrol policy CNST02005, Patrolling Transmission Pipelines. The policy covers the DOT transmission system and local transmission lines.

- The Standards, Policies & Codes area of National Grid's Network Strategy organization has developed a Pipeline Public Awareness (PPA) program as a result of the Pipeline Safety Improvement Act of 2002. The program encompasses all of National Grid's gas transmission and distribution facilities across New York, Massachusetts and Rhode Island. The goal of the program is to educate the general public about pipeline safety, including topics such as:

  - How to recognize possible leaks in gas pipelines and what to do if a leak is suspected
  - How to contact the pipeline operator in an emergency
  - The presence of buried gas pipelines in the communities served
  - The necessity to call before excavation – Know What's Below; Call Before you Dig – Call 811
  - The significant role the public/excavators can take in helping to prevent third-party damage accidents as well as how they should respond.
  - The proper actions emergency response agencies and first responders should take in response to a pipeline emergency

    - The means to assess the effectiveness of the communications used by the PPA Program, in order to improve the Program's effectiveness over time.

- The PPA program is managed within the Operations, Codes & Policies area of Network Strategy. There is a Committee that provides oversight to the program made up of:

    - Customer Communications
    - Community & Customer Management
    - Damage Prevention
    - Emergency Planning
    - Gas Work Methods
    - Learning & Development
    - Network Strategy
    - Safety

- The PPA program has four key stakeholders:

    - Affected Public: Residents along a transmission pipeline right-of-way, places of congregation, near gas storage & operational facilities, along gas distribution lines as well as all National Grid customers should be educated on the appropriate actions and precautions to take while living in proximity of gas pipelines. This will in turn create a safer environment and allow for more reliable service.

    - Emergency Officials: Fire departments, police departments, Local Emergency Planning Management Agencies (EMA) and 911 call centers must be aware and educated on the safety measures and company plans while dealing directly with a gas pipeline emergency.

- Local Public Officials: Mayors & administrators, zoning boards, public works officials, licensing & permitting departments, building code enforcement departments and public officials must be educated and work along side National Grid to ensure the safety and cooperation of the public.

- Excavators: Employees from construction, blasting, directional drilling and landscaping companies as well as farmers, sprinkler system installers and demolition teams all need to be aware of and educated on pipeline safety. This increased awareness and education will likely reduce the number of pipeline damages and accidental leaks.

National Grid's PPA Program communicates to these key stakeholder groups in a number of ways:

- Pipeline Public Awareness brochures included in customer bills
- Public service announcements
- Paid advertising
- Direct mailings with letters and safety brochures
- National Grid websites
- Links to other pipeline safety information sites
- Facebook
- Twitter
- On-line training programs for first responders and contractors dealing with natural gas and electric
- Education materials for elementary school teachers and students regarding natural gas and electric.
- Liaison meetings with emergency and local public officials
- Attendance at community events

- National Grid also participates in collaborative outreach to key stakeholders through the Northeast Gas Association using radio and cable television spots.

- The PPA program also communicates natural gas and pipeline safety information by direct mail outreach to excavators and in conjunction with the local Call Before You Dig call centers like Dig Safely, New York 811 and Dig Safe to provide natural gas safety and damage prevention information and training sessions.

8.2 Primary Threat Mitigation

NGrid worked with the American Gas Association (AGA) and the American Gas Foundation (AGF) on the development of an AGF Study on Distribution Integrity. This study was based on an analysis of gas distribution incidents in the DOT / OPS Database for the years 1990-2002. The study concluded that the top five (5) processes having the greatest impact on distribution integrity were:

- One Call / Mark Outs Systems to reduce third party damage
- Operator Qualifications to reduce operator error
- Cathodic Protection to reduce potential corrosion leaks or wall loss
- Leak Management to reduce the potential for leaks to cause an incident
- Proactive Replacement to reduce the inventory of problematic materials or components

NGrid also included construction activities in Operator Qualifications program early in its development. Additional or accelerated actions that have been taken or are being planned in order to reduce the risks from failure of the gas distribution pipeline are documented in Appendix D. These mitigation efforts address each of the primary threat types: corrosion, natural forces, excavation damage, other outside force, material or weld failure, equipment failure, incorrect operation, and other causes. NGrid's Distribution Engineering Department continuously monitors system performance in order to evaluate threats and also monitors gas industry best practices. As necessary, the Distribution Engineering Department will work with the Standards & Policy Department to update or issue new policies and procedures to mitigate threats.

9.0 MEASUREMENT OF PERFORMANCE, MONITORING RESULTS, AND EVALUATING EFFECTIVENESS

The objective of this section of the plan is to establish performance measures that shall be monitored from an established baseline in order to evaluate the effectiveness of the DIM program. The performance measures detailed in Sections 9.1 through 9.6 have been established in order to monitor performance and assist in the ongoing evaluation of threats. Distribution Engineering shall aggregate data from various legacy data sources (and successor data systems) as necessary to track each performance measure.

9.1 Number of Hazardous Leaks either Eliminated or Repaired, per §192.703(c), Categorized by Cause

NGrid has been tracking all leaks by material and cause since 2005, consistently monitoring trends. The baseline and ongoing performance of the number of hazardous leaks either eliminated or repaired, per §192.703(c), categorized by cause, shall be documented, or included by reference, in Appendix E, Section 1. The baseline for this performance measure shall be 2010 recorded performance. Recent improvements in data scrubbing and validation make 2010 performance the best baseline from which to monitor ongoing performance.

9.2 Number of Excavation Damages

Excavation Damage was defined in §192.1001 in December of 2009 with the publishing of the Final Distribution Integrity Management Rule. NGrid has been tracking and trending leaks associated with excavation damage since 2004; however the new definition of excavation damage goes beyond just leaks. Thus, the baseline for this performance measure will be 2010 performance. The baseline and ongoing performance of the number of excavation damages shall be documented, or included by reference, in Appendix E, Section 2.

9.3 Number of Excavation Tickets (received from the notification center)

The baseline and ongoing performance of the number of excavation tickets received from the notification center(s) shall be documented, or included by reference, in Appendix E, Section 3. The baseline for this performance metric will be 2010 performance.

9.4 Total Number of Leaks either Eliminated or Repaired, Categorized by Cause

NGrid has been tracking all leaks by material and cause since 2004, consistently monitoring trends. Recent improvements in data scrubbing and validation make 2010 performance the best baseline from which to monitor ongoing performance. The baseline and ongoing performance of the total number of leaks either eliminated or repaired, categorized by cause, shall be documented, or included by reference, in Appendix E, Section 4.

9.5 Number of Hazardous Leaks Either Eliminated or Repaired, per §192.703(c), Categorized by Material

NGrid has been tracking all leaks by material and cause since 2004, consistently monitoring trends. The baseline and ongoing performance of the number of hazardous leaks either eliminated or repaired, per §192.703(c), categorized by material, shall be documented, or included by reference, in Appendix E, Section 5. The baseline for this performance measure shall be 2010 recorded performance. Recent improvements in data scrubbing and validation make 2010 performance the best baseline from which to monitor ongoing performance.

9.6 Additional Performance Measures

As it is determined that additional performance measures are needed to evaluate the effectiveness of the DIM Program in controlling an identified threat, the performance measures shall be documented, or included by reference, in Appendix E, Section 6.

Additional performance measures initially established include:

- Workable Leak Backlog at the End of Year (known system leaks scheduled for repair)
- Total Excavation Damages per 1000 Tickets
- Main Leak Rates by Material Excluding Damages

- Service Repairs per 1000 Services by Material, Excluding Damages
- Total Leak Receipts
- Response Time Performance

NGrid monitors many other metrics in the course of conducting and monitoring operations and process safety. Extensive investigation/research, monitoring and improvement works are being performed on some special projects like Farm Tap investigation and design upgrade to new Process Safety Standards, Inner-Tite fitting Inspection etc. All the reports are incorporated by reference in its most updated form. Additional performance measures may be added to Section 9.6 when warranted to control threats.

10.0 PERIODIC EVALUATION AND IMPROVEMENT

The objective of this section of the plan is to periodically re-evaluate threats and risks on the entire pipeline and periodically evaluate the effectiveness of its program.

10.1 Plan Updating and Documentation

This written integrity management plan shall be reviewed periodically and updated as required to reflect changes and improvements that have occurred in process, procedures and analysis for each element of the program. NGrid performs extensive trending and analysis annually and documents it in the System Integrity Report. Additionally, NGrid will update risk assessment and ranking by asset class on an annual basis. In addition to the annual efforts, a complete program re-evaluation shall be completed, at a minimum, every five years. The complete program re-evaluations shall address:

- Frequency of the next complete program re-evaluation based on the complexity of the system and changes in factors affecting the risk of failure
- Verification of general information
- Incorporation of new system information
- Re-evaluation of threats and risk
- Review the frequency of the measures to reduce risk
- Review the effectiveness of the measures to reduce risk
- Modification of the measures to reduce risk and refine/improve as needed

- Review performance measures, their effectiveness, and necessary improvements

Form F-1 in Appendix F may be used to document Periodic Review and Updating. All changes to the written plan, inclusive of material from the appendices, shall be recorded on the Revision Control Sheet on page ii. However, changes to material in the appendices that is included by reference need not be recorded on the Revision Control Sheet. This plan shall reside on the NGrid intranet with the accompanying change-management. Any significant update or major change to the plan will be informed to the appropriate regulatory agency.

10.2 Effectiveness Review

An assessment of the performance measures described in Sections 9.1 through 9.5 shall be performed periodically. The NGrid System Integrity Report shall be prepared annually. The evaluation of threats and risks shall be performed annually. Other discretionary measures (mitigation beyond minimum code requirements) may be necessary and shall be assessed at the discretion of management. An emerging threat in one or more location shall be evaluated for relevance to other areas. If the reviews described above demonstrate significant changes to threats or system performance, a complete program re-evaluation may be completed in a shorter timeframe than five years. Form F-1 in Appendix F may be used to document Effectiveness Reviews.

11.0 REPORTING RESULTS

11.1 State & Federal Annual Reporting Requirements

The following shall be reported annually, by March 15, to PHMSA as part of the annual report required by 49 CFR, § 191.11:

- Number of hazardous leaks either eliminated or repaired (or total number of leaks if all leaks are repaired when found), per § 192.703(c), categorized by cause
- Number of excavation damages
- Number of excavation tickets (receipt of information by the underground facility operator from the notification center)
- Total number of leaks either eliminated or repaired, categorized by cause

- Information related to failure of mechanical fittings, excluding those that result only in non-hazardous leaks, shall be reported to PHMSA on the Gas Distribution Mechanical Fitting Failure Form (PHMSA F-7100.1-2).

These measures, as well as any others that may be required by the State, shall also be reported to the appropriate State Agency as per GEN01020 (incorporated by reference). A copy of the reports shall be maintained in the Distribution Integrity Management Program files.

12.0 DOCUMENT AND RECORD RETENTION

The following records shall be retained in the Distribution Integrity Management Program files.

- The most current as well as prior versions of this written DIM Plan and its Appendices
- Documents supporting Knowledge of Facilities (material supporting Appendix A of the DIM Plan as well as the annual System Integrity Report)
- Documents supporting threat identification (material supporting Appendix B of the DIM Plan)
- Documents supporting the identification and implementation of measures to address risks (material supporting Appendix D of the DIM Plan)
- Annual Reports to PHMSA (as required by §191.11) and State pipeline safety authorities
- Mechanical fitting Failure Reports

Documentation demonstrating compliance with the requirements of 49 CFR, Part 192, Subpart P shall be retained for at least 10 years.

APPENDICES FOR RHODE ISLAND

RHODE ISLAND APPENDIX A – KNOWLEDGE OF FACILITIES

A summary of PHMSA Reportable Gas Incidents (reported on PHMSA F7100-1) as well as details of recent incidents are provided in Tables A-1, A-2 and A-3 below.

Table A-1: Reportable Gas Incidents by Year

Year	Number of Incidents	Fatalities	Injuries	Property Damage
2014	0	0	0	-
2013	1	0	0	$29,184
2012	1	0	0	$133,377
2011	0	0	0	-
2010	0	0	0	-
2009	1	0	2	$100,000
2008	0	0	0	-
2007	0	0	0	-
2006	0	0	0	-
2005	0	0	0	-
2004	2	0	2	$118,000
2003	1	0	0	$100,000
2002	0	0	0	-
2001	0	0	0	-
2000	2	0	0	$250,000
1999	0	0	0	-
1998	0	0	0	-
1997	0	0	0	-
1996	1	0	0	$250,000
1995	0	0	0	-
1994	1	0	1	$100,000
1993	1	0	0	$300,000
1992	2	0	1	$142,500
1991	0	0	0	-
1990	0	0	0	-
1989	0	0	0	-
1988	0	0	0	-
1987	1	0	2	-
1986	0	0	0	-
1985	2	0	0	$26,000
Total	16	0	8	$1,549,061

Table A-2: Reportable Gas Incidents by Cause

Year	Corrosion	Natural Forces	Excavation Damage	Outside Force	Material or Weld Failure	Equip. Failure	Incorrect Operation	Other
2014	0	0	0	0	0	0	0	0
2013	0	0	1	0	0	0	0	0
2012	0	0	0	1	0	0	0	0
2011	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0
2009	0	0	0	1	0	0	0	0
2008	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0
2004	0	2	0	0	0	0	0	0
2003	0	1	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	2
1999	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0
1996	0	0	1	0	0	0	0	0
1995	0	0	0	0	0	0	0	0
1994	1	0	0	0	0	0	0	0
1993	0	0	1	0	0	0	0	0
1992	0	1	1	0	0	0	0	0
1991	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0
1987	1	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0
1985	0	1	0	0	0	0	0	1
30-Year Total	2	5	4	2	0	0	0	3

New Table A-3: 10-YEAR INCIDENT HISTORY DETAILS

YEAR	Facility	Asset Class/Subclass	Street	Town	Leak Cause	Details
2009	SERVICE (@ METER SET)	Protected Coated Steel - LP - Outside Set	Rugby St	Providence	Other Outside Force	Vehicular Damage
2012	I&R	Valve	Purgatory Road	Middletown	Other Outside Force	Vandalism, Contractor working for St. George's School hit an underground gas main, forcefully entered into NG's District Regulator building & closed a valve which caused 483 service outage.
2013	MAIN	Protected Coated Steel – 8" – HP(35#)	Rocky Hill Road & Rte-116	Providence	Excavation	Mechanical Puncture on Gas Main by Excavator

RHODE ISLAND APPENDIX B
THREAT IDENTIFICATION

In February thru April of 2011, groups of Subject Matter Experts (SMEs) were brought together, each having knowledge of threats in the various communities served by NGrid. Details on SME qualifications as well as copies of their interview records are located in the Distribution Integrity Management Program files. A summary of the threats identified are presented below in Tables B-1 and B-2.

Table B-1: Summary of Applicable Threats

Primary Threat Category	SME's to Consider the Following	Rhode Island
Corrosion	Is there known evidence of Corrosion on the system?	Yes
	Is there a known history of leakage on the system due to Corrosion?	Yes
	Threat Applicable?	Yes
Natural Force	Is there known evidence of damage or failures on the system due to natural forces?	Yes
	Is there a known history of leakage on the system due to Natural forces?	Yes
	Threat Applicable?	Yes
Excavation Damage	Is there known evidence of damage or failures on the system due to Excavation Damage?	Yes
	Is there a known history of leakage on the system due to Excavation Damage?	Yes
	Threat Applicable?	Yes
Other Outside Forces	Is there known evidence of damage or failures on the system due to Other Outside Forces?	Yes
	Is there a known history of leakage on the system due to Other Outside Forces?	Yes
	Threat Applicable?	Yes
Material or Weld Failure	Is there known evidence of damage or failures on the system due to Material or Weld Failure?	Yes
	Is there a known history of leakage on the system due to Material or Weld Failure?	Yes
	Threat Applicable?	Yes

Primary Threat Category	SME's to Consider the Following	Rhode Island
Equipment Failure	Is there known evidence of damage or failures on the system due to Equipment Failure?	Yes
	Is there a known history of leakage on the system due to Equipment Failure?	Yes
	Threat Applicable?	Yes
Incorrect Operations	Is there known evidence of damage or failures on the system due to Incorrect Operations?	Yes
	Is there a known history of leakage on the system due to Incorrect Operations?	Yes
	Threat Applicable?	Yes
Others	Is there known evidence of damage or failures on the system due to others reasons?	Yes
	Is there a known history of leakage on the system due to other reasons?	Yes
	Threat Applicable?	Yes

Table B-2: Summary of SME Interview Responses for Threat Identification

Primary Threat Category	Material or Sub-Threat	SME's to Consider the Following	Rhode Island
Corrosion	Cast Iron Pipe	Does Cast Iron pipe exist in the system?	**Yes**
		Is there a known history of body-of-pipe leaks, fractures, or graphitization?	**Yes**
	Bare Steel or Wrought Iron Pipe (with no CP other than Localized hot spotting with anodes)	Do bare (uncoated) steel main or services exist in the system that are not under CP?	**Yes**
		Is there known evidence of external corrosion on bare steel or wrought iron pipes not under CP?	**Yes**
		Is there a history of leakage on bare steel or wrought iron pipes not under CP?	**Yes**
	Bare Steel or Wrought Iron Pipe (with CP other than just localized hot spotting with anodes)	Do bare (uncoated) steel main or services exist in the system that are under CP?	**No**
		Is there known evidence of external corrosion on bare steel pipes under CP?	**No**
		Is there a known history of leakage on bare steel pipes under CP?	**No**
	Coated Steel with CP	Is there known evidence of external corrosion on coated steel pipe with CP?	**Yes**
		Is there a known history of leakage on coated steel pipe with CP?	**Yes**
		Are some CP systems frequently down (not achieving the required level of protection); more than 10% of the time?	**Yes**
	Coated Steel w/o CP	Is there known evidence of external corrosion on coated steel pipe without CP?	**Yes**
		Is there a known history of leakage on coated steel pipe without CP?	**Yes**
	Copper Services	Are direct buried or inserted copper services known to exist in the system?	**Yes**
		Is there a known history of leakage on copper services?	**Yes**
	Stray Current	Do distribution facilities exist near DC transit systems, high voltage DC transmission systems or other known sources of DC current?	**Yes**

Primary Threat Category	Material or Sub-Threat	SME's to Consider the Following	Rhode Island
		Are any facilities known to be impacted by sources of stray DC current that has or may result in corrosion?	**Yes**
	Internal Corrosion	Are liquids known to exist within any portions of the distribution system?	**Yes**
		Is there known evidence of internal corrosion on steel pipe?	**No**
		Is there a known history of leakage caused by internal corrosion of steel pipe?	**No**
	Atmospheric Corrosion on above ground facilities	Do above ground distribution facilities exist in areas exposed to marine atmosphere, high humidity, atmospheric pollutants or agricultural chemicals?	**Yes**
		Is there known evidence of external atmospheric corrosion on exposed steel pipe, equipment or fittings?	**Yes**
		Is there a known history of leakage caused by atmospheric corrosion of steel pipe?	**Yes**
	Atmospheric Corrosion of facilities in Vaulted areas underground	Do gas distribution facilities exist underground in vaulted areas?	**Yes**
		Is there known evidence of external atmospheric corrosion on exposed steel pipe, equipment or fittings?	**Yes**
		Is there a known history of leakage caused by atmospheric corrosion of steel pipe in vaults?	**Yes**
	Corrosion of carrier pipe in Cased Crossing	Do steel carrier pipes exist within cased crossings?	**Yes**
		Are there any existing known contacts between carrier pipes and casings?	**No**
		Is there known evidence of past or active external corrosion on cased steel pipe?	**No**
		Is there a known history of leakage caused by corrosion on cased steel pipe?	**NO**
	Other Corrosion	Are there other corrosion threats?	**wall piece, at dis-similar metals & isolated fittings**

Primary Threat Category	Material or Sub-Threat	SME's to Consider the Following	Rhode Island
Natural Forces	Seismic Activity	Are there any seismically active zones or fault lines that exist in the area?	**Yes**
		Is there a history of leakage associated with Seismic activity?	**No**
	Earth Movement / Landslide (Unstable Soil)	Are there any areas susceptible to earth movement or landslide in the area?	**No**
		Is there a known history of leakage associated with landslide or earth movement?	**No**
	Frost Heave	Are there any areas susceptible to frost heave that exist in the area?	**Yes**
		Is there a known history of leakage resulting from frost heave?	**Yes**
	Flooding	Are there any areas within the gas system that are subject to flooding?	**Yes**
		Is there a known history of leakage or damage associated with flooding?	**Yes**
	Over-pressure due to snow/ice blockage	Are pressure control equipment vents subject to ice blockage during the winter?	**Yes**
		Is there a known history of over-pressure events as a result of snow/ice blockage?	**Yes**
	Tree Roots	Is there a known history of leakage to pipe or fittings as a result of tree root damage?	**Yes**
	Other Natural Forces	Is there a known history of leakage or damage due to other natural force causes; including but not limited to lightning, wild fire or high winds (tornados)?	**Lightning**
Excavation Damage	Improper Excavation Practice	Has damage requiring repair or replacement occurred on properly marked facilities due to the failure of the excavator to follow proper excavation rules and procedures?	**Yes**
	Facility not located or marked	Has damage requiring repair or replacement occurred due to failure to locate a valid and timely locate request?	**Yes**

Primary Threat Category	Material or Sub-Threat	SME's to Consider the Following	Rhode Island
	One-call notification center error	Has damage requiring repair or replacement occurred due to an error made at the one-call notification center?	**No**
	Mis-Marked Facilities	Has damage requiring repair or replacement occurred due to the mis-marking of facilities?	**Yes**
		Threat Applicable?	**Yes**
	Incorrect Facility Records	Has damage requiring repair or replacement occurred due incorrect facility records?	**Yes**
	Other Excavation Damage	Has damage requiring repair or replacement occurred due other causes?	**Yes**
	Blow off Riser Damage	Has damage requiring repair or replacement occurred due mapping, marking and contractor communication issue?	**Yes**
Other Outside Force Damage	Vehicle Damage to Riser/Meter	Are existing risers and/or meters exposed to damage from vehicular damage that do not have barriers or other protection conforming to current design requirements?	**Yes**
		Has known leakage occurred due to vehicle damage to risers/meters.	**Yes**
	Vehicle Damage to above-ground equip/station	Are regulator stations or other above ground station equipment exposed to damage from vehicular damage that do not have barriers or other protection conforming to current design requirements?	**Yes**
		Has known leakage occurred due to vehicle damage to above ground stations or equipment?	**No**
	Vandalism	Are gas valves or station equipment susceptible to damage by vandalism that has the potential to pose a risk to employees or the public?	**Yes**
		Has leakage or other unsafe condition been created by vandalism?	**Yes**
	Structure Fire	Is there a history of damage to gas meters or other equipment due to structure fires?	**Yes**

Primary Threat Category	Material or Sub-Threat	SME's to Consider the Following	Rhode Island
	Other Outside Force Damage	Has damage requiring repair or replacement occurred due other outside forces?	**Falling ice, Heat ground contamination, down electric lines**
Material or Weld Failure	Century Products (MDPE 2306)	Is Century Products (MDPE 2306) pipe (Tan) known to exist in the system?	**No**
		Is there a history of leakage of Century Products (MDPE 2306) pipe due to material failure?	**No**
	Aldyl A (MDPE 2306)	Is pre-1973 Aldyl A pipe (Tan, but can turn grey) known to exist in the system?	**Yes**
		Has pre-1973 Aldyl A pipe been known to leak due to brittle-like failure from rock impingement or other stresses?	**Yes**
		Is there a history of leakage of pre-1973 Aldyl A pipe due to material failure?	**Yes**
	Aldyl AAAA (MDPE 2306) Green Aldyl	Is Green Aldyl pipe known to exist in the system?	**No**
		Is there a history of brittle like failures of Green Aldyl pipe?	**No**
		Is there a history of leakage of Green Aldyl pipe due to material failure?	**No**
	PVC – Polyvinyl Chloride	Is PVC pipe known to exist in the system?	**No**
		Is there a history of leakage of PVC pipe due to material failure?	**No**
	ABS – Acrylonitrile Butadiene Styrene	Is ABS pipe known to exist in the system?	**No**
		Is there a history of leakage of ABS pipe due to material failure?	**No**
	CAB – Cellulose Acetate Butyrate	Is CAB pipe known to exist in the system?	**No**
		Is there a history of leakage of CAB pipe due to material failure?	**No**
	PB – Polybutylene	Is PB pipe known to exist in the system?	**Yes**
		Is there a history of leakage of PB pipe due to material failure?	**Yes**
	PP – Polypropylene	Is PP pipe known to exist in the system?	**No**

Primary Threat Category	Material or Sub-Threat	SME's to Consider the Following	Rhode Island
		Is there a history of leakage of PP pipe due to material failure?	**No**
	Polyamide - PA	Is PA pipe known to exist in the distribution system?	**No**
		Is there a history of leakage of PA pipe due to material failure?	**No**
	PE Fusion failure	Is there a history of PE Fusion Failures or leakage in the system?	**Yes**
		Are any types of PE fusion (type, material, size, age, process, geographic area) more prone to leakage or failure?	**Yes**
	Pre-1940 Oxy-Acetylene Girth Weld	Do pre-1940 Oxy-Acetylene Girth Welds exist on pipe greater than 4 inch?	**Yes**
		Is there a history of pre-1940 Oxy-Acetylene Girth Weld failures or leakage in the system due to material failure?	**Yes**
	Other	Do other material failures occur that present a possible current or future risk?	**No**
Equipment Failure	Plexco Service Tee Celcon Caps	Are Plexco Service Tee Celcon Caps known to exist in the system?	**No**
		Is there a history of leakage of Plexco Service Tee Celcon Caps due to material failure?	**No**
	PP – Delrin Insert Tap Tees	Are Delrin Insert Tap Tees known to exist in the system?	**Yes**
		Is there a history of leakage of Delrin Insert Tap Tees?	**No**
	Stab Type Mechanical	Is there a history of Stab Type Mechanical Fitting failures or leakage in the system due to pullout?	**No**
		Is there a history of Stab Type Mechanical Fitting failures or leakage in the system due to seal leakage?	**Yes**
	Other Equipment Failure	What Types and Manufactures of Stab Type Mechanical Fittings have you seen used in the System?	**Perfection LYCO & AMP**
		Are any types of Stab Type Mechanical Fitting (type, material, size, age, manufacturer, geographic area) more prone to leakage or failure?	**LYCO**

Primary Threat Category	Material or Sub-Threat	SME's to Consider the Following	Rhode Island
	Nut Follower Type Mechanical Fittings	Is there a history of Nut Follower Type Mechanical Fitting failures or leakage in the system due to pullout?	**No**
		Is there a history of Nut Follower Type Mechanical Fitting failures or leakage in the system due to seal leakage?	**No**
		What Types and Manufactures of Nut Follower Type Mechanical Fittings have you seen used in the System?	**Dresser, Normac, Innertite, Kerotest**
		Are any types of Nut Follower Type Mechanical Fitting (type, material, size, age, manufacturer, geographic area) more prone to leakage or failure?	**Kerotest**
	Bolted Type Mechanical Fittings	Is there a history of Bolted Type Mechanical Fitting failures or leakage in the system due to pullout?	**No**
		Is there a history of Bolted Type Mechanical Fitting failures or leakage in the system due to seal leakage?	**Early vintage**
		What Types and Manufactures of Bolted Type Mechanical Fittings have you seen used in the System?	**Dressers, Smith Blair, & CSI**
		Are any types of Bolted Type Mechanical Fitting (type, material, size, age, manufacturer, geographic area) more prone to leakage or failure?	**Early vintage smith Blair**
	Other Type Mechanical Fittings	Is there a history of other types of Mechanical Fitting failures or leakage in the system due to pullout?	**No**
		Is there a history of other types of Mechanical Fitting failures or leakage in the system due to seal leakage?	**No**
		What other types and manufactures of Mechanical Fittings have you seen used in the System (other than Stab, Nut-follower, or bolted type?)	**Dresser 700 posi lock**

Primary Threat Category	Material or Sub-Threat	SME's to Consider the Following	Rhode Island
		Of the "other mechanical fittings" listed above, are any types of Mechanical Fitting (type, material, size, age, manufacturer, geographic area) more prone to leakage or failure?	**No**
	Valves	Are valves inoperable, inaccessible and or paved over without timely identification and repairs?	**Yes**
		Are certain types or makes of valves more likely to leak?	**Kerotest**
	Service Regulators	Is there a history of service regulator failures that present a threat to the public or employees?	**No**
		Are certain types or makes of service regulator more likely to create a risk?	**Farm Taps & Mercury**
	Meters	Is there a history of meter failures that present a threat to the public or employees?	**No**
		Are certain types or makes of meters more likely to create a risk?	**No**
	Control/Relief Station Equipment	Is there a history of control or relief station equipment failures that present a threat to the public or employees?	**No**
		Are certain types or makes of station equipment more likely to create a risk?	**No**
	Other Equipment Failure	Is there a history of other equipment failures that present a threat to the public or employees?	**Single Stage stations**
		Are certain types or makes of other equipment more likely to create a risk?	**No**
Incorrect Operations	General	Have inadequate procedures or safety practices, or failure to follow correct procedures, or other operator error resulted in an incident that created a risk to the gas distribution system?	**Yes**
	Gas lines bored through Sewers	Have pipes been installed via unguided or guided bore without proper procedures to ensure other facilities are not damaged?	**Yes**

Primary Threat Category	Material or Sub-Threat	SME's to Consider the Following	Rhode Island
		Have pipes unknowingly bored through sewer lines been damaged by sewer line cleaning operations?	**Yes**
Other	Bell Joint Leakage	Does Cast Iron pipe exist in the system?	**Yes**
		Is there a history of bell joint leaks?	**Yes**
		Are certain diameters or parts of the system known to be more prone to bell joint failure or leakage than others?	**No**
	Inserted Copper Puncture	Do copper services inserted in steel exist in the system?	**Yes**
		Is there a history of leakage of copper services due to puncture by a deteriorated steel outer casing?	**No**
	Copper Sulfide	Have any safety incidents occurred as a result of copper sulfide in copper services or service regulators?	**No**
	Construction over gas mains & services	Have others constructed over gas facilities or taken other action that prevents effective leak survey and other maintenance?	**Yes**
		When identified, is construction that impacts required maintenance corrected in a timely manner?	**Yes**
	Other	Are there any other known threats to the Gas Distribution system that we need to be aware of?	**gas mains in Catch basins, Vibration equipment, Anaerobic sealants**

RHODE ISLAND APPENDIX C
EVALUATION AND RANKING OF RISK

HIGHEST RANKED RISKS

STATE: RHODE ISLAND
REGION: ALL
FACILITY: MAINS

Mitigation Will Be As Per Appendix D, Except As Otherwise Indicated In Notes

Material	Pressure	Diameter	Mileage	Risk Score	Threat Category	Additional Mitigation Notes
Protected Coated Steel	HP	Over 8"	27.05	KNOWN INCIDENT	EXCAVATION	
Unprotected Bare Steel	> 60 PSI,Not T	Upto 4"	1.52	4.16	CORROSION	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking
Unprotected Bare Steel	> 60 PSI,Not T	Over 4" Thru 8"	0.81	4.16	CORROSION	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking
Unprotected Bare Steel	> 60 PSI,Not T	Over 8"	1.90	4.16	CORROSION	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking
Cast Iron	HP	Under 4"	0.01	3.66	NATURAL FORCE	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking
Wrought Iron	HP	Under 4"	0.11	3.66	NATURAL FORCE	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking
Unprotected Bare Steel	HP	Upto 4"	163.80	3.28	CORROSION	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking
Unprotected Bare Steel	HP	Over 4" Thru 8"	27.38	3.28	CORROSION	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking
Unprotected Bare Steel	HP	Over 8"	3.71	3.28	CORROSION	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking

Material	Pressure	Diameter	Mileage	Risk Score	Threat Category	Additional Mitigation Notes
Cast Iron	HP	4" Thru 8"	8.43	3.07	NATURAL FORCE	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking
Ductile Iron	HP	Over 4" Thru 8"	0.80	2.90	NATURAL FORCE	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking
Cast Iron	LP	Under 4"	7.50	2.89	NATURAL FORCE	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking
Wrought Iron	LP	Under 4"	1.15	2.89	NATURAL FORCE	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking
Plastic	> 60 PSI,Not T	Upto 4"	48.64	2.62	EXCAVATION	
Plastic	> 60 PSI,Not T	Over 4" Thru 8"	22.62	2.62	EXCAVATION	
Plastic	> 60 PSI,Not T	Over 8"	0.16	2.62	EXCAVATION	
Plastic	> 60 PSI,Not T	Upto 4"	48.64	2.59	O. O. FORCE	
Plastic	> 60 PSI,Not T	Over 4" Thru 8"	22.62	2.59	O. O. FORCE	
Plastic	> 60 PSI,Not T	Over 8"	0.16	2.59	O. O. FORCE	
Cast Iron	LP	4" Thru 8"	680.55	2.35	NATURAL FORCE	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking
Wrought Iron	LP	4" Thru 8"	0.14	2.35	NATURAL FORCE	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking

Material	Pressure	Diameter	Mileage	Risk Score	Threat Category	Additional Mitigation Notes
Unprotected Coated Steel	> 60 PSI,Not T	Upto 4"	1.56	2.34	CORROSION	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking
Unprotected Coated Steel	> 60 PSI,Not T	Over 4" Thru 8"	1.41	2.34	CORROSION	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking
Unprotected Coated Steel	> 60 PSI,Not T	Over 8"	4.20	2.34	CORROSION	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking
Unprotected Bare Steel	LP	Upto 4"	49.75	2.30	CORROSION	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking
unprotected Bare Steel	LP	Over 4" Thru 8"	44.31	2.30	CORROSION	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking
unprotected Bare Steel	LP	Over 8"	3.21	2.30	CORROSION	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking
unprotected Bare Steel	> 60 PSI,Not T	Upto 4"	1.52	2.28	EXCAVATION	
unprotected Bare Steel	> 60 PSI,Not T	Over 4" Thru 8"	0.81	2.28	EXCAVATION	
Ductile Iron	LP	Upto 4"	6.77	2.25	NATURAL FORCE	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking
Cast Iron	HP	Over 8"	15.95	2.25	NATURAL FORCE	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking
unprotected Bare Steel	> 60 PSI,Not T	Upto 4"	1.52	2.24	NATURAL FORCE	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking
unprotected Bare Steel	> 60 PSI,Not T	Over 4" Thru 8"	0.81	2.24	NATURAL FORCE	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking
Plastic	> 60 PSI,Not T	Upto 4"	48.64	2.23	MATERIAL/WELD	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking

Material	Pressure	Diameter	Mileage	Risk Score	Threat Category	Additional Mitigation Notes
Plastic	> 60 PSI,Not T	Over 4" Thru 8"	22.62	2.23	MATERIAL/WELD	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking
Plastic	> 60 PSI,Not T	Over 8"	0.16	2.23	MATERIAL/WELD	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking
Ductile Iron	LP	Over 4" Thru 8"	7.65	2.17	NATURAL FORCE	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking
Plastic	HP	Upto 4"	813.74	2.11	EXCAVATION	
Plastic	HP	Over 4" Thru 8"	183.70	2.11	EXCAVATION	
Plastic	HP	Over 8"	4.36	2.11	EXCAVATION	
Ductile Iron	HP	Over 4" Thru 8"	0.80	1.79	CORROSION	An additional factor will be applied to the replacement qualification and prioritization algorithm to account for this asset's DIMP risk ranking
Protected Coated Steel	Local T	Upto 4"	0.13	2.08	EXCAVATION	Patrolled as Transmission Weekly (Class 4) & Quarterly (Class 1,2,3)
Protected Coated Steel	Local T	Over 4" Thru 8"	0.01	2.08	EXCAVATION	Patrolled as Transmission Weekly (Class 4) & Quarterly (Class 1,2,3)
Protected Coated Steel	Local T	Over 8"	0.35	2.08	EXCAVATION	Patrolled as Transmission Weekly (Class 4) & Quarterly (Class 1,2,3)

HIGHEST RANKED RISKS

STATE: RHODE ISLAND
REGION: ALL
FACILITY: SERVICE (Active & Inactive)

Mitigation Will Be As Per Appendix D, Except As Otherwise Indicated In Notes

Facility	Material	Pressure	Meter Set	Quantity	Risk Score	Threat Category	Additional Mitigation Notes
Service	Protected Coated Steel	LP	Outside	944	KNOWN INCIDENT	O. O. FORCE	
Service	Unprotected Bare Steel	> 60 PSI,Not T	Inside	69	7.32	CORROSION	
Service	Unprotected Bare Steel	> 60 PSI,Not T	Outside	198	7.32	CORROSION	
Service	Unprotected Bare Steel	HP	Inside	997	7.08	CORROSION	
Service	Unprotected Bare Steel	LP	Inside	34,403	5.98	CORROSION	
Service	Unprotected Bare Steel	HP	Outside	2,003	5.67	CORROSION	
Svc-Inactive	Unprotected Bare Steel	HP	n/a	9	5.67	CORROSION	Review And (If Warranted) Schedule Cut Off When Exposed Or Within Public Works
Service	Unprotected Bare Steel	LP	Outside	2,168	4.49	CORROSION	

Facility	Material	Pressure	Meter Set	Quantity	Risk Score	Threat Category	Additional Mitigation Notes
Svc-Inactive	Unprotected Bare Steel	LP	n/a	76	4.49	CORROSION	Review And (If Warranted) Schedule Cut Off When Exposed Or Within Public Works
Service	Unprotected Coated Steel	> 60 PSI,Not T	Inside	15	3.29	CORROSION	
Service	Unprotected Coated Steel	> 60 PSI,Not T	Outside	131	3.29	CORROSION	
Service	Plastic	HP	Inside	6,389	3.20	EXCAVATION	
Service	Plastic	> 60 PSI,Not T	Inside	94	3.20	EXCAVATION	
Service	Plastic	> 60 PSI,Not T	Outside	5,138	3.20	EXCAVATION	
Service	Unprotected Coated Steel	HP	Inside	2,836	3.19	CORROSION	
Service	Cast Iron	HP	Inside	5	3.08	NATURAL FORCE	
Service	Cast Iron	LP	Inside	132	2.93	NATURAL FORCE	
Service	Wrought Iron	LP	Inside	5	2.93	NATURAL FORCE	
Service	Plastic	LP	Inside	22,786	2.90	EXCAVATION	
Service	Unprotected Coated Steel	LP	Inside	2,114	2.87	CORROSION	

Facility	Material	Pressure	Meter Set	Quantity	Risk Score	Threat Category	Additional Mitigation Notes
Service	Plastic	HP	Outside	71,898	2.58	EXCAVATION	
Service	Unprotected Coated Steel	HP	Outside	4,099	2.55	CORROSION	
Service	Cast Iron	HP	Inside	5	2.48	EXCAVATION	
Svc-Inactive	Plastic	HP	n/a	58	2.48	EXCAVATION	Review And (If Warranted) Schedule Cut Off When Exposed Or Within Public Works
Service	Plastic	> 60 PSI,Not T	Inside	94	2.33	MATERIAL/WELD	
Service	Plastic	> 60 PSI,Not T	Outside	5,138	2.33	MATERIAL/WELD	
Service	Cast Iron	LP	Outside	28	2.22	NATURAL FORCE	
Service	Wrought Iron	LP	Outside	5	2.22	NATURAL FORCE	
Service	Plastic	LP	Outside	26,577	2.18	EXCAVATION	
Svc-Inactive	Plastic	LP	n/a	85	2.18	EXCAVATION	Review And (If Warranted) Schedule Cut Off When Exposed Or Within Public Works
Service	Unprotected Coated Steel	LP	Outside	163	2.15	CORROSION	
Service	Plastic	LP	Inside	22,786	2.13	MATERIAL/WELD	

RHODE ISLAND APPENDIX D
IDENTIFICATION AND IMPLEMENTATION OF MEASURES TO ADDRESS RISKS

Primary Threat Category	Sub-Threat	Existing Mitigation or Additional/Accelerated Actions Rhode Island
Corrosion	Cast Iron Pipe Graphitization (including risk of crack or break due to becoming brittle)	Proactive leak surveys, Proactive Leak Prone Pipe replacement program, reactive pipe replacement program and Leak management programs
	Bare Steel or Wrought Iron Pipe	Proactive leak surveys, Proactive Leak Prone Pipe replacement program, reactive pipe replacement program and Leak management programs
	Coated Steel w/o CP	Proactive leak surveys, Proactive Leak Prone Pipe replacement program, reactive pipe replacement program and Leak management programs
	Copper Services	Proactive leak surveys, service tees replaced with main replacements and leak management programs
	Stray Current	Design, Proactive leak surveys, Proactive Corrosion Control inspections
	Internal Corrosion	Proactive leak surveys, Proactive Leak Prone Pipe replacement program, reactive pipe replacement program and Leak management programs
	Atmospheric Corrosion on above ground facilities	Design, Proactive leak surveys, Proactive Corrosion Control inspections
	Atmospheric Corrosion of facilities in Vaulted areas underground	Design, Proactive leak surveys, Proactive I&R and Corrosion Control inspections
	Corrosion of Buried Farm Tap Equipment	Proactive leak surveys, Proactive Corrosion Control inspections, Pressure Tests
	Corrosion of Service Fittings on cast iron mains that are not cathodically protected.	Proactive leak surveys, services associated with main replacement programs are replaced, proactive high pressure service replacement program and leak management program

Primary Threat Category	Sub-Threat	Existing Mitigation or Additional/Accelerated Actions Rhode Island
	Grounds installed on risers making CP ineffective	Cathodic Protection Monitoring
	Corrosion of carrier pipe in Cased Crossing	Cathodic Protection Monitoring
Natural Forces	Earth Movement / Landslide(Unstable Soil)	Proactive Leak Survey Programs
	Frost Heave	Proactive Leak Survey Programs / Winter Operations
	Flooding (including Coastal)	Proactive Leak Survey Programs
	Tree Roots	Proactive Leak Survey Programs
	Over-pressure due to snow/ice blockage or freeze up.	Design, Proactive Leak Survey Programs
	Other Natural Forces (Lightning, High winds)	Design, Proactive Leak Survey Programs
Excavation Damage	Improper Excavation Practice (including mitigation for high-risk tickets)	Damage Prevention Monitoring, Design, EFV's, training and emergency response
	Facility not located or marked	Damage Prevention Monitoring, Design, EFV's, training and emergency response
	One-call notification center error	Damage Prevention Monitoring, Design, EFV's, training and emergency response
	Mis-Marked Facilities	Damage Prevention Monitoring, Design, EFV's, training and emergency response

Primary Threat Category	Sub-Threat	Existing Mitigation or Additional/Accelerated Actions Rhode Island
	Incorrect Facility Records	Damage Prevention Monitoring, Design, EFV's, training and emergency response (see Table 5-7)
	Shallow Mains - reduced cover	Damage Prevention Monitoring, Design, training and emergency response
	Plastic without tracer wire that cannot be located	Damage Prevention Monitoring, Design, EFV's, training and emergency response
Other Outside Force Damage	Vehicle Damage to Riser/Meter	Design, Proactive Leak Survey Programs
	Vehicle Damage to above-ground equip/station	Design, Proactive Leak Survey Programs
	Vandalism	Design, EFV's Proactive Leak Survey Programs
	Structure Fire	Design, EFV's, training and emergency response
Material or Weld Failure	Pre-1973 Aldyl A (Tan MDPE 2306)	Proactive Leak Survey Continue to monitor leak rates. Not currently an increased threat.
	1973 and later Aldyl A (Tan MDPE 2406)	Proactive Leak Survey Continue to monitor leak rates. Not currently an increased threat.
	Aldyl 4A (Green MDPE 2306)	Not Applicable.
	PE other than Aldyl A & 4A	Proactive Leak Survey Continue to monitor leak rates. Not currently an increased threat.
	Delrin Insert Tap Tees	Proactive Leak Survey Continue to monitor leak rates. Not currently an increased threat.
	Plexco Service Tee Celcon Caps	Not Applicable
	PE Fusion failure	Proactive Leak Survey Continue to monitor leak rates. Not currently an increased threat.

Primary Threat Category	Sub-Threat	Existing Mitigation or Additional/Accelerated Actions Rhode Island
	Pre-1940 Oxy-Acetylene Girth Weld	Proactive Leak Survey Continue to monitor leak rates. Not currently an increased threat.
Equipment Failure	Stab Type Mechanical	Proactive Leak Survey Continue to monitor leak rates. Not currently an increased threat.
	Nut Follower Type Mechanical Fittings	Proactive Leak Survey Continue to monitor leak rates. Not currently an increased threat.
	Bolted Type Mechanical Fittings	Proactive Leak Survey Continue to monitor leak rates. Not currently an increased threat.
	Other Type Mechanical Fittings	Proactive Leak Survey Continue to monitor leak rates. Not currently an increased threat.
	Valves	Proactive Leak Survey Continue to monitor leak rates. Not currently an increased threat.
	Service Regulators	Proactive Leak Survey Continue to monitor leak rates. Not currently an increased threat.
	Meters (including Tin Meters)	Proactive Leak Survey Continue to monitor leak rates. Not currently an increased threat.
	Control/Relief Station Equipment	Design, I&R Inspections, Operator Qualifications, training and emergency response
Incorrect Operations	General	Operator Qualifications, training and emergency response
	Gas lines bored through Sewers	Operator Qualifications, training and emergency response
Other	Bell Joint Leakage, Cast Iron and Ductile Iron	Proactive Leak Survey Continue to monitor leak rates. Not currently an increased threat.
	Construction over gas mains & services	Operator Qualifications, training and emergency response

RHODE ISLAND APPENDIX E
MEASUREMENT OF PERFORMANCE, MONITORING RESULTS, AND EVALUATION EFFECTIVENESS

Appendix E, Section 1 – Number of Hazardous Leaks Either Eliminated or Repaired, Categorized by Cause

The baseline and ongoing performance of the number of Hazardous(Type 1) Leaks for Main and Service combined Either Eliminated or Repaired, Categorized by Cause is provided below:

Cause		2008	2009	2010	2011	2012	2013	2014	2015
Corrosion	Actual	644	705	310	504	458	376	545	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (576 for 2008-2013)							
Natural Forces	Actual	3	4	17	72	22	59	123	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (44 for 2008-2013)							
Excavation Damage	Actual	139	27	140	107	130	114	92	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (131 for 2008-2013)							
Other Outside Force	Actual	2	0	0	1	0	2	9	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (1 for 2008-2013)							
Material or Welds	Actual	2	1	2	0	1	15	25	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (6 for 2008-2013)							
Equipment Failure	Actual	64	32	34	83	76	72	107	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (71 for 2008-2013)							
Incorrect Operations	Actual	3	0	1	0	0	0	0	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (1 for 2008-2013)							
Other	Actual	425	737	736	346	234	449	308	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (591 for 2008-2013)							
Total	Actual	1,282	1,506	1,240	1,113	921	1,087	1,209	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (1,291 for 2008-2013)							

Appendix E, Section 2 – Number of Excavation Damages

The baseline and ongoing performance of the number of excavation damages is provided below:

		2010	2011	2012	2013	2014	2015	2016	2017
Excavation Damages	Actual	158	80	88	76	80			
	Baseline	2010 Actual Performance will be the Baseline							

Appendix E, Section 3 – Number of Excavation Tickets

The baseline and ongoing performance of the number of excavation tickets is provided below:

		2010	2011	2012	2013	2014	2015	2016	2017
Excavation Tickets	Actual	46,808	50,463	51,461	54,714	61,384			
	Baseline	2010 Actual Performance will be the Baseline							

Appendix E, Section 4 – Total Number of Leaks Either Eliminated or Repaired, Categorized by Cause

The baseline and ongoing performance of the number of Leaks for Main and Service combined Either Eliminated or Repaired, Categorized by Cause is provided below:

Cause		2008	2009	2010	2011	2012	2013	2014	2015
Corrosion	Actual	1,265	1,318	707	630	653	588	819	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (1,029 for 2008-2013)							
Natural Forces	Actual	60	5	22	77	26	59	137	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (55 for 2008-2013)							
Excavation Damage	Actual	141	28	140	107	133	115	92	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (132 for 2008-2013)							
Other Outside Force	Actual	7	0	0	2	1	2	9	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (3 for 2008-2013)							
Material or Welds	Actual	3	2	11	0	2	18	30	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (10 for 2008-2013)							
Equipment Failure	Actual	216	70	50	96	154	128	159	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (149 for 2008-2013)							
Incorrect Operations	Actual	2	0	3	2	0	0	0	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (2 for 2008-2013)							
Other	Actual	1,503	2,252	1,646	1,479	1,261	914	807	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (1,731 for 2008-2013)							
Total	Actual	3,197	3,675	2,579	2,393	2,230	1,824	2053	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (2,987 for 2008-2013)							

Appendix E, Section 5 – Number of Hazardous Leaks Either Eliminated or Repaired, Categorized by Material (Excluding Excavation Damage Leaks)

The baseline and ongoing performance of the number of Leaks for Main and Service combined Either Eliminated or Repaired, Categorized by Material (excluding excavation damage leaks) is provided below:

Cause		2008	2009	2010	2011	2012	2013	2014	2015
Cast Iron / Wrought Iron	Actual	373	388	322	324	303	393	481	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (370 for 2008-2013)							
Unprotected Bare	Actual	420	624	470	404	389	477	515	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (507 for 2008-2013)							
Unprotected Coated	Actual	75	88	71	54	41	49	40	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (72 for 2008-2013)							
Protected Bare	Actual	0	0	0	0	0	0	0	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (0 for 2008-2013)							
Protected Coated	Actual	0	0	0	0	0	0	0	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (0 for 2008-2013)							
Plastic	Actual	247	364	223	208	40	51	78	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (251 for 2008-2013)							
Copper	Actual	2	0	1	0	1	1	0	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (1 for 2008-2013)							
Other	Actual	11	15	13	16	17	2	3	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (15 for 2008-2013)							
Total	Actual	1,128	1,479	1,110	1,006	791	973	1,117	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (1,196 for 2008-2013)							

Appendix E, Section 6 – Additional Performance Measures

The baseline and ongoing performance of the number of known system leaks at the end of the year scheduled for repair is provided below:

		2008	2009	2010	2011	2012	2013	2014	2015
Workable Backlog	Actual	264	77	15	33	54	26	38	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (125 for 2008-2013)							

The baseline and ongoing performance of total damages per 1000 tickets is provided below:

		2010	2011	2012	2013	2014	2015	2016	2017
Total Damages per 1000 Tickets	Actual	3.38	1.58	1.71	1.39	1.30			
	Baseline	2010 Actual Performance will be the Baseline							

The baseline and ongoing performance of Total Leak Receipts is provided below:

		2008	2009	2010	2011	2012	2013	2014	2015
Total Leak Receipts	Actual	3,134	3,652	2,624	2,502	2,417	2,252	2,753	
	Baseline	Rolling average since 2008 + 0.5 standard deviation (3,028 for 2008-2013)							

The baseline and ongoing performance of the Response Time Performance are provided below:

Regular Day									
Response Time		2008	2009	2010	2011	2012	2013	2014	2015
30 Minutes	Actual	95.6%	95.3%	96.1%	96.1%	95.4%	95.6%	95.0%	
	Baseline	94.10% as established by NGrid							

Nights & Weekends									
Response Time		2008	2009	2010	2011	2012	2013	2014	2015
45 Minutes	Actual	96.3%	95.8%	95.8%	96.5%	97.0%	96.4%	96.3%	
	Baseline	94.38% as established by NGrid							

The baseline and ongoing performance of the main leak rates (leak repairs by mile of main) by Material excluding Damages are provided below:

Main Leak Rates (leak repairs by mile of main) by Material Excluding Damages								
Rhode Island		2008	2009	2010	2011	2012	2013	2014
Cast Iron	Actual	1.54	1.65	1.10	1.09	1.13	0.93	1.19
	Baseline	Rolling average since 2008 + 0.5 standard deviations (1.38 for 2008-2013)						
All Steel	Actual	0.63	0.75	0.51	0.42	0.53	0.25	0.21
	Baseline	Rolling average since 2008 + 0.5 standard deviations (0.60 for 2008-2013)						
Plastic	Actual	0.28	0.25	0.19	0.18	0.01	0.01	0.00
	Baseline	Rolling average since 2008 + 0.5 standard deviations (0.21 for 2008-2013)						

The baseline and ongoing performance of the service leak rates (leak repairs by 1000 services) by Material excluding Damages are provided below:

Service Leak Rates (leak repairs per 1000 services) by Material Excluding Damages								
Rhode Island		2008	2009	2010	2011	2012	2013	2014
Copper	Actual	11.24	0.00	5.85	0.00	4.81	4.83	0.00
	Baseline	Rolling average since 2008 + 0.5 standard deviations (6.55 for 2008-2013)						
All Steel	Actual	5.08	8.98	6.35	6.41	6.72	9.33	11.39
	Baseline	Rolling average since 2008 + 0.5 standard deviations (7.97 for 2008-2013)						
Plastic	Actual	1.81	2.88	1.61	1.58	0.36	0.42	0.69
	Baseline	Rolling average since 2008 + 0.5 standard deviations (1.92 for 2008-2013)						

Extensive investigation/research, monitoring and improvement works are being performed on some special projects listed below and all the reports are incorporated by reference in its most updated form.

1. Inner-Tite Inspection Program.

2. Bowling Lane, Westerly RI Incidence Analysis.

3. Removal of pre-1974 Aldyl-A 60 psig main from Union St and Miller St, Warrren RI.

4. Water Intrusion relay: Hope St. in Bristol. This job was NOT begun Fall of 2014 due to difficulty in obtaining the permit to open the road along a RIPTA bus route.

RHODE ISLAND APPENDIX F
PERIODIC EVALUATION AND IMPROVEMENT

2014 REGIONAL DISTRIBUTION INTEGRITY ASSESSMENT

Distribution Engineering has reviewed all of the findings in the annual Trend-Based Distribution System Integrity Analysis (*System Integrity Report*) in accordance with our Distribution Integrity Management Plan, and found leak receipts and repairs went up in 2014. These changes are believed to be the result of some recent incidents which increased public awareness, two consecutive years of severe weather condition and LPP deteriorating performance. National Grid has accelerated LPP replacement program to address this issue. There are no immediate causes for concern that would warrant changes to DIMP. Some anomalies were found and either explained as non-systemic or set up for continued research and/or monitoring.

Below is a summary of the individual key integrity measure results for the following federal (PHMSA) filing entity that constitutes National Grid-US.

NationalGrid-RI	
2014System Integrity Report Summary	
REGIONS	RI
ITEMS	
• Leak Receipts	↑
• Workable Leak Backlog	↑
• LPP Main and Service Inventories	↓
• Overall Main Leak Rate	↑
• Cast Iron Main Break Rate	↑
• Steel Main Corrosion Leak Rate	—
• Service Leak Rate	↑

Rhode Island (RI)

- Leak receipts increased .
- Workable leak backlog increased slightly .
- Leak prone main and service inventories continue to decline steadily.
- Overall main leak rate and Cast iron main break rate increased. Steel main corrosion leak rate remain steady .
- Service leak rate increased.

Form F-1: Periodic Updating and Review

Annual Evaluation of Performance Measures that Exceeded Baseline				
Performance Measure	**Actual Performance for Year __2014___**	**Established Baseline**	**Are additional measures beyond minimum code requirement necessary?**	**Has an engineering evaluation been completed and documented?**
Leak Receipts	2,753	3,028	NO	Annual System Integrity Report
Workable leak Backlog	38	125	NO	Annual System Integrity Report
LPP Main Inventory	1,305 miles	1,356 miles (2013)	NO	Annual System Integrity Report
Overall Main Leak Rate	0.37	0.66	NO	Annual System Integrity Report
Cast Iron Main Break Rate	0.17	0.09	NO	Annual System Integrity Report
Steel main Corrosion Leak Rate	0.21	0.41	NO	Annual System Integrity Report
Service Leak Rate	3.97	4.01	NO	Annual System Integrity Report
Existing Date for Complete Program re-evaluation:___YES_______ Is a shorter timeframe for complete program re-evaluation warranted? : __NO____				

Required frequency	Program Re-evaluation Element	Date Completed
Required Annually	Evaluate Performance Measures	07/24/2015
As needed	Update Knowledge of System Characteristics, Environmental Factors and Threats	07/24/2015
As needed	Update General Information	07/24/2015
As needed	Update Threat Identification	07/24/2015
As needed	Update Risk Evaluation and Ranking Process	07/24/2015
Required Annually	Update Risk Evaluation and Ranking of Risks	07/24/2015
As needed	Update Risk Evaluation and Ranking Validation	07/24/2015
As needed	Update Risk Evaluation and Ranking Process Improvement Action Plans	07/24/2015
As needed	Update Action Plans	

RHODE ISLAND APPENDIX G
CROSS REFERENCE OF 49 CFR PART 192, SUBPART P REQUIREMENTS TO THE DIM PLAN

The table below provides a cross reference between 49 CFR Part 192, Subpart P (Gas Distribution Pipeline Integrity Management) and this Gas Distribution Integrity Management Plan.

49 CFR Part 192, Subpart P	DIM Plan Reference
§192.1005 No later than August 2, 2011 a gas distribution operator must develop and implement an integrity management program that includes a written integrity management plan as specified in § 192.1007.	3.0
§192.1007 A written integrity management plan must contain procedures for developing and implementing the following elements:	
§192.1007 (a) *Knowledge.* An operator must demonstrate an understanding of its gas distribution system developed from reasonably available information.	5.0, 5.1, 5.2, 5.3, 5.4, 5.5
§192.1007 (a) (1) Identify the characteristics of the pipeline's design and operations and the environmental factors that are necessary to assess the applicable threats and risks to its gas distribution pipeline.	5.3
§192.1007 (a) (2) Consider the information gained from past design, operations, and maintenance.	5.2
§192.1007 (a) (3) Identify additional information needed and provide a plan for gaining that information over time through normal activities conducted on the pipeline (for example, design, construction, operations or maintenance activities).	5.4
§192.1007 (a) (4) Develop and implement a process by which the IM program will be reviewed periodically and refined and improved as needed.	10.1, 10.2
§192.1007 (a) (5) Provide for the capture and retention of data on any new pipeline installed. The data must include, at a minimum, the location where the new pipeline is installed and the material of which it is constructed.	5.5
§192.1007 (b) *Identify threats.* The operator must consider the following categories of threats to each gas distribution pipeline: corrosion, natural forces, excavation damage, other outside force damage, material, weld or joint failure, equipment failure, incorrect operation, and other concerns that could threaten the integrity of the pipeline.	6.0
§192.1007 (b) An operator must consider reasonably available information to identify existing and potential threats. Sources of data may include, but are not limited to, incident and leak history, corrosion control records, continuing surveillance records, patrolling records, maintenance history, and excavation damage experience.	5.1, 6.0,
§192.1007 (c) *Evaluate and rank risk.* An operator must evaluate the risks associated with its distribution pipeline. In this evaluation, the operator must determine the relative importance of each threat and estimate and rank the risks posed to its pipeline. This evaluation must consider each applicable current and potential threat, the likelihood of failure associated with each threat, and the potential consequences of such a failure.	7.1, 7.2, 7.3
§192.1007 (c) An operator may subdivide its pipeline into regions with similar characteristics (e.g., contiguous areas within a distribution pipeline consisting of mains, services and other appurtenances; areas with common materials or environmental factors), and for which similar actions likely would be effective in reducing risk.	Non-Mandatory

49 CFR Part 192, Subpart P	DIM Plan Reference
§192.1007 (d) *Identify and implement measures to address risks.* Determine and implement measures designed to reduce the risks from failure of its gas distribution pipeline. These measures must include an effective leak management program (unless all leaks are repaired when found).	8.1, 8.2
§192.1007 (e) (1) *Measure performance, monitor results, and evaluate effectiveness.* Develop and monitor performance measures from an established baseline to evaluate the effectiveness of its IM program. …... These performance measures must include the following: (i) Number of hazardous leaks either eliminated or repaired, per § 192.703(c), categorized by cause; (ii) Number of excavation damages; (iii) Number of excavation tickets (receipt of information by the underground facility operator from the notification center); (iv) Total number of leaks either eliminated or repaired, categorized by cause; (v) Number of hazardous leaks either eliminated or repaired per § 192.703(c), categorized by material; and (vi) Any additional measures the operator determines are needed to evaluate the effectiveness of the operator's IM program in controlling each identified threat.	9.1 – 9.6
§192.1007 (e) (1) *Measure performance, monitor results, and evaluate effectiveness. ….* An operator must consider the results of its performance monitoring in periodically re-evaluating the threats and risks.	10.2
§192.1007 (f) *Periodic Evaluation and Improvement.* An operator must re-evaluate threats and risks on its entire pipeline and consider the relevance of threats in one location to other areas.	7.1, 10.1
§192.1007 (f) Each operator must determine the appropriate period for conducting complete program evaluations based on the complexity of its system and changes in factors affecting the risk of failure. The operator must conduct a complete program reevaluation at least every five years. The operator must consider the results of the performance monitoring in these evaluations.	10.2
§192.1007 (g) *Report results.* Report, on an annual basis, the four measures listed in paragraphs (e)(1)(i) through (e)(1)(iv) of this section, as part of the annual report required by § 191.11. An operator also must report the four measures to the state pipeline safety authority if a state exercises jurisdiction over the operator's pipeline.	11.1
§192.1009 Each operator must report, on an annual basis, information related to failure of mechanical fittings, excluding those that result only in nonhazardous leaks, as part of the annual report required by §191.11 beginning with the report submitted March 15, 2011. This information must include, at a minimum, location of the failure in the system, nominal pipe size, material type, nature of failure including any contribution of local pipeline environment, coupling manufacturer, lot number and date of manufacture, and other information that can be found in markings on the failed coupling. An operator also must report this information to the state pipeline safety authority if a state exercises jurisdiction over the operator's pipeline.	11.1
§192.1011 An operator must maintain records demonstrating compliance with the requirements of this subpart for at least 10 years. The records must include copies of superseded integrity management plans developed under this subpart.	12.0

49 CFR Part 192, Subpart P	DIM Plan Reference
§192.1013 (a) An operator may propose to reduce the frequency of periodic inspections and tests required in this part on the basis of the engineering analysis and risk assessment required by this subpart. (b) An operator must submit its proposal to the PHMSA Associate Administrator for Pipeline Safety or, in the case of an intrastate pipeline facility regulated by the State, the appropriate State agency. The applicable oversight agency may accept the proposal on its own authority, with or without conditions and limitations, on a showing that the operator's proposal, which includes the adjusted interval, will provide an equal or greater overall level of safety. (c) An operator may implement an approved reduction in the frequency of a periodic inspection or test only where the operator has developed and implemented an integrity management program that provides an equal or improved overall level of safety despite the reduced frequency of periodic inspections.	Not covered by DIM Plan
§192.1015 (a) (a) General. No later than August 2, 2011 the operator of a master meter system or a small LPG operator must develop and implement an IM program that includes a written IM plan as specified in paragraph (b) of this section. The IM program for these pipelines should reflect the relative simplicity of these types of pipelines. (b) Elements. A written integrity management plan must address, at a minimum, the following elements: (1) Knowledge. The operator must demonstrate knowledge of its pipeline, which, to the extent known, should include the approximate location and material of its pipe-line. The operator must identify additional information needed and provide a plan for gaining knowledge over time through nor-mal activities conducted on the pipeline (for example, design, construction, operations or maintenance activities). (2) Identify threats. The operator must consider, at minimum, the following categories of threats (existing and potential): Corrosion, natural forces, excavation damage, other outside force damage, material or weld failure, equipment failure, and incorrect operation.(3) Rank risks. The operator must evaluate the risks to its pipeline and estimate the relative importance of each identified threat. (4) Identify and implement measures to mitigate risks. The operator must determine and implement measures designed to reduce the risks from failure of its pipeline. (5) Measure performance, monitor results, and evaluate effectiveness. The operator must monitor, as a performance measure, the number of leaks eliminated or repaired on its pipe-line and their causes. (6) Periodic evaluation and improvement. The operator must determine the appropriate period for conducting IM program evaluations based on the complexity of its pipeline and changes in factors affecting the risk of failure. An operator must re-evaluate its entire pro-gram at least every five years. The operator must consider the results of the performance monitoring in these evaluations. (c) Records. The operator must maintain, for a period of at least 10 years, the following records: (1) A written IM plan in accordance with this section, including superseded IM plans; (2) Documents supporting threat identification; and (3) Documents showing the location and material of all piping and appurtenances that are installed after the effective date of the operator's IM program and, to the extent known, the location and material of all pipe and appurtenances that were existing on the effective date of the operator's program.	2.0

nationalgrid	Gas Work Method **Design of Mains and Distribution Systems**	Doc.# **ENG04030** Page 1 of 7
	Identification, Evaluation and Prioritization of Distribution Main Segments for Replacement	Revision 2 – 09/15/2015

Identification, Evaluation and Prioritization of Distribution Main Segments for Replacement ENG04030

1. Purpose

This procedure describes and details the identification, evaluation, and prioritization of distribution main segments for replacement, and prescribes methods to be used for corrective action.

Potential areas of active corrosion are identified using leakage surveys in conjunction with an analysis of the corrosion and leak history records.

2. Responsibilities

Distribution Engineering or designee shall be responsible to:

- Gather and evaluate gas facility and leak data, and determine required calculations.
- Determine qualification and prioritization procedure and remedial action for active corrosion, non-active continuing corrosion, and other systemic integrity issues.

Main and Service Replacement or designee shall be responsible for:

- Identifying main segments for replacement and prioritizing them according to this procedure.

3. Personal & Process Safety

All required PPE shall be worn or utilized in accordance with the current National Grid Safety Policy when performing tasks associated with this document.

4. Operator Qualification Required Tasks [Qualified or Directed & Observed]

None

5. Content

5.1 Identification of Main Segments for Replacement

a. Main segment candidates are identified through four avenues:

1) Field Requests, which will be reviewed throughout the year.
2) Mains located in Public Improvement Job Areas, which will also be reviewed throughout the year, as requested by Field Operations and/or Public Works employees.
3) Annual screenings by Main and Service Engineering, as deemed appropriate. Screenings will vary among the regions, based on the data and tools available for the systems.
4) Lab failure analysis reports reviewed by Distribution Engineering for systemic issues.
5) IM prioritization factor as found in National Grid's Distribution Integrity Management Program (DIMP) listed in attachment 1.

IM factor is applied in order to help accelerate the attrition of mains which belong to an asset group which is known to have a higher likelihood of incident or is of a high relative risk.

6)

b. All identified main segment candidates shall be evaluated and prioritized by Main and Service Engineering in accordance with the criteria set forth in this procedure. Minimum segment lengths for screening and engineering review will vary among the regions; however, no

Engineering review is required for O&M replacements up to 50 feet. Segments identified by Distribution Engineering for systemic integrity issues will be replaced and prioritized as determined appropriate by Distribution Engineering.

5.2 Evaluation/Prioritization of Steel Main Segments for Replacement

a. Data Collection - Minimum Data Required:
   1) All Repaired Corrosion Leaks on Main Segment for the last 10 years
   2) All repaired corrosion leaks on services for last 10 years. (In order to consider service leaks in main prioritization calculation, there should be main leaks)
   3) All Open Leaks that are believed to be on the actual Main Segment

b. For all applicable leaks, the following data is required:
   1) Leak Number
   2) Date (date found for open leaks, date repaired for repaired leaks)
   3) Leak Class (original class for open leaks, repaired class for repaired leaks)
   4) For repaired leaks, the following additional data is also required:
      i. Number of Clamps Installed to Repair and specific clamp locations
      ii. Condition of Main When Repaired
      iii. Address Based Leak Location
      iv. Length of segment exhibiting significant leak activity (i.e. from first leak to last leak).
      v. Building Types in Area of Main Segment (None, Single Family Houses, Small Buildings, Public Buildings)

c. Calculate a main deterioration factor (“D”) using the formula:

$$D = N \times 500 / L_{(calc)}$$

Where:
$L_{(calc)}$ = Length of Segment exhibiting significant leak activity (i.e. first leak to last leak).

The segment length used in calculations is not necessarily the total length being considered for replacement. “L” should be determined by the evaluating engineer as the length of the segment exhibiting significant leak activity. In no case should the length used for calculations extend beyond the locations of the leaks).

and

N = Repair Factor (within the defined “L_{calc}”).

1) If the leak was repaired with 1 clamp, by another method, is still open, or associated service corrosion leak repair, N=1
2) If the leak was repaired with 2-3 clamps, N=2
3) If the leak was repaired with 4-5 clamps, N=3
4) If the leak was repaired with 6-7 clamps, N=4
5) If the leak was repaired with >7 clamps, N=5

THE SUM OF ALL THE "N"s FOR EACH LEAK IS PLUGGED INTO THE FORMULA

This method estimates the deterioration according to the actual number of physical repairs and normalizes it for the length of the segment.

d. Calculate an incident probability factor ("P") using the formula:

$$P = \{[(\# \text{ Class1 Leaks}/0.5) + (\# \text{ Class2A Leaks}/1.5) + (\# \text{ Class2 Leaks}/2) + (\# \text{ Class3 Leaks}/3)] \times 500\} / L_{(calc)}$$

This method estimates public safety incident probability by weighting each leak based on how far the gas migrated toward buildings, again normalized according to the segment length. (Note – If leak class is unknown, Class 2A will be assumed).

e. Calculate a risk factor ("R") using the formula:

$$R = P \times C$$

Where:

P = Probability Factor Calculated in previous step.
C = Consequence Factor

1) If there are no buildings in the area, C = 0
2) If there are only single family homes, C = 1
3) If there are small buildings (multi-family, strip mall, etc), C = 1.2
4) If there are public buildings (school, church, hospital, etc) C = 1.5

This is the standard Risk Analysis calculation where Risk is defined as the product of the likelihood of an event and the potential consequence of that event. Consequences increase with building size and number of people affected.

f. Calculate the preliminary prioritization factor ("Pr") using the formula:

$$Pr = D + R + IM$$

Where:

D = Deterioration Factor Calculated in "c".
R = Risk Factor Calculated in "e".

The prioritization calculation takes into account both the deterioration of the main and the risk to public safety.

g. The following adjustments may be needed:

1) Before making a final determination and prioritization of a main segment replacement, the details of the job are reviewed and "engineering judgment" is applied where appropriate. This application may result in the following types of adjustments:
   i. Changing the priority of the job

ii. Increasing or decreasing the job length/scope
iii. Breaking the job into smaller segments
iv. Merging several segments into one job

2) These adjustment may be made based on the following types of information, if available and applicable:
   i. Analysis of the age of the leaks and any increasing frequency of leak occurrences
   ii. Pipe vintage and service insert activity associated with the main
   iii. Service leaks at the main connection due to corrosion
   iv. Adjustments based on very long or very short segments
   v. Observed pipe condition from leak repair data
   vi. Observed pipe condition from recent field exposure
   vii. Clustering of repairs and/or clamps along the segment
   viii. Other replacement jobs in the vicinity
   ix. Cathodic protection systems in place
   x. Specific locations of intersections, fittings, material transitions, diameter transitions, etc.
   xi. Customer complaints, Executive complaints, Regulatory Agency complaints
   xii. Corporate good will
   xiii. Unusual hazards or exposure in the area
   xiv. Proximity to gas regulating equipment
   xv. Proximity to transmission main
   xvi. Unusual difficulty or expense of repairs
   xvii. Main location
   xviii. Identification of outdated construction methods or problematic materials or fittings
   xix. Depth of cover and soil conditions
   xx. High open leak counts
   xxi. Water intrusion or other geographic considerations
   xxii. Any special or unusual conditions or considerations identified by Field Operations
   xxiii. Any other safety, integrity, operational or economic factors that are available and deemed appropriate

Segments that qualify based on their preliminary prioritization calculation may not be disqualified by adjustments.

h. Qualification of job for replacement:

1) Jobs will be approved and prioritized based on the calculated Prioritization Factor “Pr” and applied adjustments. Enough jobs should be approved to accommodate the replacement levels determined by the model(s) in use at the time.

Some jobs will be mandatory to replace.

2) In general, a condition of "Active Corrosion" will be determined when the preliminary Prioritization Factor ("Pr") calculation is equal to or greater than 15 (Pr ≥15).
3) Each region will be further responsible for declaring jobs as "Active Corrosion" by modifying this criterion based on specific regional operating conditions as required, in order to comply with any more stringent definitions provided by the regulators in the State(s) in which the region operates.
4) Any unprotected bare steel main containing "Active Corrosion" must be replaced within two years in NY and three years in MA – unless extenuating circumstances make it unfeasible to do so, in which case, other appropriate mitigative measures are to be taken (Conduct a leakage survey of the segment once a year as a minimum).
5) Any unprotected coated steel main containing "Active Corrosion" must have cathodic protection engineered and installed within one year or be replaced within two years in NY and three years in MA - unless extenuating circumstances make it unfeasible to do so, in which case, other appropriate mitigative measures are to be taken (Conduct a leakage survey of the segment once a year as a minimum) .
6) Any cathodically protected main containing "Active Corrosion" must be brought up to acceptable cathodic protection within one year or replaced within two years in NY and three years in MA - unless extenuating circumstances make it unfeasible to do so (An example of such a circumstance may be when a street is under guarantee or a moratorium from excavation), in which case, other appropriate mitigative measures are to be taken. (Conduct a leakage survey of the segment once a year as a minimum).
7) In NYC and LI, another label is given to each job to provide a macro view as to the type of work to be performed throughout the year.
   i. A "TS 300" label is associated with any job with a preliminary Prioritization Factor ("Pr") calculation of 15 or more (Pr ≥ 15), known as "Active Corrosion". This label is also given to both cast iron and plastic jobs, however it is known that main segment is not actively corroding and there is no mandated timetable to replace.
   ii. A TS 900 label is given to any job which has received additional points from Public Works considerations (as described below).
   iii. A TS 800 label is given to the remainder of the jobs in which the preliminary Prioritization Factor ("Pr") calculation is less than 15 (Pr < 15) and will be replaced according to resources and replacement level recommendations.

i. Impact Identification:
   1) Every approved job should be processed through the Planning and Corrosion areas of Gas Systems Engineering for:
      i. Sizing (determining the appropriate replacement material and diameter).
      ii. Determining if the replacement will have any impact on existing cathodic protection systems.
      iii. Determining if abandonment is an appropriate option over replacement.
      iv. Determining if a system uprating is an appropriate option as part of the replacement.

5.3 Evaluation/prioritization of cast iron main segments for replacement

a. Cast Iron Main Segments will be evaluated in a similar manner as Steel Main segments, where the Prioritization factor will be the sum of the Deterioration Factor,Risk factor and DIMP factor (Pr = D + R + IM).

b. Candidates are reviewed based primarily on breakage and/or graphitization history; and all segments that contain 2 or more breaks and/or graphitization repairs within 400 ft. must be reviewed.

c. If the candidate segment has had 2 or more breaks and/or graphitization repairs within 400 ft. and the MAOP is greater than six inches of water column – the segment has automatic approval for replacement. The Prioritization score will automatically be set at 15 (TS300)

d. If the candidate segment doesn't have at least 2 breaks and/or graphitization repairs or if the pressure is six inches of water column or less – approval will be based on the Prioritization calculation

   i. If "Pr" is equal to or greater than 15 (Pr ≥ 15), replacement will be required (however, a cast iron segment is not deemed active corrosion)

   ii. If "Pr" is less than 15 (Pr < 15), prioritize and replace according to resources and replacement level recommendations

e. The Repair Factor "N" (as defined 5.2 – c for steel evaluation), will be assigned for each leak, as follows:

1) For cast iron – main breaks, graphitization (corrosion of cast iron) and joint leak repairs are examined.

   i. If the leak is still open or associated service corrosion leak repair, N = 1

   ii. If the leak was repaired only by joint sealing, N = 0.5

   iii. If the leak was a break,crack or graphitization, N = 3

f. Engineering judgment should also be applied to both the prioritization and determination of the segment length to be replaced based on the pressure, diameter, dates of failures, surrounding areas, etc.

5.4 Evaluation/prioritization of plastic main segments for replacement

a. Vintage Plastic Main Segments shall be evaluated by Distribution Engineering based on Lab Failure Analysis Reports that are reviewed for systemic issues.

   I. If Distribution Engineering determines that a systemic issue exists in a specific main segment due to improper fusion or other construction defects, the entire affected section of main will be forwarded to Main and Service Replacement Group for prioritization and expedited replacement.

b. Plastic Main Segments (including non-vintage plastic) will be evaluated in a similar manner as Steel Main segments, where the Prioritization factor will be the sum of the Deterioration Factor, Risk factor and DIMP factor (Pr = D + R + IM).

c. For plastic pipe segments in "b", above, the following criteria shall apply:

   1) For plastic – previous squeeze-offs, point loading failures (e.g. – rock impingement) and material defects (e.g. – cracking) and construction defect failures (e.g. – butt fusion joint) are examined.

      Where:

N = Repair Factor (within the defined "L")

i. If the leak is still open, N = 1
ii. If the leak was the result of an improper squeeze-off, N = 2 x (the number known squeeze-offs on ALDYL-A pre 1985 pipe)
iii. If the leak was the result of a point loading failure, N = 2
iv. If the leak was a the result of a construction defect or material defect, N = 3
v.

5.5 Reinforcements and Jobs in public improvement areas

a. Additional adjustments may be applied for candidate segments in public works areas or for which reinforcement opportunities have been identified - by the addition of a Public Works (PW) and/or Reinforcement (RI) factor to the Prioritization calculation:

$$Pr = D + R + PW + RI$$

1) For Road Resurfacing, PW = 2.4
2) For Road Reconstruction, PW = 4.2
3) For Size-Pressure Upgrade Reinforcement, RI = 2.5

These factors are applied because of potential cost savings in combining main replacements with other work, as well as anticipated avoidance of performing work on protected streets that were recently improved.

.

a.

6. Knowledge Base & References (Click here)

Knowledge Base		References
1 - Compliance History	5 - Job Aid	1 - Regulatory – Codes
2 - Data Capture	6 - Learning & Development	2 - Technical Documents
3 - Definitions	7 - Standard Drawings	3 - Tools Catalog
4 - Document History	8 - Tools & Equipment	

7. Attachments

Attachment 1: DIMP Factor List 2014

2014 SYSTEM INTEGRITY REPORT

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Enterprise
Gas Distribution Systems
Trend-Based Integrity Analysis

RI

Irfaan Ally, Sr. Engineer
Gas Distribution Engineering
Network Strategy – Gas Systems Engineering

CONTACT:
Mohammad A Islam (516) 545-2363 Sr. Engineer – Gas Distribution Engineering
Saadat Khan (516) 807-2335 Manager – Gas Distribution Engineering

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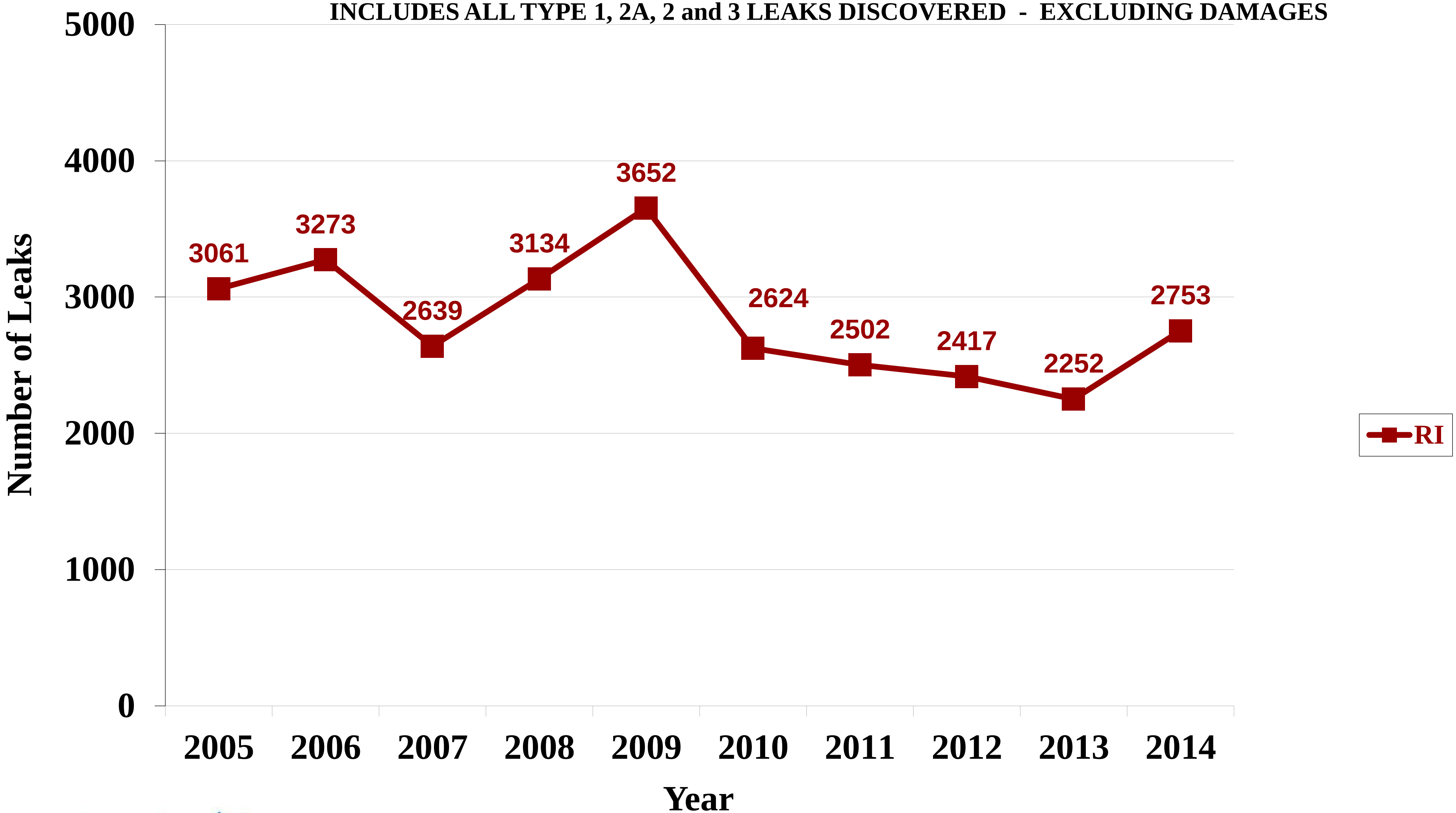
LEAK MANAGEMENT ANALYSIS

2014 SYSTEM INTEGRITY REPORT

TOTAL LEAK RECEIPTS

INCLUDES ALL TYPE 1, 2A, 2 and 3 LEAKS DISCOVERED - EXCLUDING DAMAGES



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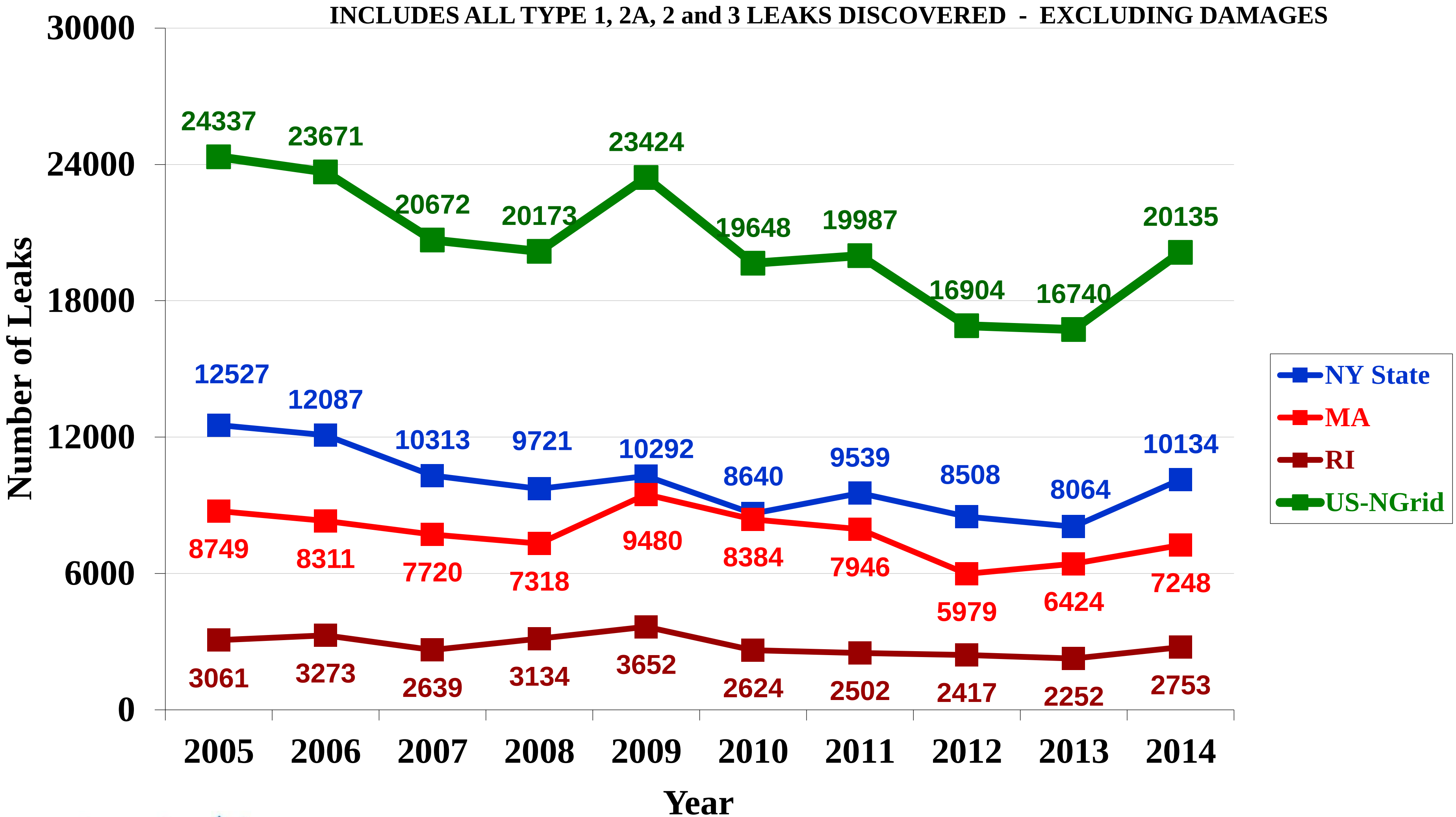
2014 SYSTEM INTEGRITY REPORT

TOTAL LEAK RECEIPTS



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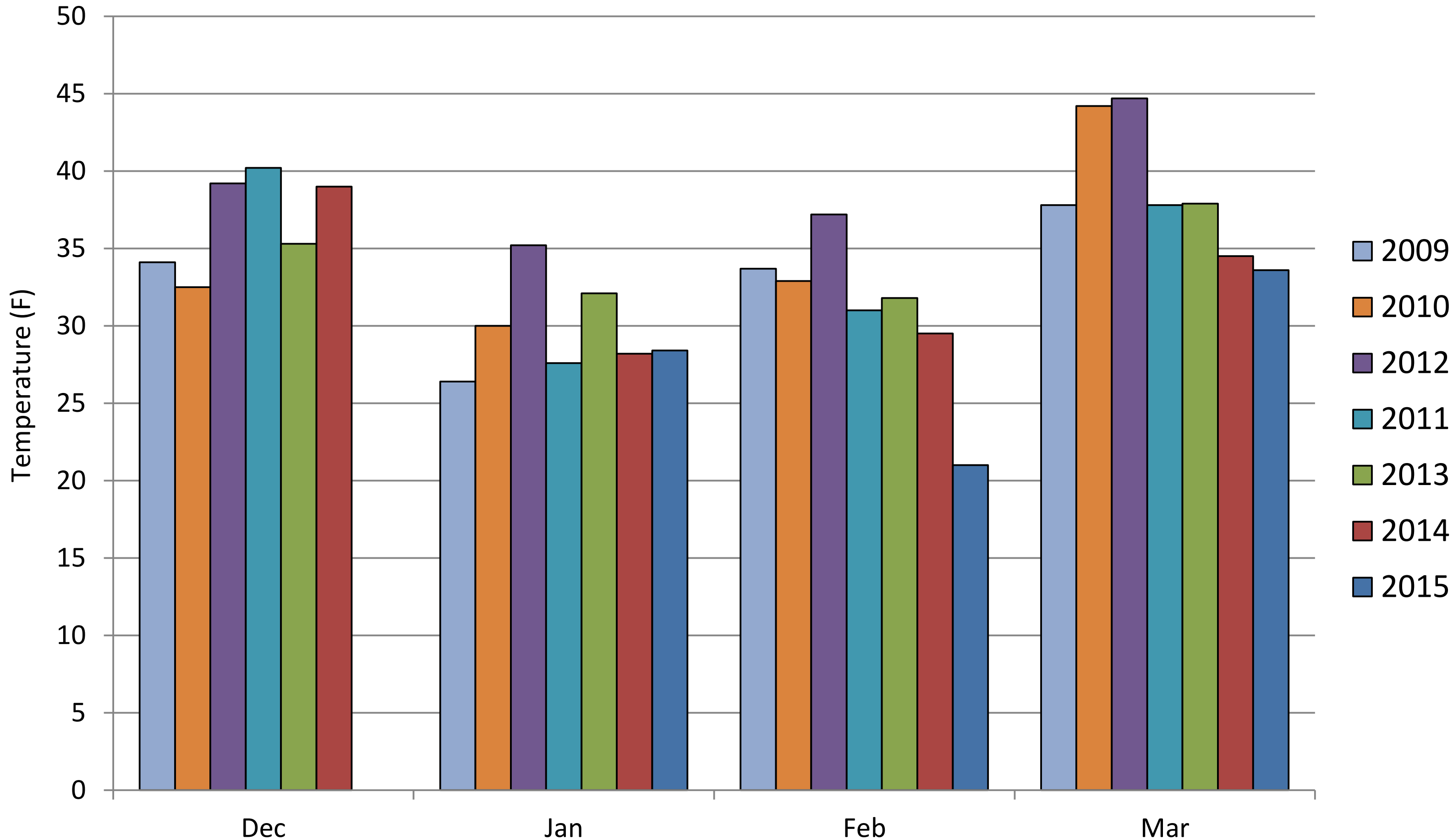
2014 SYSTEM INTEGRITY REPORT

Average Monthly Temperature



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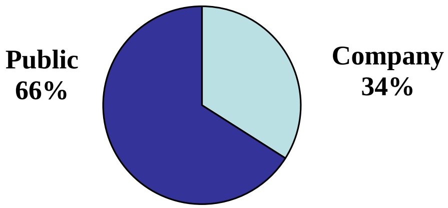
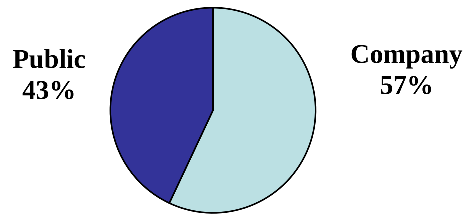
2014 SYSTEM INTEGRITY REPORT

2014 LEAK RECEIPTS
BY DISCOVERY SOURCE (EXCLUDING DAMAGES)

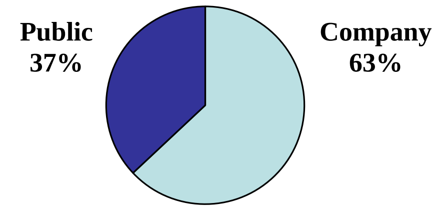
NY State



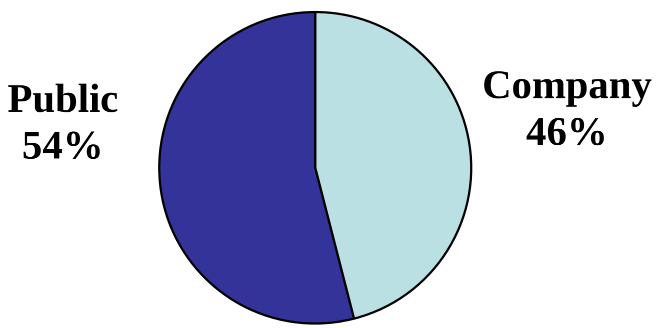
MA State



RI



US-NGrid



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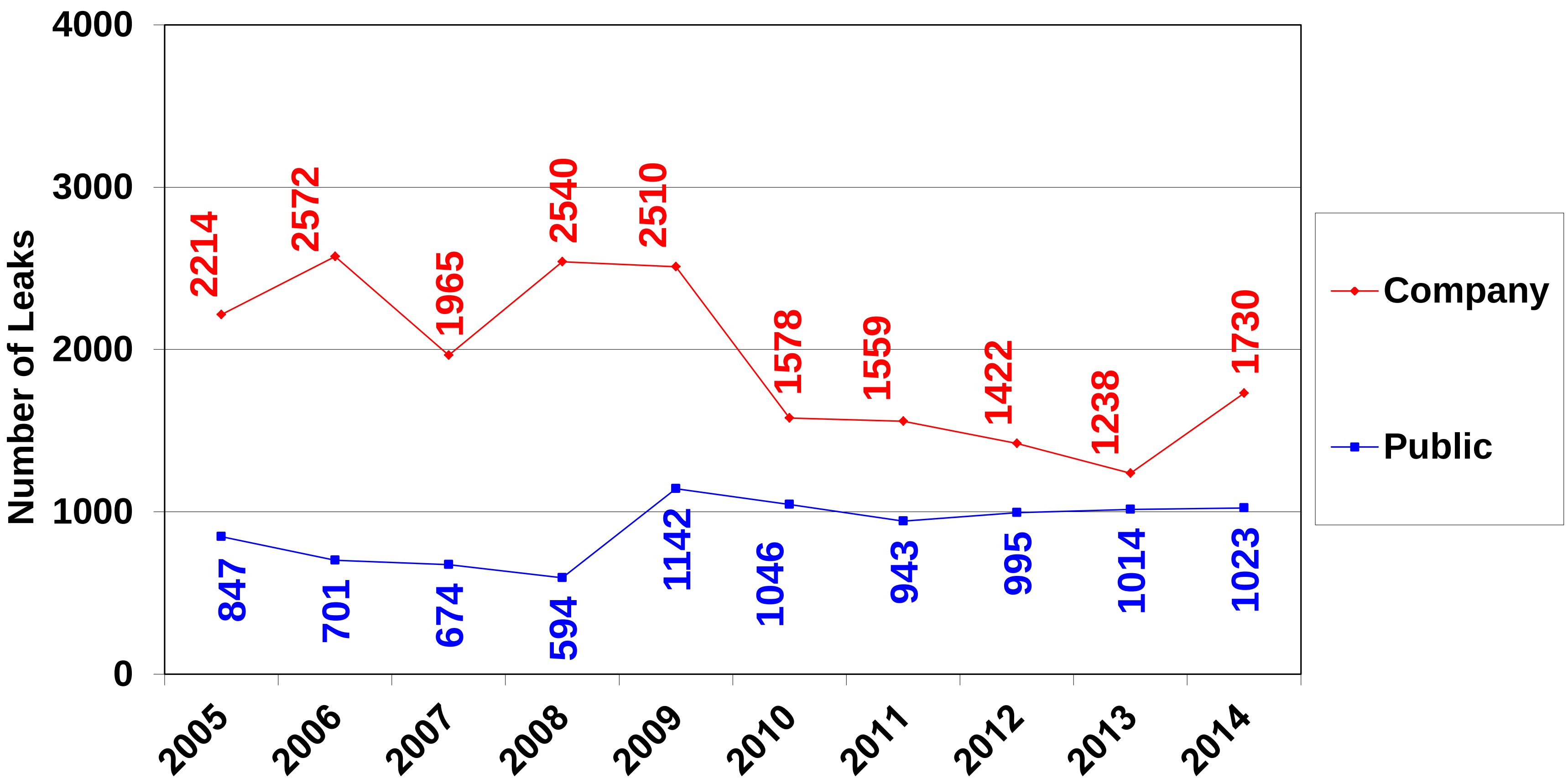
2014 SYSTEM INTEGRITY REPORT

2005 - 2014 LEAK RECEIPTS

By Discovery Source (Excluding damages)



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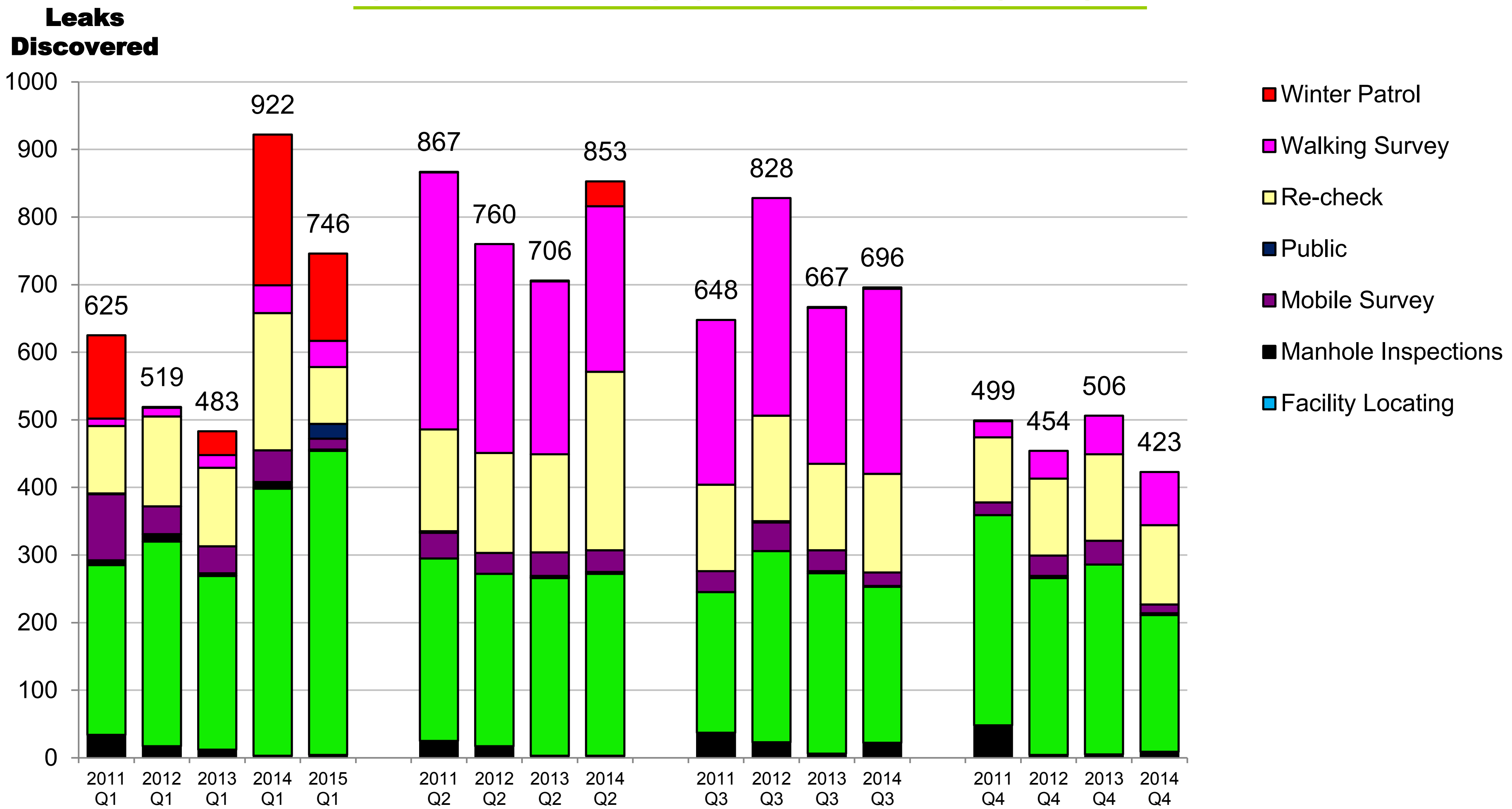
2014 SYSTEM INTEGRITY REPORT

Total Leaks Receipts

COMPARISON BY SOURCE



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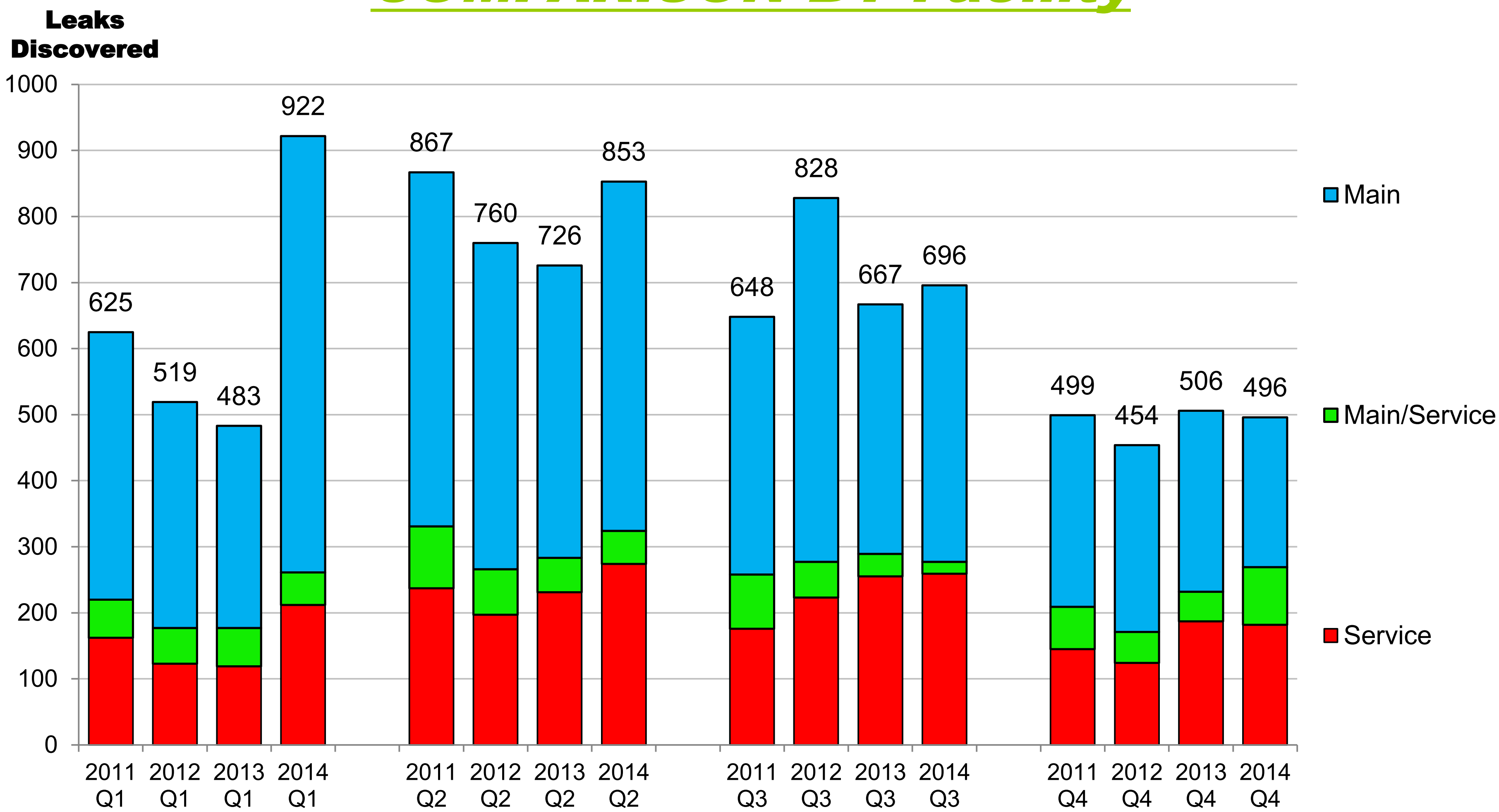
2014 SYSTEM INTEGRITY REPORT

Total Leaks Receipts

COMPARISON BY Facility



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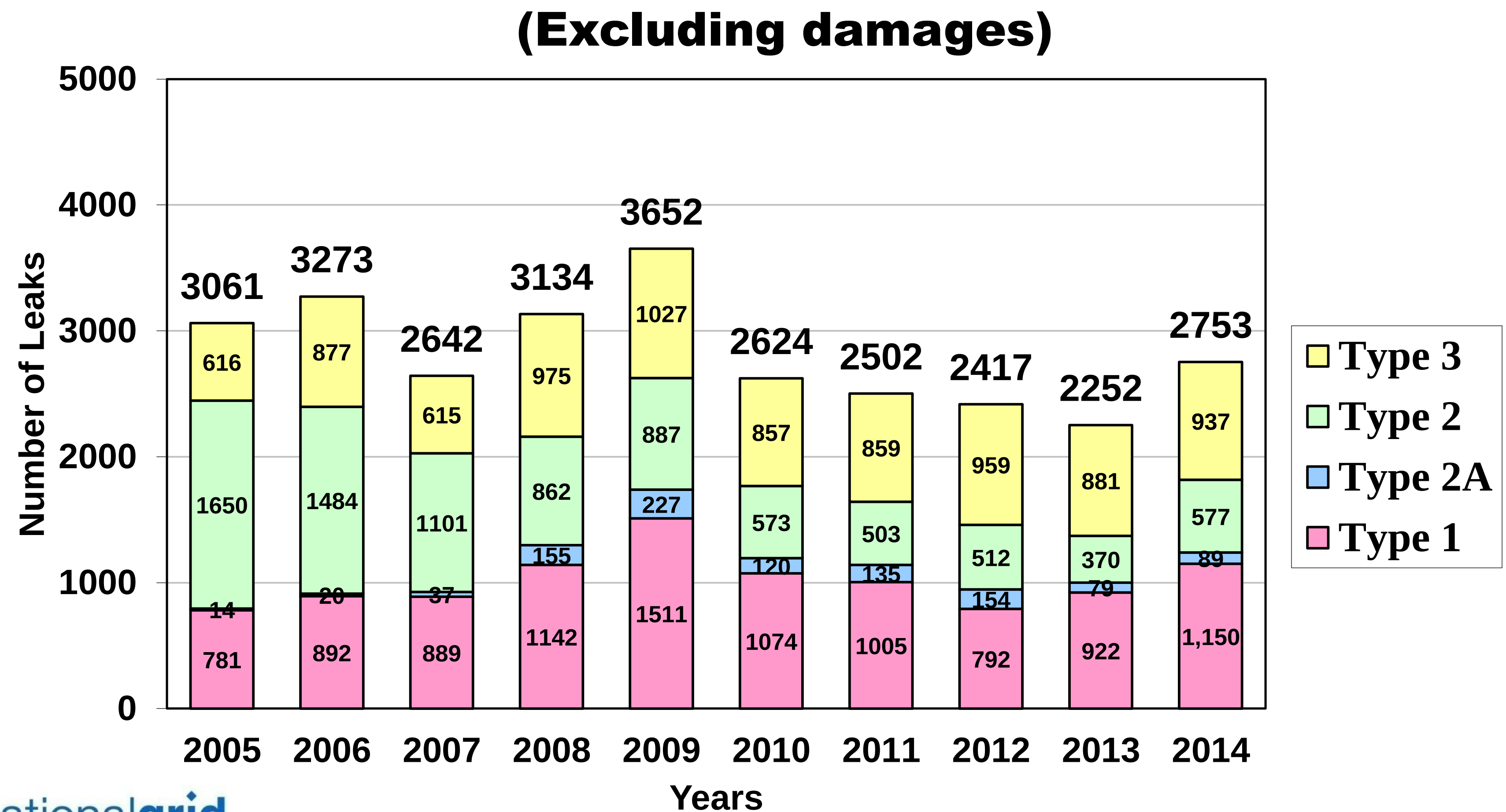
2014 SYSTEM INTEGRITY REPORT

LEAK RECEIPTS

By ORIGINAL Type



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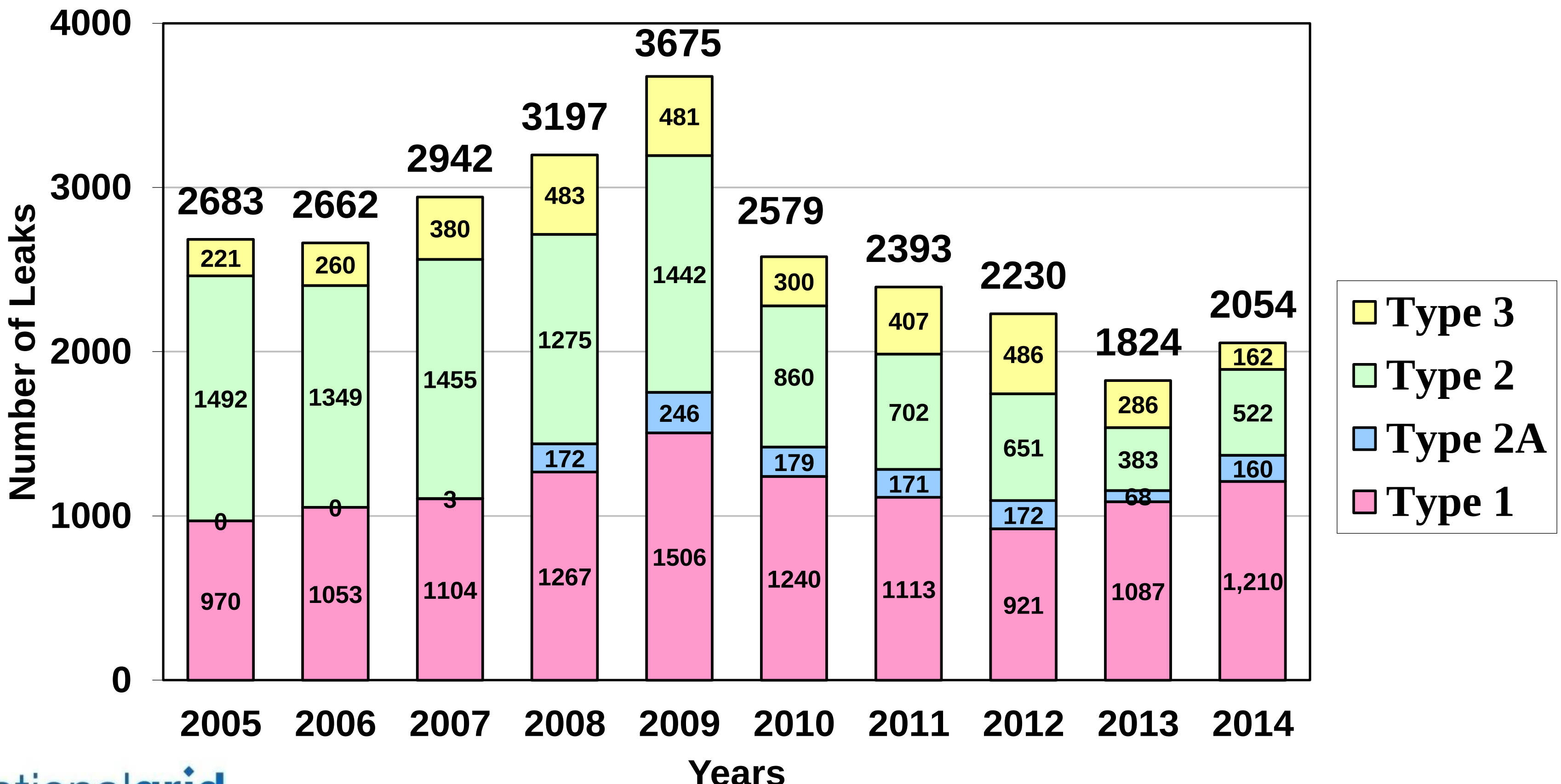
2014 SYSTEM INTEGRITY REPORT

LEAKS REPAIRED
By REPAIRED Type

(Including damages)



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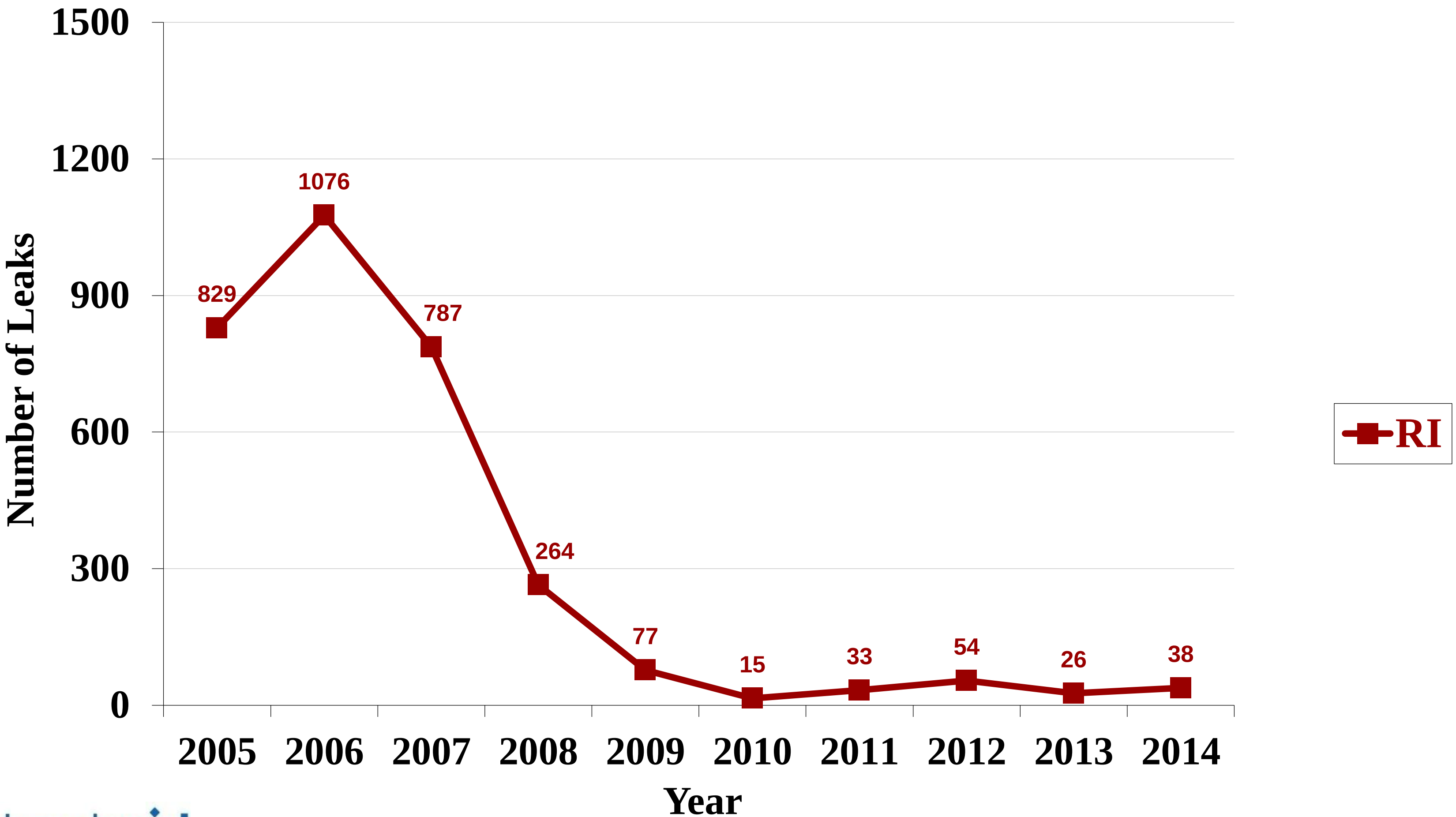
2014 SYSTEM INTEGRITY REPORT

YEAR-END WORKABLE LEAK BACKLOGS



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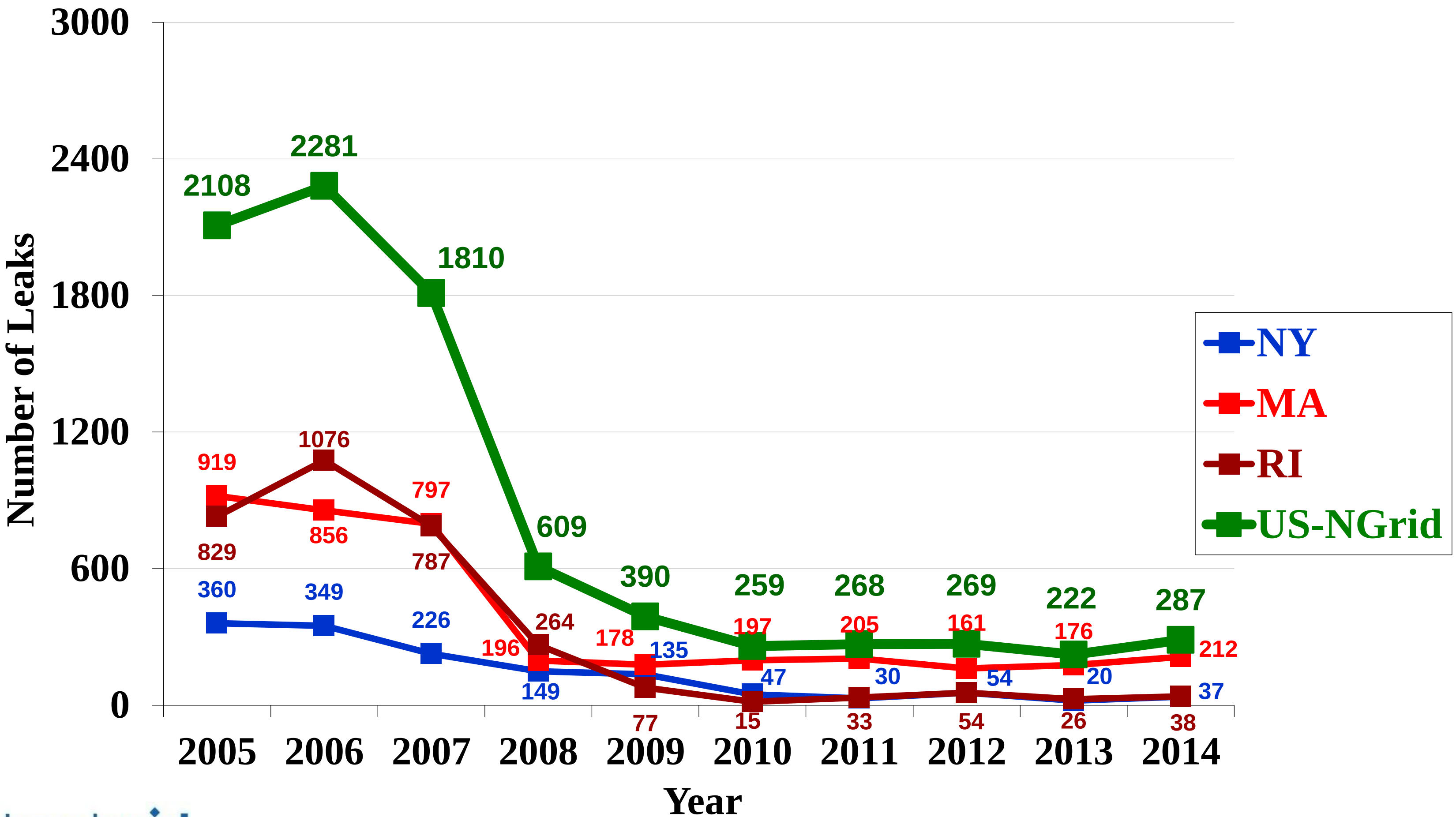
2014 SYSTEM INTEGRITY REPORT

US NGrid YEAR-END WORKABLE LEAK BACKLOGS



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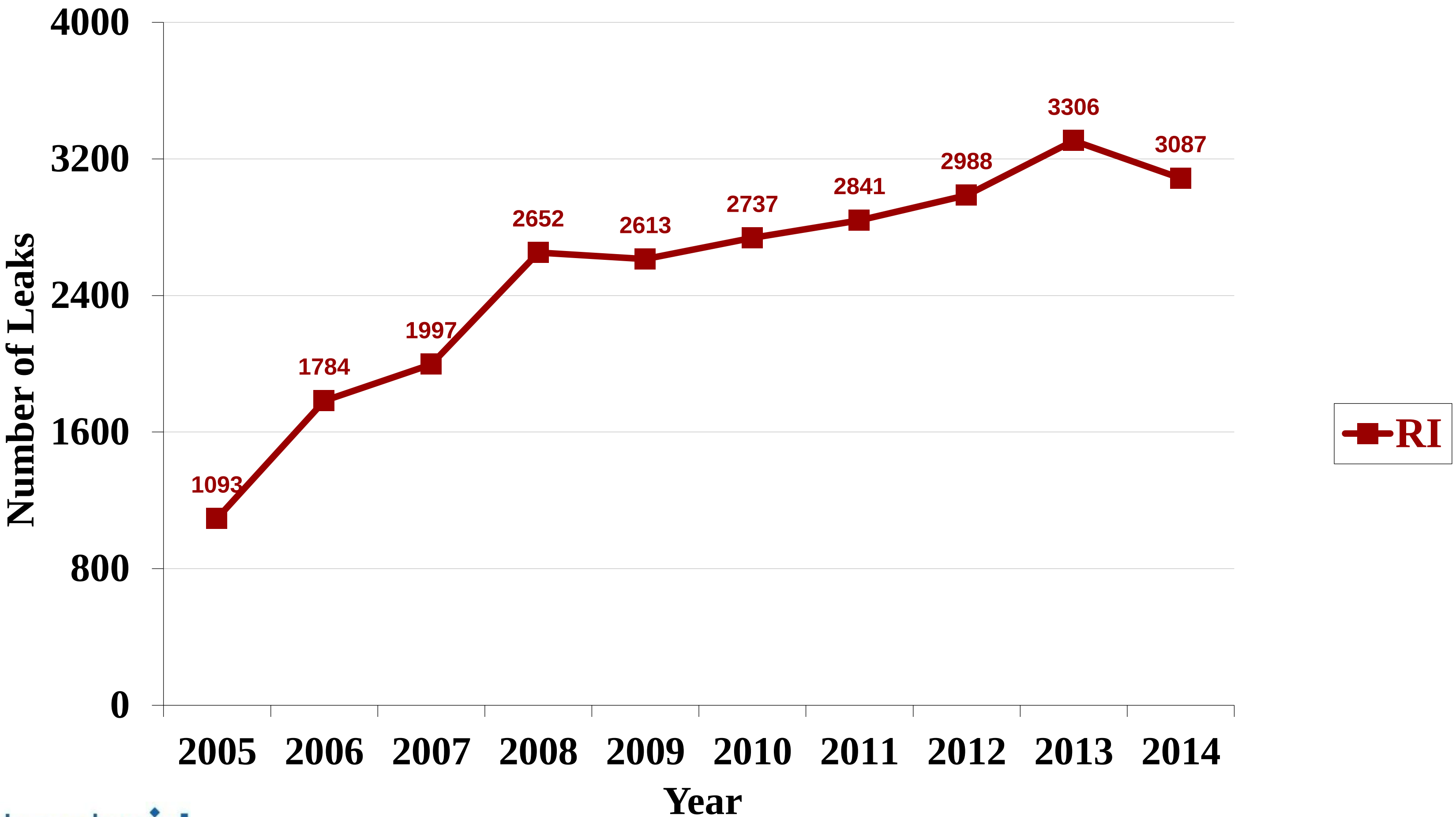
2014 SYSTEM INTEGRITY REPORT

YEAR-END OPEN TYPE 3



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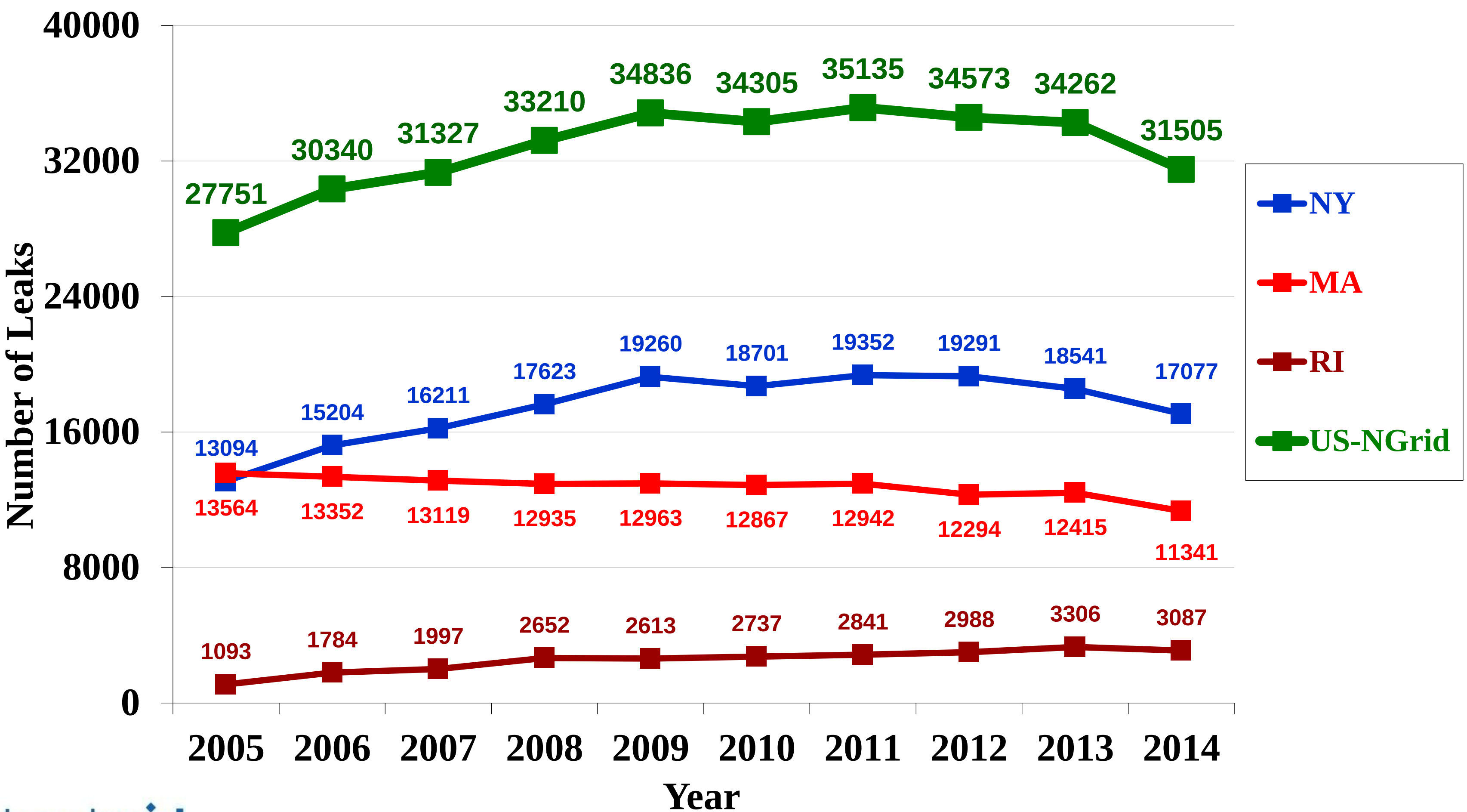
2014 SYSTEM INTEGRITY REPORT

US NGrid YEAR-END OPEN TYPE 3



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2014 SYSTEM INTEGRITY REPORT

MAIN INVENTORY ANALYSIS

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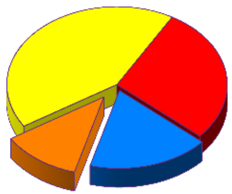
2014 SYSTEM INTEGRITY REPORT

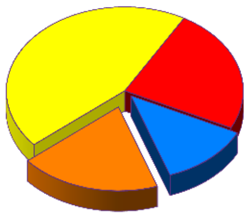
MAIN INVENTORY

SUMMARY – All States

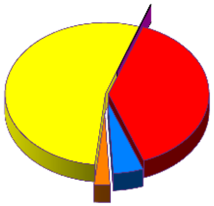
NY
20,708 MILES



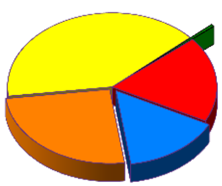
MA
11,064 MILES



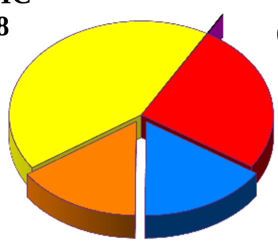
2013 PHMSA Average



Rhode Island
3,188 MILES



National Grid-US
34,960 MILES



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2014 SYSTEM INTEGRITY REPORT

NATIONAL GRID MAIN REPLACEMENT

Rate Case Supported "Leak-Prone" Main Replacement Levels										
Region	2014 Total Main (Miles)	2014 Leak Prone Main (Miles)	Leaks/Miles of Total Main (Repair rate)	Leaks/Miles of Leak Prone Main (Repair rate)	(5) 2014 Annual "Planned" Replacement (Miles)	Planned Replacement % of Leak prone system	(5) 2014 Annual "Actual" Replacement (Miles)	Actual Replacement % of Leak prone system	(5) 2015 Annual "Planned" Replacement (Miles)	Years to LPP Main Elimination based on "Current" annual plan
NYC	4,134	1,900	0.75	1.57	43.0	2.3%	42.8	2.3%	42.0	45
LI	7,931	3,860	0.13	0.25	62.0	1.6%	51.5	1.3%	80.8	48
Upstate NY	8,643	757	0.08	0.85	43.0	5.7%	42.0	5.5%	43.1	17
RI	3,188	1,305	0.37	0.84	64.1	4.9%	28.8	2.2%	71.5	17
BGC & EGC	7,206	3,236	0.71	1.53	142.0	4.4%	110.0	3.4%	146.6	22
CCC & CLW	3,858	263	0.06	0.79	52.8	20.1%	48.6	18.5%	48.6	5

Note:

1. Leaks per mile of total main excludes Excavation leaks.
2. Leaks per mile of Leak-Prone main (LPP) excludes Excavation leaks and Plastic leaks. (Also, all non-Excavation Steel leaks are assumed to have occurred on Unprotected Steel)
3. Leak-Prone Pipe = Unprotected steel (Bare & Coated) + CI/WI + Aldyl-A (MD, 1985 and prior) + Other.
4. Miles of Leak-Prone main replaced includes all Proactive programs (Main Replacement program & System Reinforcement) and all Reactive programs (Public Works, Water Intrusion & Leak/reactive).
5. Annual planned and actual replacement miles are CY.
6. Data sources are 2014 & 2015 US Gas Leak Prone Pipe Replacement Programs monthly reports from Gas Resource Management CMS.

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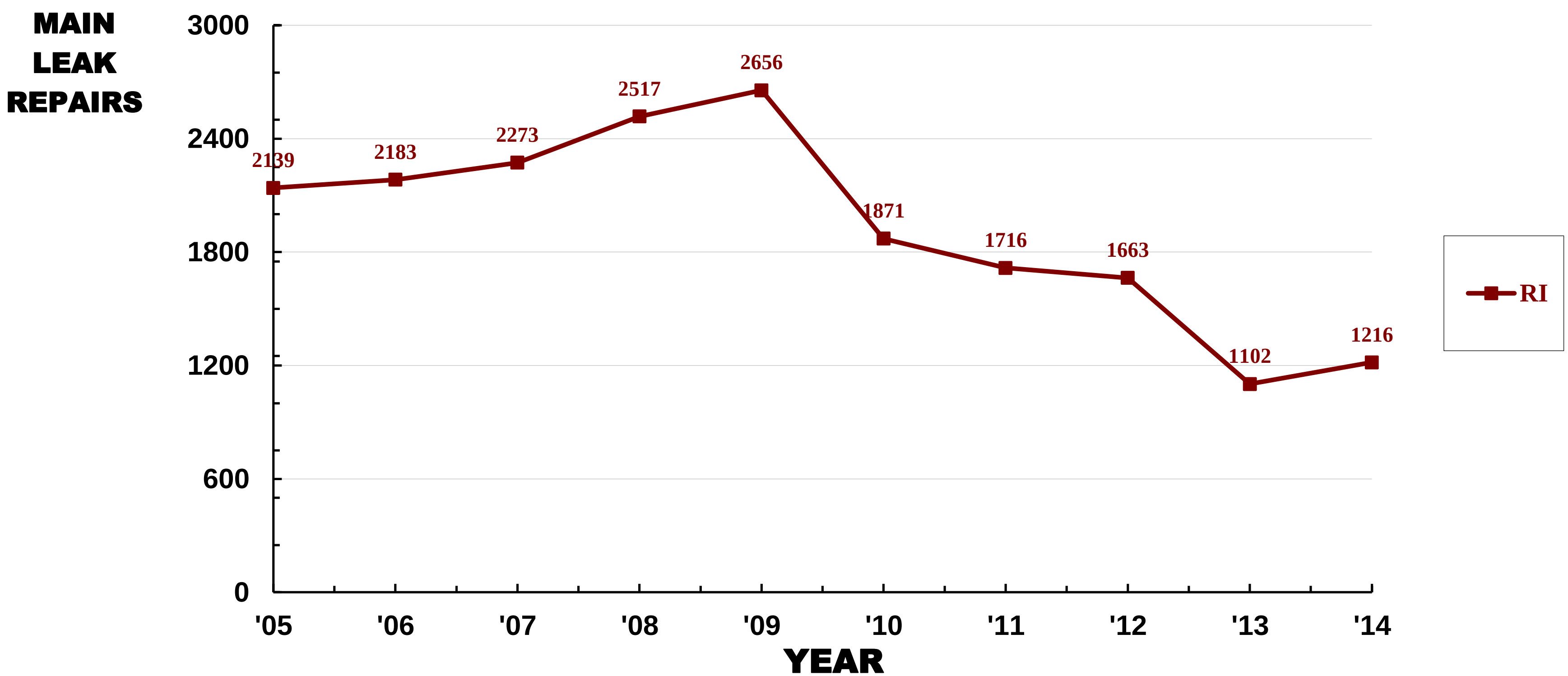
MAIN LEAK REPAIR ANALYSIS

2014 SYSTEM INTEGRITY REPORT

TOTAL MAIN LEAK REPAIRS

INCLUDING Damages



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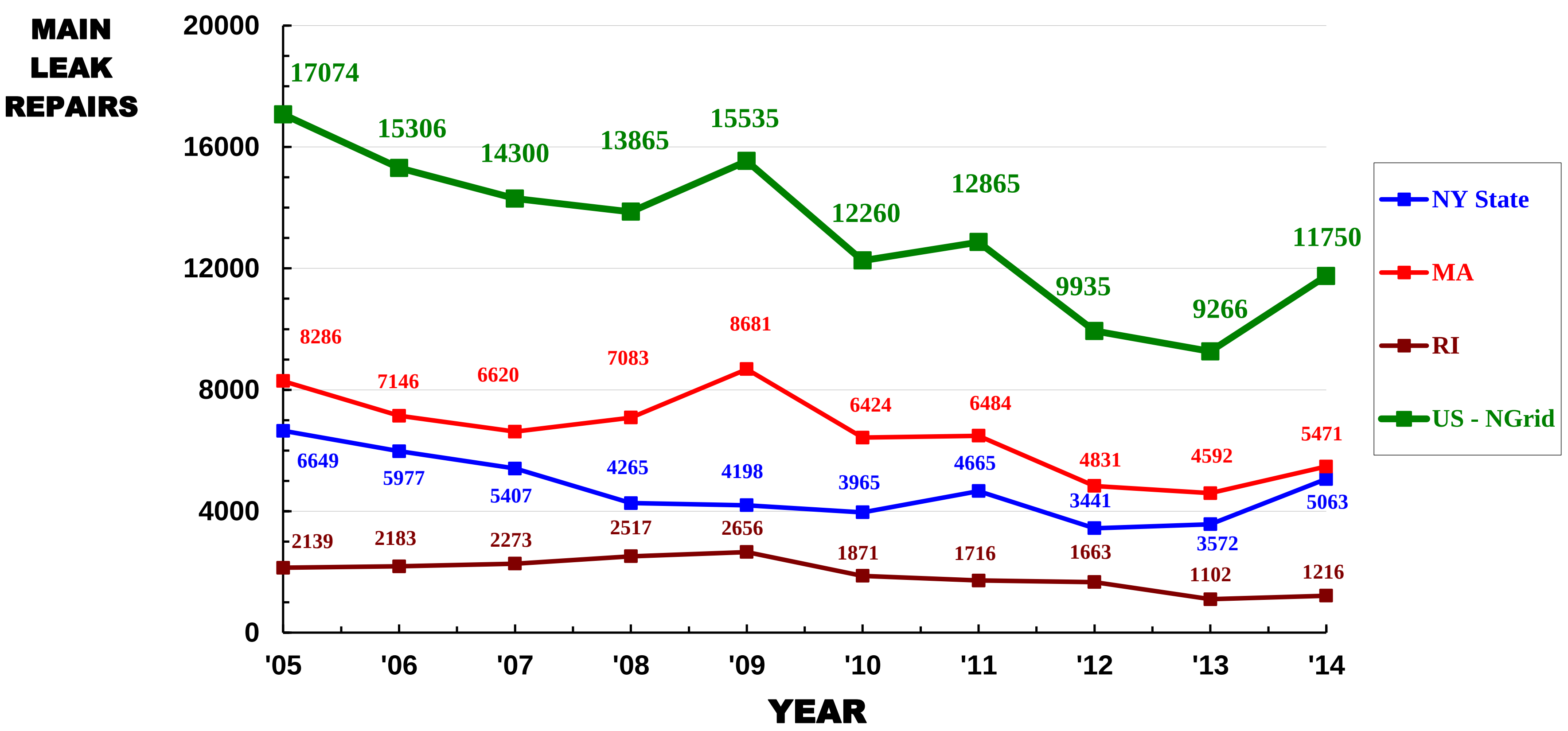
2014 SYSTEM INTEGRITY REPORT

TOTAL MAIN LEAK REPAIRS

INCLUDING Damages



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NOTE: Cast Iron Leaks Count Total Individual Joint Repairs

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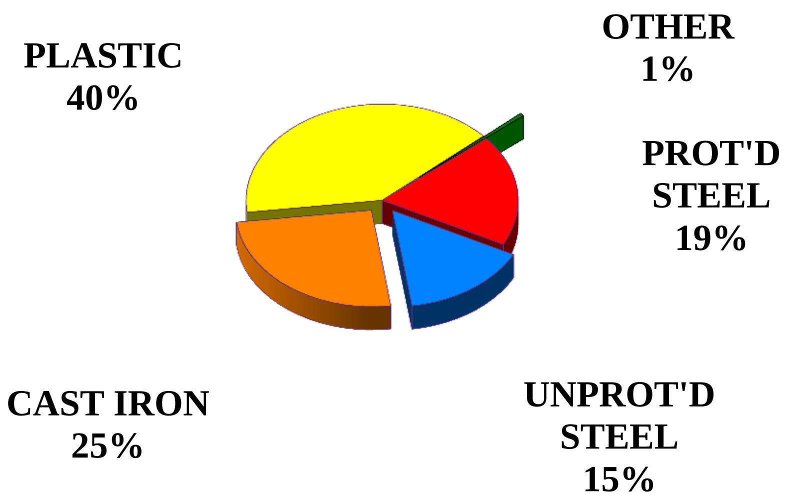
2014 SYSTEM INTEGRITY REPORT

2014 TOTAL MAIN LEAKS REPAIRS

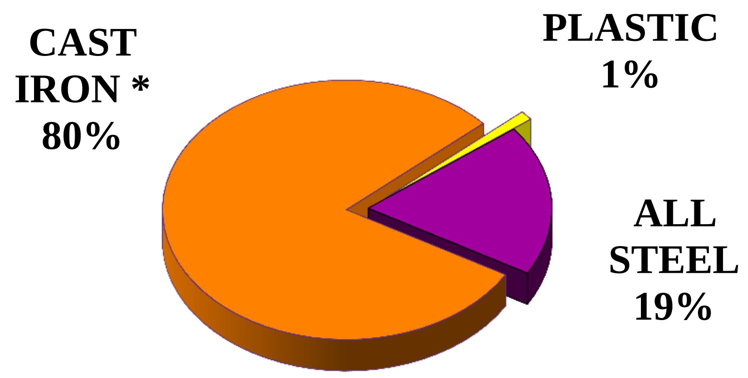
TOTAL MAIN INVENTORY *BY MATERIAL*

3,188 MILES



TOTAL MAIN LEAK REPAIRS *BY MATERIAL*

1,204 LEAKS (including damages)



NOTE: (*) CI Leaks include Other material Leaks.
Leak Count Totals Individual Repairs.

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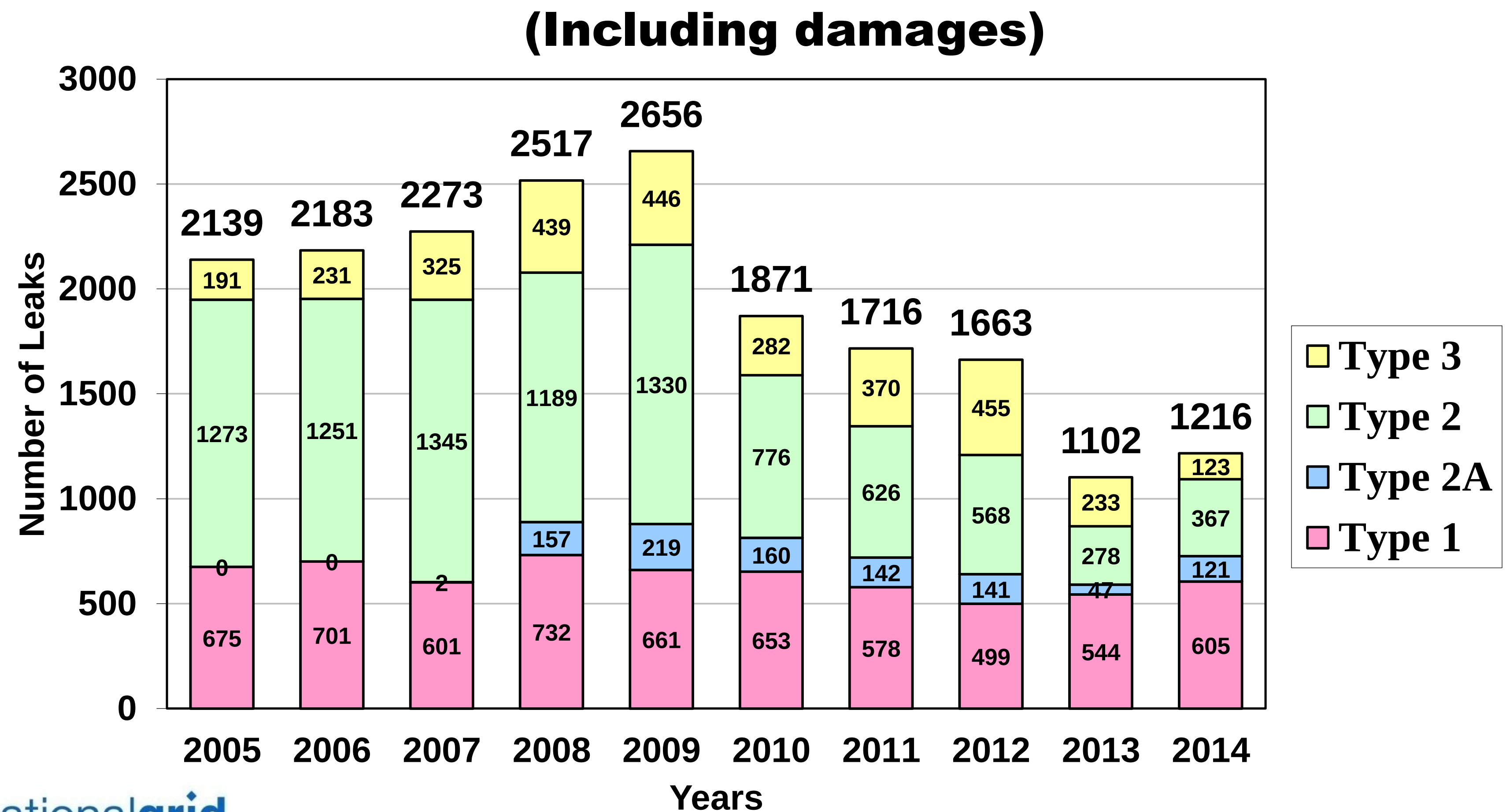
2014 SYSTEM INTEGRITY REPORT

LEAKS REPAIRED By REPAIRED Type

MAIN



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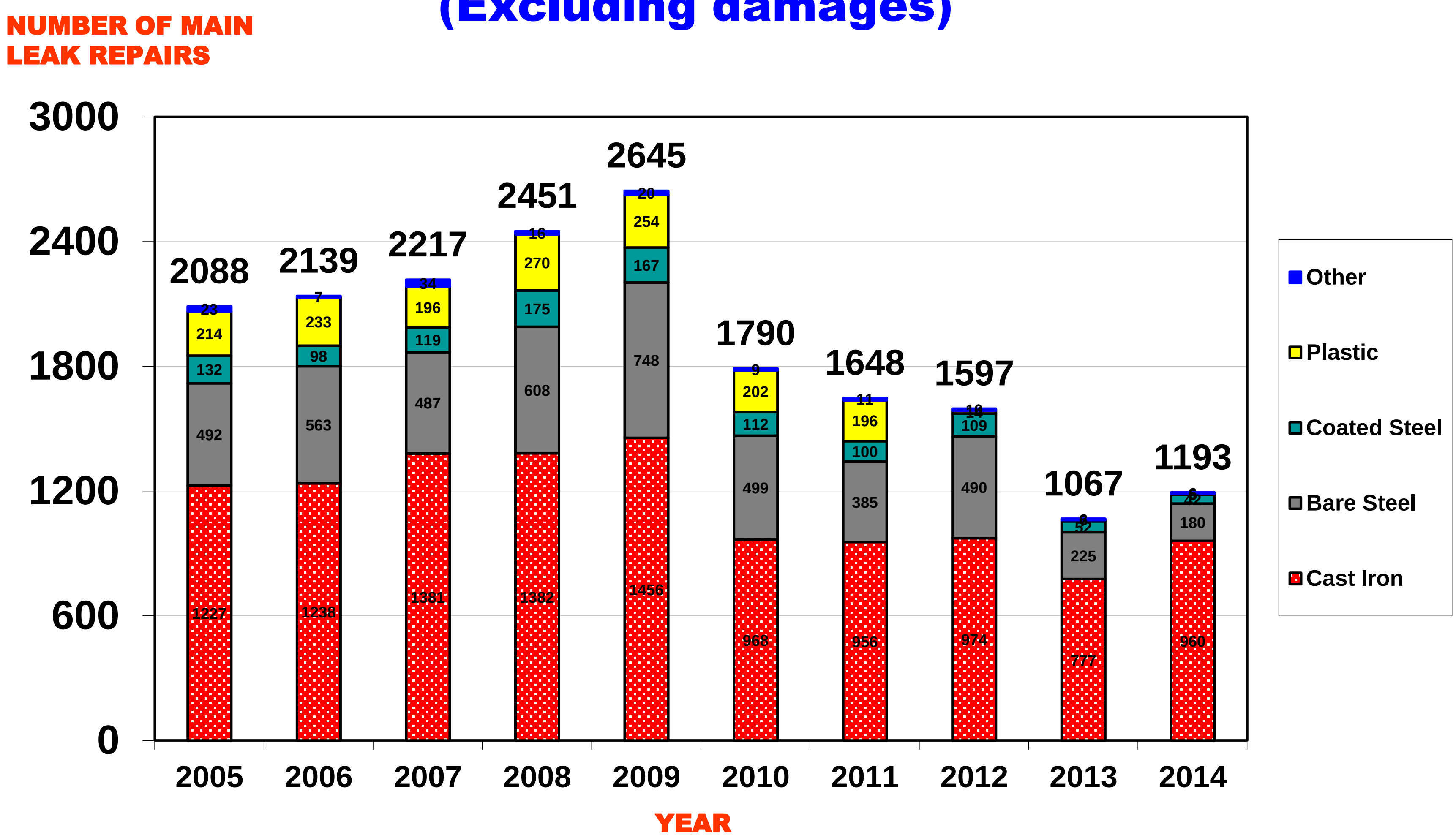
2014 SYSTEM INTEGRITY REPORT

2005 -2014 MAIN LEAK REPAIRS

All Main Leak Repairs by Material (Excluding damages)



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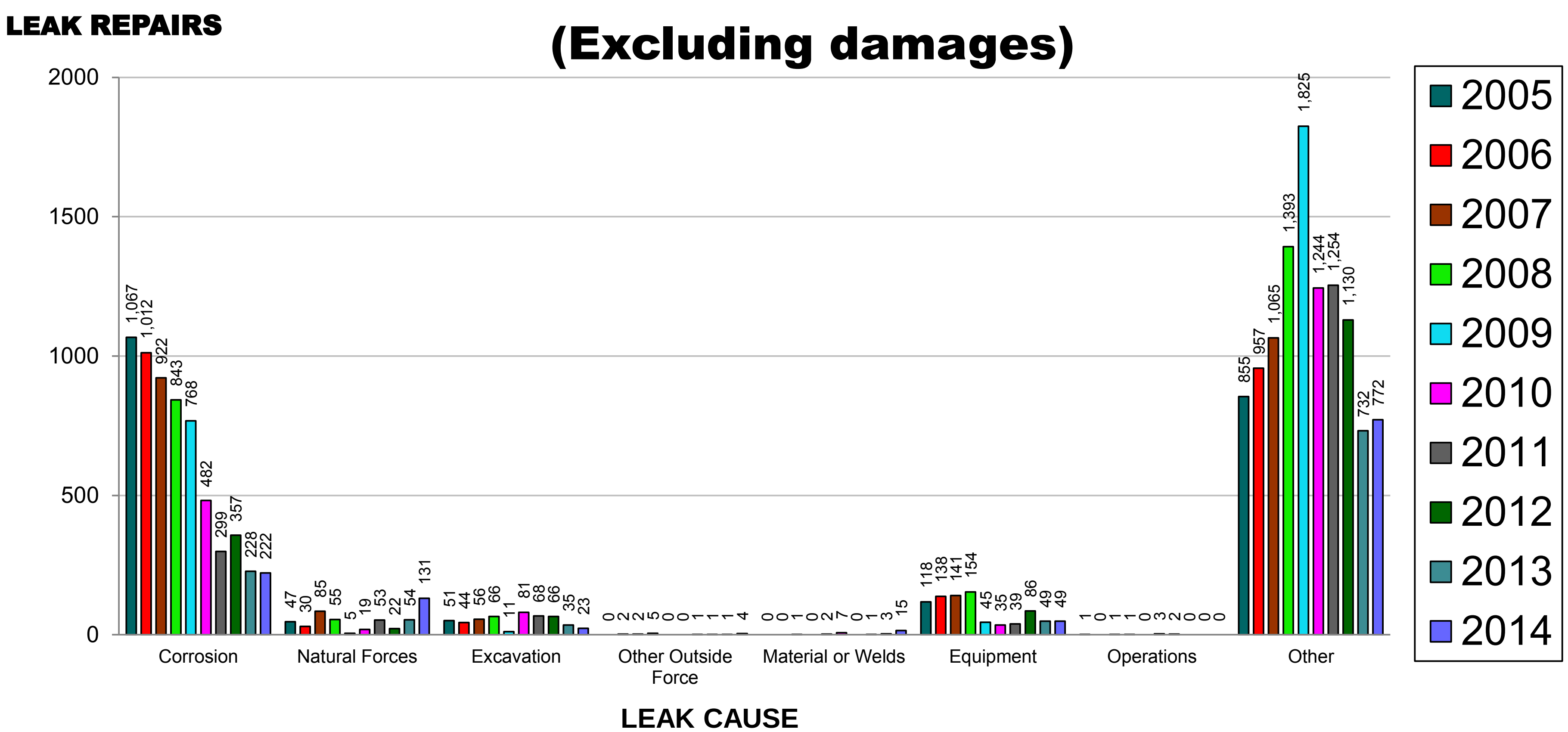
2014 SYSTEM INTEGRITY REPORT

MAIN LEAKS REPAIRED

COMPARISON BY LEAK CAUSES



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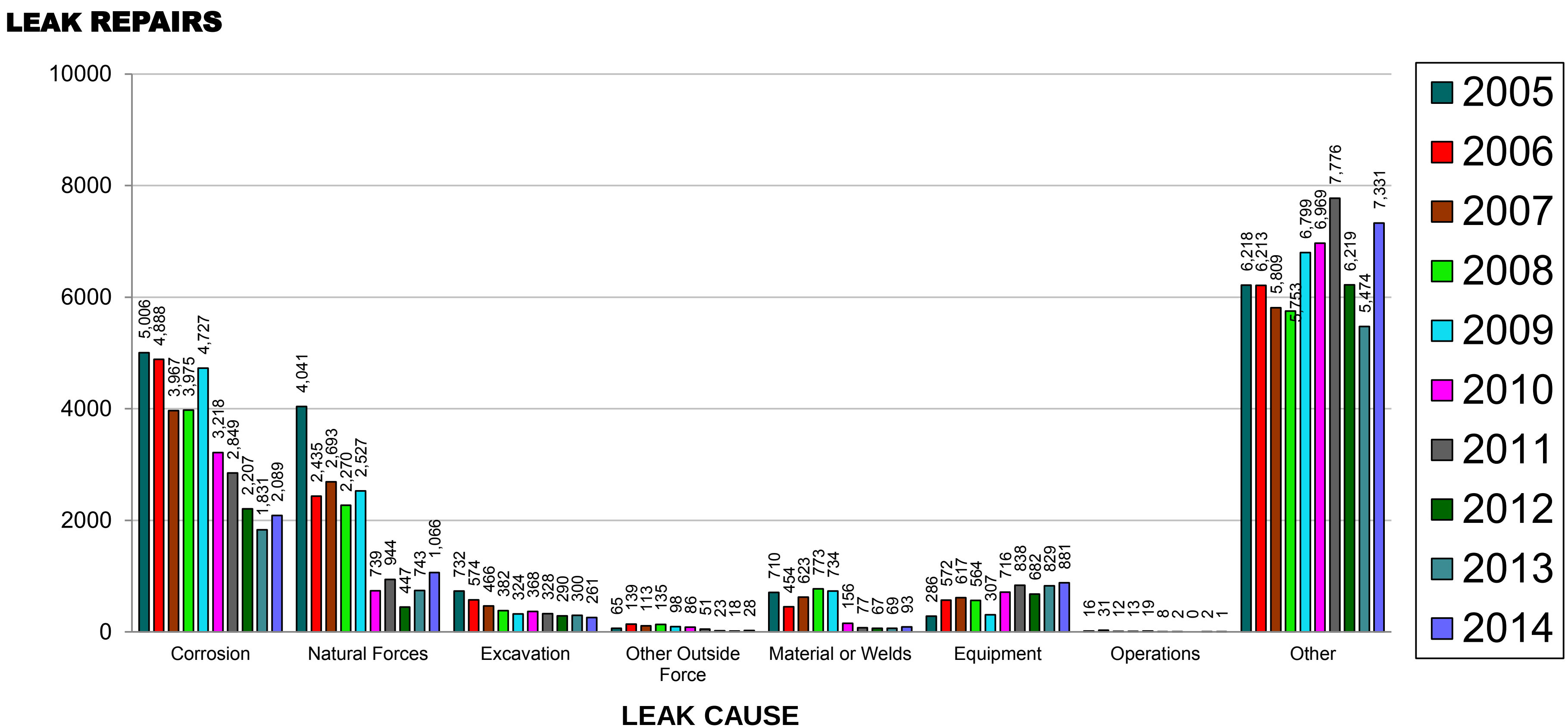
2014 SYSTEM INTEGRITY REPORT

NGRID

MAIN LEAKS REPAIRED

COMPARISON BY LEAK CAUSES



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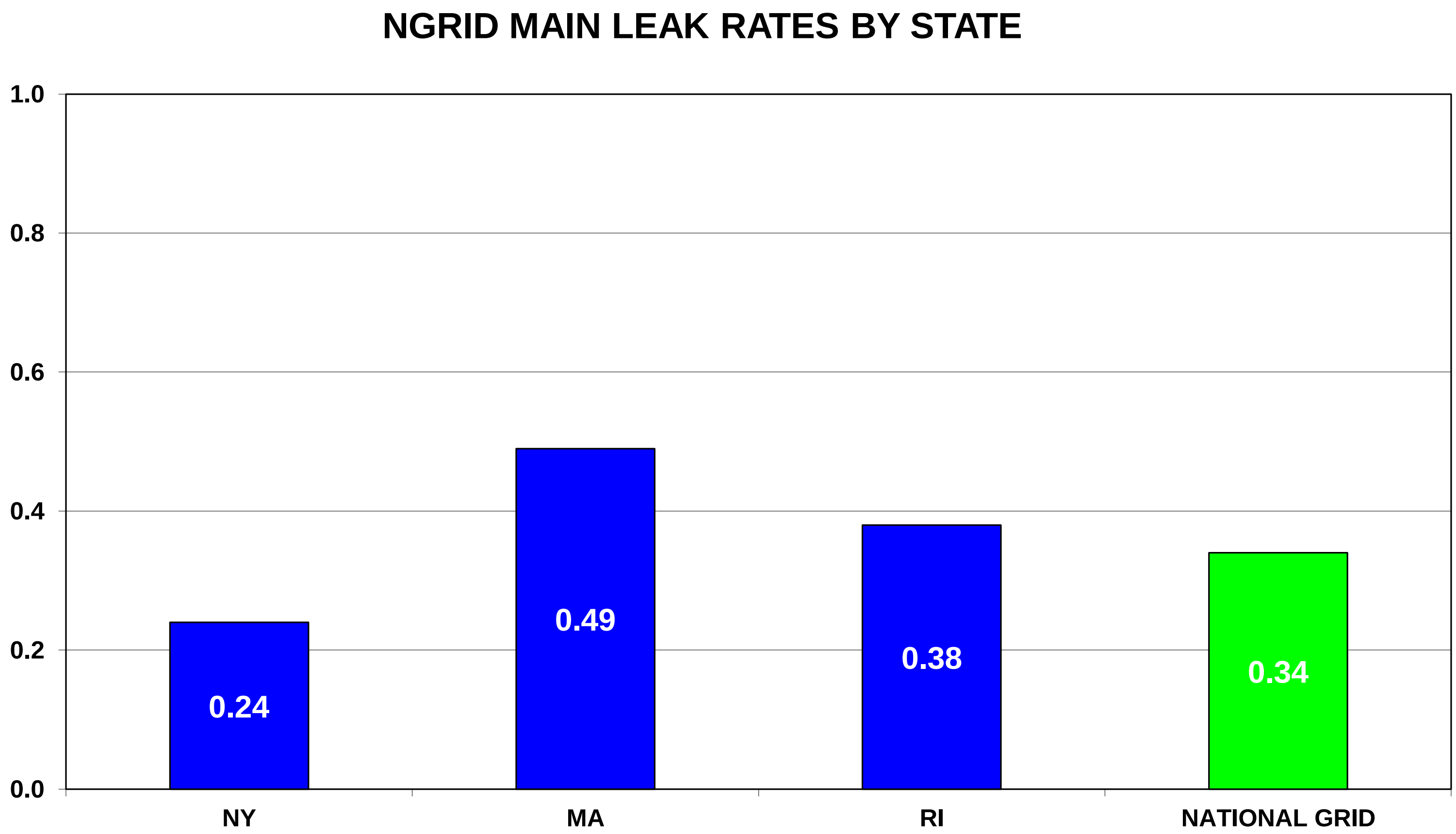
2014 SYSTEM INTEGRITY REPORT

2014 MAIN LEAK "RATES"

Total Main Leak Repairs (incl. damages) / Mile of Total Main



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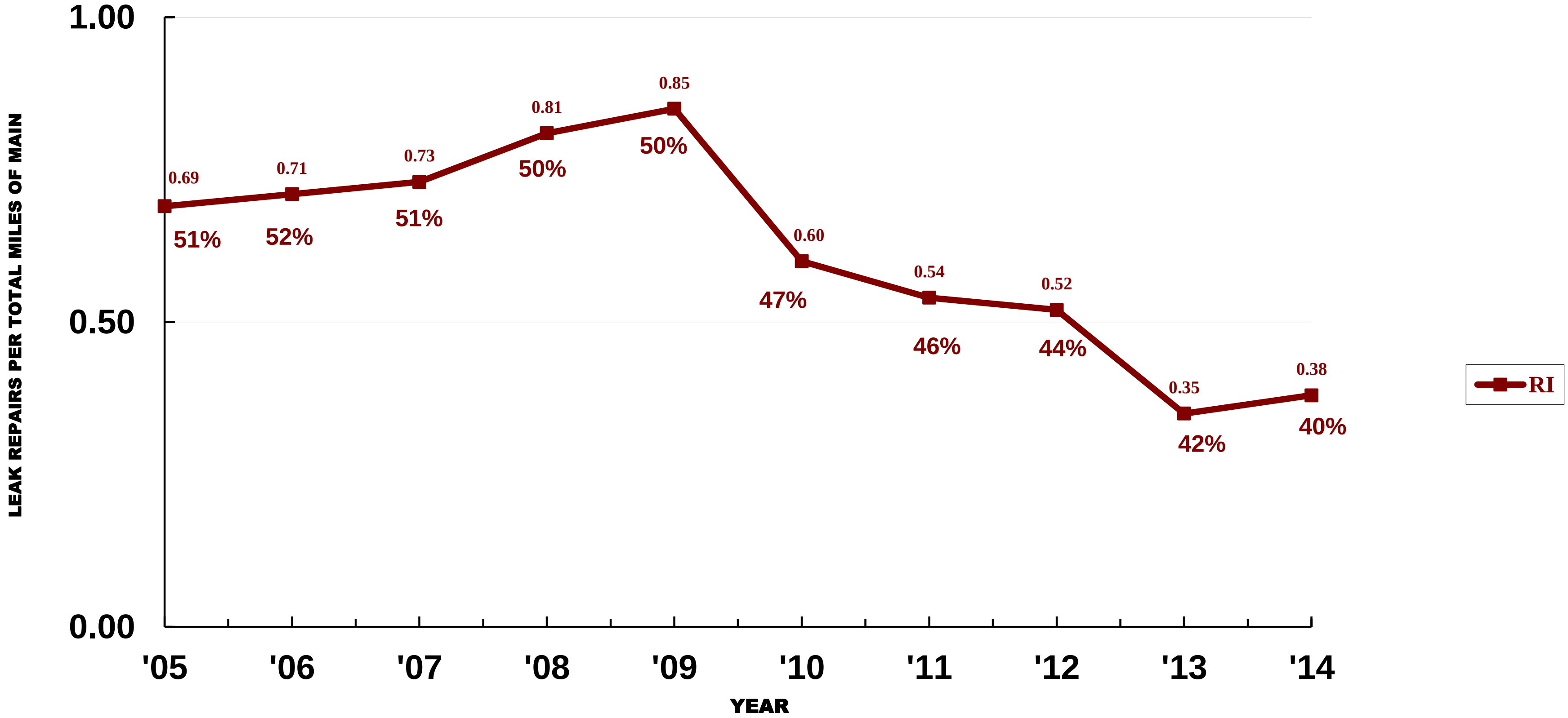
2014 SYSTEM INTEGRITY REPORT

TOTAL MAIN LEAK "RATES"

INCLUDING Damages

PERCENTAGES SHOWN ARE PERCENT OF LEAK-PRONE PIPE



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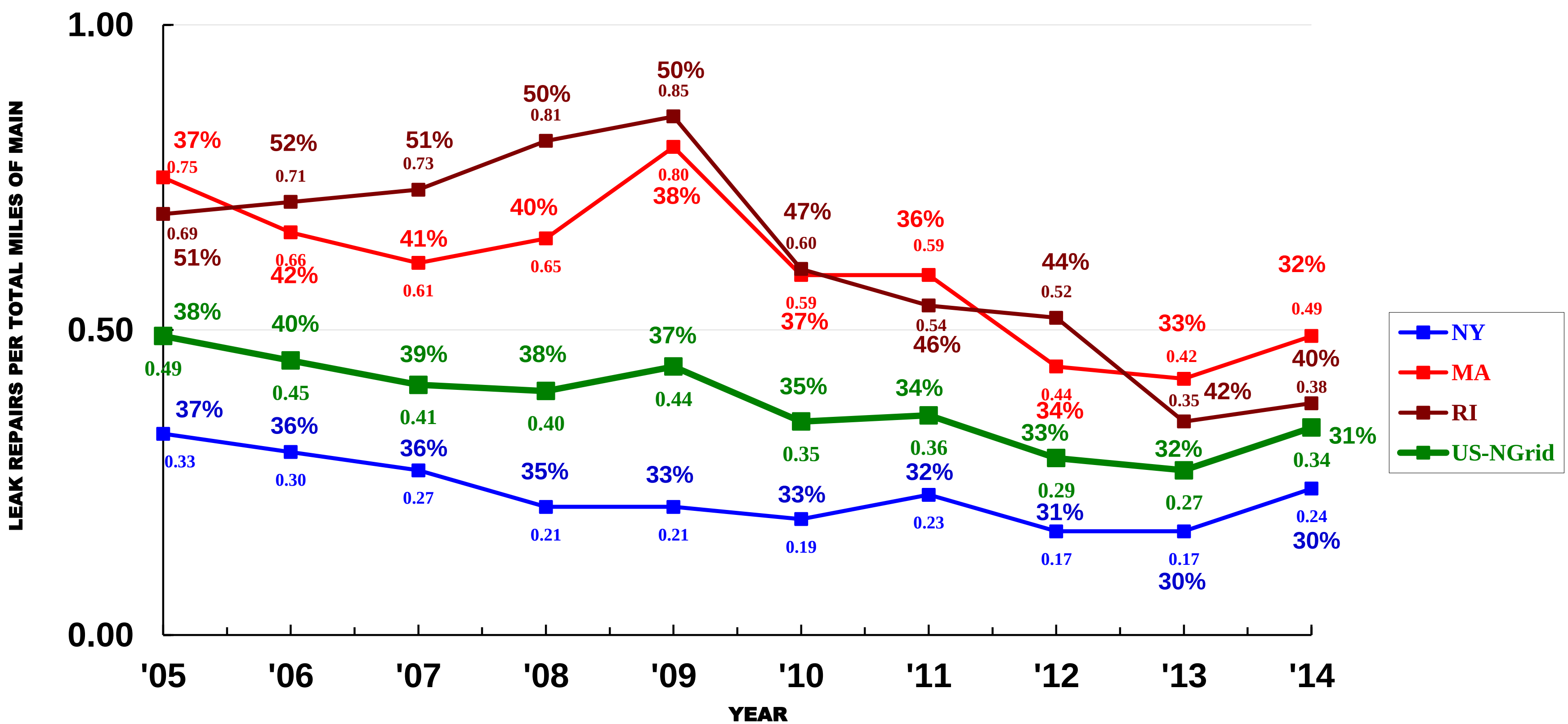
COUNTING EACH INDIVIDUAL REPAIR AS A LEAK

2014 SYSTEM INTEGRITY REPORT

TOTAL MAIN LEAK "RATES"

INCLUDING Damages

PERCENTAGES SHOWN ARE PERCENT OF LEAK-PRONE PIPE



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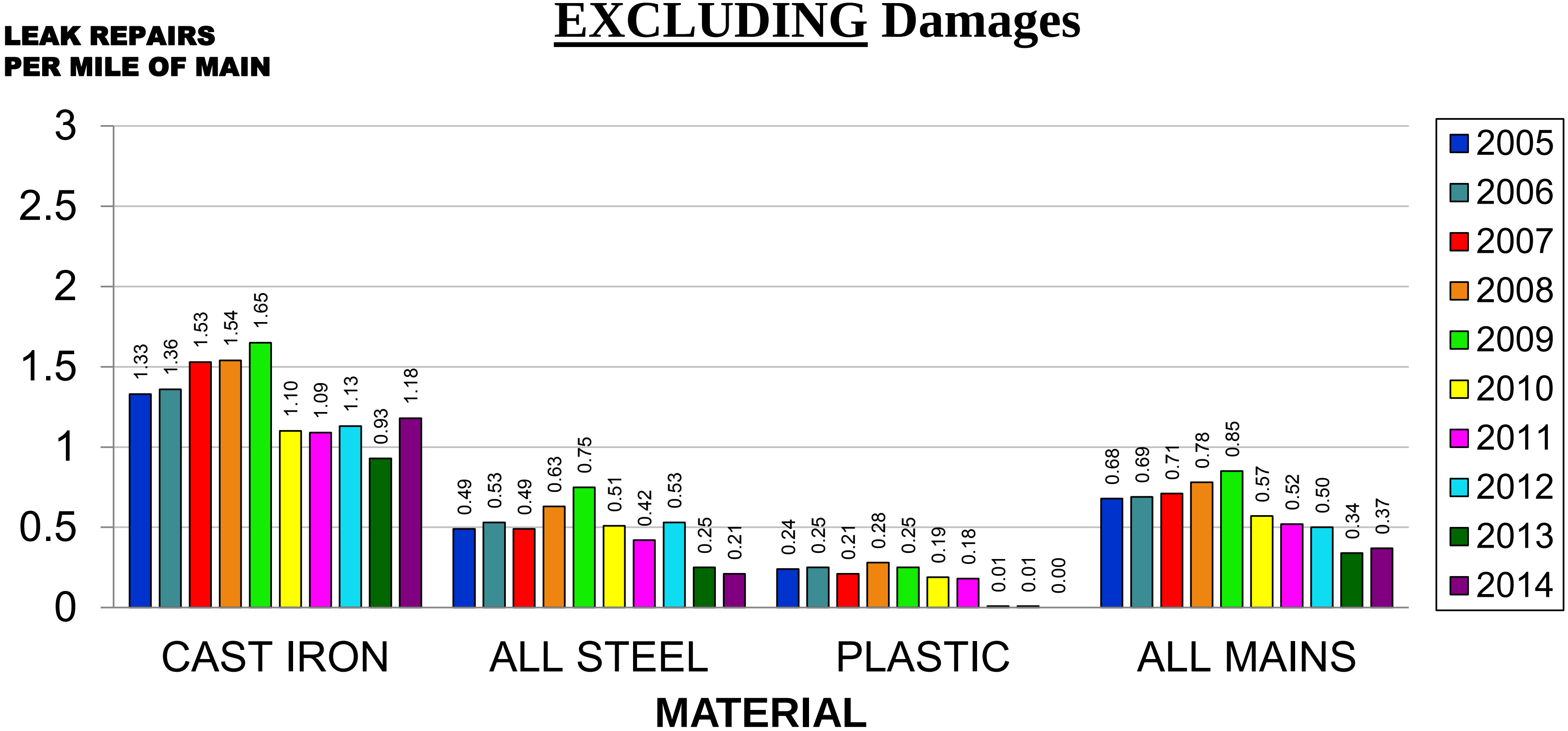
2014 SYSTEM INTEGRITY REPORT

MAIN LEAK "RATES"

COMPARISON BY MATERIAL

EXCLUDING Damages



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2014 SYSTEM INTEGRITY REPORT

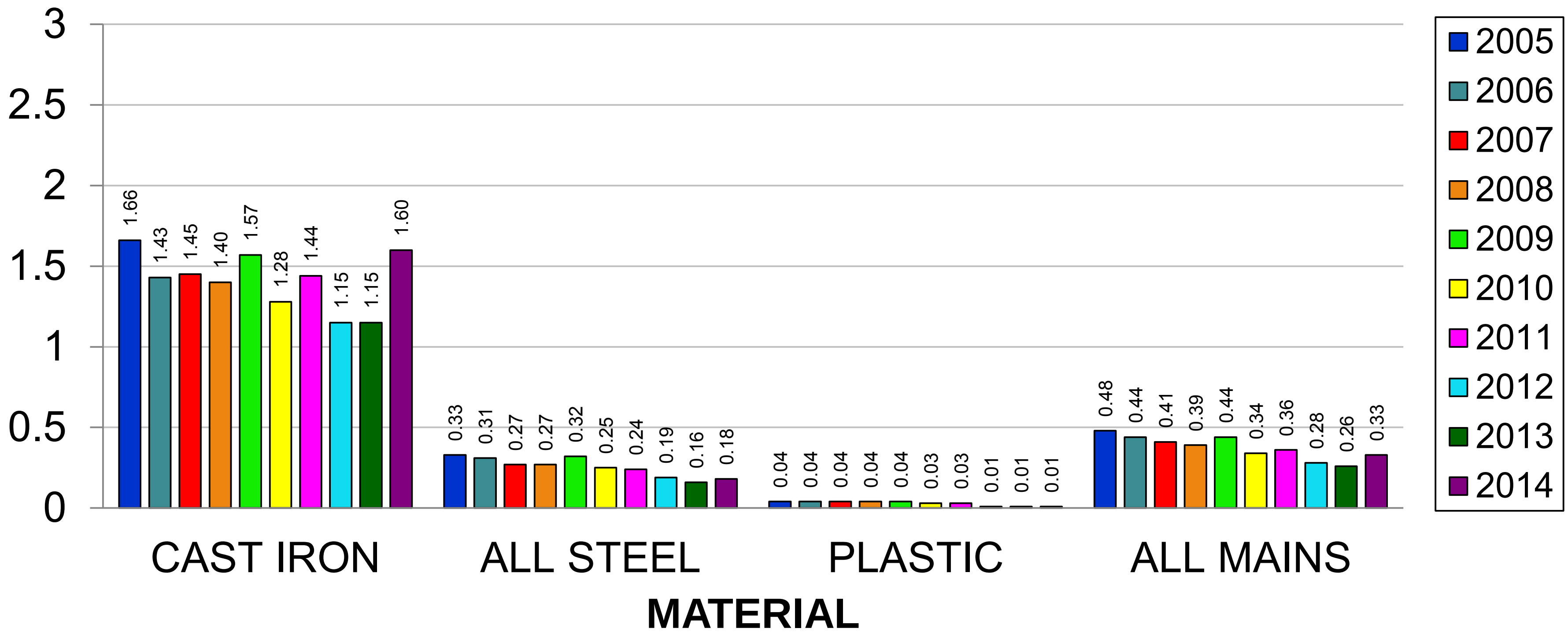
US-NGrid

MAIN LEAK "RATES"

COMPARISON BY MATERIAL

EXCLUDING Damages

LEAK REPAIRS
PER MILE OF MAIN



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2014 SYSTEM INTEGRITY REPORT

A CLOSER LOOK AT CAST IRON MAINS

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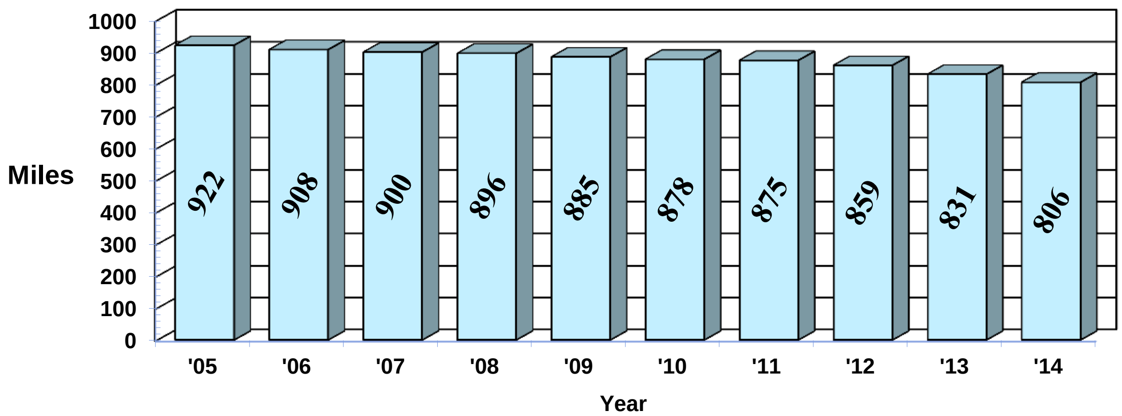
2014 SYSTEM INTEGRITY REPORT

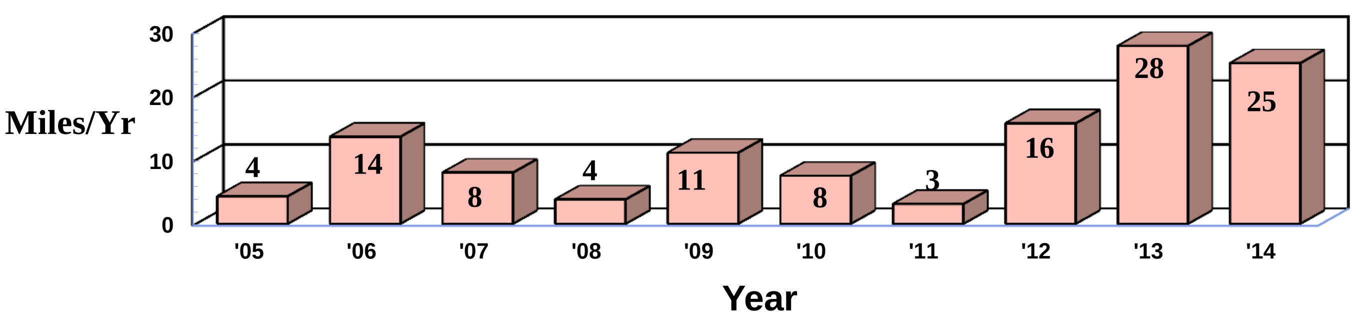
CAST IRON MAIN INVENTORY

DOT-Reported Pipe Inventories



CAST IRON ATTRITION RATE

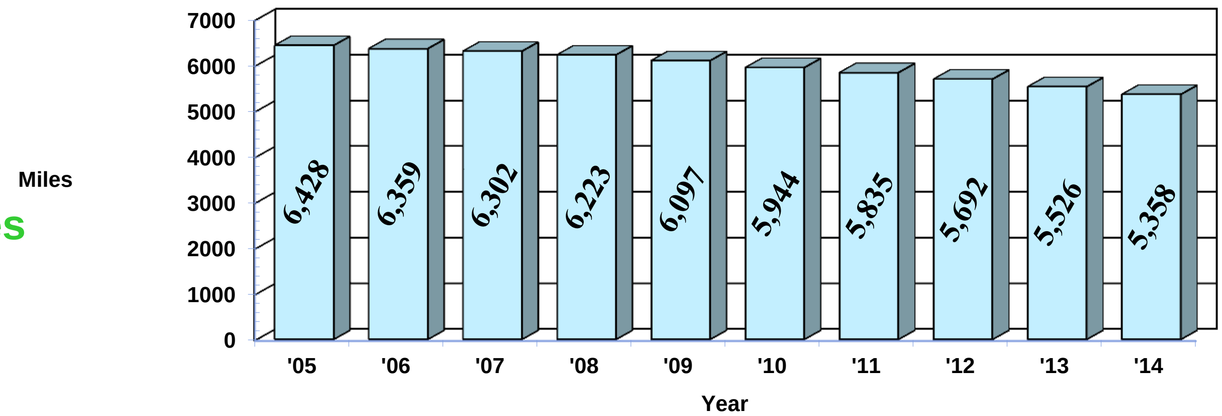
Avg 10-Yr Attrition Rate: 12.00 Miles/Year (1.37%)



2014 SYSTEM INTEGRITY REPORT

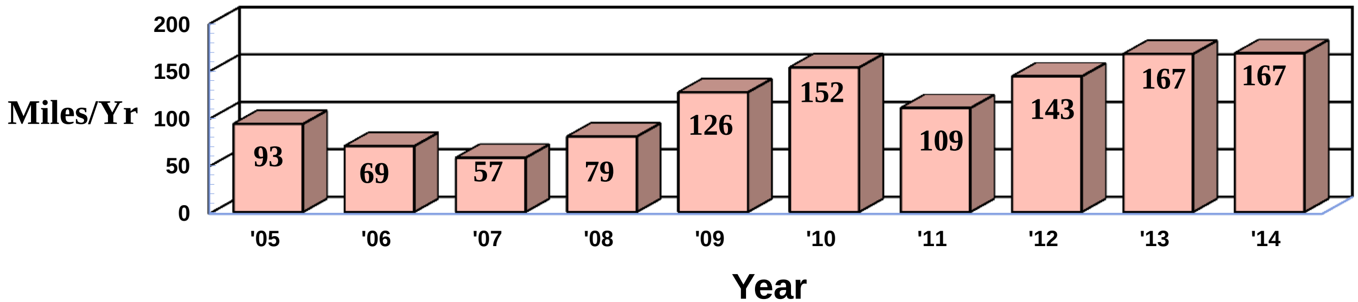
US-NGrid CAST IRON MAIN INVENTORY

DOT-Reported Pipe Inventories



CAST IRON ATTRITION RATE

Avg 10-Yr Attrition Rate: 116.30 Miles/Year (1.94%)



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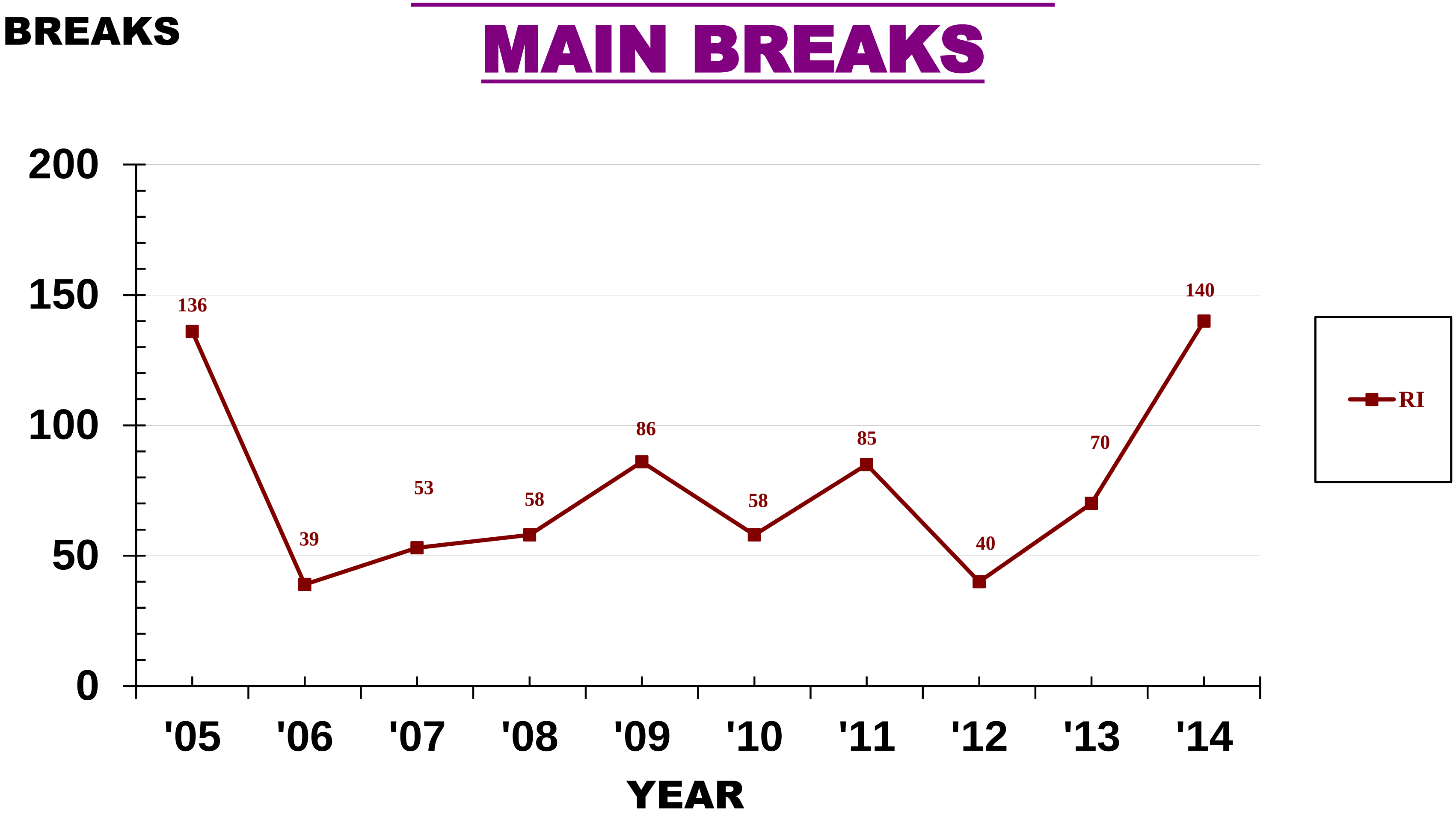
2014 SYSTEM INTEGRITY REPORT

TOTAL CAST IRON MAIN BREAKS



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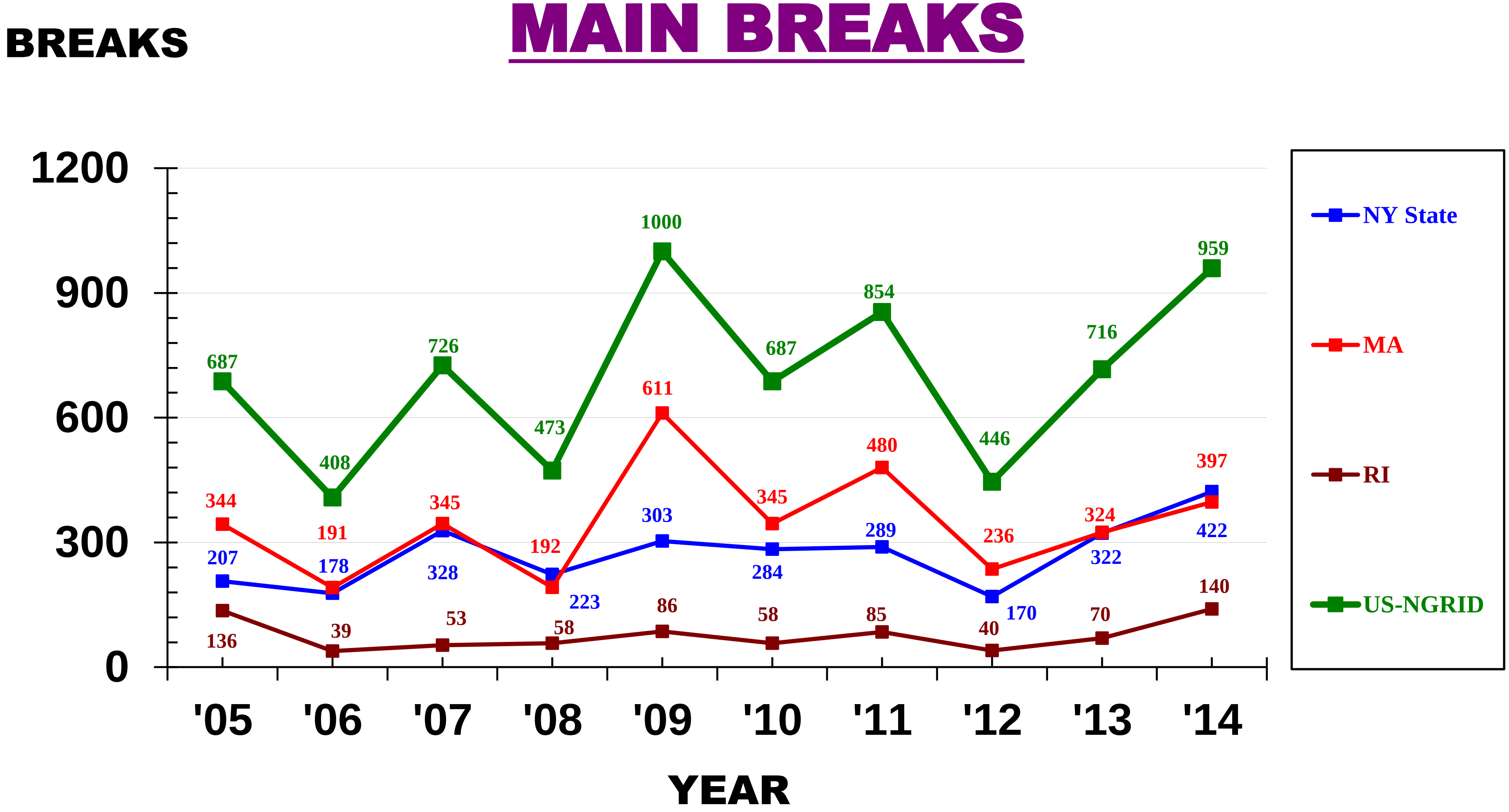
2014 SYSTEM INTEGRITY REPORT

TOTAL CAST IRON MAIN BREAKS



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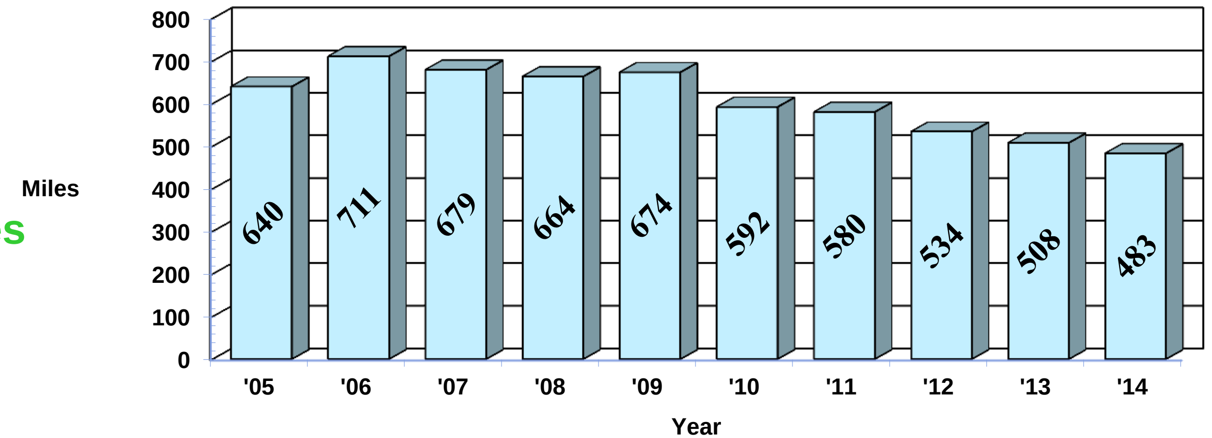
2014 SYSTEM INTEGRITY REPORT

A CLOSER LOOK AT STEEL MAINS

2014 SYSTEM INTEGRITY REPORT

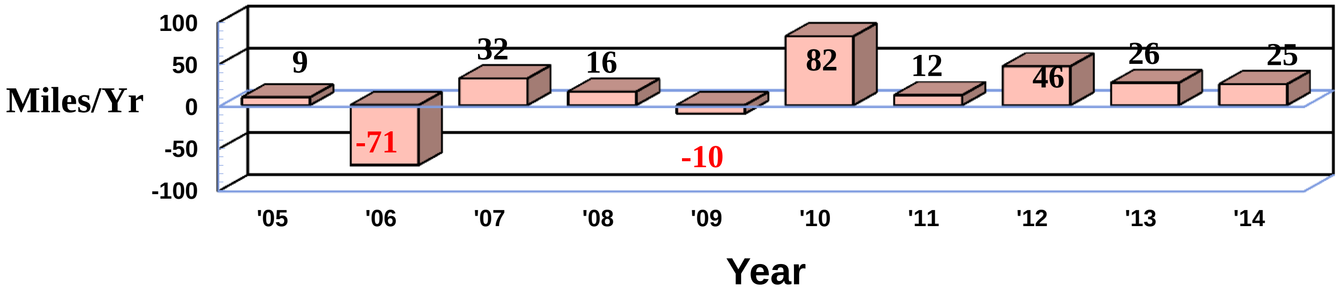
UNPROTECTED STEEL MAIN INVENTORY

DOT-Reported Pipe Inventories



UNPROTECTED STEEL ATTRITION RATE

Avg 10 -Yr Attrition Rate: 16.60 Miles/Year (3.06%)



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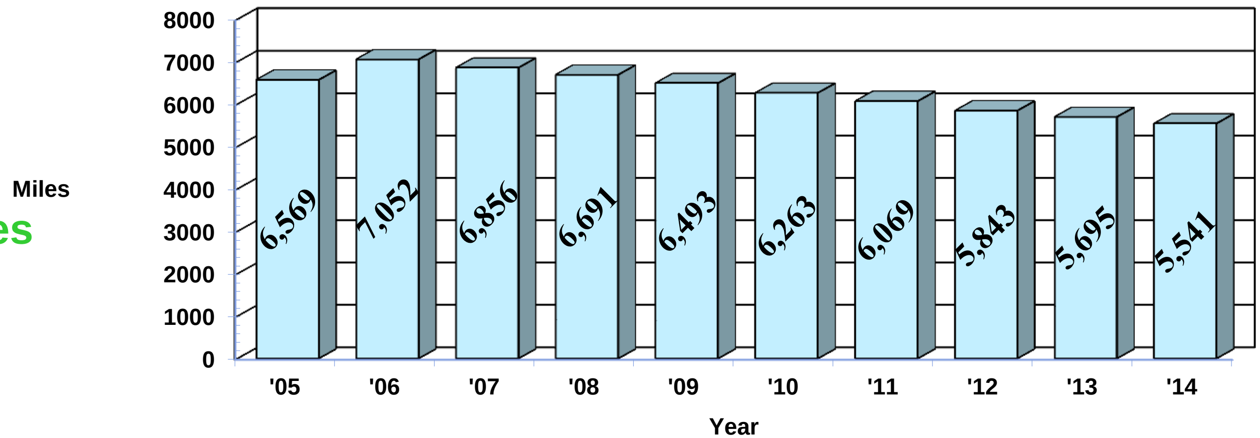
NOTE: In RI, Attrition is due to both replacement and "added" cathodic protection.

2014 SYSTEM INTEGRITY REPORT

US-NGrid

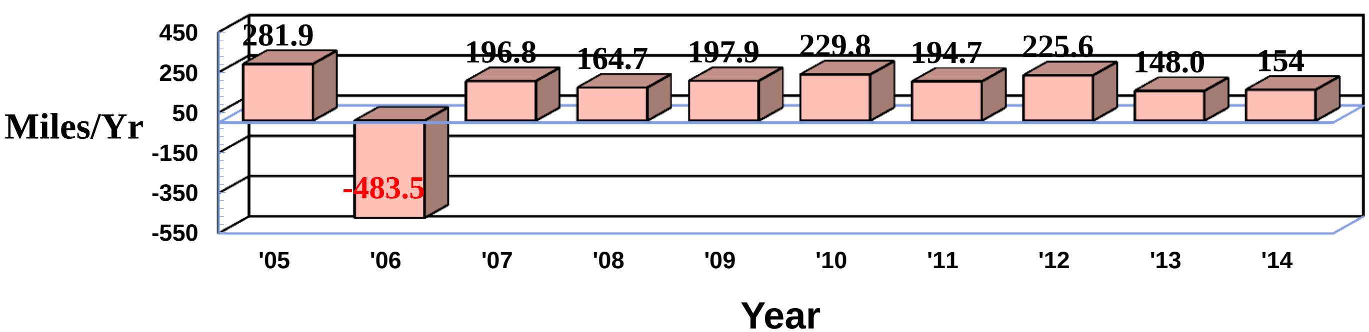
UNPROTECTED STEEL MAIN INVENTORY

DOT-Reported Pipe Inventories



UNPROTECTED STEEL ATTRITION RATE

Avg 10 -Yr Attrition Rate: 131.00 Miles/Year (2.15%)



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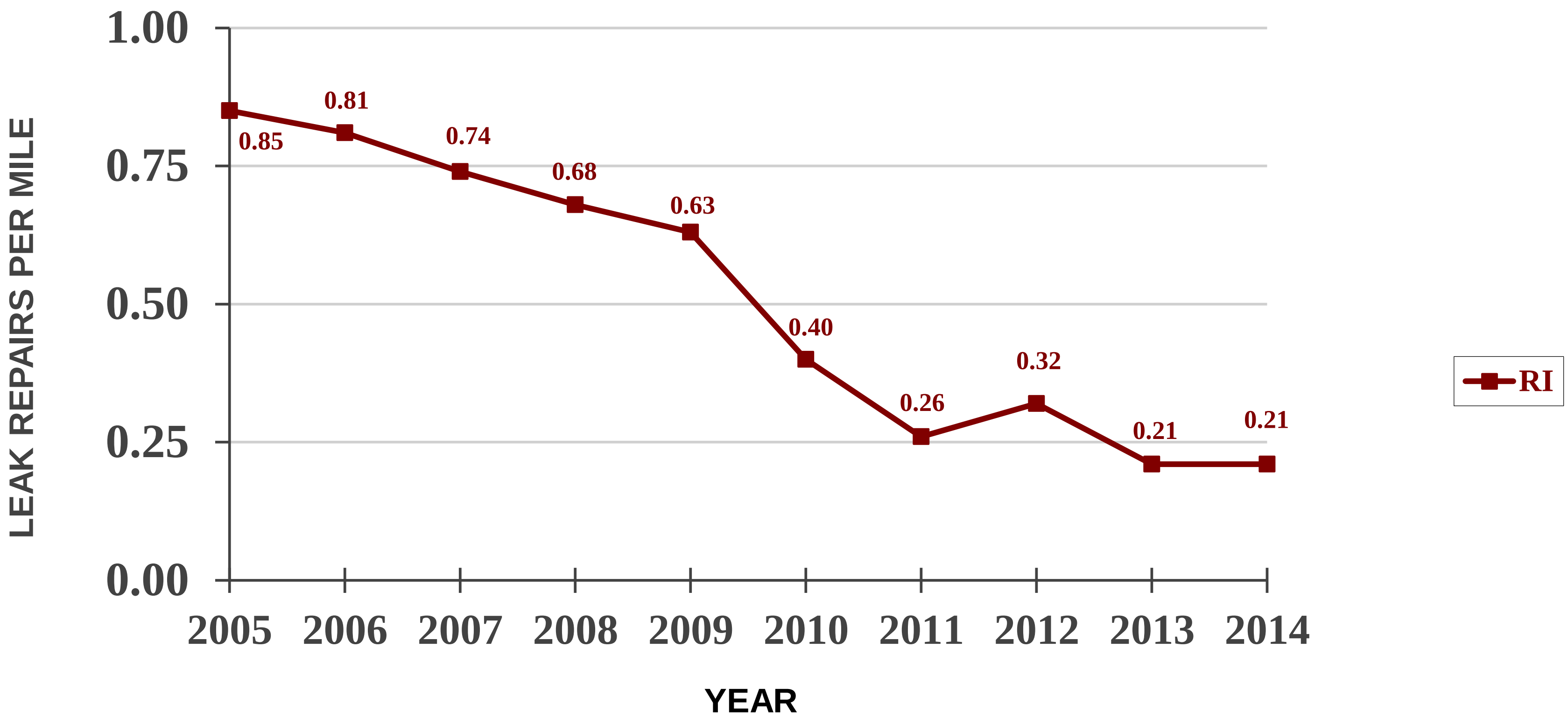
NOTE: In US-NGrid (MA & RI) Attrition is due to both replacement and “added” cathodic protection.

2014 SYSTEM INTEGRITY REPORT

MAIN CORROSION LEAK "RATES"

CORROSION Leak Repairs Per Mile of "TOTAL" Steel

INCLUDES **ALL** CORROSION LEAKS, REGARDLESS OF MAIN MATERIAL



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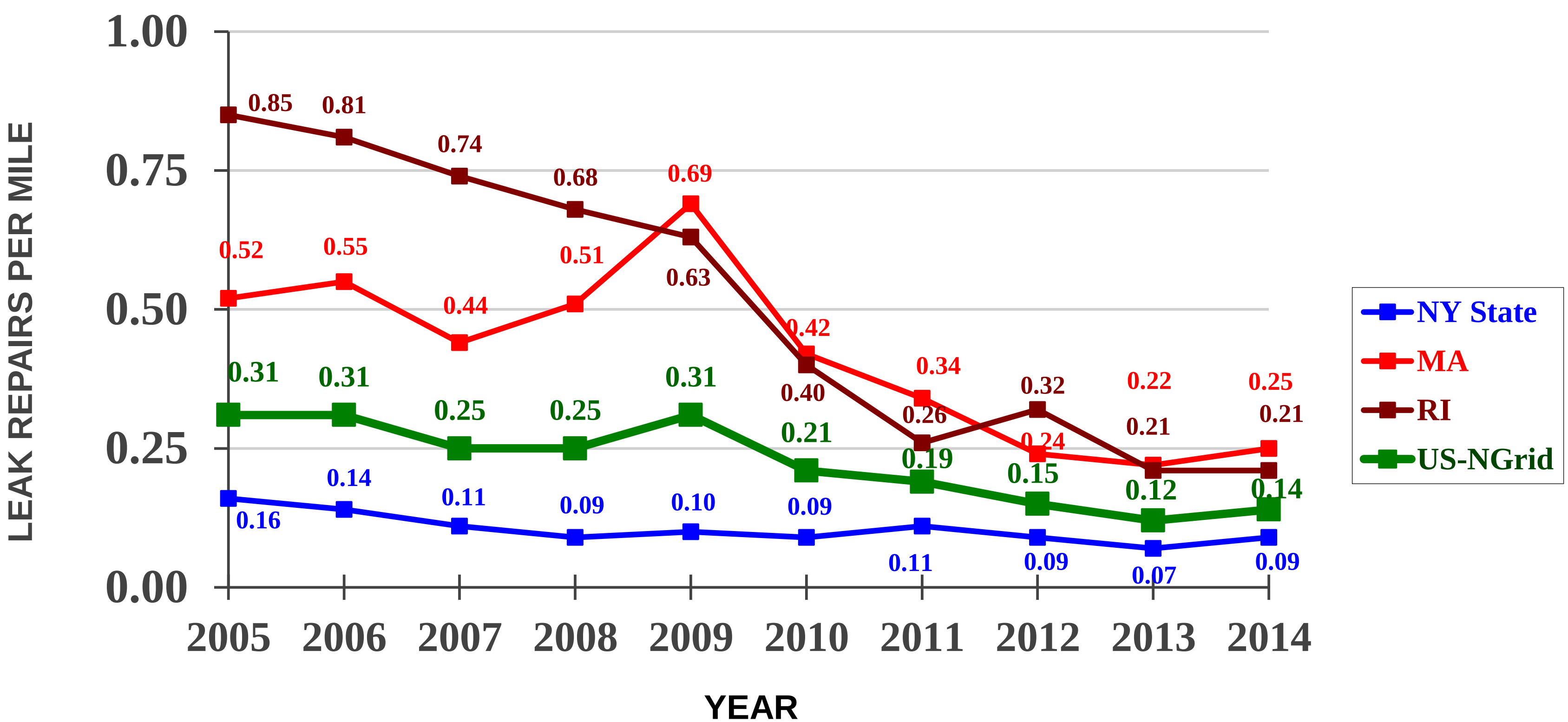
2014 SYSTEM INTEGRITY REPORT

MAIN CORROSION LEAK "RATES"

CORROSION Leak Repairs Per Mile of "TOTAL" Steel

INCLUDES **ALL** CORROSION LEAKS, REGARDLESS OF MAIN MATERIAL



SERVICE INVENTORY ANALYSIS

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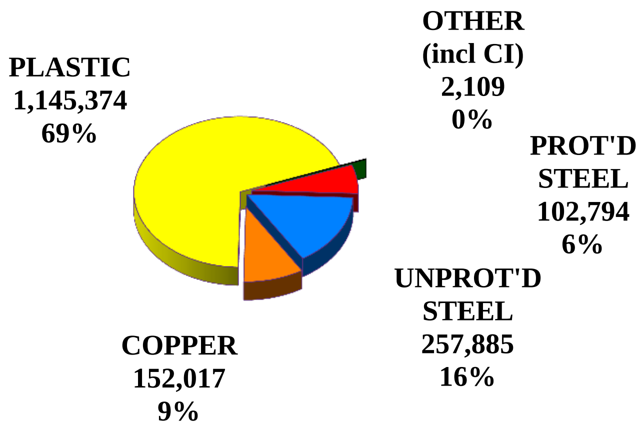
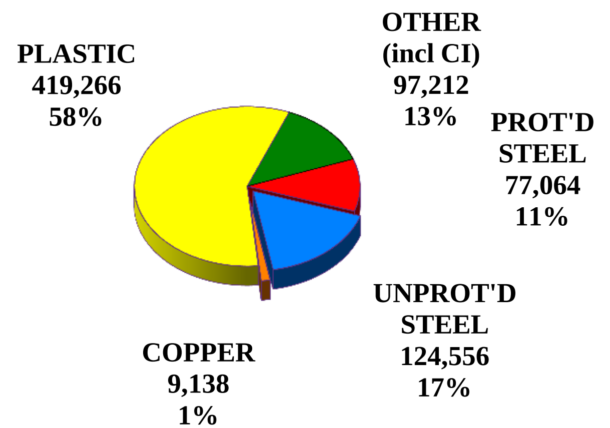
2014 SYSTEM INTEGRITY REPORT
SERVICE INVENTORY

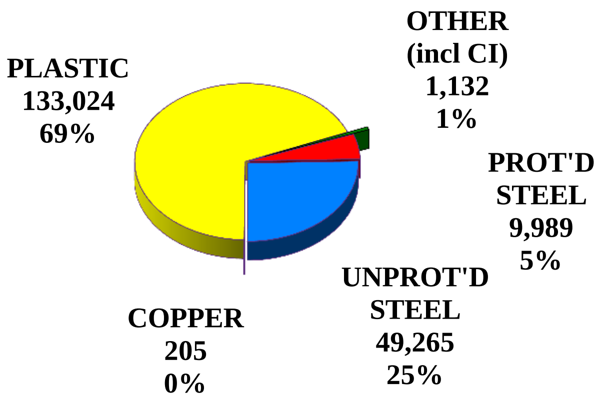
NY State 1,660,179 SERVICES



MA 727,236 SERVICES

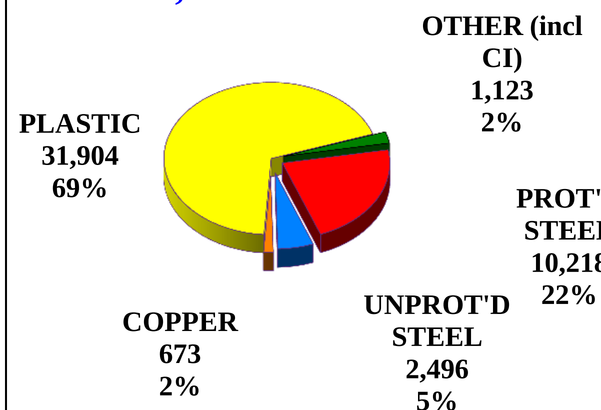


RI 193,615 SERVICES



2013 PHMSA Average

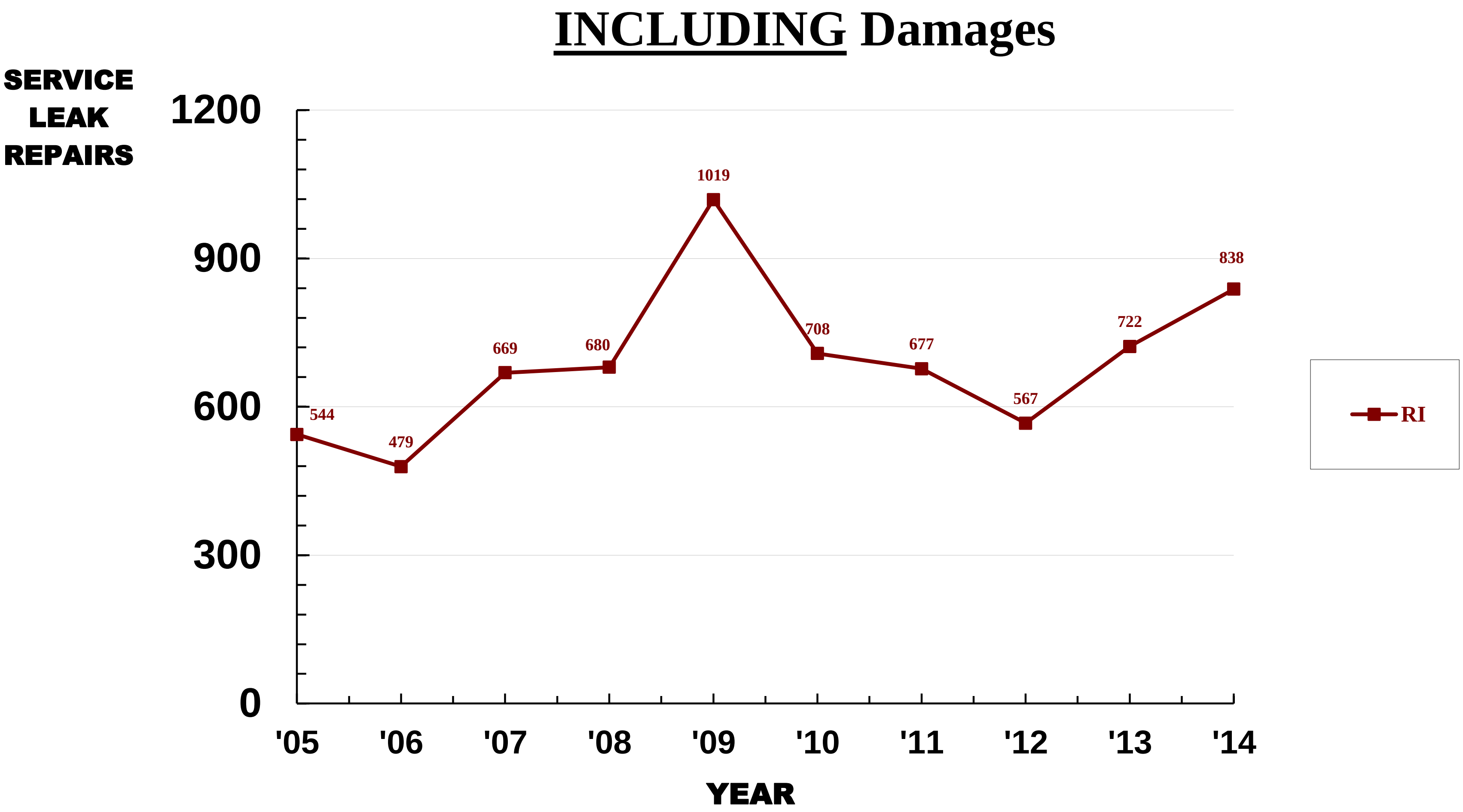
46,414 SERVICES



SERVICE LEAK REPAIR ANALYSIS

2014 SYSTEM INTEGRITY REPORT

TOTAL SERVICE LEAK REPAIRS



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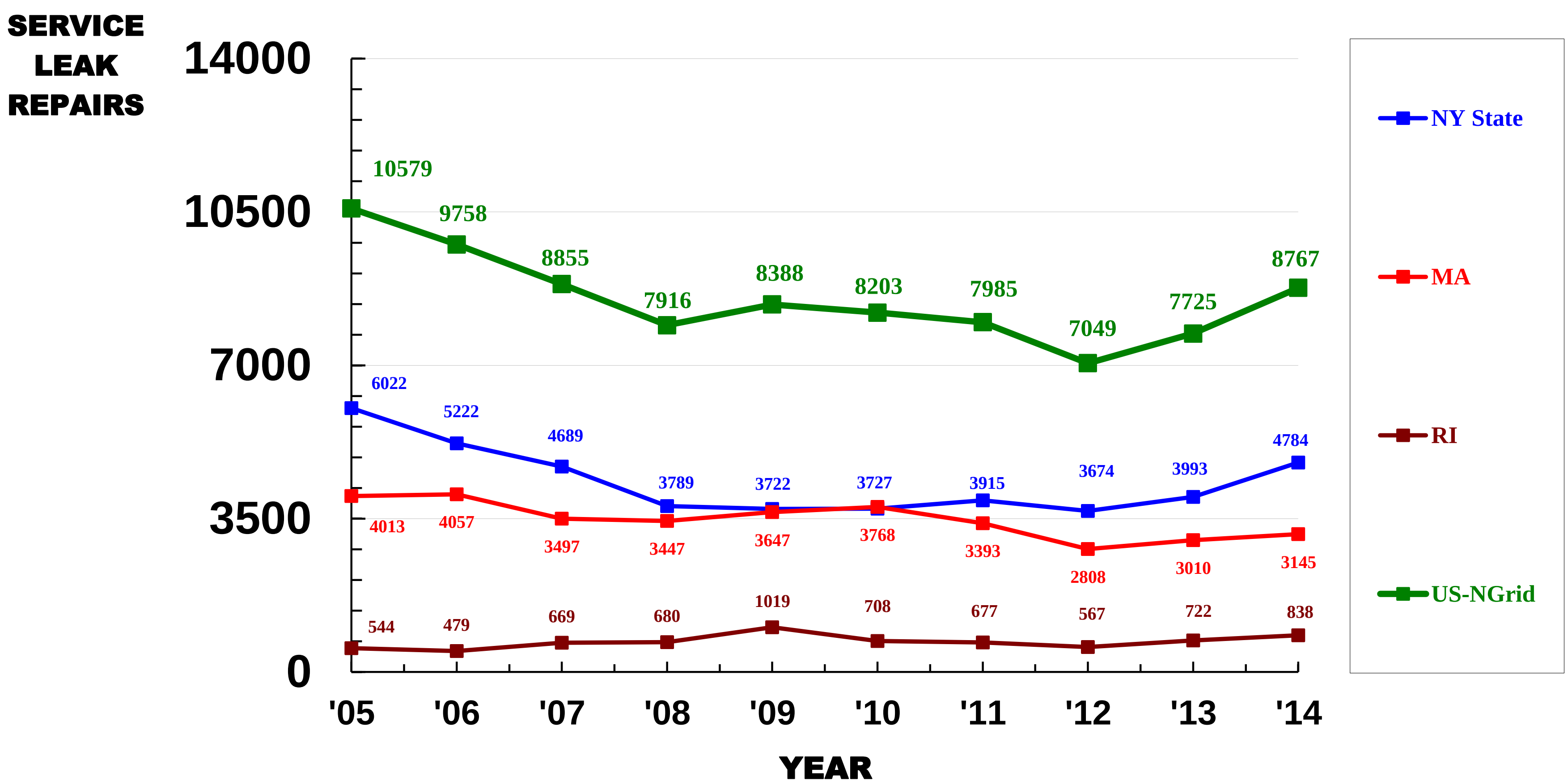
2014 SYSTEM INTEGRITY REPORT

TOTAL SERVICE LEAK REPAIRS

INCLUDING Damages



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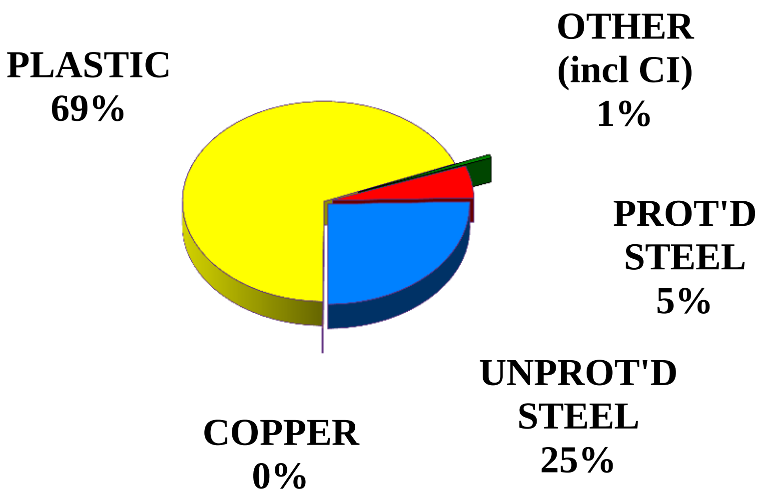
2014 SYSTEM INTEGRITY REPORT

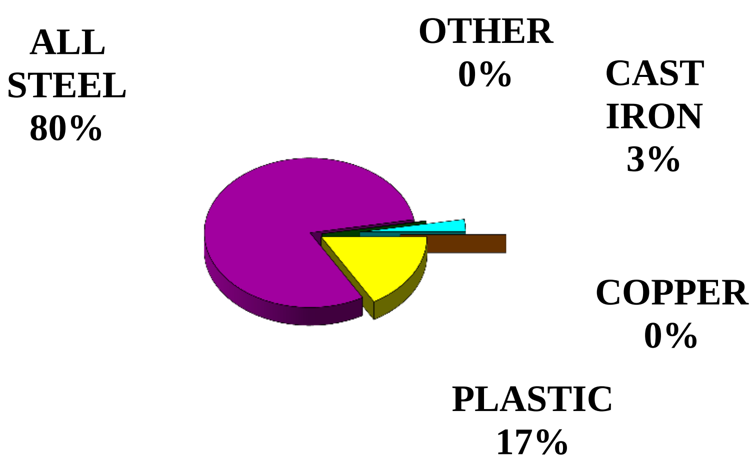
2014 TOTAL SERVICE LEAK REPAIRS

INCLUDING Damages

TOTAL SERVICE INVENTORY
BY MATERIAL
193,615 SERVICES



TOTAL SERVICE LEAK REPAIRS
BY MATERIAL
850 LEAKS



IMPORTANT: *Service Repairs are identified by the service material. This is not necessarily the material that leaked. For example - a leak caused by corrosion of a steel valve or fitting on a plastic service is shown as a plastic service leak.*

2014 SYSTEM INTEGRITY REPORT

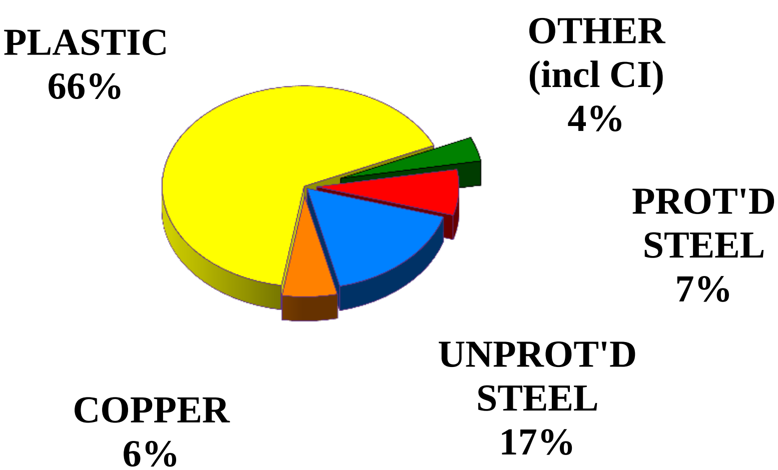
2014 TOTAL SERVICE LEAK REPAIRS

US-NGrid

INCLUDING Damages

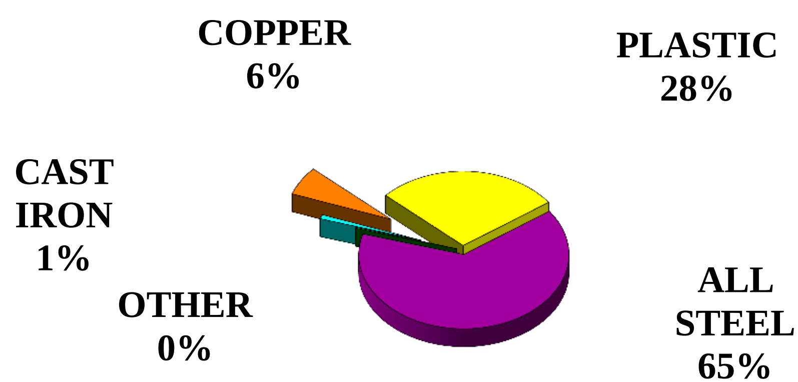
TOTAL SERVICE INVENTORY
BY MATERIAL

2,581,030 SERVICES



TOTAL SERVICE LEAK REPAIRS
BY MATERIAL

8,779 LEAKS

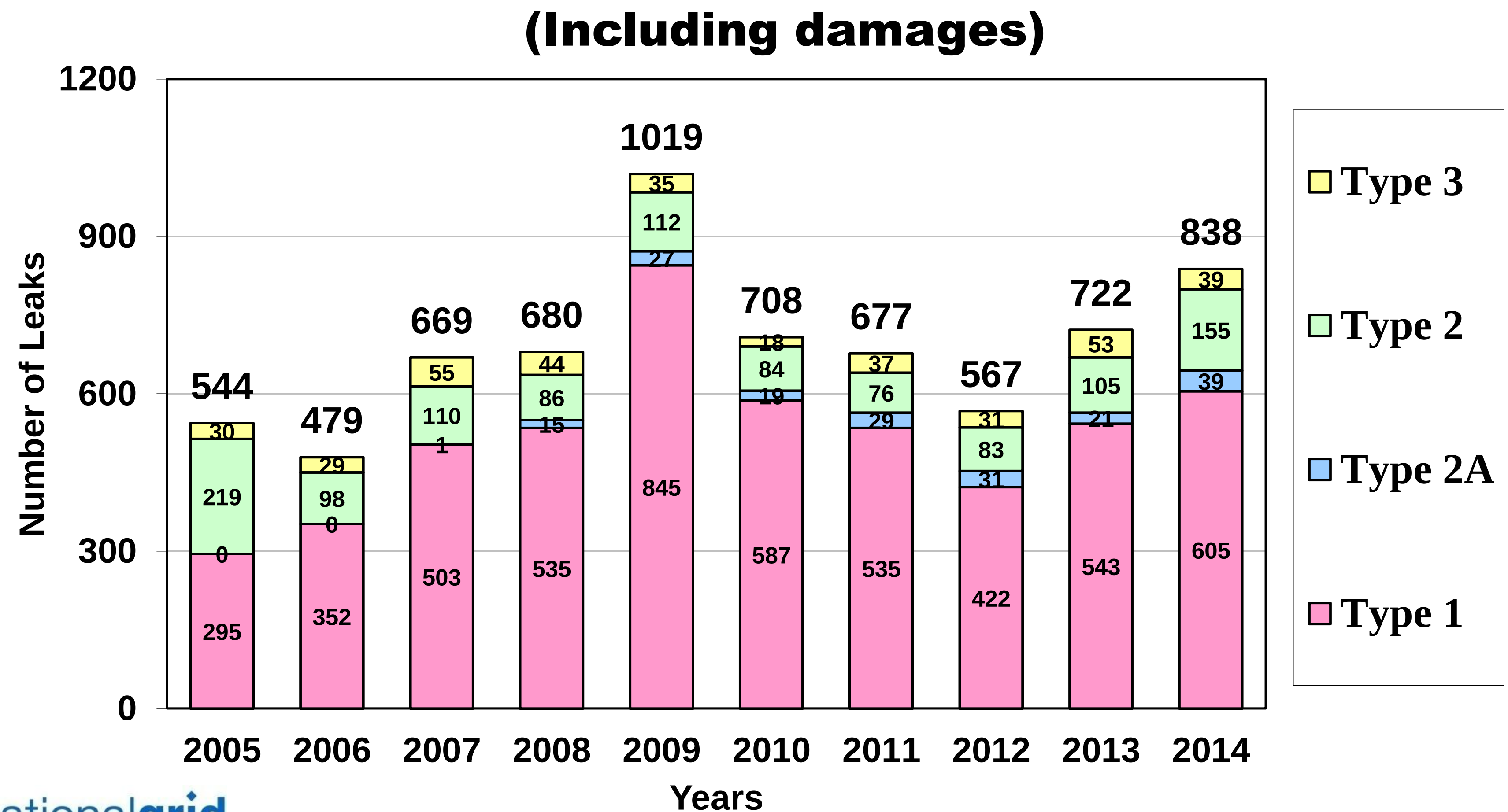


IMPORTANT: *Service Repairs are identified by the service material. This is not necessarily the material that leaked. For example - a leak caused by corrosion of a steel valve or fitting on a plastic service is shown as a plastic service leak.*

2014 SYSTEM INTEGRITY REPORT

LEAKS REPAIRED By REPAIRED Type

SERVICE



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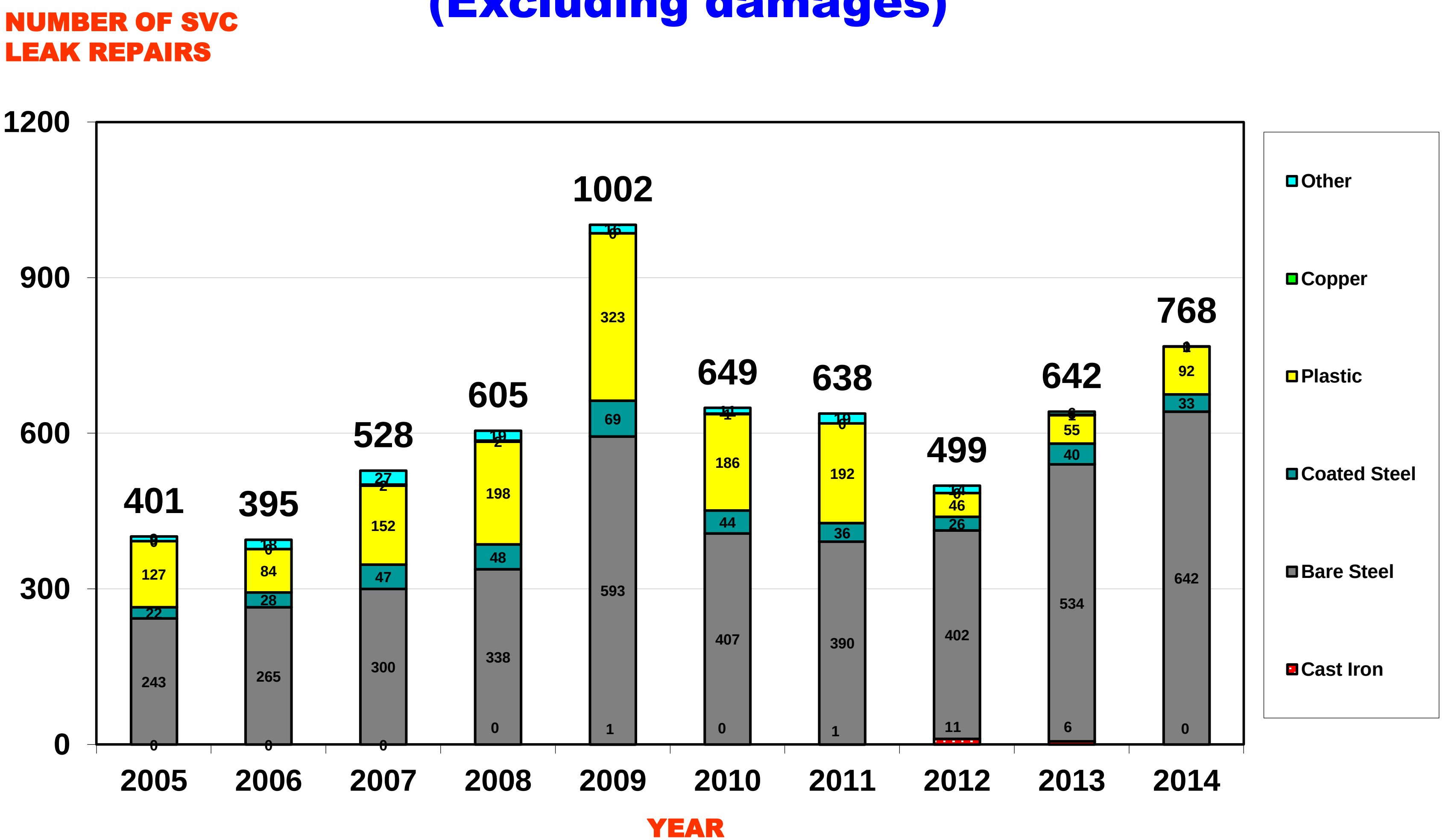
2014 SYSTEM INTEGRITY REPORT

2005 -2014 SERVICE LEAK REPAIRS

All Service Leak Repairs by Material
(Excluding damages)



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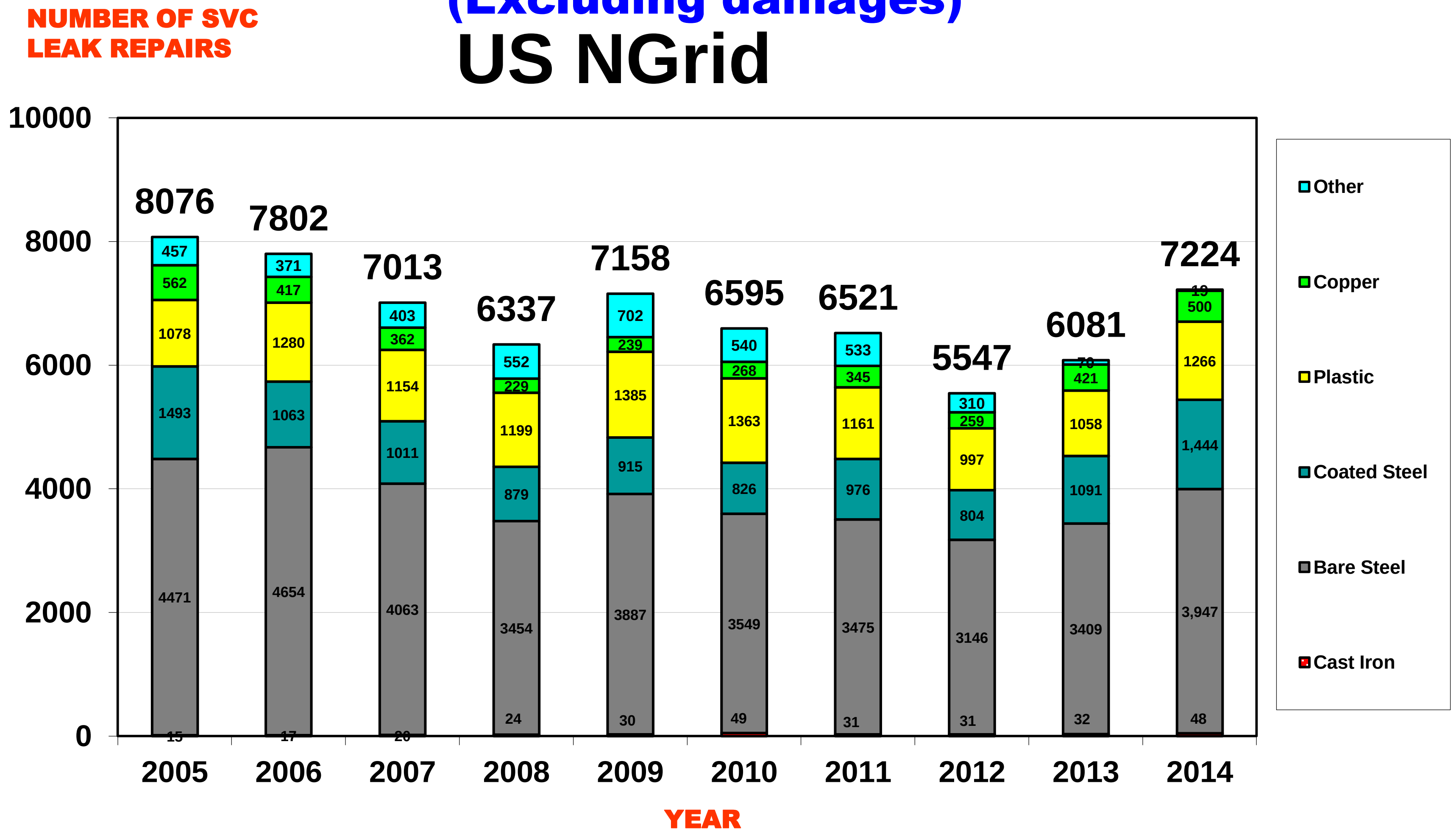
2014 SYSTEM INTEGRITY REPORT

2005 -2014 SERVICE LEAK REPAIRS

All Service Leak Repairs by Material (Excluding damages)



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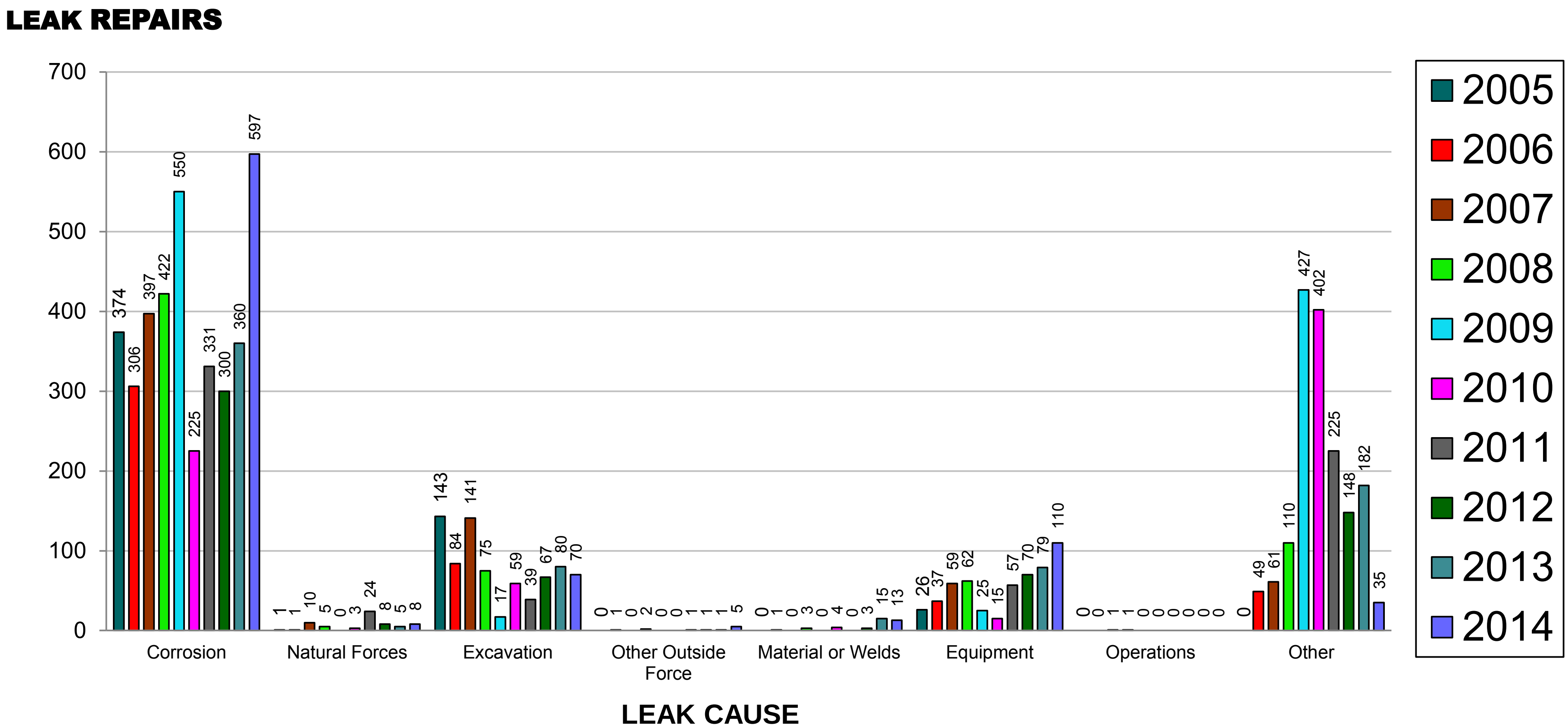
2014 SYSTEM INTEGRITY REPORT

SERVICE LEAKS REPAIRED

COMPARISON BY LEAK CAUSES

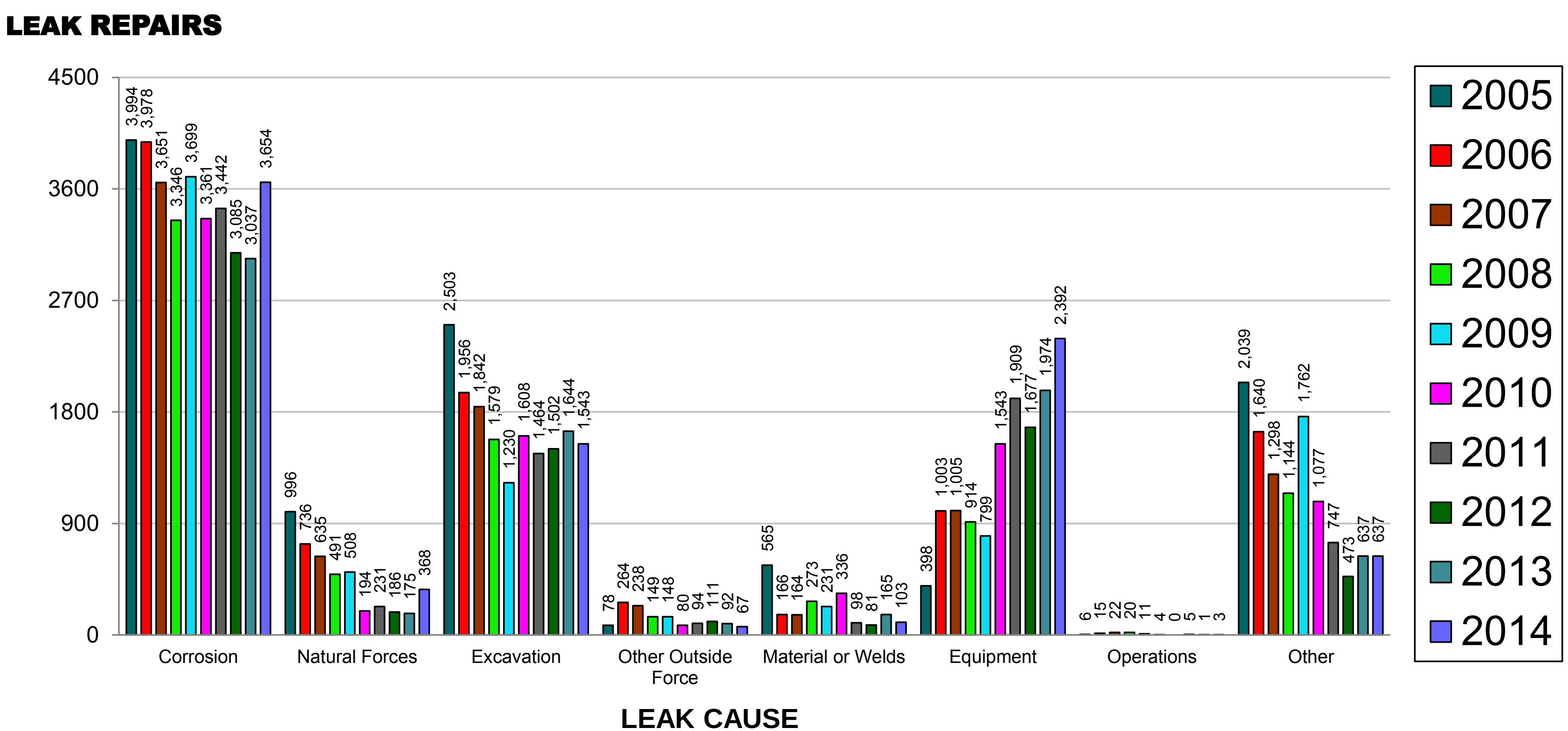


2014 SYSTEM INTEGRITY REPORT

NGRID

SERVICE LEAKS REPAIRED

COMPARISON BY LEAK CAUSES



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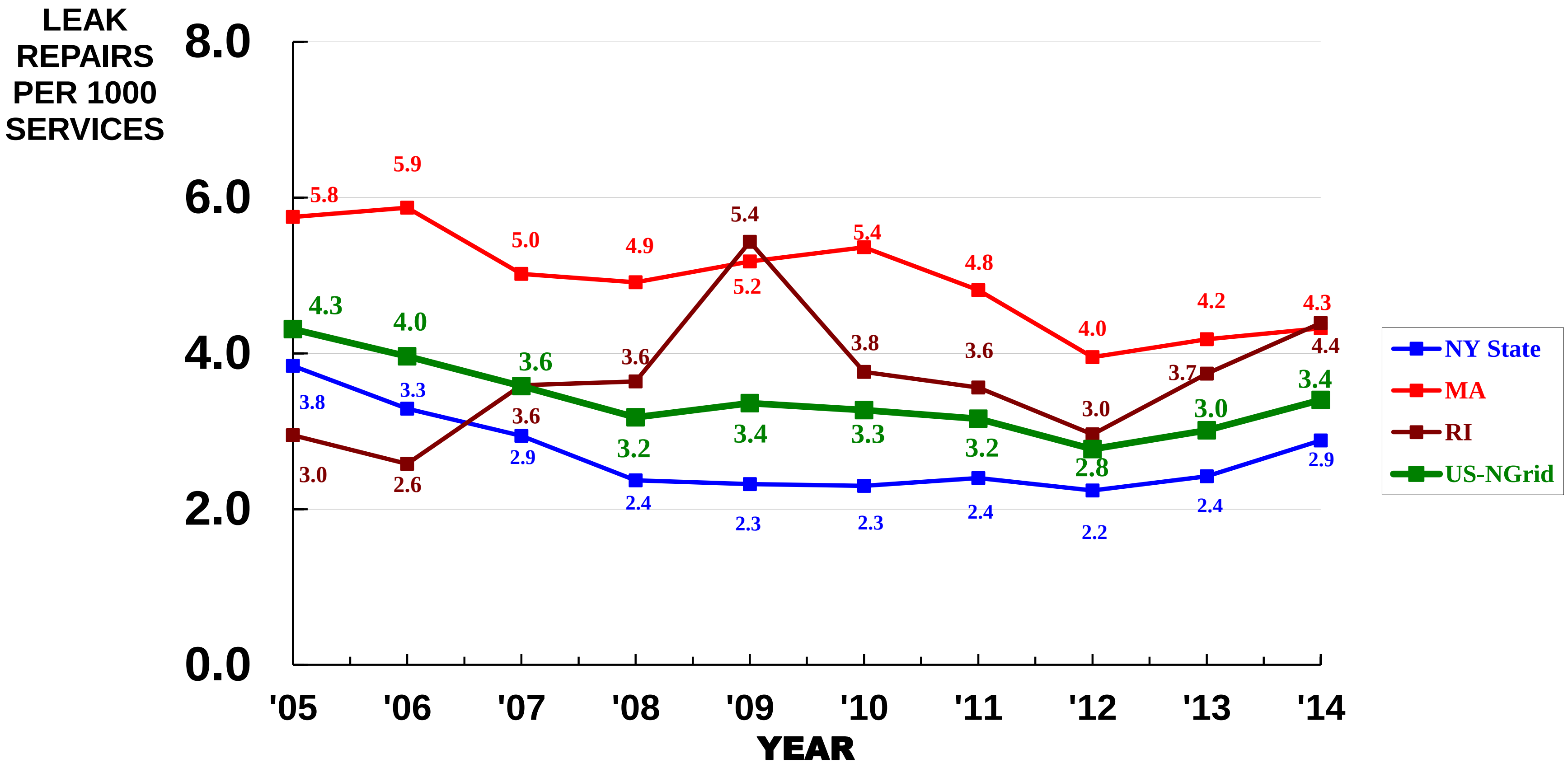
2014 SYSTEM INTEGRITY REPORT

TOTAL SERVICE LEAK "RATES"

INCLUDING Damages



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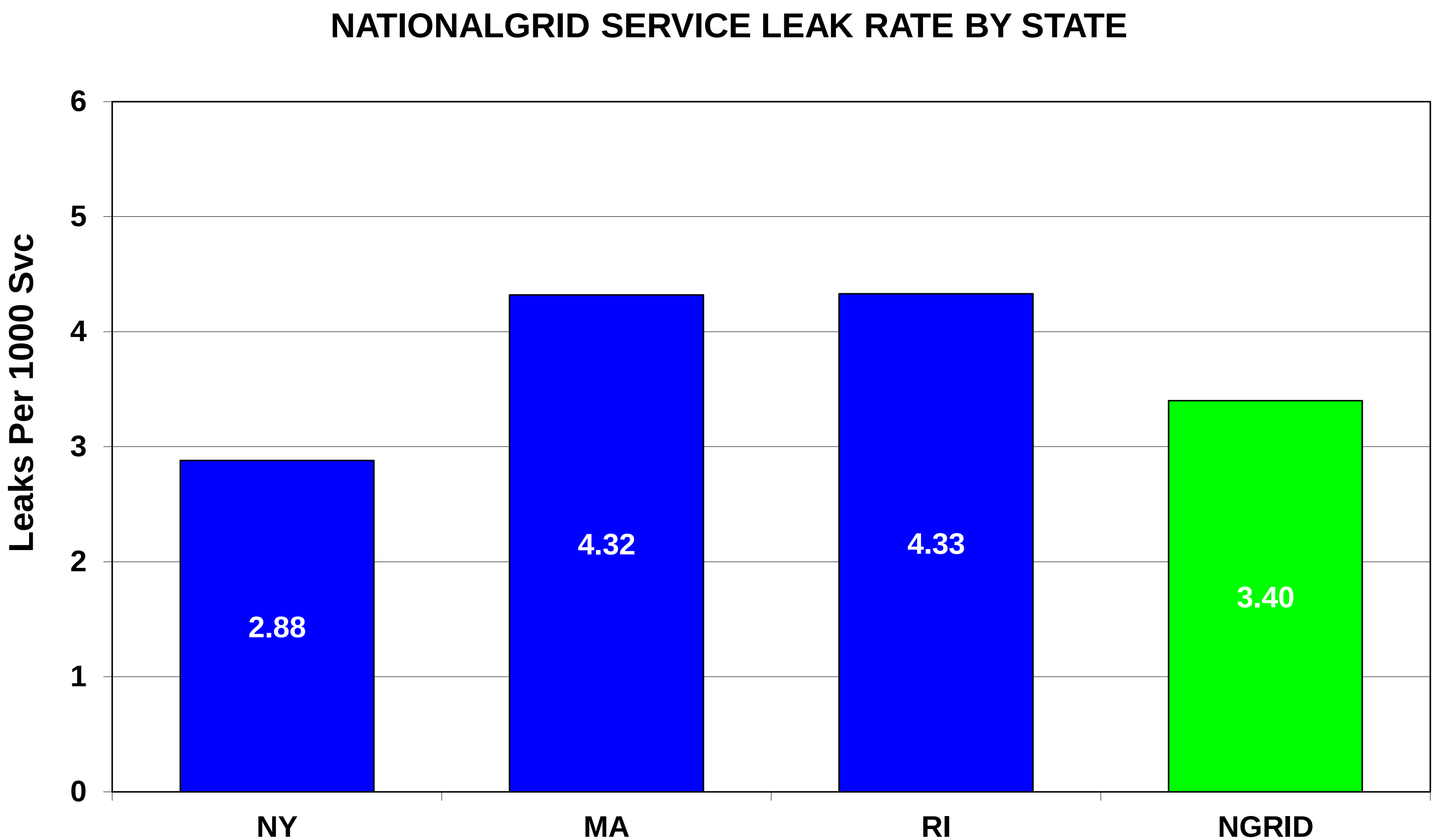
2014 SYSTEM INTEGRITY REPORT

2014 SERVICE LEAK "RATES"

Total Service Leak Repairs (incl. damages) / 1,000 Total Services



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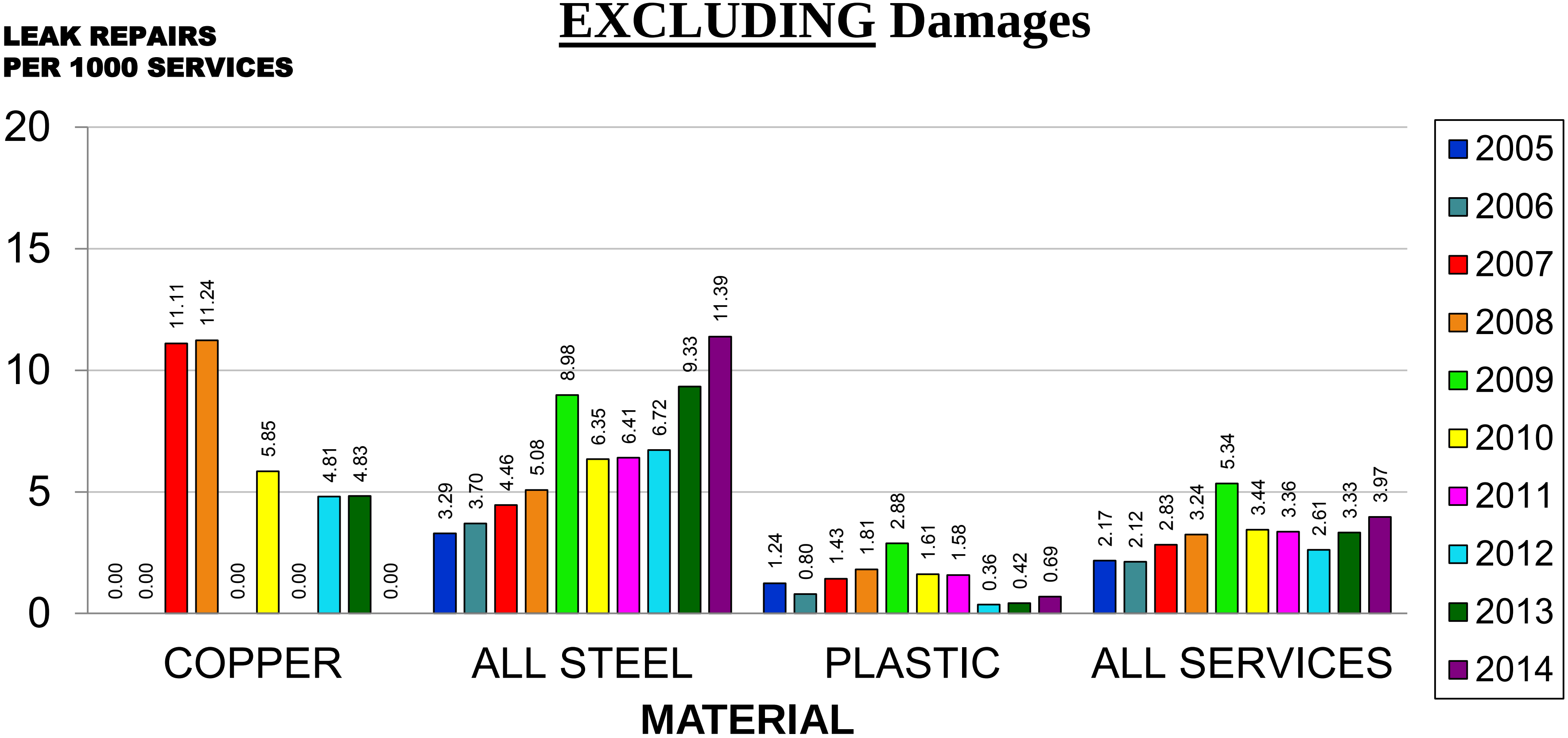
2014 SYSTEM INTEGRITY REPORT

TOTAL SERVICE LEAK "RATES"

COMPARISON BY MATERIAL

EXCLUDING Damages



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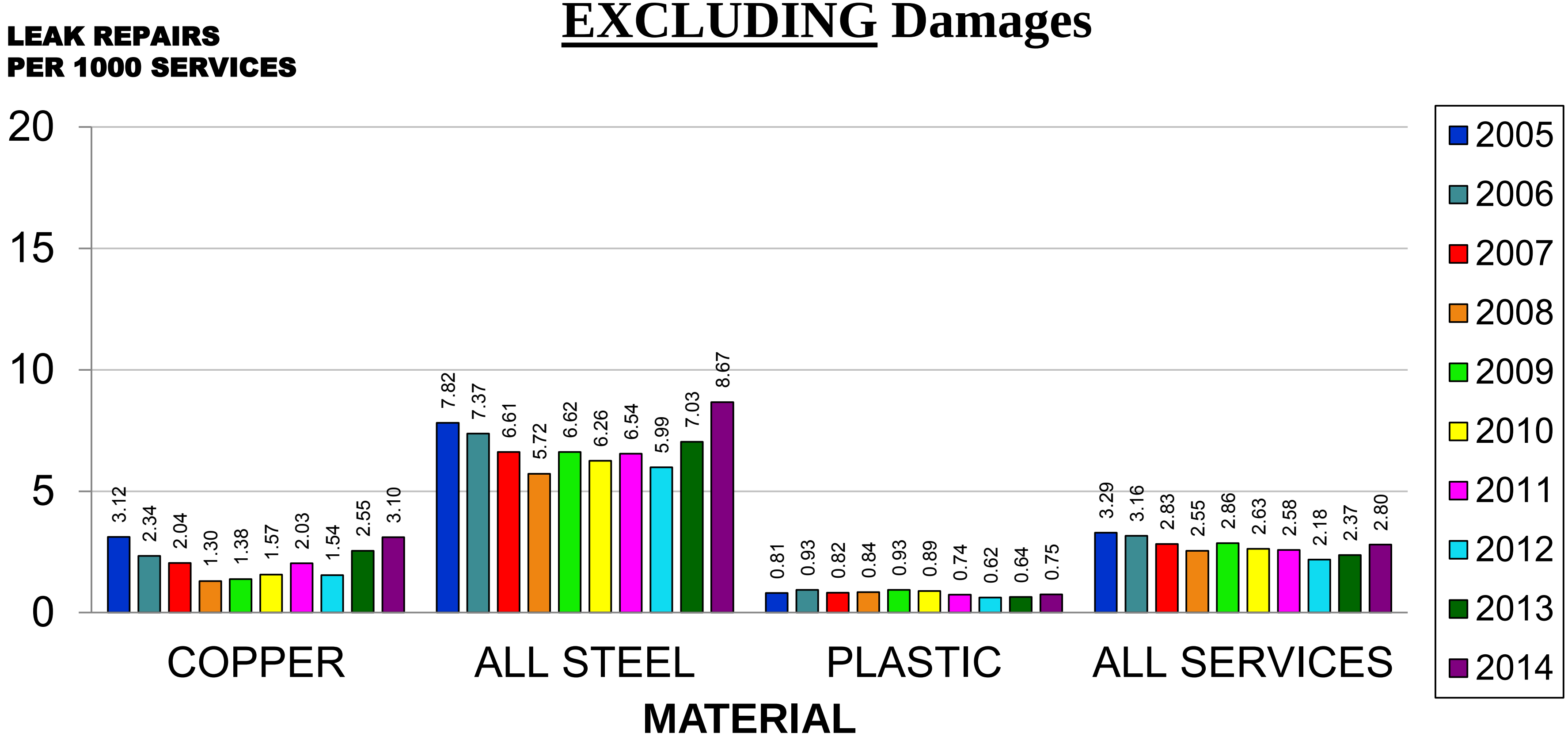
2014 SYSTEM INTEGRITY REPORT

US-NGrid TOTAL SERVICE LEAK "RATES"

COMPARISON BY MATERIAL

EXCLUDING Damages



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2014 SYSTEM INTEGRITY REPORT

NATIONAL GRID-US
2014 GAS DISTRIBUTION
SYSTEM STATISTICS

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2014 SYSTEM INTEGRITY REPORT

2014 GAS DISTRIBUTION SYSTEM STATISTICS

STATE	LEGACY	2014 PIPELINE / CUSTOMER / SENDOUT STATISTICS								
		Miles of Main	# of Services	Avg Service Length (ft/svc)	Miles of Services	TOTAL Distribution Pipeline	Residential Customers	Commercial and Industrial Customers	TOTAL Customers	Sendout (MDT)
	NYC	4,134	568,913	45	4,849	8,983	1,155,286	70,296	1,225,582	174,246
	LI	7,931	535,580	65	6,593	14,524	515,408	59,661	575,069	104,622
	UPSTATE	8,643	555,686	73	7,662	16,305	556,507	46,039	602,546	136,368
ALL NEW YORK STATE		***20,708***	***1,660,179***	***61***	***19,104***	***39,812***	***2,227,201***	***175,996***	***2,403,197***	***415,236***
	BOSTON	6,342	495,167	46	4,333	10,675	579,026	52,559	631,585	121,354
	ESSEX	863	43,215	78	641	1,504	47,683	4,952	52,635	7,490
	CAPE	2,462	113,534	76	1,623	4,085	102,487	9,509	111,996	12,376
	LOWELL	1,396	75,320	72	1,030	2,426	82,795	9,281	92,076	15,732
ALL MASSACHUSETTS		***11,064***	***727,236***	***55***	***7,627***	***18,691***	***811,991***	***76,301***	***888,292***	***156,952***
RHODE ISLAND		3,188	193,615	66	2,423	5,611	236,671	24,599	261,270	43,381
TOTAL NGRID-US		**34,960**	**2,581,030**	**60**	**29,154**	**64,114**	**3,275,863**	**276,896**	**3,552,759**	**615,569**

CAUTION:

This chart is for comparative-illustrative purposes only. The data is not audited & many assumption have been made.

Inventory data is from the CY 2014 Annual DOT/PHMSA Distribution Reports.
Customer data is from the Gas Customer Data base, Active Gas Accounts as of End of January 2015.
Sendout data is from the sendouts for the 12-month period ending 6/30/14, used to calculate UFG for the DOT Reports.

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2014 SYSTEM INTEGRITY REPORT

2014 GAS DISTRIBUTION SYSTEM STATISTICS

STATE	LEGACY	PERCENTAGES OF NGRID-US SYSTEM					ASSET RATIOS			GAS CONSUMPTION RATIOS			
		% of Main	% of Services	% of Distribution Pipeline	% of Customers	% of Sendout	Service Density (Svcs / Mile Main)	Meter Density (Customers / Service)	Customer Density (Customers / Mile Total Pipeline)	Main Capacities Used (Sendout MDT / Mile Main)	Service Capacities Used (Sendout MDT/ Service)	Pipeline Capacities Used (Sendout MDT / Mile Total Pipe)	Customer Usage (Sendout MDT / Customer)
	NYC	11.8%	22.0%	14.0%	34.5%	28.3%	138	2.2	136.4	42.15	0.31	19.40	0.142
	LI	22.7%	20.8%	22.7%	16.2%	17.0%	68	1.1	39.6	13.19	0.20	7.20	0.182
	UPSTATE	24.7%	21.5%	25.4%	17.0%	22.2%	64	1.1	37.0	15.78	0.25	8.36	0.226
ALL NEW YORK STATE		***59.2%***	***64.3%***	***62.1%***	***67.6%***	***67.5%***	***80***	***1.4***	***60.4***	***20.05***	***0.25***	***10.43***	***0.173***
	BOSTON	18.1%	19.2%	16.7%	17.8%	19.7%	78	1.3	59.2	19.13	0.25	11.37	0.192
	ESSEX	2.5%	1.7%	2.3%	1.5%	1.2%	50	1.2	35.0	8.68	0.17	4.98	0.142
	CAPE	7.0%	4.4%	6.4%	3.2%	2.0%	46	1.0	27.4	5.03	0.11	3.03	0.111
	LOWELL	4.0%	2.9%	3.8%	2.6%	2.6%	54	1.2	37.9	11.27	0.21	6.48	0.171
ALL MASSACHUSETTS		***31.6%***	***28.2%***	***29.2%***	***25.0%***	***25.5%***	***66***	***1.2***	***47.5***	***14.19***	***0.22***	***8.40***	***0.177***
RHODE ISLAND		9.1%	7.5%	8.8%	7.4%	7.0%	61	1.3	46.6	13.61	0.22	7.73	0.166
TOTAL NGRID-US		**100%**	**100%**	**100%**	**100%**	**100%**	**74**	**1.4**	**55.4**	**17.61**	**0.24**	**9.60**	**0.173**

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2014 SYSTEM INTEGRITY REPORT

SEPARATE LEAK-PRONE PIPE ANALYSIS

STATE	LEGACY	2014 LEAK-PRONE PIPE INVENTORY						LEAK-PRONE PIPE %'s		
		Leak - Prone Main (miles)	% of TOTAL Main	Leak - Prone Services (#)	% of TOTAL Services	Miles of Leak - Prone Services	TOTAL Leak - Prone Pipe (in miles)	% of NG-US Leak - Prone Main (miles)	% of NG-US Leak - Prone Services (#)	% of NG-US TOTAL Leak - Prone Pipe
	NYC	1,900	46.0%	24,450	4.3%	208	2,108	16.8%	5.6%	12.8%
	LI	3,860	48.7%	104,003	19.4%	1,280	5,140	34.1%	23.9%	31.3%
	UPSTATE	757	8.8%	131,541	23.7%	1,814	2,571	6.7%	30.2%	15.7%
ALL NEW YORK STATE		***6,517***	***31.5%***	***259,994***	***15.7%***	***3,302***	***9,819***	***57.6%***	***59.7%***	***59.8%***
	BOSTON	3,135	49.4%	111,733	22.6%	978	4,113	27.7%	25.7%	25.0%
	ESSEX	101	11.7%	4,836	11.2%	72	173	0.9%	1.1%	1.1%
	CAPE	97	3.9%	4,092	3.6%	59	156	0.9%	0.9%	0.9%
	LOWELL	166	11.9%	5,424	7.2%	74	240	1.5%	1.2%	1.5%
ALL MASSACHUSETTS		***3,499***	***31.6%***	***126,085***	***17.3%***	***1,182***	***4,681***	***30.9%***	***29.0%***	***28.5%***
RHODE ISLAND		1,305	40.9%	49,439	25.5%	619	1,924	11.5%	11.4%	11.7%
TOTAL NGRID-US		**11,321**	**32.4%**	**435,518**	**16.9%**	**5,103**	**16,424**	**100%**	**100%**	**100%**

NOTES:

Leak-Prone Main includes Cast Iron/Wrought Iron, Unprotected Steel , Aldyl-A and Other Material.
Leak-Prone Service includes Cast Iron/Wrought Iron and Unprotected Steel.

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2014 SYSTEM INTEGRITY REPORT

LEAK AND REPAIR ANALYSIS

STATE	LEGACY	2014 LEAK DATA				LEAK RATE RATIOS					
		TOTAL Leak Receipts (Main & Service)	TOTAL Leak Repairs (Main & Service)	Year-End Workable Leak Backlog	TOTAL Repairs + Workable Leaks	TOTAL Leak Receipts / Mile TOTAL Pipe	TOTAL Leak Receipts / Mile Leak-Prone Pipe	TOTAL Leak Repairs / Mile TOTAL Pipe	TOTAL Leak Repairs / Mile Leak-Prone Pipe	Repairs + Workables / Mile TOTAL Pipe	Repairs + Workable / Mile Leak-Prone Pipe
	NYC	4,984	4,923	24	4,947	0.6	2.4	0.5	2.3	0.6	2.3
	LI	3,350	3,067	8	3,075	0.2	0.7	0.2	0.6	0.2	0.6
	UPSTATE	1,800	1,857	5	1,862	0.1	0.7	0.1	0.7	0.1	0.7
ALL NEW YORK STATE		***10,134***	***9,847***	***37***	***9,884***	***0.3***	***1.0***	***0.2***	***1.0***	***0.2***	***1.0***
	BOSTON	6,240	7,563	212	7,775	0.6	1.5	0.7	1.8	0.7	1.9
	ESSEX	294	280	-	280	0.2	1.7	0.2	1.6	0.2	1.6
	CAPE	390	496	-	496	0.1	2.5	0.1	3.2	0.1	3.2
	LOWELL	324	277	-	277	0.1	1.3	0.1	1.2	0.1	1.2
ALL MASSACHUSETTS		***7,248***	***8,616***	***212***	***8,828***	***0.4***	***1.5***	***0.5***	***1.8***	***0.5***	***1.9***
RHODE ISLAND		2,753	2,054	38	2,092	0.5	1.4	0.4	1.1	0.4	1.1
TOTAL NGRID-US		**20,135**	**20,517**	**287**	**20,804**	**0.3**	**1.2**	**0.3**	**1.2**	**0.3**	**1.3**

NOTES:

TOTAL Leak Receipts (Main & Service) data excludes Excavation Leaks.
TOTAL Leak Repairs (Main & Service) data includes Excavation Leaks.
TOTAL Leak Repairs (Main & Service) data excludes Above Ground Leaks.

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Overall Regional Gas Distribution Integrity Assessment Summary

2014 SYSTEM INTEGRITY REPORT

Overall Regional Distribution Integrity Assessment Summary

Distribution Engineering has reviewed all of the findings in the annual Trend-Based Distribution System Integrity Analysis (*System Integrity Report*) in accordance with our Distribution Integrity Management Plan(DIMP), and finds leak receipts and repairs went up in 2014. This changes are believed to be the result of some recent incidents which increased public awareness, two consecutive years of severe weather condition and LPP deteriorating performance. National Grid has accelerated LPP replacement program to address this issue. There are no immediate causes for concern that would warrant changes to DIMP. Some anomalies were found and either explained as non-systemic or set up for continued research and/or monitoring. These will be explained in notes to this report. It is noted here that CI main break rates increased in every region and this is believed to be weather dependent.

Below is a summary of the individual key integrity measure results for the eight (8) federal (PHMSA) filing entities that constitute National Grid-US.

NATIONAL GRID

2014 System Integrity Report Summary

REGIONS / ITEMS	KEDNY	KEDLI	NMPC	BGC	EGC	CCC	CLW	RI
• Leak Receipts	Increase	Decrease	Increase	Increase	Slight Increase	Slight Increase	Slight Increase	Increase
• Workable Leak Backlog	Slight Increase	Decrease	Slight Increase	Increase	Decrease	Decrease	Decrease	Slight Increase
• LPP Main and Service Inventories	Decrease	Decrease	Decrease	Decrease	Decrease	Decrease	Decrease	Decrease
• Overall Main Leak Rate	Increase	Slight Increase	Slight Increase	Slight Increase	Slight Increase	Decrease	Slight Increase	Slight Increase
• Cast Iron Main Break Rate	No Change	Increase	Increase	Increase	No Change	No CI	Increase	Increase
• Steel Main Corrosion Leak Rate	Increase	Increase	No Change	Increase	Increase	Decrease	No Change	No Change
• Service Leak Rate	Increase	Slight Increase	Increase	Increase	Increase	Increase	Increase	Increase

Increase Slight Increase No Change Decrease