Analysis of Data from Required Reporting of Mechanical Fitting Failures that result in a Hazardous Leak (§192.1009)

This report describes how the Pipeline and Hazardous Materials Safety Administration (PHMSA) will process and analyze data on mechanical fitting failures that result in an incident, collected from operators of gas distribution pipelines as required in §192.1009. This report also includes preliminary analytical results.

Contents

Mechanical Fitting Failure Reporting Requirements

PHMSA requires operators to submit Mechanical Fitting Failure Reports (MFFR) for the previous calendar year by March 15th of the next year. Operators must submit their reports electronically through the PHMSA Pipeline Data Mart (PDM) system. This data is available to PHMSA personnel to download and analyze. This report describes how PHMSA will process and analyze data from operators of gas distribution pipelines for mechanical joint failures that resulted in a hazardous leak as required in §192.1009. The reporting requirements of §192.1009 are:

> *§192.1009 What must an operator report when compression couplings fail?*
> *(a) Except as provided in paragraph (b) of this section, each operator of a distribution pipeline system must submit a report on each mechanical fitting failure, excluding any failure that results only in a nonhazardous leak, on a Department of Transportation Form PHMSA F-7100.1-2. The report(s) must be submitted in accordance with § 191.12.*
> *(b) The mechanical fitting failure reporting requirements in paragraph (a) of this section do not apply to the following:*
> *(1) Master meter operators;*
> *(2) Small LPG operator as defined in § 192.1001; or*
> *(3) LNG facilities.*

The MFFR Form collects information on the particulars of natural gas pipeline leaks involving mechanical fittings so safety concerns can be identified and addressed appropriately. Collected information includes the type of mechanical fitting involved, fitting material, manufacturer, year manufactured, year installed, the two materials being joined, leak location, and apparent cause of leak.

Overview

The following flowcharts and process descriptions describe PHMSA's process for analyzing MFFR data along with expected outputs. PHMSA's intent of the analysis is to identify trends, and to that purpose, the following outputs are expected to be produced. These outputs are discussed in greater detail in this document.

- General information from MFFR reports (e.g., number of reports, number of operators)
- Information pertaining to Material Type of the Fittings
- Information pertaining to Leak Cause
- Information pertaining to Type of Fitting Involved
- Information pertaining to Leak Location
- Information pertaining to Manufacturer of the Fitting
- Operator Reporting
- Technical Review and Analysis

Rulemaking is in progress to change the Mechanical Fitting Failure Report to the "Mechanical Joint Failure Report (MJFR)" to communicate that the leak occurred within a joint connection of pipe and that the apparent cause of leakage may not be due to equipment failure of the mechanical fitting. This report will use the term "MJFR" to reflect the intended update.

PHMSA's MJFR team will analyze the MJFR data and document observations from the team's perspective in an electronic format suitable for transmission and filling. The MJFR team is comprised of PHMSA engineers, data analysts, and other staff.

1.0 Receipt of Data and Initial Processing

The MJFR Team will download the previous calendar year's data from the PDM approximately one month following the operator submission deadline, to allow time for PHMSA IT personnel to perform quality checks. The MJFR Team will scan the incoming data to ensure it meets their needs and note any issues to PHMSA IT personnel. Following the acceptance of the data for analysis purposes, the MJFR Team will begin analysis. The MJFR Raw data is available at http://primis.phmsa.dot.gov/dimp/perfmeasures.htm .

2.0 Data Triaging and Analyses

The MJFR Team members will analyze the MJFR data and generate the tables and charts outlined in this procedure. Typically, the MJFR Team moves the data from PDM into a computer application called "SAS" to manipulate the data for analysis. The team then moves the output from SAS into PowerPoint for presentation and discussion purposes. The team may perform other evaluations and analyses depending upon the analysis.

2.1 Gather Information to Support Analysis and Review of Data

Input: Excel Spreadsheet from PDM based on data received as of March 31, 2018

Output: Various tables and charts, examples in the report below

Description: The MJFR Team will use the following spreadsheets and tables to gather data in appropriate formats to support analysis and review.

Spreadsheets and associated tables required to perform analysis and expected Outputs

Description of Data to be analyzed	Description of Data Source(s)	Typical Output
2.2.1 General Overview of the MJFR Information	Total number of reports, operators, manufacturers and the amounts of missing information for a given year	Table 1
2.2.2 General information on the Age of the Mechanical Fittings that Failed	Year of manufactured/installed, amounts of missing information, and average time to failure and range (Part C Items 6 & 7)	Table 2
2.2.3 Decade of Installation of Mechanical Fitting that Failed	Decade of installation of the mechanical fittings that failed (Part C Items 6 or 8)	Table 3

Description of Data to be analyzed	Description of Data Source(s)	Typical Output
2.3.1 Average and Range Time to Failure by Fitting Material	Average and range time to failure by material type (Part C Item 13 compared to Item 6)	Table 4
2.3.2 Frequency of Material Type	Frequency of failure by Material Type (Part C Item 13)	Figure 1 and Table 5
2.3.3 Comparison of First Pipe Material by Second Pipe Material	First pipe material by second pipe material (Part C Item 14)	Tables 6
2.3.4 Fitting Material by Apparent Cause of Leak	Fitting Material (Part C Item 13) by Leak Cause (Part C Item 15)	Table 7
2.3.5 Sizes of Pipe being Joined	Number of failures by sizes of pipe being joined (First Pipe Nominal Size and Second Pipe Nominal Size) (Part C Item 14)	Tables 8
2.4.1 Apparent Causes of Leaks	Leak cause from cause categories (Part C Item 15)	Figure 2 and Table 9
2.4.2 Leak Cause Expanded	Leak causes expanded (Part C Item 15)	Table 10
2.5.1 Mechanical Fitting Involved	Mechanical Fitting Involved (coupling, adaptor, etc.) (Part C Item 4)	Figure 3 and Table 11
2.5.2 Mechanical Fitting Type	Mechanical Fitting Type (nut follower, stab, etc.) (Part C Item 3)	Figure 4 and Table 12
2.5.3 Fitting Material by Mechanical Fitting Involved	Fitting Material (Part C Item 13) by Mechanical Fitting Involved (Part C Item 3)	Tables 13, 14
2.5.4 Material by Type of Mechanical Fitting	Fitting Material (Part C Item 13) by Type of Mechanical Fitting (Part C Item 4)	Table 15
2.6.1 Leak Location	Aboveground/Belowground, Outside/Inside and Meter/Service (Part C Item 5)	Figure 5 and Table 16
2.6.2 How the Leak Occurred	Leaked Through Seal, Leaked Through Body, or Pulled Out (Part C Item 16)	Figure 6
2.6.3 Top 10 States reporting, Top 10 Steel State, and Top 10 Plastic States	Top 10 States reporting, Top 10 Steel State, and Top 10 Plastic States (Part C Items 1 & 13)	Table 17, 18, 19
2.6.4 States by Cause	States reporting by causes of leaks (Part C Items 1 & 15)	Table 20

Description of Data to be analyzed	Description of Data Source(s)	Typical Output
2.6.5 Leak Location (above or below ground) by Fitting Material	Fitting Material by Leak Location (above or below ground) (Part C Items 5 & 13)	Table 21
2.6.6 Leak Location (inside or outside) by Fitting Material	Fitting Material by Location (inside or outside) (Part C Items 5 & 13)	Table 22
2.6.7 Leak Location (service type) by Fitting Material	Fitting Material by Location (service type) (Part C Items 5 & 13)	Table 23
2.7 Quantification of the Role of Mechanical Joints in Hazardous Leaks	Total Number of MJFR submitted each year & Total Number of hazardous leaks repaired or replaced each year from PHMSA reports (primis.phmsa.dot.gov/dimp/perfmeasures.htm)	Table 24
2.7.1 Manufacturer of Fitting by Year Manufactured	Line plot of failures by manufacturer by year manufactured (Part C Items 7 & 9)	Figure 7
2.7.2 Manufacturer by Years in Service	Line plot of failures by manufacturer by years of service (Part C Items 6 & 9)	Figure 8
2.7.3 Top 10 Manufacturers of Fittings	Top 10 reported manufacturers (Part C Item 9)	Table 25
2.7.4 Manufacturer by Year of Failure	Line plot of number of failures by manufacturer by year of failure (Part C Items 2 & 9)	Figure 9
2.7.5 Manufacturer by Leak Causes	Manufacturer by leak causes (Part C Items 9 & 15)	Table 26
2.7.6 Manufacturer by Mechanical Fitting Involved	All years of manufacturer by mechanical fitting type involved (Part C Items 3 & 9)	Table 27
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2.2 General information from MJFR reports

2.2.1 General Overview of the MJFR Information

Input: Original Excel Spreadsheet from PDM

Output: Table 1 - General overview of the Mechanical Joint Failure Reports

Description: General information about the number of reports, number of operators, and number of manufacturers and the amounts of missing information.

Analysis: From this information, the MJFR Team will develop observations on coverage and representation of the information reported.

Table 1. General overview of the Mechanical Joint Failure Reports, 2011-2017, as of 04/02/2018

	2011	2012	2013	2014	2015	2016	2017
Number of Reports	8344	7654	9993	11901	15003	18174	13790
Number of Reporting Operators	195	201	188	188	193	187	178
Number of states of origin	50 and DC	50 and DC	48 and DC	50 and DC	49 and DC	49 and DC	50 and DC
Number of Manufacturers	38	35	35	36	36	38	40
Percent of Missing Manufacturers	51%	48%	52%	53%	60%	71%	71%

2.2.2 General information on the Age of the Mechanical Fittings that Failed

Input: Data analyzed from SAS Computer Application

Output: Table 2 - Year of installation and manufacture of failed mechanical fittings

Description: General information about the year manufactured and/or installed the amounts of missing information, and the average time to failure and range.

Analysis: From this information, the MJFR Team will develop observations on the validity of data and accuracy of the average service life of reported failures.

Table 2. General information about the year of manufactured of mechanical fittings reported in Mechanical Joint Failure Reports, 2011-2017

	2011	2012	2013	2014	2015	2016	2017
Percent Missing Year of Manufacture	89%	88%	88%	88%	90%	94%	94%
Percent Missing Year of Installation	42%	36%	39%	33%	33%	26%	26%
Average Time to Failure and Range	33 Years (0 - 124)	33 Years (0 – 132)	34 Years (0 – 121)	37 Years (0 – 124)	41 Years (0 – 123)	45 Years (0-165)	41 Years (0-152)

**The percent of overlapping year of manufacturer and year of install is a subset of reported values and therefore is very small.*

2.2.3 Decade of Installation of Mechanical Fitting that Failed

Input: Data analyzed from SAS Computer Application

Output: Table 3 - Decade of installation of failed mechanical fittings

Description: Table of decade of installation of the mechanical fittings that failed. The table is read by comparing the percentages of this table to percentages from the annual reports about mileage installed in given decades.

Analysis: From this information, the MJFR Team will develop observations on the validity of the data, as the distribution across the decades should be similar to the distribution of pipe across the decades from the annual reports.

Table 3. Decade of installation of mechanical fittings that failed and were reported to the Mechanical Joint Failure Reports, 2011-2017

	2011 Count (%)	2012 Count (%)	2013 Count (%)	2014 Count (%)	2015 Count (%)	2016 Count (%)	2017 Count (%)
Pre 1940s	41 (2%)	22 (3%)	15 (3%)	14 (4%)	91 (19%)	73 (19%)	72 (18%)
1940s	23 (1%)	6 (1%)	25 (5%)	13 (4%)	27 (5%)	13 (3%)	11 (3%)
1950s	191 (11%)	70 (9%)	59 (13%)	31(8%)	57 (12%)	36 (9%)	49 (12%)
1960s	337 (19%)	168 (21%)	91 (19%)	53(14%)	62 (13%)	54 (14%)	55 (13%)
1970s	483 (27%)	232 (29%)	122 (25%)	81 (22%)	98 (21%)	67 (17%)	67 (16%)
1980s	379 (21%)	185 (24%)	82 (17%)	101 (27%)	96 (20%)	84 (21%)	73 (18%)
1990s	155 (9%)	60 (8%)	51 (11%)	59 (15%)	37 (7%)	40 (11%)	53 (13%)
2000s	164 (9%)	33 (4%)	27 (6%)	15 (4%)	11 (2%)	16 (4%)	28 (6%)
2010s	5 (1%)	6 (1%)	3 (1%)	6 (2%)	1 (1%)	6 (2%)	1 (1%)

2.3 Fitting Material and Pipe Type

2.3.1 Average and Range Time to Failure by Fitting Material

Input: Data analyzed from SAS Computer Application

Output: Table 4 - Average time to failure by fitting material type

Description: Table of average and range time to failure by fitting material (Part C Item 13 of the form).

Analysis: From this information, the MJFR Team will develop observations on time to failure on various fitting material types.

Table 4. Average and range of time to failure by fitting material type of mechanical fittings that failed and were reported to the Mechanical Joint Failure Reports, 2011-2017

	2011	2012	2013	2014	2015	2016	2017
	Average (Range)	Average (Range)	Average (Range)	Average (Range)	Average (Range)	Average (Range)	Average (Range)
Steel	40 (0 – 124)	41 (0 – 117)	42 (0 – 113)	44 (0-124)	48 (0-123)	50 (0 – 165)	46 (0 – 152)
Plastic	21 (0 – 70)	21 (0 – 87)	22 (0 – 84)	23 (0-115)	25 (0-102)	26 (0 – 105)	26 (0 – 117)
Combination (Steel and Plastic)	26 (0 – 76)	20 (0 – 90)	22 (0 – 113)	23 (0-115)	26 (0-90)	29 (0 – 71)	28 (0 – 118)
Unknown	42 (0 – 71)	37 (1 – 61)	39 (3 – 60)	43 (2-86)	48 (2-116)	53 (0 – 117)	46 (0 – 118)
Other	50 (0 – 111)	51 (1 – 117)	49 (0 – 121)	37 (2-113)	33 (0-94)	34 (23 – 81)	34 (6 – 121)
Brass	41 (0 – 82)	45 (0 – 132)	43 (0 – 69)	46 (1-113)	46 (0 – 95)	47 (0 – 87)	48 (4 – 149)

Note: Based on all data, when the year of manufacture and the year of install are both reported, the majority of the dates are within a year of each other. Since the dates are similar and year of install was reported more often, year of install will be used.

2.3.2 Frequency of Failure by Material Type

Input: Data analyzed from SAS Computer Application

Output: Figure 1 and Table 5 - Frequency of mechanical fitting failures by material type

Description: Bar chart of material type with the y-axis showing the percentage of each year's total failures that material accounted for, and table representing the data with the counts and percent.

Analysis: From this information, the MJFR Team will develop observations on the ratio of material types that are used and trends across years.

Figure 1. Frequency of mechanical fittings involved by material type reported to the Mechanical Joint Failure Reports, 2011-2017

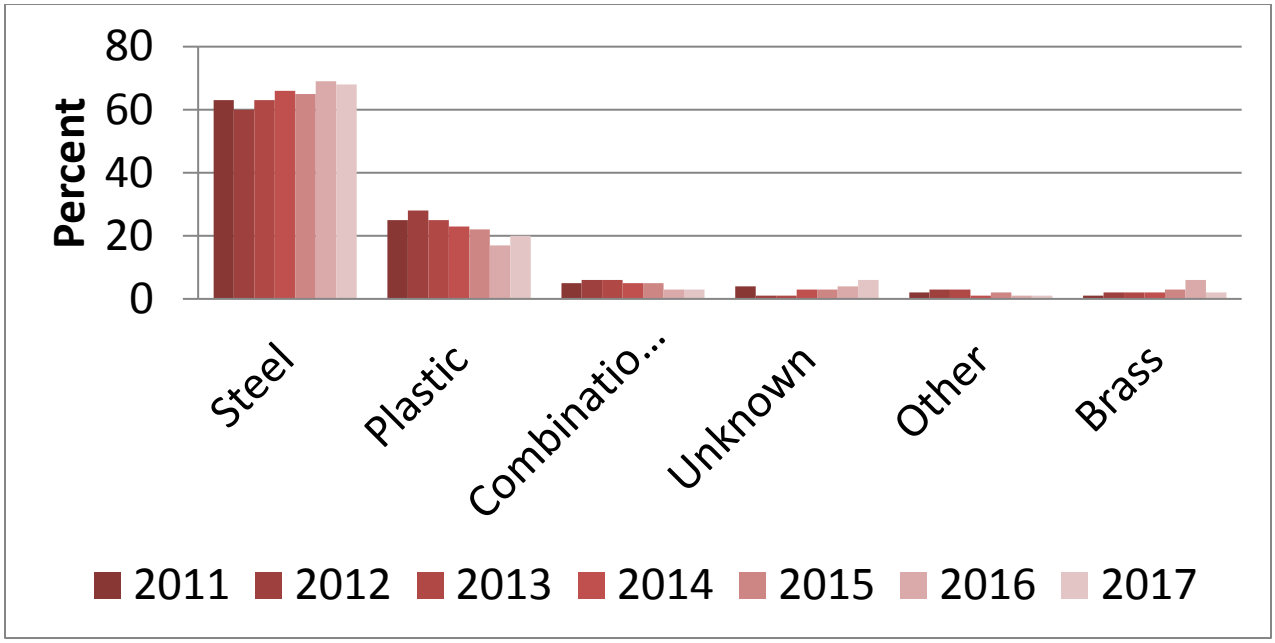


Table 5. Frequency of mechanical fittings involved by material type reported to the Mechanical Joint Failure Reports, 2011-2017

	2011 Count (%)	2012 Count (%)	2013 Count (%)	2014 Count (%)	2015 Count (%)	2016 Count (%)	2017 Count (%)
Steel	5238 (63%)	4579 (60%)	6110 (63%)	7614 (66%)	9424 (65%)	12209 (69%)	9001 (68%)
Plastic	2069 (25%)	2066 (28%)	2465 (25%)	2682 (23%)	3176 (22%)	2892 (17%)	2767 (20%)
Combination (Steel and Plastic)	449 (5%)	451 (6%)	560 (6%)	572 (5%)	703 (5%)	482 (3%)	359 (3%)
Unknown	341 (4%)	92 (1%)	127 (1%)	356 (3%)	447 (3%)	740 (4%)	818 (6%)
Other	165 (2%)	184 (3%)	271 (3%)	125 (1%)	261 (2%)	81 (1%)	71 (1%)
Brass	82 (1%)	168 (2%)	174 (2%)	219 (2%)	491 (3%)	1031 (6%)	249 (2%)

2.3.3 Comparison of First Pipe Material by Second Pipe Material Type

Input: Data analyzed from SAS Computer Application

Output: Table 6 - Comparisons of first pipe and second pipe materials being joined where mechanical fitting failure occurred

Description: Table comparing first pipe material and second pipe material (Part C Item 14). The highest numbers and percentages should be in the diagonal. Along with the table list the percentage of pipe material that had some plastic and the percentage of pipe material that had some steel.

Analysis: From this information, the MJFR Team will develop observations on how the various material types are combined. The various tables will also help identify any outliers.

Table 6. Comparison of first pipe material to second pipe material fittings of mechanical fittings that failed and were reported to the Mechanical Joint Failure Reports, (all years) 2011-2017

	Second Pipe Material Type							
First Pipe Material Type		**Cast/Wro**	**Copper**	**Ductile**	**Other**	**Plastic**	**Steel**	**Unknown**
	Cast/Wro	832 (1%)	8	14	1	73	101	7
	Copper	42	2155 (3%)	1	3	376	445	288
	Ductile	35	0	803 (1%)	0	7	7	0
	Other	0	7	0	97 (<1%)	13	2492	0
	Plastic	45	162	8	21	21334 (26%)	4369	89
	Steel	49	239	9	212	4578	41958 (51%)	294
	Unknown	0	2	0	1	34	35	821 (1%)

2.3.4 Fitting Material by Leak Cause

Input: Data analyzed from SAS Computer Application

Output: Table 7 - Fitting material by leak cause

Description: Table for Fitting Material (Part C Item 13) by Apparent Cause of Leak (Part C Item 15). The table is read comparing percentages in the year column to the other year column for the various causes and fitting material.

Analysis: From this information, the MJFR Team will develop observations on frequency of leak causes by material type.

Table 7. Fitting material by leak cause of mechanical fittings that failed and were reported to the Mechanical Joint Failure Reports, 2011-2017

	Corrosion	Equipment	Excavation	Incorrect Operation	Material or Weld	Natural Forces	Other	Other Outside Forces
Steel	7%	53%	2%	3%	9%	18%	7%	1%
Plastic	1%	30%	2%	23%	28%	6%	9%	1%
Combination	7%	25%	2%	17%	29%	10%	8%	2%
Unknown	3%	24%	3%	5%	26%	36%	2%	1%
Other	7%	36%	2%	2%	9%	30%	13%	1%
Brass	4%	68%	4%	1%	13%	7%	2%	1%
Total	**5%**	**46%**	**3%**	**8%**	**15%**	**15%**	**7%**	**1%**

2.3.5 Sizes of Pipe being Joined

Input: Data analyzed from SAS Computer Application

Output: Table 8 - Comparisons of first pipe and second pipe sizes being joined where mechanical fitting failure occurred

Description: Plot of the number of failures by pipe sizes being joined (Part C Item 14, First Pipe Nominal Size and Second Pipe Nominal Size). First pipe size is reflected in the rows, and Second pipe size is reflected in the columns.

Analysis: From this information, the MJFR Team will develop observations on the number of reported failures from joining various pipe sizes with mechanical fittings.

Table 8. Sizes of pipe being joined by mechanical fittings that failed and were reported to the Mechanical Joint Failure Reports, (all years) 2011-2017

	¼ inch	½ inch	¾ inch	1 inch	1 ¼ inch	1 ½ inch	1 ¾ inch	2 inch	3 inch	4 inch	6 inch	8 inch or larger
¼ inch	196 (<1%)	69	28	7	4	2	0	7	1	0	0	0
½ inch	69	11860 (14%)	4256	748	58	5	0	246	8	31	13	5
¾ inch	27	2033	18714 (22%)	412	100	11	0	391	29	44	11	6
1 inch	9	691	492	17626 (21%)	218	16	2	105	13	32	11	6
1 ¼ inch	6	173	199	353	4892 (6%)	46	1	99	14	21	9	3
1 ½ inch	0	12	11	33	40	852 (1%)	0	10	0	2	0	3
1 ¾ inch	0	1	3	2	2	1	4 (0%)	1	0	1	0	0
2 inch	2	693	533	382	130	25	8	12688 (15%)	33	14	10	7
3 inch	1	32	37	45	25	2	0	40	401 (1%)	5	1	0
4 inch	0	73	65	114	57	2	0	59	8	1241 (1%)	15	1
6 inch	0	19	25	29	17	1	0	21	8	7	1240 (2%)	2
8 inch or larger	0	12	11	10	5	3	0	10	6	2	14	966 (1%)

**Percentages are rounded based on total number*

2.4 Causes of Hazardous Leak

2.4.1 Chart of Leak Causes

Input: Data analyzed from SAS Computer Application

Output: Figure 2 and Table 9 - Frequency of leak causes

Description: Bar chart of Apparent Cause of Leak (Part C Item 15) with percentages on the y-axis and causes on x-axis, and table representing the data with the counts and percent. The table is read comparing percentages in the year column to the other year column for the various causes.

Analysis: From this information, the MJFR Team will develop observations on the distribution of leak cause.

Figure 2. Frequency of leak causes of mechanical fittings that failed and were reported to the Mechanical Joint Failure Reports, 2011-2017

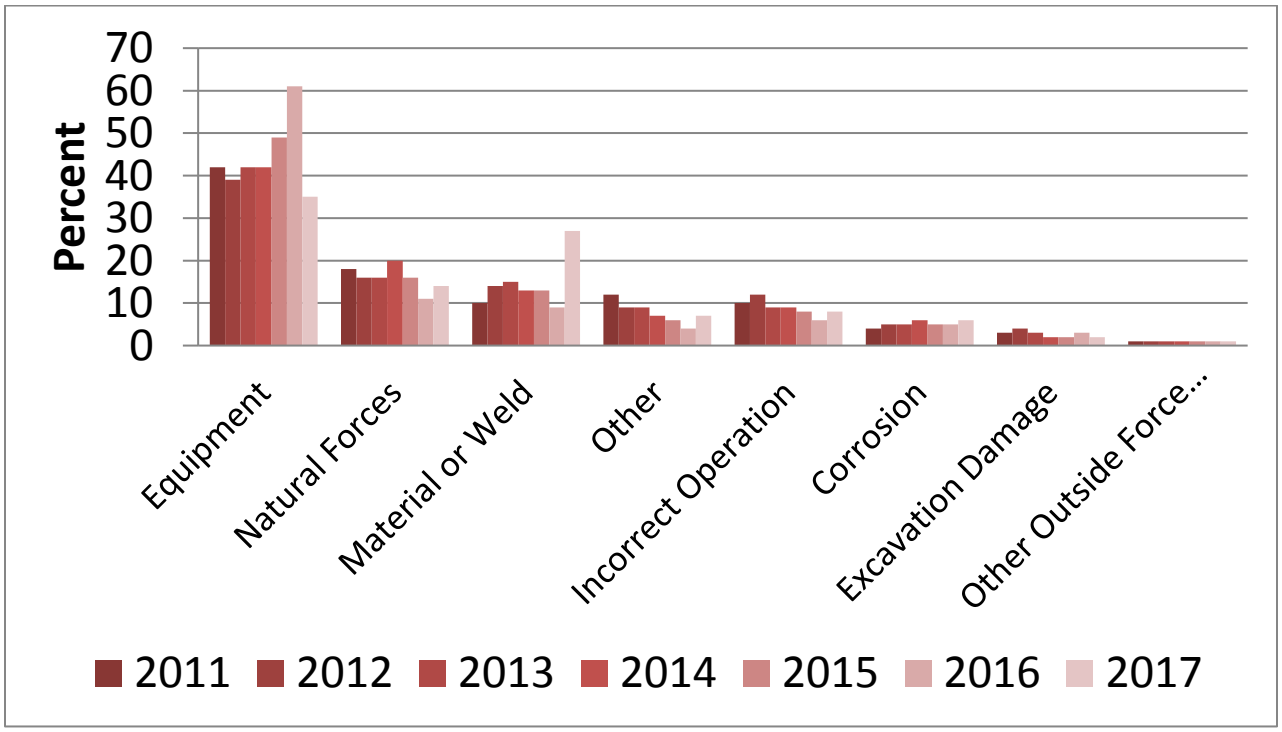


Table 9. Frequency of leak causes of mechanical fittings that failed and were reported to the Mechanical Joint Failure Reports, 2011-2017

	2011 Count (%)	2012 Count (%)	2013 Count (%)	2014 Count (%)	2015 Count (%)	2016 Count (%)	2017 Count (%)
Equipment	3506 (42%)	2985 (39%)	4215 (42%)	4940 (42%)	7318 (49%)	11033 (61%)	4887 (35%)
Natural Forces	1558 (18%)	1201 (16%)	1614 (16%)	2336 (20%)	2326 (18%)	1980 (11%)	1942 (14%)
Material or Weld	802 (10%)	1093 (14%)	1483 (15%)	1572 (13%)	1999 (13%)	1679 (9%)	3744 (27%)
Other	1003 (12%)	718 (9%)	881 (9%)	852 (7%)	974 (6%)	832 (4%)	980 (7%)
Incorrect Operation	807 (10%)	877 (12%)	910 (9%)	1068 (9%)	1137 (8%)	1121 (6%)	1030 (8%)
Corrosion	332 (4%)	389 (5%)	535 (5%)	692 (6%)	702 (5%)	820 (5%)	805 (6%)
Excavation	229 (3%)	266 (4%)	223 (3%)	255 (2%)	351 (2%)	456 (3%)	312 (2%)
Other	105 (1%)	79 (1%)	62 (1%)	47 (1%)	83 (1%)	100 (1%)	90 (1%)

2.4.2 Leak Causes Expanded

Input: Data analyzed from SAS Computer Application

Output: Table 10 - Frequency of leak causes (expanded)

Description: Table with leak causes expanded as the title and Leak Cause Natural Forces Thermal Expansion/Contraction, Leak Cause Material/Welds and Leak Cause Excavation Damage Occurred presenting both the count and percent by report year. The table is read comparing percentages in the year column to the other year column for the various questions.

Analysis: From this information, the MJFR Team will develop observations on any issues identified in specific leak causes.

Table 10. Frequency of leak causes expanded information of mechanical fittings that failed and were reported to the Mechanical Joint Failure Reports, 2011-2017

Question	Responses	2011 Count (%)	2012 Count (%)	2013 Count (%)	2014 Count (%)	2015 Count (%)	2016 Count (%)	2017 Count (%)
Leak Cause Natural Forces Thermal Expansion / Contraction	**No**	763 (57%)	667 (59%)	826 (52%)	899 (37%)	977 (41%)	1184 (59%)	1028 (53%)
	Yes	573 (43%)	459 (41%)	777 (48%)	1469 (63%)	1365 (59%)	812 (41%)	914 (47%)
Leak Cause Material/Welds	**Construction/ Installation Defect**	174 (21%)	311 (28%)	456 (31%)	396 (25%)	712 (35%)	642 (38%)	2112 (56%)
	Design Defect	629 (78%)	791 (72%)	1029 (69%)	1218 (75%)	1308 (65%)	1077 (62%)	1632 (44%)
Leak Cause Excavation Damage	**At time of leak discovery**	166 (75%)	228 (86%)	196 (87%)	238 (90%)	325 (91%)	430 (92%)	286 (92%)
	Previous to leak discovery	54 (25%)	36 (14%)	28 (13%)	25 (10%)	32 (9%)	35 (8%)	26 (8%)

2.5 Type of Fitting

2.5.1 Chart of Mechanical Fitting Involved

Input: Data analyzed from SAS Computer Application

Output: Figure 3 and Table 11 - Frequency of applications where failures are occurring

Description: Bar chart of percentage of failure per type of Mechanical Fitting Involved (Part C Item 4 on the report form) with percentages on the y-axis and Type on x-axis, and table representing the data with the counts and percent. The table is read comparing percentages in the year column to the other year column for the various types of fittings.

Analysis: From this information, the MJFR Team will develop observations on the distribution of type of mechanical fitting failing.

Figure 3. Frequency of mechanical fitting involved of mechanical fittings that failed and were reported to the Mechanical Joint Failure Reports, 2011-2017

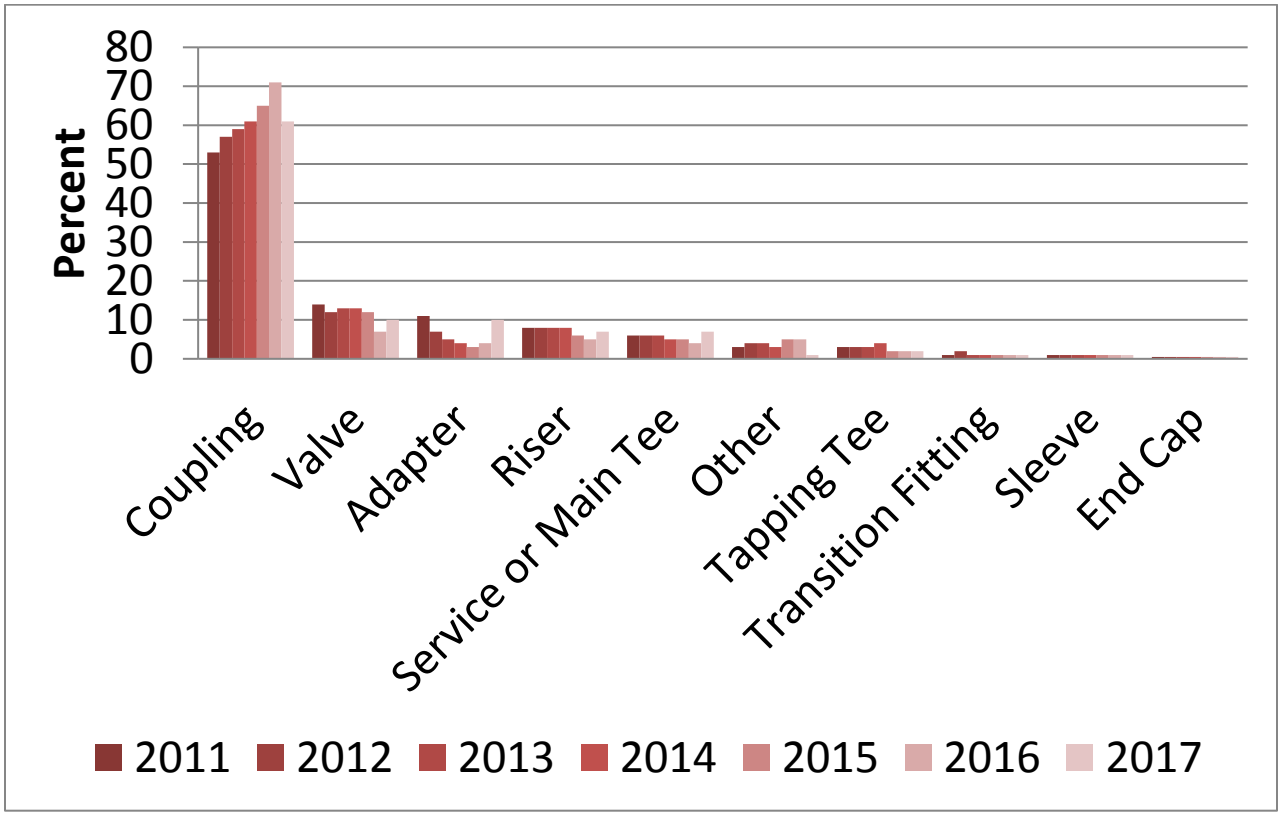


Table 11. Frequency of mechanical fitting involved of mechanical fittings that failed and were reported to the Mechanical Joint Failure Reports, 2011-2017

	2011 Count (%)	2012 Count (%)	2013 Count (%)	2014 Count (%)	2015 Count (%)	2016 Count (%)	2017 Count (%)
Coupling	4423 (53%)	4407 (57%)	5921 (59%)	7301 (61%)	9733 (65%)	13033 (71%)	8425 (61%)
Valve	1196 (14%)	908 (12%)	1339 (13%)	1545 (13%)	1737 (12%)	1317 (7%)	1358 (10%)
Adapter	877 (11%)	507 (7%)	493 (5%)	393 (4%)	445 (3%)	739 (4%)	1432 (10%)
Riser	700 (8%)	603 (8%)	761 (8%)	986 (8%)	931 (6%)	927 (5%)	927 (7%)
Service or Main Tee	471 (6%)	503 (6%)	571 (6%)	616 (5%)	798 (6%)	732 (4%)	955 (7%)
Other	275 (3%)	301 (4%)	360 (4%)	365 (3%)	743 (5%)	829 (5%)	717 (1%)
Tapping Tee	211 (3%)	205 (3%)	319 (3%)	450 (4%)	364 (2%)	376 (2%)	318 (2%)
Transitional	98 (1%)	140 (2%)	144 (1%)	109 (1%)	138 (1%)	107 (1%)	93 (1%)
Sleeve	66 (1%)	55 (1%)	51 (1%)	103 (1%)	62 (1%)	43 (<1%)	57 (<1%)
End Cap	27 (<1%)	25 (<1%)	34 (<1%)	33 (<1%)	52 (<1%)	71 (<1%)	54 (<1%)

2.5.2 Chart of Mechanical Fitting Type

Input: Data analyzed from SAS Computer Application

Output: Figure 4 and Table 12 - Frequency of failure by type of mechanical fitting

Description: Bar chart of percentages by Type of Mechanical Fitting (Part C Item 3 on the report form) with percentage on the y-axis and type of mechanical fitting on the x-axis, and table representing the data with the counts and percent. The table is read comparing percentages in the year column to the other year column for the various mechanical fitting types.

Analysis: From this information, the MJFR Team will develop observations on the distribution of type of mechanical fitting involved in the failure.

Figure 4. Frequency of mechanical fitting type of mechanical fittings that failed and were reported to the Mechanical Joint Failure Reports, 2011-2017

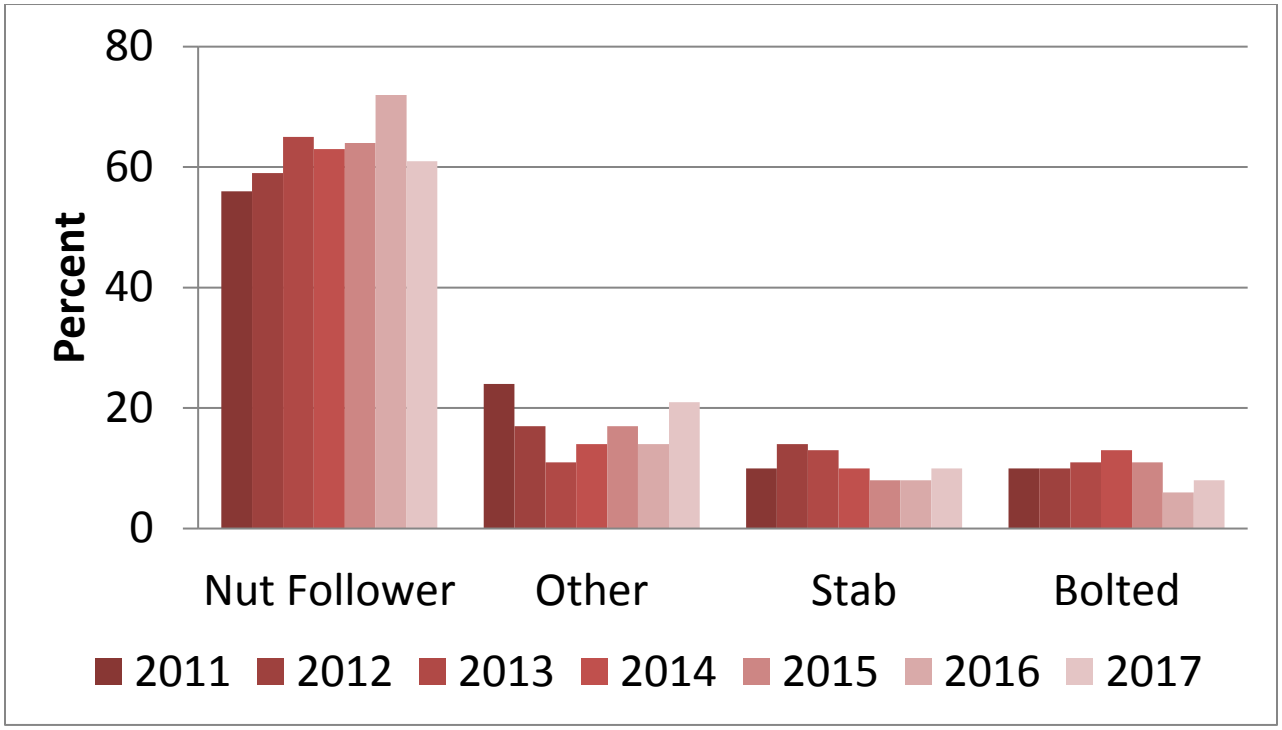


Table 12. Frequency of mechanical fitting type of mechanical fittings that failed and were reported to the Mechanical Joint Failure Reports, 2011-2017

	2011 Count (%)	2012 Count (%)	2013 Count (%)	2014 Count (%)	2015 Count (%)	2016 Count (%)	2017 Count (%)
Nut Follower	4715 (56%)	4462 (59%)	6463 (65%)	7499 (63%)	9576 (64%)	12962 (72%)	8453 (61%)
Other	2011 (24%)	1289 (17%)	1138 (11%)	1736 (14%)	2610 (17%)	2500 (14%)	2861 (21%)
Stab	812 (10%)	1084 (14%)	1262 (13%)	1165 (10%)	1144 (8%)	1593 (8%)	1372 (10%)
Bolted	806 (10%)	819 (10%)	1130 (11%)	1501 (13%)	1673 (11%)	1119 (6%)	1104 (8%)

2.5.3 Material of Mechanical Fitting Involved

Input: Data analyzed from SAS Computer Application

Output: Table 13 and Table 14 - Frequency of failure of material of mechanical fitting involved

Description: Table of Fitting Material (Part C Item 13) by Mechanical Fitting Involved (Part C Item 3) by the reporting years. The table is read comparing percentages in the year column to the other year column for the various fitting material and types. Table 14 is provided with all the data across the reporting years and is read comparing the percentages across the rows.

Analysis: From this information, the MJFR Team will develop observations on which type of mechanical fitting is most likely from the various material types.

Table 13. Frequency of material of mechanical fitting involved of mechanical fittings that failed and were reported to the Mechanical Joint Failure Reports, 2014-2017

	Bolted				Nut Follower				Stab				Other			
	2014	2015	2016	2017	2014	2015	2016	2017	2014	2015	2016	2017	2014	2015	2016	2017
Steel	14%	8%	5%	7%	70%	74%	81%	71%	1%	1%	1%	1%	15%	17%	13%	21%
Plastic	9%	9%	8%	8%	44%	42%	38%	34%	34%	30%	33%	41%	13%	19%	21%	17%
Combo	6%	20%	3%	9%	49%	46%	46%	45%	21%	13%	21%	24%	24%	21%	30%	22%
Unk	13%	60%	15%	22%	58%	33%	32%	44%	1%	1%	46%	4%	28%	6%	7%	30%
Other	32%	10%	10%	23%	59%	30%	69%	62%	3%	1%	0%	0%	6%	59%	21%	15%
Brass	5%	3%	1%	1%	88%	94%	93%	91%	4%	1%	1%	2%	3%	2%	5%	6%
Total	12%	11%	6%	8%	63%	64%	71%	61%	10%	8%	9%	10%	15%	18%	14%	21%

Table 14. Frequency of material of mechanical fitting involved of mechanical fittings that failed and were reported to the Mechanical Joint Failure Reports, all years combined 2011-2017

	Bolted	Nut Follower	Stab	Other
Steel	9%	73%	2%	16%
Plastic	8%	41%	35%	16%
Combination	8%	51%	17%	24%
Unknown	23%	46%	14%	17%
Other	46%	33%	1%	20%
Brass	3%	91%	1%	5%
Total	10%	64%	10%	16%

2.5.4 Fitting Material by Type of Mechanical Fitting

Input: Data analyzed from SAS Computer Application

Output: Table 15 - Frequency of failure of material of mechanical fitting by its application

Description: Table of Fitting Material by Type of Mechanical Fitting. The table is read comparing percentages in the year column to the other year column for the various mechanical fitting and fitting material.

Analysis: From this information, the MJFR Team will develop observations based on percentages of material type and type of fitting.

Table 15. Frequency of fitting material by type of mechanical fitting of mechanical fitting involved of mechanical fittings that failed and were reported to the Mechanical Joint Failure Reports, (all years) 2011-2017

	Adapter	Coupling	End Cap	Other	Riser	Service or Main Tee	Sleeve	Tapping Tee	Transition Fitting	Valve
Steel	7%	70%	0%	3%	6%	4%	1%	2%	1%	6%
Plastic	1%	46%	1%	2%	6%	7%	0%	7%	1%	29%
Combination	6%	28%	0%	4%	40%	5%	1%	2%	9%	5%
Unknown	2%	56%	0%	17%	1%	12%	2%	1%	0%	9%
Other	1%	16%	0%	42%	2%	7%	5%	1%	0%	26%
Brass	3%	86%	0%	1%	1%	5%	0%	0%	0%	4%
Total	6%	63%	0%	3%	7%	5%	1%	3%	1%	11%

2.6 Location of Hazardous Leaks

2.6.1 Leak Location

Input: Data analyzed from SAS Computer Application

Output: Figure 5 and Table 16 - Leak location

Description: Bar chart with Leak Location (Part C Item 5) as the title and Aboveground/Belowground, Outside/Inside and Meter/Service on the x-axis with the percentages on the y-axis, and table representing the data with the counts and percent. The table is read comparing percentages in the year column to the other year column for the various fitting material and types.

Analysis: From this information, the MJFR Team will develop observations on the general description of the leak location.

Figure 5. Frequency of the location of the hazardous leak of mechanical fittings that failed and were reported to the Mechanical Joint Failure Reports, 2011-2017

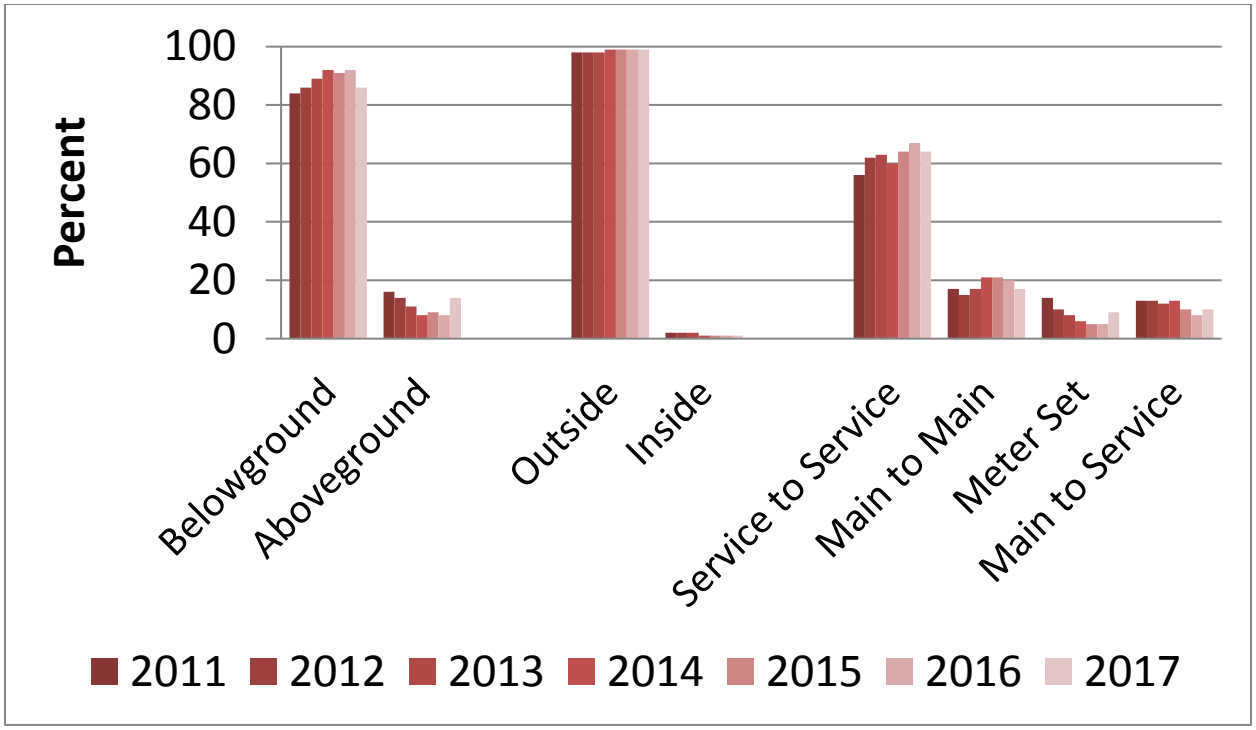


Table 16. Frequency of the location of the hazardous leak of mechanical fittings that failed and were reported to the Mechanical Joint Failure Reports, 2011-2017

	2011 Count (%)	2012 Count (%)	2013 Count (%)	2014 Count (%)	2015 Count (%)	2016 Count (%)	2017 Count (%)
Belowground	6986 (84%)	6610 (86%)	8919 (89%)	10923 (92%)	13652 (91%)	16807 (92%)	11862 (87%)
Aboveground	1358 (16%)	1044 (14%)	1074 (11%)	978 (8%)	1351 (9%)	1359 (8%)	1927 (13%)
Outside	8216 (98%)	7486 (98%)	9820 (98%)	11766 (99%)	14826 (99%)	17907 (99%)	13696 (99%)
Inside	128 (2%)	168 (2%)	173 (2%)	135 (1%)	177 (1%)	267 (1%)	94 (1%)
Service to Service	4707 (56%)	4720 (62%)	6290 (63%)	7074 (60%)	9524 (63%)	12110 (67%)	8793 (64%)
Main to Main	1389 (17%)	1124 (15%)	1767 (17%)	2590 (21%)	3181 (20%)	3696 (20%)	2412 (17%)
Meter Set	1147 (14%)	798 (10%)	781 (8%)	735 (6%)	821 (6%)	846 (5%)	1231 (9%)
Main to Service	1104 (13%)	1012 (13%)	1155 (12%)	1502 (13%)	1477 (11%)	1522 (8%)	1354 (10%)

2.6.2 How the Leak Occurred

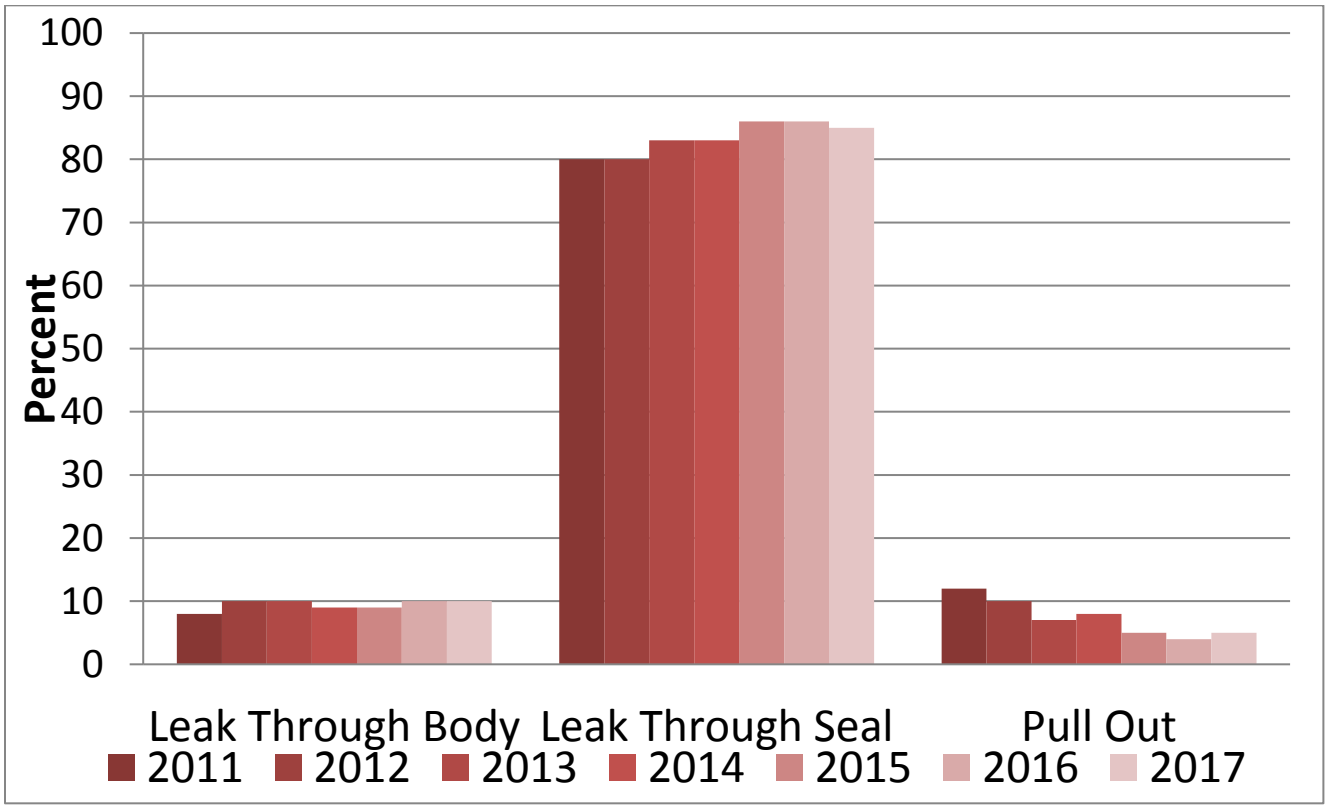
Input: Data analyzed from SAS Computer Application

Output: Figure 6 - Frequency of how the leak occurred

Description: Bar chart of how the leak occurred (Part C Item 16 of the report form) with percentage on the y-axis and options for how the leak occurred on the x-axis.

Analysis: From this information, the MJFR Team will develop observations on distribution of leak occurrence.

Figure 6. Frequency of how the leak occurred of mechanical fittings that failed and were reported to the Mechanical Joint Failure Reports, 2011-2017



2.6.3 Top 10 States reporting, Top 10 Steel State, and Top 10 Plastic States

Input: Data analyzed from SAS Computer Application

Output: Table 17 - Comparison of percentages of failures in States Overall
Table 18 - Comparison of percentages of failures in States for steel
Table 19 - Comparison of percentages of failures in States by plastic

Description: Tables with the columns Top 10 States reporting (Table 17), Top 10 Steel State (Table 18), and Top 10 Plastic States (Table 19). This table considers where the mechanical fitting failure occurred based on the raw data of all reports. For reference, a column of the percentages of the total number of services in each State in 2011, based on annual report data, is also included for each category.

Analysis: From this information, the MJFR Team will develop observations on distribution of percentages of mechanical fitting failures in the States taking into context percentage of pipe material installed based on the annual reports. Even with this information provided, PHMSA cautions users of this data analysis on the need to consider the information in the appropriate context. There is no definitive information publicly available about the number of fittings in a given State. Therefore, PHMSA is unable to adjust the failure reports data for comparison by the quantity produced or in use. For additional information, specific to a certain State to help put numbers in better context, users are encouraged to contact the State.

Table 17. Percentage of MJFR by State, 2011-2017

Top 10 States – based on number of services reported from Gas Distribution Annual Reports							
Number of Services	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
CA	TX	TX	TX	PA	VA	VA	PA
13%	13%	13%	12%	12%	13%	24%	10%
TX	IL	IL	PA	TX	PA	MD	IL
7%	12%	9%	10%	10%	11%	16%	10%
IL	PA	PA	IN	IN	TX	PA	IN
6%	9%	8%	8%	8%	10%	7%	9%
OH	OH	IN	NY	VA	MD	IN	VA
5%	7%	7%	7%	8%	8%	6%	9%
MI	IN	MI	IL	OH	IN	TX	TX
5%	7%	6%	7%	7%	8%	5%	7%
NY	NY	NY	TN	NY	NY	IL	MD
5%	6%	6%	7%	6%	6%	5%	7%
PA	MI	OH	VA	IL	MI	MI	MI
4%	5%	6%	6%	5%	5%	4%	6%
NJ	MS	TN	OH	MI	OH	NJ	OH
4%	3%	5%	6%	5%	4%	3%	5%
GA	CA	CA	MI	TN	IL	OH	NY
3%	3%	4%	5%	5%	4%	3%	5%
IN	VA	VA	CA	WI	CA	NY	TN
3%	3%	4%	3%	3%	3%	3%	4%

Table 18. Percentage of MJFR Steel by State, 2011-2017

Top 10 Steel States– based on number of steel services reported from Gas Distribution Annual Reports							
Number of Steel Services	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
CA	TX	TX	TX	TX	VA	VA	IL
17%	19%	18%	16%	13%	16%	28%	14%
TX	IL	IL	IN	IN	TX	MD	IN
9%	18%	13%	12%	11%	13%	21%	11%
IL	IN	IN	IL	VA	MD	IN	VA
5%	9%	10%	9%	9%	11%	8%	10%
NY	NY	MI	TN	PA	IN	IL	TX
4%	6%	6%	9%	8%	10%	7%	9%
MI	OH	NY	VA	OH	NY	TX	MD
4%	6%	6%	6%	7%	6%	7%	9%
OH	MI	TN	NY	IL	MI	MI	MI
4%	5%	6%	6%	6%	6%	4%	7%
NJ	MS	OH	MI	TN	IL	DC	NY
4%	5%	5%	6%	6%	5%	3%	5%
PA	TN	VA	OH	NY	OH	NY	OH
4%	4%	4%	5%	5%	5%	3%	5%
LA	CO	MD	PA	MI	PA	OH	TN
4%	3%	3%	3%	5%	3%	2%	4%
CO	VA	MS	WI	MD	TN	MO	PA
3%	2%	3%	2%	4%	2%	2%	3%

Table 19. Percentage of MJFR Plastic by State, 2011-2017

Top 10 Plastic States - – based on number of plastic services reported from Gas Distribution Annual Reports							
Number of Plastic Services	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
CA 12%	PA 26%	PA 20%	PA 22%	PA 23%	PA 25%	PA 18%	PA 24%
TX 7%	OH 11%	CA 14%	CA 12%	OH 9%	CA 12%	CA 14%	CA 8%
OH 5%	CA 10%	OH 7%	OH 8%	CA 8%	VA 6%	VA 8%	OH 7%
NY 5%	NY 5%	NY 6%	NY 8%	VA 7%	OH 5%	OH 6%	TN 7%
MI 5%	GA 4%	AZ 5%	VA 6%	NY 6%	NY 5%	MO 4%	VA 6%
PA 5%	CT 4%	NV 4%	NV 4%	WI 5%	NV 4%	NV 4%	AZ 4%
IL 5%	MA 4%	VA 4%	AZ 3%	GA 3%	AZ 4%	MD 3%	MO 4%
NJ 3%	MO 3%	TN 3%	TN 3%	TN 3%	WI 3%	AZ 3%	NY 4%
GA 3%	SC 3%	TX 3%	CT 3%	TX 3%	MA 3%	NY 3%	IN 3%
IN 3%	AZ 3%	CT 3%	MA 3%	CT 3%	MD 2%	WI 3%	NV 3%

2.6.4 States by Causes of Hazardous Leak

Input: Data analyzed from SAS Computer Application

Output: Table 20 - Comparison of frequency of failures in States by cause

Description: Table with the columns of states reporting and causes of leaks for all years of data.

Analysis: From this information, the MJFR Team will develop observations on distribution of which States the failures are occurring in and the distribution of the causes in states.

Table 20. Number of MJF by leak cause by State for all years of data

State	Corrosion	Equipment	Excavation Damage	Incorrect Operation	Material or Weld	Natural Forces	Other	Other Outside Force Damage
AK	1	16	0	1	1	36	8	1
AL	38	209	19	67	195	95	10	11
AR	5	40	9	6	8	34	15	7
AZ	2	31	4	340	295	9	10	6
CA	56	9	26	1271	622	23	537	32
CO	8	728	63	7	25	112	6	3
CT	14	841	6	13	296	281	11	1
DC	52	827	25	37	111	1	0	6
DE	2	1	1	2	10	16	18	0
FL	9	133	18	25	22	7	59	2
GA	3	508	41	121	32	22	7	7
HI	5	2	2	1	0	0	96	1
IA	11	52	21	10	97	58	4	0
ID	0	0	4	62	48	1	11	1
IL	242	4156	86	38	186	845	128	25
IN	521	2242	110	150	325	2156	823	36
KS	116	344	40	34	88	187	3	14
KY	97	182	27	497	461	95	188	17
LA	6	245	16	28	83	41	20	3
MA	69	23	5	72	229	240	389	5
MD	126	4475	137	173	935	47	90	7
ME	0	0	0	24	0	6	2	0
MI	176	2349	276	131	94	1017	247	17
MN	27	315	2	80	56	108	65	4
MO	48	1022	197	39	237	103	174	63
MS	3	622	35	327	23	446	1	2
MT	0	22	22	0	33	73	0	2
NC	10	512	82	65	126	52	37	5
ND	0	8	4	1	20	40	1	1
NE	0	9	3	6	5	13	5	0
NH	25	133	4	8	3	36	20	0
NJ	217	595	23	258	287	584	39	40
NM	1	375	4	6	2	1	136	1
NV	0	30	2	349	375	11	5	3
NY	299	2943	46	214	422	146	258	4
OH	797	295	115	1047	589	342	966	35
OK	30	30	16	77	119	114	28	3
OR	1	12	25	60	77	0	24	2
PA	415	1877	16	367	3151	1951	303	66
RI	0	4	0	3	2	2	5	1
SC	7	190	19	112	179	4	41	3
SD	3	13	3	3	39	59	0	0
TN	6	2577	59	42	164	128	20	7
TX	231	2615	216	160	352	3077	1091	96
UT	4	8	4	5	5	8	7	3
VA	403	7099	99	518	959	320	235	8
VT	0	10	0	13	0	32	0	0
WA	31	32	41	115	78	5	37	2
WI	175	214	123	35	887	66	18	13
WV	15	15	14	2	122	12	51	4
WY	0	10	10	2	12	36	3	0

2.6.5 Leak Location (above or below ground) by Fitting Material

Input: Data analyzed from SAS Computer Application

Output: Table 21 - Leak location

Description: Table of Fitting Material by Leak Location (above or below ground). The table is read comparing percentages in the year column to the other year column for the various locations fitting and fitting material.

Analysis: From this information, the MJFR Team will develop observations based on percentage of material type and location

Table 21. Comparison of Fitting Material by Leak Location, 2011-2017

	Aboveground							Belowground						
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Steel	79%	72%	75%	74%	68%	74%	82%	59%	59%	62%	65%	64%	69%	66%
Plastic	2%	3%	2%	2%	12%	13%	6%	29%	31%	28%	25%	23%	16%	23%
Combination	14%	16%	18%	19%	15%	7%	4%	4%	4%	4%	4%	4%	2%	2%
Unknown	2%	2%	1%	1%	1%	1%	7%	4%	1%	1%	3%	4%	6%	7%
Other	1%	2%	1%	1%	1%	1%	1%	2%	3%	3%	1%	2%	1%	1%
Brass	2%	5%	3%	3%	3%	5%	1%	1%	2%	2%	2%	3%	6%	2%
Total	16%	14%	11%	8%	9%	8%	14%	84%	86%	89%	92%	91%	92%	86%

2.6.6 Leak Location (inside or outside) by Fitting Material

Input: Data analyzed from SAS Computer Application

Output: Table 22 - Leak location

Description: Table of Fitting Material by Location (inside or outside). The table is read comparing percentages in the year column to the other year column for the locations and fitting material.

Analysis: From this information, the MJFR Team will develop observations on percentage of material type and location.

Table 22. Frequency of leak location (inside or outside) by fitting material of mechanical fittings that failed and were reported to the Mechanical Joint Failure Reports, 2011-2017

	Inside							Outside						
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Steel	70%	82%	89%	69%	71%	79%	73%	63%	60%	63%	66%	65%	69%	68%
Plastic	10%	6%	4%	13%	8%	8%	15%	25%	28%	26%	23%	22%	16%	20%
Combination	5%	5%	3%	6%	4%	3%	6%	5%	6%	6%	5%	5%	3%	3%
Unknown	2%	1%	1%	3%	1%	1%	0%	4%	1%	1%	3%	3%	5%	7%
Other	2%	0%	0%	1%	1%	1%	0%	2%	3%	3%	1%	2%	1%	1%
Brass	10%	7%	3%	8%	15%	8%	5%	1%	2%	2%	2%	3%	6%	2%
Total	2%	2%	2%	1%	1%	1%	1%	98%	98%	98%	99%	99%	99%	99%

2.6.7 Leak Location (main and service connection) by Fitting Material

Input: Data analyzed from SAS Computer Application

Output: Table 23 - Frequency of leak location (main or service connection) by fitting material

Description: Table of Fitting Material by Location (main and service connections). The table is read comparing percentages in the year column to the other year column for the various locations and fitting material.

Analysis: From this information, the MJFR Team will develop observations based on percentage of material type and location.

Table 23. Frequency of leak location (main or service connection) by fitting material of mechanical fittings that failed and were reported to the Mechanical Joint Failure Reports, 2014-2017

	Main to Main				Main to Service				Meter Set				Service to Service			
	2014	2015	2016	2017	2014	2015	2016	2017	2014	2015	2016	2017	2014	2015	2016	2017
Steel	88%	78%	87%	82%	61%	65%	60%	58%	61%	65%	60%	89%	58%	61%	65%	63%
Plastic	4%	4%	3%	4%	27%	25%	25%	28%	27%	25%	25%	2%	32%	28%	20%	26%
Combo	1%	3%	1%	1%	4%	5%	3%	3%	4%	5%	3%	6%	4%	4%	2%	3%
Unknown	6%	13%	7%	12%	5%	2%	5%	8%	5%	2%	5%	1%	2%	1%	5%	6%
Other	1%	1%	1%	1%	2%	3%	1%	1%	2%	3%	1%	0%	1%	2%	1%	1%
Brass	1%	1%	1%	1%	1%	1%	5%	1%	1%	1%	5%	1%	3%	5%	8%	2%
Total	21%	21%	20%	17%	12%	10%	8%	10%	12%	10%	8%	9%	60%	64%	67%	64%

2.7 Manufacturer of Fitting

Special note for this section: The section is based on the name of manufacturer associated with the MFF, as reported by the operator. PHMSA cautions users that potential data quality issues may exist with the information reported, and users should consider the information in the appropriate context, such as number of fittings that may be in service, length of time a manufacturer may have been producing fittings, and number of fittings a manufacturer may produce (i.e. overall market share).

PHMSA conducted some additional conservative data analysis to improve the data quality, mostly relating to spelling errors. These tables are based on the frequency of reporting. There is no information available about the number of fittings various manufactures produced and sold. Therefore, PHMSA is unable to adjust the failure reports by the quantity in use. The best measure PHMSA can use to put the information into context based on other information reported is rate of hazardous leaks eliminated/repaired. For additional information, specific to a certain manufacturer to help put numbers in better context, such as amount fittings they may have produced or sold, contact the manufacturer. Manufacturers will not be able to provide information on number of fittings sold that were actually installed, as that is information the operators would have.

Table 24. Quantification of the Role of Mechanical Joints in Hazardous Leaks, Mechanical Joint Failure Reports, 2011-2017

	2011	2012	2013	2014	2015	2016	2017	Total
Number of MJFRs Submitted	8,344	7,654	9,993	11,901	15,003	18,174	13,790	84,859
Hazardous Leaks eliminated/repaired	191,630	187,204	190,789	205,880	213,848	209,846	202,208	1,401,405
%MJFR of Hazardous Leaks eliminated/ repaired	4.4%	4.1%	5.2%	5.8%	7.0%	8.7%	6.8%	6.1%

2.7.1 Manufacturer of Fitting by Year Manufactured

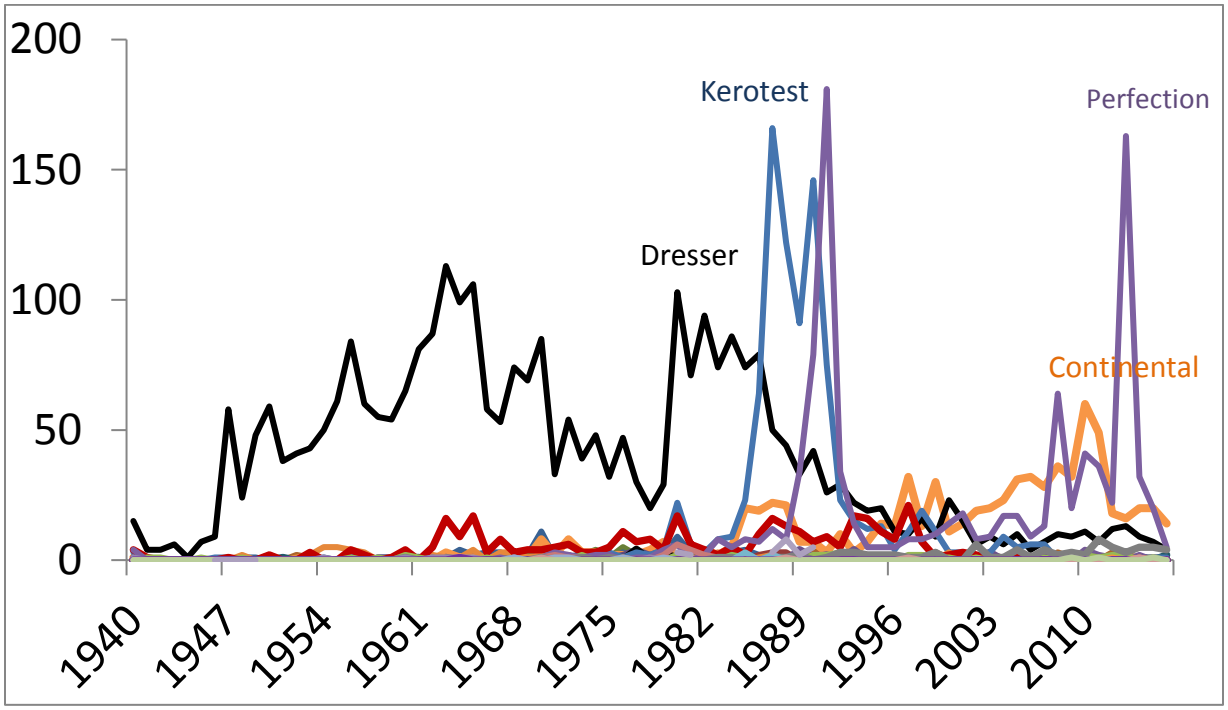
Input: Data analyzed from SAS Computer Application

Output: Figure 7 - Line plot of the number of failures by manufacturer by year fitting manufactured

Description: Line plot of the number of failures by manufacturer as reported by operators by year of fitting manufacture on the x-axis. All data will be presented in the plot.

Analysis: From this information, the MJFR Team will develop observations on the validity of the data by those manufacturers with known issues for give manufactured years. Manufacturers with 3 or less MJFRs are put into the “Other” category and not plotted.

Figure 7. Line plot of the number of failures by manufacturer by year fitting manufactured, 2011-2017



2.7.2 Manufacturer by Years in Service

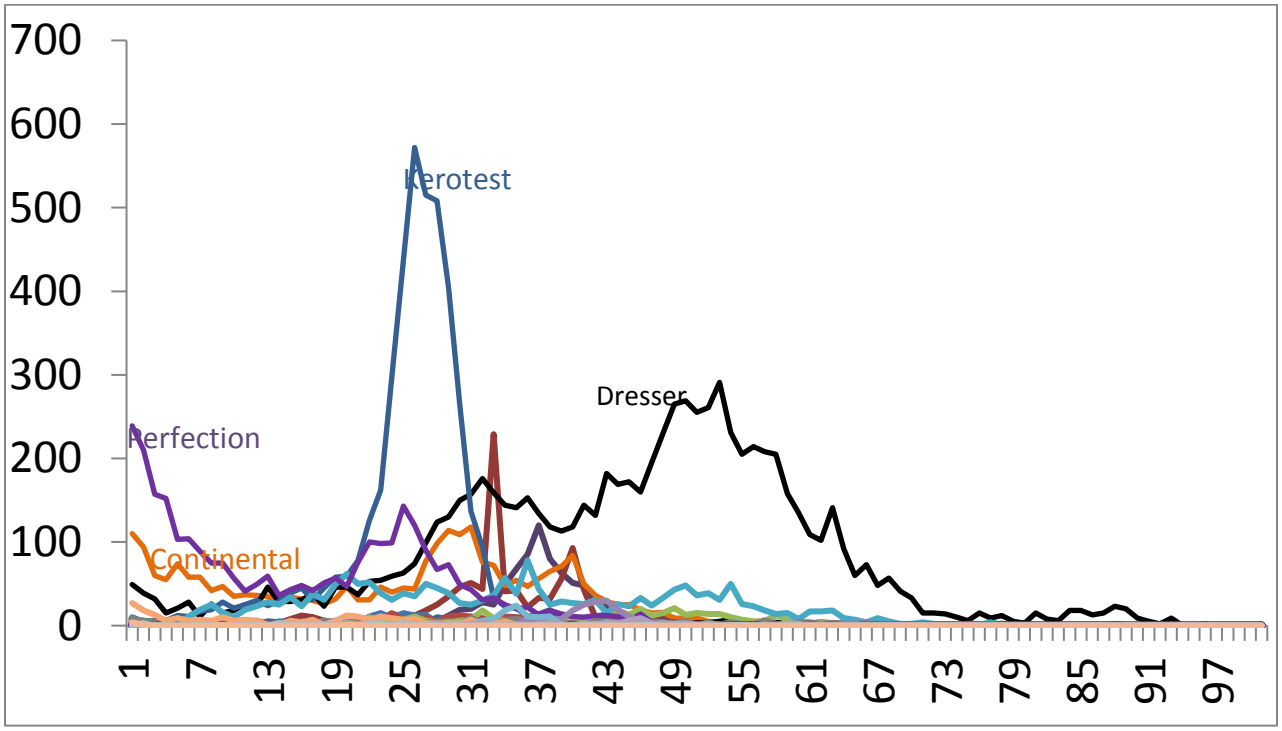
Input: Data analyzed from SAS Computer Application

Output: Figure 8 - Line plot of the number of failures by manufacturer by years of service

Description: Line plot of the number of failures by manufacturer as reported by operators by years of service on the x-axis. All data will be present in the plot.

Analysis: From this information, the MJFR Team will develop observations on those manufacturers who do have longer/shorter times in service. Manufacturers with 3 or less MJFRs are put into the "Other" category and not plotted.

Figure 8. Line plot of number of failures by manufacturer by years of service



2.7.3 Frequency of Manufacturers of Fittings

Input: Data analyzed from SAS Computer Application

Output: Table 25 - Manufacturers of failed mechanical fittings

Description: Table of the frequency of manufacturers reported by operators based on percentage of the data base. Due to the extent of the table, only the first 10 are listed. The table is read comparing percentages in the year column to the other year column for the various manufacturers.

Analysis: From this information, the MJFR Team will develop observations on prospective view of those manufacturers who have the highest reported number of failures.

The current view of Table 25 shows the last 4 years. Future version of Table 25 will include additional columns added for each year up to the previous 5 years. From this information, the MJFR Team will develop observations on the changes to the top 10 reported manufacturers.

Table 25. Frequency of manufacturers reported in MJFR data based on percentage of data, 2012-2017

Manufacturer	2012	Manufacturer	2013	Manufacturer	2014	Manufacturer	2015	Manufacturer	2016	Manufacturer	2017
Dresser	21%	Dresser	21%	Dresser	22%	Dresser	20%	Dresser	12%	Dresser	17%
Perfection	7%	Kerotest	8%	Kerotest	7%	Kerotest	6%	Kerotest	4%	Continental	5%
Kerotest	6%	Perfection	5%	Normac	5%	Perfection	4%	Continental	3%	Kerotest	5%
Normac	5%	Normac	4%	Perfection	5%	Continental	3%	Perfection	3%	Perfection	4%
Continental	5%	Continental	4%	Continental	3%	Normac	3%	Normac	2%	Chicago	4%
AMP	2%	AMP	1%	AMP	1%	AMP	1%	Chicago	2%	Normac	3%
Chicago	2%	Mueller	1%	Mueller	1%	Mueller	1%	AMP	1%	AMP	1%
RW Lyall	1%	RW Lyall	<1%	RW Lyall	1%	RW Lyall	<1%	Mueller	<1%	Mueller	1%
Mueller	1%	Handley	<1%	RobRoy	1%	Central Plastics	<1%	Powell	<1%	Powell	1%
Inner-tite	<1%	Inner-tite	<1%	Central Plastics	<1%	Chicago	<1%	RW Lyall	<1%	American	1%

2.7.4 Manufacturer by Year of Failure

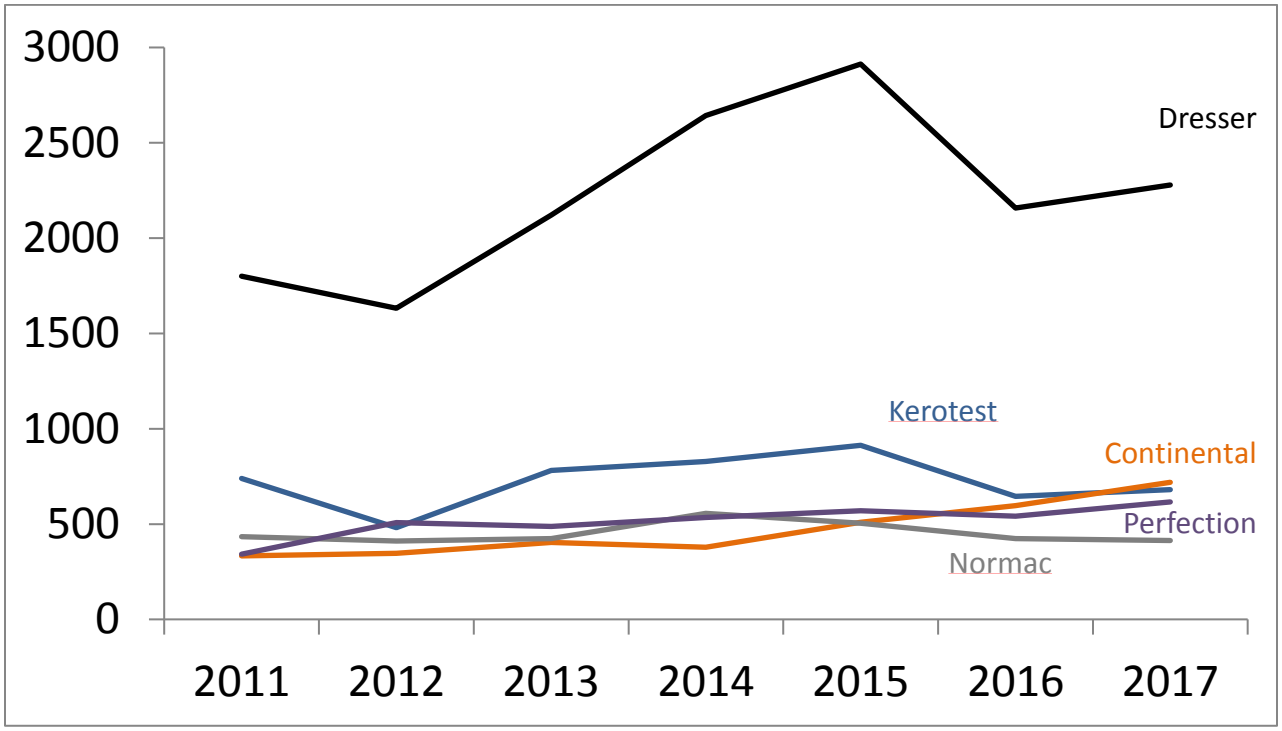
Input: Data analyzed from SAS Computer Application

Output: Figure 9 - Line plot of the number of failures by manufacturer by year of failure

Description: Line plot of the number of failures by manufacturer as reported by operators by year of failure on the x-axis. All data will be presented in the plot.

Analysis: From this information, the MJFR Team will develop observations on prospective view of those manufacturers who have an upward trend in the number of reported failures. Manufacturers with 3 or less MJFRs are put into the “Other” category and not plotted.

Figure 9. Line plot of number of failures by manufacturer by year of failure



2.7.5 Manufacturer by Leak Causes

Input: Data analyzed from SAS Computer Application

Output: Table 25 - Frequency of manufacturers by reported apparent cause of leak

Description: Table of manufacturers reported by operators, subdivided by reported apparent cause of leak (Part C Item 15) based on all data for all years.

Analysis: From this information, the MJFR Team will develop observations on manufacturers and leaks causes associated with those manufacturers. Manufacturers with 3 or less MJFRs are put into the "Other" category.

Table 26. Manufacturers by reported apparent cause of leak, 2011-2017

Manufacturer	Corrosion	Equipment	Excavation Damage	Incorrect Operation	Material or Weld	Natural Forces	Other	Other Outside Force Damage
ALDYL	0	3	1	0	3	2	3	0
AMERICAN	2	66	1	29	18	4	5	0
AMP	10	116	11	106	622	54	34	7
ANVIL RED	4	0	0	2	2	16	0	0
B K	0	8	0	0	0	0	0	0
CENTRAL PLASTICS (GEO	36	75	6	35	59	19	21	0
CHICAGO	59	959	7	48	12	31	2	2
CONICO	0	3	0	0	0	0	0	0
CONIND	0	1	0	0	0	0	0	0
CONINO	0	6	0	3	2	1	2	0
CONTINENTAL	148	1149	85	861	646	181	183	33
CSI/SMITH BLAIR/ROCKWELL	20	102	6	13	29	34	10	3
DRESSER	751	8800	370	679	974	2861	1033	75
DRISCO	3	35	4	1	9	3	4	1
DUPONT	1	3	2	27	36	4	3	5
EASTERN EBERHARD	1	1	1	1	2	1	5	0
FLO-CONTROL	0	3	0	0	0	18	0	0
HANDLEY	1	51	1	19	76	11	11	1
INNER-TITE	154	12	1	6	16	12	6	3
INTERNATIONAL	1	0	0	1	2	0	1	0
KEROTEST	38	2180	6	209	2163	191	264	20
LATIMER	7	3	0	0	1	0	0	0
M.T. DEASON	0	11	0	2	0	0	1	0
MET FIT	6	23	8	39	22	13	8	0
MGL	0	0	0	0	13	0	0	0
MUELLER	99	190	23	30	65	116	20	4
MURRAY	1	0	0	0	0	0	0	0
NORMAC	293	626	65	495	485	732	455	14
OTHER	22	107	13	36	54	63	72	14
PERFECTION	159	450	38	1526	755	207	433	28
PERFORMANCE	0	13	3	14	0	0	1	0
PLEXCO	0	11	2	21	20	0	1	0
POWELL	10	0	0	45	103	0	32	2
ROBROY	31	4	0	58	10	20	26	0
RW LYALL	17	93	65	91	74	32	25	11
SKINNER	6	14	1	2	1	12	3	0
SPEAR	0	0	0	1	0	8	0	1
SWEDGELOCK	0	6	1	0	0	0	1	1
TELSCO	30	29	1	37	16	6	11	0
UNK	2383	23740	1393	2554	6150	8423	3559	344
UPONOR	2	21	2	8	5	5	5	1
US POLY	0	1	1	6	1	1	4	0
WAYNE	12	86	2	19	41	17	8	0

2.7.6 Manufacturer by Mechanical Fitting Involved

Input: Data analyzed from SAS Computer Application

Output: Table 27 - Frequency of manufacturer by mechanical fitting involved

Description: Table based on all years of manufacturer by type of mechanical fitting involved.

Analysis: From this information, the MJFR Team will develop observations on prospective view of those manufacturers and mechanical fitting involved associated with those manufacturers. Manufacturers with 3 or less MJFRs are put into the "Other" category.

Table 27. Manufacturers by mechanical fitting type involved, 2011-2017

Manufacturer	Bolted	Nut Follower	other	Stab
ALDYL	1	1	10	0
AMERICAN	6	54	6	59
AMP	164	36	617	143
ANVIL RED	1	22	1	0
B K	0	0	8	0
CENTRAL PLASTICS (GEO	49	62	72	68
CHICAGO	4	136	976	4
CONICO	1	2	0	0
CONIND	0	0	1	0
CONINO	0	4	10	0
CONTINENTAL	497	899	991	899
CSI/SMITH BLAIR/ROCKWELL	82	87	44	4
DRESSER	2273	12134	917	219
DRISCO	4	21	17	18
DUPONT	5	3	69	4
EASTERN EBERHARD	9	3	0	0
FLO-CONTROL	0	18	3	0
HANDLEY	0	148	14	9
INNER-TITE	1	172	32	5
INTERNATIONAL	0	5	0	0
KEROTEST	75	4634	236	126
LATIMER	0	11	0	0
M.T. DEASON	0	12	2	0
MET FIT	2	10	77	30
MGL	6	0	7	0
MUELLER	66	304	161	16
MURRAY	0	1	0	0
NORMAC	30	2861	240	34
OTHER	65	182	100	34
PERFECTION	155	131	318	2992
PERFORMANCE	1	3	5	22
PLEXCO	2	11	25	17
POWELL	0	13	179	0
ROBROY	0	105	38	6
RW LYALL	107	42	122	137

Manufacturer	Bolted	Nut Follower	other	Stab
SKINNER	24	8	7	0
SPEAR	0	10	0	0
SWEDGELOCK	0	5	4	0
TELSCO	4	121	4	1
UNK	4515	31688	8782	3561
UPONOR	1	23	17	8
US POLY	0	1	9	4
WAYNE	2	147	24	12

2.8 Operators submitting MJFR

The MJFR Team members will analyze the data and generate the tables and charts outlined in this report. Typically, the data from PDM is moved into a computer application called “SAS” in which the data is manipulated for analysis. The output from SAS is moved into PowerPoint for presentation and discussion purposes. The most current data is available on the public and internal sides of the PDM. Other evaluations and analyses may be performed depending upon the trends in the data. For instance, the MJFR Team may decide to evaluate the number of MJFRs by mile of main or service that an operator is reporting or on an individual operator basis, as appropriate.

PHMSA cautions users of this data analysis to consider the information in the appropriate context such as amount and type of fittings an operator may have in their systems, system mileage, etc. There is no definitive information publicly available about the number of fittings produced or installed. Many operators do maintain an inventory tracking system of the number of fittings that may have purchased vs. in stock vs. installed, but numbers can vary. Therefore, PHMSA is unable to adjust the failure reports by the quantity produced or in use. For additional information, specific to a certain operator to help put numbers in better context, users are encouraged to contact the operator.

2.8.1 Frequency of Operator by Year of Failure

Input: Data analyzed from SAS Computer Application

Output: Table 28 - Frequency of operator-reported fitting failures by year

Description: Table of operator-reported failures by year.

Analysis: From this information, the MJFR Team will develop observations on prospective view of operators and reports.

Table 28. Operators reporting by year of failure

Operator	2011	2012	2013	2014	2015	2016	2017
ALABAMA GAS CORPORATION	48	48	55	41	29	25	0
ALEXANDER CITY MUNICIPAL GAS	0	0	0	3	2	0	0
ALLIANT ENERGY - INTERSTATE POWER AND LIGHT COMPANY	0	7	7	6	8	5	3
ALLIANT ENERGY - WISCONSIN POWER & LIGHT CO	0	0	0	0	0	0	1
AMEREN ILLINOIS COMPANY	136	141	171	192	352	347	297
AMERENUE	1	2	1	0	12	2	6
APPALACHIAN NATURAL GAS DISTRIBUTION COMPANY	0	0	0	2	0	0	0
ARKANSAS WESTERN GAS CO	1	1	0	0	0	0	0
ATLANTA GAS LIGHT CO	140	82	59	132	62	69	61
ATMOS ENERGY CORPORATION - COLORADO/KANSAS	3	4	13	3	3	2	7
ATMOS ENERGY CORPORATION - KY/MID-STATES (KENTUCKY)	14	19	21	18	24	14	14
ATMOS ENERGY CORPORATION - KY/MID-STATES (MID-STATES)	21	32	6	13	21	8	14
ATMOS ENERGY CORPORATION - LOUISIANA	8	23	14	22	29	31	27
ATMOS ENERGY CORPORATION - MID-TEX	453	382	482	397	593	404	221
ATMOS ENERGY CORPORATION - MISSISSIPPI	271	127	103	169	183	253	234
ATMOS ENERGY CORPORATION - WEST TEXAS	1	7	7	5	12	7	12
ATMOS PIPELINE - TEXAS	0	11	51	0	0	0	0
AUSTELL NATURAL GAS SYSTEM, CITY OF	1	0	0	0	0	0	0
AUSTIN UTILITIES	0	0	1	0	0	0	0
AVISTA CORP	19	37	32	52	53	42	28
BALTIMORE GAS & ELECTRIC CO	13	16	13	11	10	13	0
BALTIMORE GAS AND ELECTRIC COMPANY	0	0	0	0	0	0	11
BANGOR GAS CO LLC	1	5	0	0	0	0	0
BERKSHIRE GAS CO	5	4	17	20	33	23	6
BLACK HILLS ENERGY	4	6	6	8	5	5	4
BLACKSTONE GAS CO	0	1	2	0	1	0	0
BOSTON GAS CO	5	2	2	1	2	1	1
BRADY MUNICIPAL GAS CORP, CITY OF	0	6	6	1	1	0	0
BRENHAM UTILITY, CITY OF	3	1	2	5	3	6	0
CALERA MUNICIPLE GAS SYSTEM, TOWN OF	2	0	0	0	0	0	0
CARTERSVILLE GAS DEPT, CITY OF	2	4	1	1	0	0	3
CASCADE NATURAL GAS CORP	0	0	0	0	0	1	0
CASTROVILLE UTILITY SYSTEM	0	1	0	293	0	1	0
CEDAR FALLS MUNICIPAL UTILITY	0	0	0	1	0	0	0
CENTERPOINT ENERGY RESOURCES CORP.	0	18	10	4	4	47	79

Operator	2011	2012	2013	2014	2015	2016	2017
CENTERPOINT ENERGY RESOURCES, DBA CENTERPOINT ENERGY MINNESOTA GAS	39	23	55	62	31	19	42
CENTERPOINT ENERGY RESOURCES CORP.	0	119	201	262	267	157	304
CENTERVILLE, TOWN OF	2	0	0	1	0	1	4
CENTRAL FLORIDA GAS CORP	0	0	3	0	0	1	2
CENTRAL HUDSON GAS & ELECTRIC CORP	25	27	30	15	7	8	8
CHAMBERSBURG GAS DEPT	0	0	0	1	0	0	0
CHATTANOOGA GAS CO	30	33	25	41	43	9	5
CHELSEA GAS AUTH	0	0	0	0	1	0	0
CHESAPEAKE UTILITIES CORPORATION	0	15	8	0	3	3	0
CHESAPEAKE UTILITY CORP	7	0	0	0	0	0	0
CHEYENNE LIGHT FUEL & POWER	0	1	4	0	1	0	0
CHIRENO MUNICIPAL GAS, CITY OF	0	0	0	0	7	0	3
CIRCLE PINES UTILITY	3	0	0	0	0	0	0
CITIZENS GAS & COKE UTILITY	190	236	378	228	219	184	253
CITY OF BENSON	0	0	0	1	3	0	0
CITY OF CALERA NATURAL GAS	0	1	1	1	0	1	1
CITY OF DULUTH PUBLIC WORKS & UTILITIES	0	0	0	0	0	0	8
CITY OF ROCKPORT	4	1	1	6	3	2	10
CLARKSVILLE GAS & WATER DEPT	0	0	0	0	0	3	16
COCHRAN GAS SYSTEM, CITY OF	0	0	0	0	1	0	0
COLORADO SPRINGS, CITY OF	6	7	7	10	4	8	6
COLUMBIA GAS OF KENTUCKY INC	13	30	64	64	50	44	47
COLUMBIA GAS OF MARYLAND INC	14	20	18	37	34	23	28
COLUMBIA GAS OF MASSACHUSETTS	91	44	95	86	104	91	132
COLUMBIA GAS OF OHIO INC	359	239	353	448	388	315	432
COLUMBIA GAS OF PENNSYLVANIA	52	74	89	117	59	70	93
COLUMBIA GAS OF VIRGINIA INC	45	60	117	140	142	180	136
COMMUNITY NATURAL GAS INC	2	0	0	0	0	0	0
COMMUNITY UTILITIES CO.	0	0	0	0	0	1	0
CONNECTICUT NATURAL GAS CORP	16	17	40	52	48	48	37
CONSOLIDATED EDISON CO OF NEW YORK	412	352	417	418	579	307	287
CONSUMERS ENERGY CO	368	397	470	448	671	698	756
CONSUMERS GAS UTILITY CO	0	1	0	0	0	0	0
CORINTH GAS DEPT, CITY OF	0	0	0	7	13	16	11
CORNING MUNICIPAL UTILITIES	1	1	3	2	1	1	0
CORPUS CHRISTI, CITY OF - GAS DIV	10	14	6	5	2	0	5
COVINGTON GAS DEPT, CITY OF	0	3	0	0	0	0	0
CPS ENERGY	360	224	254	10	414	294	359
CULLMAN - JEFFERSON CO GAS DIST	1	0	0	0	0	2	0
DALTON WATER LIGHT & SINKING FUND COMMISSION	0	1	0	0	0	0	0
DANVILLE, CITY OF	1	1	1	0	4	3	3
DECATUR UTILITIES - GAS DEPARTMENT	0	1	0	0	0	0	0

Operator	2011	2012	2013	2014	2015	2016	2017
DELMARVA POWER & LIGHT COMPANY	1	1	1	6	6	5	5
DELTA NATURAL GAS CO INC	0	0	0	0	1	1	0
DOMINION EAST OHIO	76	63	62	51	39	41	0
DOMINION ENERGY OHIO	0	0	0	0	0	0	41
DOMINION ENERGY WEST VIRGINIA	0	0	0	0	0	0	5
DOMINION HOPE	12	19	19	19	18	6	0
DTE GAS COMPANY	0	0	8	3	3	2	1
DUBLIN, CITY OF	4	0	0	0	0	1	1
DUKE ENERGY KENTUCKY	1	10	11	3	6	9	15
DUKE ENERGY OHIO	26	78	26	39	23	21	68
DUPO GAS SYSTEM, VILLAGE OF	0	0	0	1	0	0	0
EASTERN NATURAL GAS CO	7	2	0	0	0	0	0
EASTON UTILITIES COMMISSION	0	0	0	3	1	2	0
ELIZABETHTOWN GAS CO	31	21	37	14	20	6	7
ELK RIVER PUBLIC UTIL DIST	0	0	0	2	0	0	0
ELKTON GAS SERVICE - DIV PENNS & SOUTHERN GAS CO	0	0	0	0	1	0	0
ENERGY NORTH NATURAL GAS INC	6	4	12	62	73	37	31
ENERGY WEST MONTANA	7	1	1	3	2	7	0
ENSTAR NATURAL GAS CO	14	13	2	16	6	4	8
ENTERGY GULF STATES	4	0	8	24	68	39	21
ENTERGY NEW ORLEANS, INC	3	5	3	6	7	3	0
ENTERGY NEW ORLEANS, LLC	0	0	0	0	0	0	2
ENTEX, A NORAM ENERGY COMPANY (FORM. DIV OF ARKLA	198	45	0	0	0	0	0
EQUITABLE GAS COMPANY, LLC	0	17	32	0	0	0	0
EQUITABLE RESOURCES (A.K.A EQUITABLE GAS CO)	10	0	0	0	0	0	0
ESSEX COUNTY GAS CO	0	2	0	0	0	0	1
FAIRBANKS NATURAL GAS	0	0	0	1	0	0	0
FAIRFIELD MUNICIPAL GAS UTILITY	2	1	0	0	0	0	1
FAIRHOPE GAS SYSTEM, CITY OF	0	1	0	0	0	0	0
FALFURRIAS UTILITY BOARD	0	18	6	43	11	0	5
FALLS CITY UTILITIES	0	1	0	0	0	0	0
FAYETTEVILLE PUBLIC UTILITIES GAS DEPT.	0	0	2	0	0	3	0
FITCHBURG GAS & ELECTRIC LIGHT CO	2	9	18	10	9	6	3
FLORENCE GAS DEPT, CITY OF	3	1	0	0	0	17	32
FLORIDA CITY GAS	1	0	0	0	2	0	0
FLORIDA PUBLIC UTILITIES CO	6	10	7	6	10	7	3
FORT HILL NATURAL GAS AUTH	0	0	0	0	5	5	6
FULTON MUNICIPAL GAS SYSTEM	0	0	0	0	0	2	0
GAINESVILLE REGIONAL UTIL GAS DEPT	1	0	0	0	0	1	0
GREAT PLAINS NATURAL GAS CO	4	1	0	0	2	1	0
GREATER MINNESOTA GAS INC.	0	0	0	0	1	0	0
GREENVILLE UTILITIES COMMISSION	2	1	9	3	7	7	10

Operator	2011	2012	2013	2014	2015	2016	2017
GREENWOOD COMMISSION OF PUBLIC WORKS	2	9	2	2	3	0	1
GUYMON MUNICIPAL GAS CO	0	1	0	0	0	1	0
HALLS GAS DEPT, TOWN OF	1	0	0	0	0	0	0
HALSTEAD GAS DEPT, CITY OF	0	1	0	0	0	0	0
HAMILTON GAS DEPT, CITY OF	8	8	10	1	2	6	2
HASTINGS UTILITIES	2	0	0	0	1	0	0
HAWAI`IGAS	0	0	11	29	1	0	0
HAWAII GAS	0	0	0	0	3	11	15
HAWARDEN GAS DEPT, CITY OF	1	2	2	1	0	0	0
HAWLEY UTILITIES COMM	0	0	0	0	0	1	0
HENDERSON MUNICIPAL GAS	0	0	0	0	0	1	0
HOLYOKE GAS & ELECTRIC DEPT, CITY OF	0	1	9	16	14	0	0
HUMBOLDT UTILITIES - GAS DEPT	13	17	9	4	7	3	4
HUNTSVILLE GAS SYSTEM	13	9	13	15	26	11	11
INDIANA GAS CO INC	87	66	61	95	97	55	60
INDIANA NATURAL GAS CORP	0	0	0	0	1	0	0
INTERMOUNTAIN GAS CO	9	4	3	9	10	16	14
JACKSON ENERGY AUTHORITY	44	19	31	13	10	11	6
KANSAS GAS SERVICE	89	68	62	0	0	0	0
KANSAS GAS SERVICE COMPANY, A DIVISION OF ONE GAS, INC.	0	9	27	197	159	110	63
KEYSPAN ENERGY DELIVERY - NY CITY	1	0	0	0	0	0	0
KEYSTONE RURAL GAS DISTRICT #1	2	1	2	0	0	3	0
KINGS MOUNTAIN NATURAL GAS SYSTEM	0	0	0	2	0	1	1
KNG ENERGY INC	2	0	0	1	4	2	3
KNOXVILLE UTILITIES BOARD	6	7	12	16	11	15	12
LACLEDE GAS CO	181	11	91	128	261	292	0
LAKE APOPKA NATURAL GAS DISTRICT	4	2	0	1	6	8	10
LAKE PARK MUNICIPAL UTILITIES	1	0	0	0	0	0	0
LAMONI MUNICIPAL UTILITIES	0	0	0	0	0	0	1
LANCASTER MUNICIPAL GAS CO, CITY OF	10	4	5	5	4	7	15
LAS CRUCES, CITY OF	1	4	1	1	0	0	1
LAURENS COMMISSION OF PUBLIC WORKS	0	0	0	2	1	0	2
LAWRENCEBURG GAS DEPT, CITY OF	16	10	8	9	6	9	7
LAWRENCEVILLE, CITY OF	0	1	1	9	40	6	8
LEBO MUNICIPAL GAS SYSTEM	1	0	0	0	0	0	0
LEFORS GAS DEPT, CITY OF	0	1	0	0	0	0	0
LEWISBURG GAS DEPARTMENT	3	0	1	5	2	1	0
LEXINGTON GAS SYSTEM	7	8	5	6	11	6	16
LIBERTY ENERGY (GEORGIA) CORP D/B/A LIBERTY UTILITIES GEORGIA	0	0	0	0	0	0	27
LIBERTY UTILITIES (NEW ENGLAND NATURAL GAS COMPANY) CORP	0	0	0	0	0	1	3
LIBERTY UTILITIES MASSACHUSETTS	0	0	8	11	12	9	0

Operator	2011	2012	2013	2014	2015	2016	2017
LITTLE RIVER MUNICIPAL SYSTEM, CITY OF	0	0	1	0	0	0	0
LIVE OAK GAS DEPT, CITY OF	0	1	0	0	0	0	0
LONG BEACH GAS DEPT, CITY OF	9	7	7	6	7	18	4
LOUISVILLE GAS & ELECTRIC CO	167	174	207	186	135	109	69
LUMBERPORT - SHINNSTON GAS CO	0	0	0	0	1	0	0
LYTLE MUNICIPAL SYSTEM	0	1	0	0	0	1	0
MADISON GAS & ELECTRIC CO	2	2	3	0	0	0	0
MADISON, CITY OF	5	9	0	0	0	0	0
MAINE NATURAL GAS	0	0	0	1	0	2	12
MARIANNA, CITY OF	1	1	2	1	1	1	1
MARSHALL COUNTY GAS DISTRICT	5	7	11	5	2	2	5
MEMPHIS LIGHT GAS & WATER DIVISION	106	247	546	423	203	214	504
METROPOLITAN UTILITIES DISTRICT	4	2	0	3	4	2	2
MICHIGAN CONSOLIDATED GAS CO (MICHCON)	2	5	0	0	0	0	0
MICHIGAN GAS UTILITIES CO	19	30	29	42	19	8	26
MIDAMERICAN ENERGY COMPANY	41	58	38	36	22	36	17
MIDDLEBOROUGH GAS & ELECTRIC DEPT	0	0	0	1	70	1	0
MIDDLEBOROUGH GAS & ELECTRICT DEPT	5	0	0	0	0	0	0
MIDWEST NATURAL GAS CORP	2	0	3	0	0	0	0
MIDWEST NATURAL GAS INC	1	0	0	0	0	0	0
MINNESOTA ENERGY RESOURCES CORPORATION	1	1	0	1	1	1	0
MISSISSIPPI RIVER GAS LLC	2	1	0	0	0	0	0
MISSOURI GAS ENERGY	1	1	0	0	19	68	0
MOBILE GAS SERVICE CORP	15	8	14	19	15	9	7
MONROE NATURAL GAS DEPT, CITY OF	0	0	1	0	0	0	0
MONTANA - DAKOTA UTILITIES CO	23	23	20	50	46	45	37
MOULTON MUNICIPAL GAS SYSTEM	0	0	1	0	0	0	0
MOULTRIE GAS DEPT, CITY OF	1	0	0	0	0	0	0
MOUNTAINEER GAS CO	7	5	5	0	1	1	4
MT CARMEL PUBLIC UTILITY CO	0	1	0	0	0	0	0
NATIONAL FUEL GAS DISTRIBUTION CORP	22	33	36	63	54	54	58
NATIONAL FUEL GAS DISTRIBUTION CORP - NEW YORK	40	64	99	121	92	57	57
NATIONAL GAS & OIL CORP	23	21	67	200	74	37	57
NAVASOTA, CITY OF	0	4	2	0	0	0	0
NEW ALBANY GAS SYSTEM	5	0	0	0	0	0	0
NEW ENGLAND GAS COMPANY	3	5	1	0	0	0	0
NEW JERSEY NATURAL GAS CO	20	34	47	61	51	53	66
NEW MEXICO GAS COMPANY	116	84	77	53	51	61	76
NEW YORK STATE ELECTRIC & GAS CORP	0	23	34	19	14	24	41
NGO TRANSMISSION, INC.	0	0	0	2	0	0	0
NIAGARA MOHAWK POWER CORP	8	4	2	9	25	9	9
NORTH SHORE GAS CO	4	4	1	0	1	13	19

Operator	2011	2012	2013	2014	2015	2016	2017
NORTHERN ILLINOIS GAS CO	780	425	350	273	178	533	961
NORTHERN INDIANA PUBLIC SERVICE CO	139	127	274	509	617	778	762
NORTHERN STATES POWER CO OF MINNESOTA	74	43	80	63	45	44	43
NORTHERN STATES POWER CO OF WISCONSIN	12	0	1	6	3	6	14
NORTHERN UTILITIES INC (ME)	1	0	0	3	0	4	3
NORTHERN UTILITIES, INC. (NH)	0	0	0	2	0	1	0
NORTHWEST ALABAMA GAS DISTRICT	0	1	2	7	9	2	0
NORTHWEST NATURAL GAS CO	20	27	9	8	7	13	13
NORTHWESTERN CORPORATION	0	0	0	0	0	2	0
NORTHWESTERN ENERGY LLC	13	5	5	4	2	0	0
NORWICH DEPT OF PUBLIC UTILITIES, CITY	0	1	0	3	2	1	0
NSTAR GAS COMPANY	0	1	0	11	15	0	6
NV Energy	13	18	52	35	18	18	26
OHIO GAS CO	3	2	0	1	1	0	2
OHIO VALLEY GAS CORP	0	0	0	0	0	1	0
OHIO VALLEY GAS INC	0	0	0	0	0	0	1
OKLAHOMA NATURAL GAS CO	15	8	0	0	0	0	0
OKLAHOMA NATURAL GAS COMPANY, A DIVISION OF ONE GAS, INC.	2	45	84	45	68	50	46
ORANGE & ROCKLAND UTILITY INC	0	0	48	96	137	70	74
ORWELL NATURAL GAS CO	0	0	0	0	1	0	0
PACIFIC GAS & ELECTRIC CO	229	288	296	219	408	439	437
PALO ALTO, CITY OF	1	2	0	0	0	0	1
PASCAGOULA NATURAL GAS SYSTEM, CITY	0	0	2	5	2	5	1
PECO ENERGY CO	7	15	5	3	3	4	68
PENSACOLA, ENERGY SERVICES OF	4	26	7	1	0	0	0
PEOPLES GAS LIGHT & COKE CO	68	107	138	90	47	16	41
PEOPLES GAS SYSTEM INC	8	9	16	11	24	15	11
PEOPLES NATURAL GAS COMPANY LLC	21	20	36	49	401	620	463
PEOPLES TWP LLC	3	4	3	1	0	0	0
PERRY GAS SYSTEM, CITY OF	0	0	0	0	0	1	0
PHILADELPHIA GAS WORKS	248	203	425	626	606	378	437
PIEDMONT NATURAL GAS CO INC	3	58	89	136	222	122	65
POWELL CLINCH UTIL DIST	0	2	3	8	3	10	5
PRESQUE ISLE ELECTRIC & GAS COOP	1	2	1	1	2	3	0
PUBLIC SERVICE CO OF COLORADO	139	95	112	148	109	145	142
PUBLIC SERVICE CO OF NORTH CAROLINA	11	7	24	37	51	29	29
PUBLIC SERVICE ELECTRIC & GAS CO	71	38	64	178	154	368	272
PUGET SOUND ENERGY	38	42	20	36	21	40	43
QUESTAR GAS COMPANY	33	45	1	1	1	0	0
RANTOUL, VILLAGE OF	0	0	0	1	0	0	0
RELIANT ENERGY ARKLA, DIV OF RELIANT ENERGY RESOURC	56	0	0	0	0	0	0

Operator	2011	2012	2013	2014	2015	2016	2017
REMSEN MUNICIPAL UTILITIES, TOWN OF	0	0	1	0	0	0	1
RICHMOND NATURAL GAS & SEWAGE WKS	0	0	0	0	0	1	0
RICHMOND, CITY OF	41	47	52	53	66	21	19
ROANOKE GAS CO	10	16	27	31	30	24	14
ROBSTOWN GAS SYSTEM, CITY OF	2	0	0	0	0	0	0
ROCHESTER GAS & ELECTRIC CORP	0	11	28	11	13	20	178
Rock Energy Cooperative	0	0	0	0	1	0	0
ROCKY MOUNT MUNICIPAL SYSTEM, CITY	4	0	0	2	1	3	1
ROZEL MUNICIPAL GAS SYSTEM, CITY	1	1	0	0	1	0	1
RUSSELVILLE GAS BOARD	0	0	0	0	0	0	2
SAN DIEGO GAS & ELECTRIC CO	0	2	4	6	2	2	3
SANDPIPER ENERGY	0	0	0	1	4	0	0
SAVANNAH PUBLIC UTILITY DEPT	3	1	0	0	0	0	0
SEMCO ENERGY GAS COMPANY	50	49	33	54	54	31	20
SEVIER COUNTY UTIL DIST	0	2	1	0	3	1	0
SHELBY GAS DEPT, CITY OF	0	0	0	0	1	0	0
SOMERSET GAS SERVICE	4	2	11	2	4	0	0
SOURCEGAS ARKANSAS INC.	0	0	5	5	4	0	0
SOURCEGAS LLC	5	1	6	3	4	1	0
SOUTH ALABAMA GAS DISTRICT	7	0	0	0	0	0	2
SOUTH CAROLINA ELECTRIC & GAS CO	101	77	50	40	59	42	45
SOUTH JERSEY GAS CO	26	36	30	59	78	78	123
SOUTHEAST ALABAMA GAS DISTRICT	0	0	0	0	6	6	6
SOUTHEAST GAS	0	0	0	0	0	0	1
SOUTHEASTERN NATURAL GAS CO	1	0	0	0	0	0	0
SOUTHERN CALIFORNIA EDISON CO	0	0	1	1	0	0	0
SOUTHERN CALIFORNIA GAS CO	0	23	27	28	26	13	7
SOUTHERN CONNECTICUT GAS CO	15	7	20	22	24	17	25
SOUTHERN INDIANA GAS & ELECTRIC CO	121	93	91	146	201	127	128
SOUTHERN PUBLIC SERVICE CO	1	0	0	0	0	0	0
SOUTHWEST GAS CORP	116	178	192	113	249	221	220
SOUTHWESTERN VIRGINIA GAS CO	2	6	10	4	4	1	3
SPIRE ALABAMA INC.	0	0	0	0	0	0	39
SPIRE MISSOURI INC. EAST	0	0	0	0	0	0	242
SPIRE MISSOURI INC. WEST	0	0	0	0	0	0	104
SPRINGFIELD GAS SYSTEM	0	2	0	0	0	0	0
SPRINGFIELD, CITY UTILITIES OF	56	40	72	75	92	66	48
ST CROIX VALLEY NATURAL GAS CO INC	0	0	0	0	5	5	3
SUBURBAN NATURAL GAS COMPANY	1	0	0	0	0	0	0
SUGAR HILL NATURAL GAS SYSTEM, CITY OF	2	0	0	0	0	0	0
SUPERIOR WATER LIGHT & POWER CO	0	7	3	0	0	0	7
SWEENY GAS SYSTEM, CITY OF	0	0	6	1	0	0	0
SWEETWATER BOARD OF PUBLIC UTILITES	0	0	0	1	1	1	0
SYCAMORE GAS COMPANY	4	8	4	4	5	2	3
TALLAHASSEE, CITY OF	29	0	0	0	0	0	0

Operator	2011	2012	2013	2014	2015	2016	2017
TEAVEE OIL & GAS INC	0	0	1	0	0	0	0
TEXAS GAS SERVICE COMPANY	92	141	0	0	0	0	0
TEXAS GAS SERVICE COMPANY, A DIVISION OF ONE GAS, INC.	0	4	129	157	114	110	91
THE EMPIRE DISTRICT GAS COMPANY	3	1	1	0	0	0	0
THE GAS COMPANY	16	20	1	0	0	0	0
TRUSSVILLE, UTILITIES BOARD, CITY OF	1	5	7	0	0	1	2
UGI CENTRAL PENN GAS, INC	5	9	1	2	9	4	4
UGI PENN NATURAL GAS	199	115	105	152	169	95	123
UGI UTILITIES, INC	143	140	209	315	351	189	226
UNICOI COUNTY MUNICIPAL UTILITY AUTH	0	0	0	0	0	1	1
UNION OIL & GAS INC	0	1	7	6	1	0	6
UNION UTILITY DEPT, CITY OF	3	0	0	0	1	0	0
UNISOURCE ENERGY SERVICES	3	13	12	6	7	4	6
VALLEY ENERGY, INC.	2	1	46	40	10	5	5
VECTREN ENERGY DELIVERY OF OHIO	44	17	33	70	100	69	51
VERMONT GAS SYSTEMS INC	5	16	4	8	19	1	2
VILLAGE OF MORTON	1	0	0	0	0	0	0
VIRGINIA NATURAL GAS	16	41	116	228	220	147	118
WALLER, CITY OF	0	0	1	0	0	0	0
WALNUT MUNICIPLE GAS SYSTEM, TOWN	1	2	1	1	1	0	0
WASHINGTON GAS LIGHT CO	238	298	471	930	2973	7342	1940
WATERTOWN MUNICIPAL GAS DEPT	0	0	0	1	0	0	0
WATERVILLE GAS & OIL CO	2	1	4	4	2	0	0
WE ENERGIES	12	0	0	0	0	0	0
WEST POINT GAS SYSTEM	0	0	2	0	0	0	0
WEST TEXAS GAS INC	0	0	4	0	1	3	0
WESTFIELD GAS CORP	0	0	0	0	0	2	0
WILLMUT GAS & OIL CO - MAIN OFFICE	4	3	1	3	3	3	2
WILSON GAS DEPT, CITY OF	0	11	4	6	11	6	10
WISCONSIN ELECTRIC POWER COMPANY DBA WE ENERGIES	0	1	0	46	28	38	23
WISCONSIN GAS CO	7	0	0	0	0	0	0
WISCONSIN GAS LLC DBA WE ENERGIES	0	38	219	356	258	211	202
WISCONSIN PUBLIC SERVICE CORP	4	4	1	3	0	0	1
YANKEE GAS SERVICES CO	140	121	177	231	168	101	130
YORK COUNTY NATURAL GAS AUTH	0	0	1	0	0	1	0

3.0 Future Analysis Ideas and Concepts

Additional years of data will allow for the application of the appropriate statistics. The format of the tables and figures will change over time to accommodate the additional information. For example, more line plots have been used in this year's report, which covers 7-years' worth of data.

3.1 Limitations

Due to the nature of the data, some types of analysis cannot be performed; for example, some analysis requires multiple years' worth of information. For surveillance systems, 5 years is the generally accepted minimum. The MJFR database now meets this threshold, and the information collection activity will continue for another 3 years.

The largest limitation facing MJFR analysis is the absence of denominator information. Information on how many, what type, and where the fittings were installed is not available. Another limitation that is common among surveillance systems is issues with the interpretation of the report form itself. The MJFR team has made attempts to edit any potential misunderstandings with the report form and instructions for the report form. Also, as with any other surveillance system, there is the variance of data quality between reports. An example would be the naming convention of manufacturers from submitted MJFRs with varying manufacturer names describing the same manufacturer. The MJFR Team has mapped names together when appropriate.

3.2 Updates

Data submitted for 2017 shows similar trends to the previous years of data. Tables with aggregated views of data replaced some tables that appeared in last year's report. These removed tables did not appear to add any additional information that could not be gathered from an aggregate view of the data. At this time, no other additional analysis has been identified for inclusion.

Rulemaking is in progress to change the name of the Mechanical Fitting Failure Report to Mechanical Joint Failure Report to represent that the hazardous leak occurred within a joint connection of pipe and the apparent cause of leakage may not be due to equipment failure of the mechanical fitting.

4.0 Technical Review and Analysis

Input: Figures, Tables, Data generated from Analysis in Section 2

Output: This report with updated tables and figures inserted into the document or other appropriate documentation

Description: The MJFR Team will meet to discuss the initial analysis, vet out concepts and ideas about what the data analysis represents, and consider potential additional analysis. The meetings will be held in person and via web-based meeting. Meeting minutes documenting initial observations and recommendations will be distributed for comments and review internally within PHMSA.

Following annual discussions of the data and analysis, the MJFR Team will document observations and recommendations in an electronic format suitable for transmission and filling. This documentation is typically the completion of this procedural document. Other documentation may include more informal dissemination of information through the DIMP website or presentations and discussion with stakeholders, or if more formal action is needed, a Memorandum, Technical Report, Advisory Bulletin, or email transmission to PHMSA personnel. The analysis should include consideration and discussion of, but not limited to, the following:

- Trends in data analysis
- Suspect materials, specific models of mechanical fittings, etc.
- Identification of issues that represent a threat to the integrity of the nation's distribution pipeline system
- Areas of concern identified by the MJFR Team

4.1 Overview of Analysis

Analysis of the MJFR data received to date is consistent with what was expected when PHMSA initiated this information collection activity and is consistent with other data sources (e.g., data from Gas Distribution annual reports). Data submitted for 2017 shows similar trends to previous 5 years of data collection, and trends in the data are within acceptable variance.

In summary, the majority of mechanical joint failures resulting in a hazardous leak involve nut-follower, coupling type fittings. In 2018, data analysis provides the following:

- Equipment failure is the leading reported cause of leaks (42%), and Natural forces is second (18%)
- Majority of leaks occur outside (99%), belowground (90%) involving service-to-service connections (62%)
- Steel fittings (62%) are involved the majority of reports, and plastic fittings are second (25%)
- Valves are involved in 13% of reported failures in 2017.

For the most part, the results align with the expectations when PHMSA initiated this information collection activity with mechanical joint failures involving:

- Mostly steel, mostly couplings, mostly belowground, and the number of reports being 10,000-15,000/year
- Average time to failure by fitting material type of mechanical fittings in 2015 for steel is 46 years and for plastic is 26 years

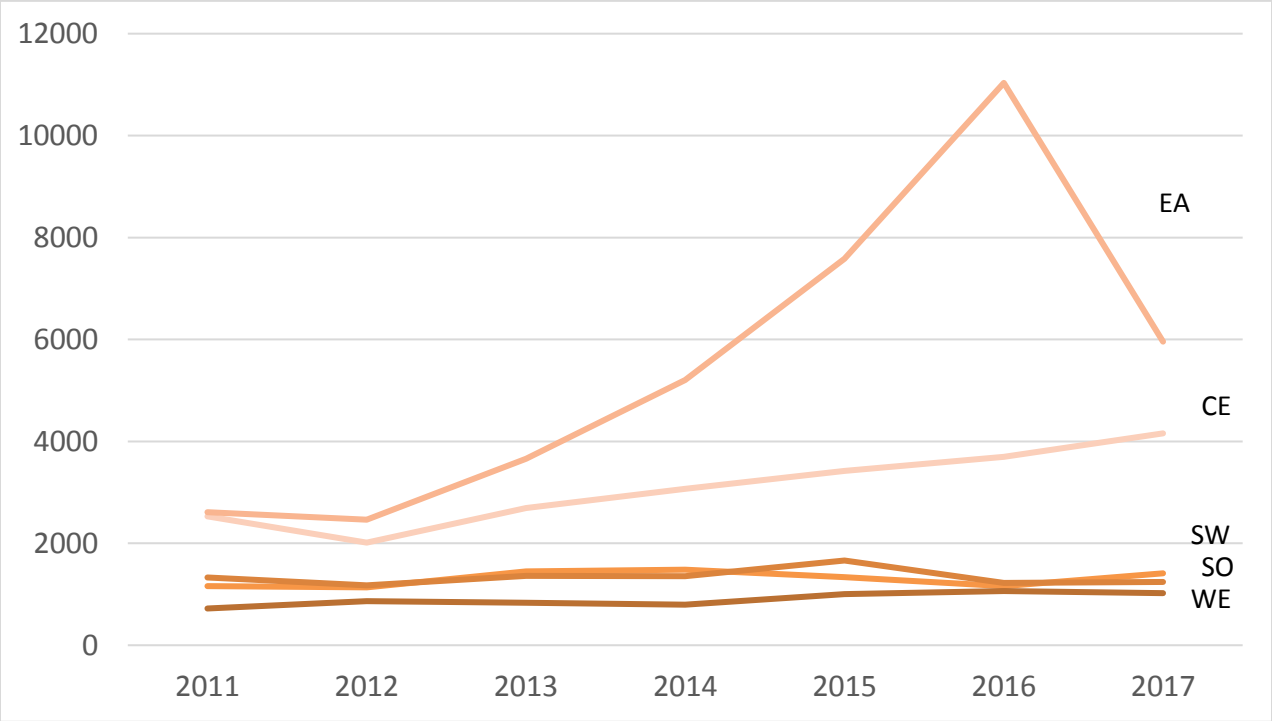
Communication of Performance Data is through the DIMP web page. To view MJFR data, go to: http://primis.phmsa.dot.gov/dimp/perfmeasures.htm
Total Report Submitted Numbers (04/02/2018):

MJFRs submitted in 2011 – 8,344
MJFRs submitted in 2012 – 7,654
MJFRs submitted in 2013 – 9,993
MJFRs submitted in 2014 – 11,901
MJFRs submitted in 2015 - 15,003
MJFRs submitted in 2016 – 18,174
MJFRs submitted in 2017 - 13,790

Figure 10. Graphic representation of MJFR by year, as of 04/02/2018

To further break down the rising trend in the number of submitted MJFRs, the team looked at PHMSA Regional data (see Figure 11). The PHMSA Regional data shows upward trends in Central and Eastern Regions, however State-by-State data is likely more meaningful. PHMSA Regions cover great distances both east to west and north to south, and differences in climate and stratigraphy in PHMSA Regions make drawing conclusions based on PHMSA Regions difficult at best. Tables 17-20 on the MJFR failure data by State are more meaningful for drawing conclusions, as a particular State's data could lead investigation into installation age and other meaningful variables. The same approximate number of operators are submitting MJFRs as in previous years, and the data analysis does not provide a specific reason for the upward trend in the number of MJFRs submitted. The MJFR data needs to be discretely evaluated on a State-by-State and at an operator level during regulatory inspections and during periodic evaluations performed in integrity management programs by operators to meet regulatory requirements.

Figure 11. MJFR data submitted by PHMSA Region per year



The Mechanical Joint Failures are being identified in many Operator's DIMPs as a significant threat requiring risk mitigation measures. The rate of hazardous leaks repaired involving a mechanical fitting for 2017 is the number of MFFR (13,790) divided by the total number of hazardous leaks reported as eliminated/repaired in 2017 (202,208) which is 6.8%. This percentage of hazardous leaks eliminated/repaired that involve a mechanical fitting over the years of the information collection activity is shown in Table 24 (on page 30).