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

This procedure describes how PHMSA will process and analyze data from operators of gas distribution pipelines for mechanical fitting failures that result in a hazardous as required in §192.1009.

Contents

Mechanical Fitting Failure Reporting Requirements

Mechanical Fitting Failure Reports (MFFR) for the previous calendar year are required to be submitted to PHMSA by March 15th of the next year. Operators are required to submit their reports electronically through the PHMSA Pipeline Data Mart (PDM) system. This data is then available to PHMSA personnel in the PDM, and the data can be downloaded and analyzed. This procedure describes how PHMSA will process and analyze data from operators of gas distribution pipelines for mechanical fitting 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 hazardous leaks involving mechanical fittings so that any identified safety concerns can be addressed appropriately. Information collected 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 PHMSA process for analyzing MFFR data is described in the following flowcharts and process descriptions along with expected outputs. The intent of the analysis 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, etc.)
- 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
- Future Analysis Ideas and Concepts
- Technical Review and Analysis

The outputs will be analyzed and observations from the team's perspective will be documented by the MFFR Team in an electronic format suitable for transmission and filling. The format 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 Associate Administrator. The MFFR team is comprised of PHMSA engineers, data analysts and other staff.

1.0 Receipt of Data and Initial Processing

The MFFR Team will obtain the previous calendar year's data from the PDM approximately one month following the deadline to allow for quality checks to be performed on the data by PHMSA IT personnel. The MFFR 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 MFFR Team will begin analysis.

2.0 Data Triaging and Analyses

The MFFR Team members will analyze the MFFR data and generate the tables and charts outlined in this procedure. 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. Other evaluations and analyses may be performed 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, 2015

Output: Various tables and charts

Responsibility: MFFR Team

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

Table 1 – 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 MFFR 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
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

Description of Data to be analyzed	Description of Data Source(s)	Typical Output
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
2.7.1 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 24
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 25
2.7.6 Manufacturer by Mechanical Fitting Involved	All years of manufacturer by mechanical fitting type involved (Part C Items 3 & 9)	Table 26
2.8.1 Operator by Year of Failure	Operators reporting by year of failure (Part A Item 2 & Part C Item 2)	Table 27

2.2 General information from MFFR reports

2.2.1 General Overview of the MFFR Information

Input: Original Excel Spreadsheet from PDM

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

Responsibility: MFFR Team

Description: General information about the number of reports, number of operators, and number of manufacturers and the amounts of missing information. An example of what the data table looks like is

provided below in Table 1. From this information, the MFFR Team will develop observations on coverage and representation of the information reported.

Table 1. General overview of the Mechanical Fitting Failure Reports, 2011-2014

	2011	2012	2013	2014
Number of Reports	8356	7614	9915	11676
Number of Reporting Operators	188	190	178	173
Number of states of origin	50 and DC	50 and DC	47 and DC	49 and DC
Number of Manufacturers	59	64	55	59
Percent of Missing Manufacturers	51%	47%	52%	52%

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

Responsibility: MFFR Team

Description: General information about the year manufactured and/or installed the amounts of missing information, and the average time to failure and range. An example of what the data looks like is provided below in Table 2. From this information, the MFFR 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 Fitting Failure Reports, 2011-2014

	2011	2012	2013	2014
Percent Missing Year of Manufacture	89%	88%	89%	89%
Percent Missing Year of Installation	42%	37%	40%	35%
Average Time to Failure and Range	33 Years (0 - 124)	33 Years (0 – 132)	34 Years (0 – 121)	37 Years (0-124)

*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

Responsibility: MFFR Team

Description: Produce a table of decade of installation of the mechanical fittings that failed. Compare percentage of this table to percentages from the annual reports about mileage installed in given decades. An example of what the data table looks like is provided below in Table 3. From this information, the MFFR Team will develop observations on the validity of the data because 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 Fitting Failure Reports, 2011-2014

	2011 Count (%)	2012 Count (%)	2013 Count (%)	2014 Count (%)
Pre 1940s	41 (2%)	22 (3%)	15 (3%)	17 (4%)
1940s	23 (1%)	6 (1%)	25 (5%)	16 (4%)
1950s	191 (11%)	71 (9%)	59 (13%)	31(8%)
1960s	338 (19%)	168 (21%)	91 (19%)	53(14%)
1970s	483 (27%)	232 (29%)	122 (25%)	84 (22%)
1980s	380 (21%)	185 (24%)	82 (17%)	103 (27%)
1990s	155 (9%)	61 (8%)	51 (11%)	59 (15%)
2000s	164 (9%)	33 (4%)	27 (6%)	15 (4%)
2010s	5 (1%)	6 (1%)	3 (1%)	6 (2%)

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

Responsibility: MFFR Team

Description: Produce a table of average and range time to failure by fitting material (Part C Item 13 of the form). An example of what the data table looks like is provided below in Table 4. Based on all data and other information, when the year of manufactured 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 there year of install is reported more, table 4 will use year of install. From this information, the MFFR 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 Fitting Failure Reports, 2011-2014

	2011	2012	2013	2014
	Average (Range)	Average (Range)	Average (Range)	Average (Range)
Steel	39 (0 – 124)	41 (0 – 117)	42 (0 – 113)	44 (0 – 124)
Plastic	21 (-1 – 70)	21 (0 – 87)	22 (0 – 84)	24 (0 – 115)
Combination (Steel and Plastic)	26 (0 – 76)	20 (0 – 90)	22 (0 – 113)	23 (0 – 115)
Unknown	41 (0 – 71)	37 (1 – 61)	39 (3 – 57)	43 (2 – 86)
Other	50 (0 – 111)	51 (1 – 117)	49 (0 – 121)	37 (2 – 113)
Brass	41 (0 – 82)	45 (0 – 132)	43 (0 – 69)	46 (1 – 1139)

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 was 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

Responsibility: MFFR Team

Description: Produce a bar chart of material type with the percentages on the y-axis. An example of what the data table looks like is provided below in Figure 1. Table 5 will also be produced representing the data with the counts and percent. From this information, the MFFR Team will develop observations on the ratio of material types that are used and trends across years.

Figure 1. Frequency of mechanical fittings by material type reported to the Mechanical Fitting Failure Reports, 2011-2014

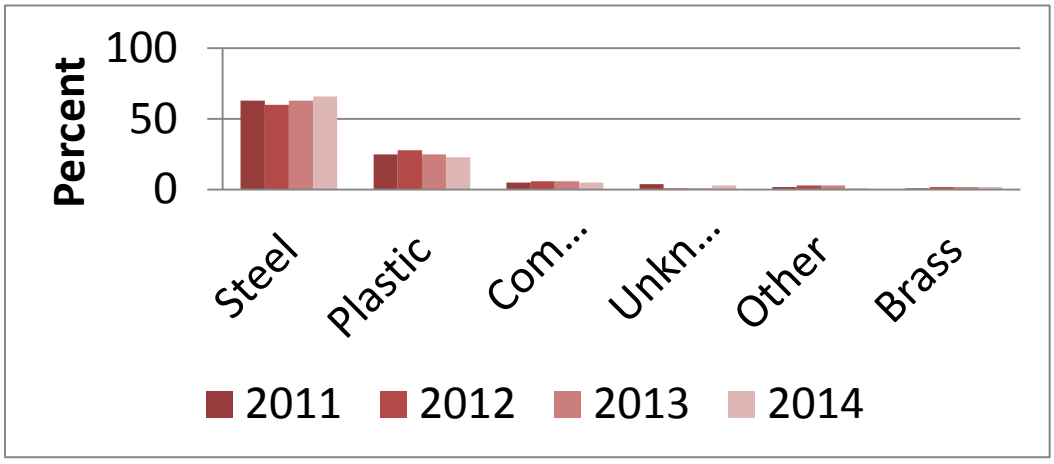


Table 5. Frequency of mechanical fittings by material type reported to the Mechanical Fitting Failure Reports, 2011-2014

	2011 Count (%)	2012 Count (%)	2013 Count (%)	2014 Count (%)
Steel	5239 (63%)	4610 (60%)	6260 (63%)	7670 (66%)
Plastic	2071 (25%)	2097 (28%)	2498 (25%)	2735 (23%)
Combination (Steel and Plastic)	455 (5%)	450 (6%)	555 (6%)	567 (6%)
Unknown	344 (4%)	94 (1%)	127 (1%)	364 (3%)
Other	165 (2%)	192 (3%)	297 (3%)	127 (1%)
Brass	82 (1%)	171 (2%)	93 (2%)	93 (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

Responsibility: MFFR Team

Description: Produce a 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. An example of what the data table looks like is provided below: Table 6 provides a summary of all the data submitted. From this information, the MFFR 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 Fitting Failure Reports, (all years) 2011-2014

	Second Pipe Material Type							
First Pipe Material Type		**Cast/Wro**	**Copper**	**Ductile**	**Other**	**Plastic**	**Steel**	**Unknown**
	Cast/Wro	497 (1%)	7	8	1	40	56	3
	Copper	6	772 (2%)	0	1	170	235	64
	Ductile	22	0	518 (1%)	0	5	6	0
	Other	0	4	0	67 (<1%)	8	1193	0
	Plastic	32	65	6	16	11012 (29%)	2525	24
	Steel	31	148	6	197	1963	17453 (47%)	98
	Unknown	0	2	0	1	12	18	152 (<1%)

2.3.4 Fitting Material by Leak Cause

Input: Data analyzed from SAS Computer Application

Output: Table 7 - Fitting material by leak cause

Responsibility: MFFR Team

Description: Produce a table for Fitting Material (Part C Item 13) by Apparent Cause of Leak (Part C Item 15). An example of what the data table looks like is provided below in Table 7. The table is read comparing percentages in the column to the other column for the various causes and fitting material. From this information, the MFFR 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 Fitting Failure Reports, 2011-2014

	Corrosion	Equipment	Excavation	Incorrect Operation	Material or Weld	Natural Forces	Other	Other Outside Forces
Steel	7%	48%	3%	4%	6%	22%	9%	1%
Plastic	0%	31%	2%	22%	29%	6%	9%	1%
Combination	7%	21%	2%	22%	25%	11%	10%	2%
Unknown	5%	31%	7%	12%	5%	35%	3%	2%
Other	8%	29%	1%	2%	9%	41%	9%	1%
Brass	5%	56%	5%	3%	12%	14%	4%	1%
Total	5%	43%	2%	9%	15%	16%	9%	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

Responsibility: MFFR Team

Description: Produce a plot of the number of failures by pipe sizes being joined (Part C Item 14, First Pipe Nominal Size and Second Pipe Nominal Size). An example of what the data table looks like is provided below in Table 8. First pipe size is reflected in the rows and Second pipe size is reflected in the columns. From this information, the MFFR 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 Fitting Failure Reports, (all years) 2011-2014

	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	81 (<1%)	28	18	6	3	2	0	0	0	0	0	0
½ inch	32	3609 (14%)	1638	420	26	2	0	48	1	9	2	1
¾ inch	14	670	3820 (15%)	133	37	2	0	86	5	11	2	3
1 inch	5	243	198	6248 (25%)	95	4	2	27	6	12	6	3
1 ¼ inch	3	74	73	160	1761 (7%)	27	1	34	7	10	4	1
1 ½ inch	0	4	2	15	17	152 (1%)	0	0	0	0	0	0
1 ¾ inch	0	1	2	0	2	0	2 (0%)	0	0	0	0	0
2 inch	1	249	172	132	47	11	1	3075 (12%)	20	9	4	2
3 inch	0	7	14	19	8	2	0	22	122 (1%)	2	1	0
4 inch	0	34	23	25	18	0	0	22	3	384 (1%)	4	0
6 inch	0	5	5	8	9	1	0	9	4	3	340 (1%)	0
8 inch or larger	0	0	3	4	2	0	0	5	4	1	3	264 (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

Responsibility: MFFR Team

Description: Produce a bar chart of Apparent Cause of Leak (Part C Item 15) with percentages on the y-axis and causes on x-axis. An example of what the figure looks like is provided below in Figure 2. Table 9 will also be produced 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. From this information, the MFFR 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 Fitting Failure Reports, 2011-2013

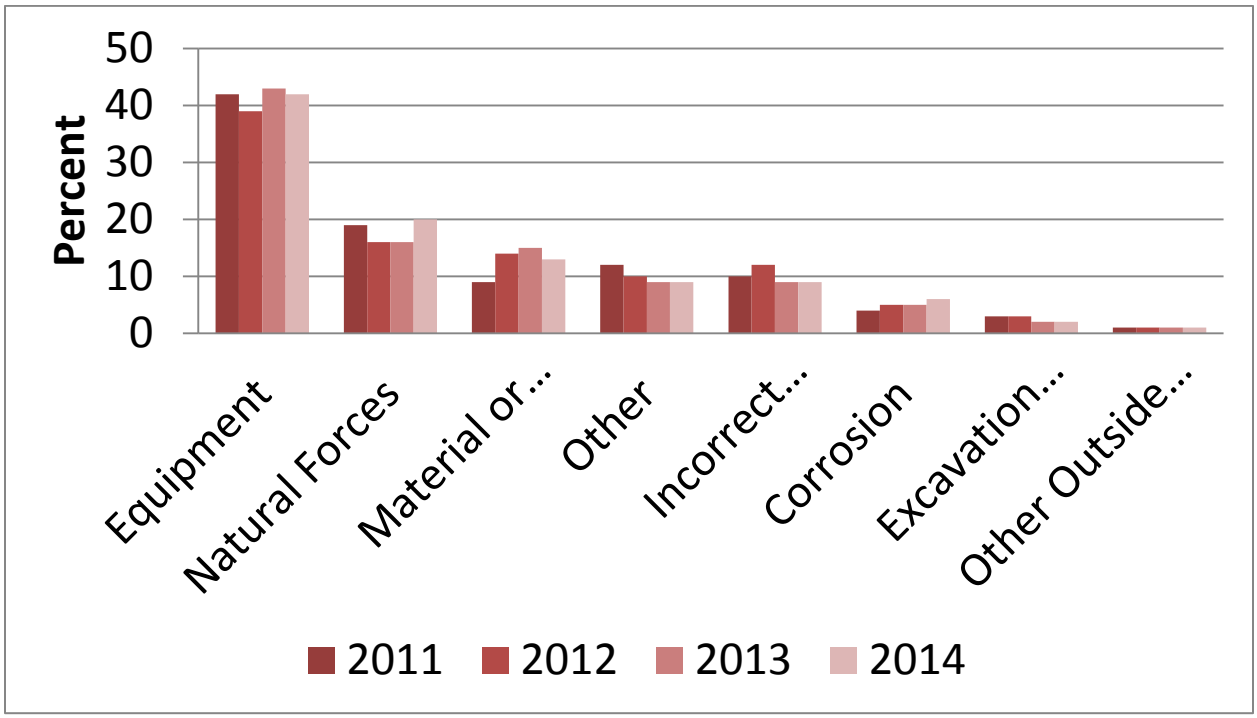


Table 9. Frequency of leak causes of mechanical fittings that failed and were reported to the Mechanical Fitting Failure Reports, 2011-2014

	2011 Count (%)	2012 Count (%)	2013 Count (%)	2014 Count (%)
Equipment	3510 (42%)	2989 (39%)	4211 (43%)	4864 (42%)
Natural Forces	1559 (19%)	1202 (16%)	1614 (16%)	2334 (20%)
Material or Weld	803 (9%)	1093 (14%)	1482 (15%)	1569 (13%)
Other	1004 (12%)	718 (10%)	880 (9%)	851 (7%)
Incorrect Operation	814 (10%)	877 (12%)	910 (9%)	1065 (9%)
Corrosion	332 (4%)	390 (5%)	533 (5%)	694 (6%)
Excavation	229 (3%)	266 (3%)	223 (2%)	254 (2%)
Other	105 (1%)	79 (1%)	62 (1%)	45 (1%)

2.4.2 Leak Causes Expanded

Input: Data analyzed from SAS Computer Application

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

Responsibility: MFFR Team

Description: Produce a 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. An example of what the data table looks like is provided below in Table 10. The table is read comparing percentages in the year column to the other year column for the various questions. From this information, the MFFR 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 Fitting Failure Reports, 2011-2014

Question	Responses	2011 Count (%)	2012 Count (%)	2013 Count (%)	2014 Count (%)
Leak Cause Natural Forces Thermal Expansion / Contraction	**No**	762 (57%)	651 (59%)	792 (50%)	863 (37%)
	Yes	574 (43%)	459 (41%)	777 (50%)	1460 (62%)
Leak Cause Material/Welds	**Construction/Installation Defect**	174 (21%)	311 (28%)	456 (31%)	395 (25%)
	Design Defect	629 (78%)	782 (72%)	1026 (69%)	1174 (75%)
	Material Defect	174 (21%)	311 (28%)	456 (31%)	395 (25%)
Leak Cause Excavation Damage	**At time of leak discovery**	166 (75%)	228 (86%)	194 (87%)	228 (90%)
	Previous to leak discovery	54 (25%)	36 (14%)	28 (13%)	25 (10%)

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

Responsibility: MFFR Team

Description: Produce a bar chart of percentages by Mechanical Fitting Involved (Part C Item 4 on the report form) with percentages on the y-axis and Type on x-axis. An example of what the data table looks

like is provided below in Figure 3. Table 11 will also be produced 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. From this information, the MFFR 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 Fitting Failure Reports, 2011-2014

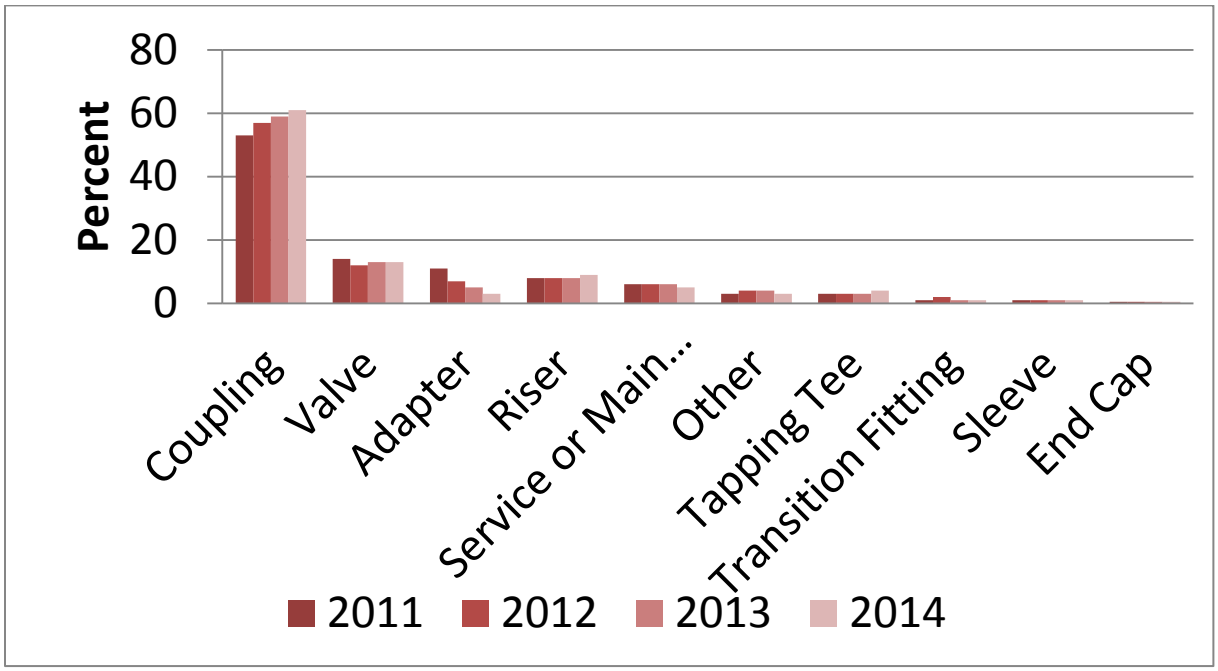


Table 11. Frequency of mechanical fitting involved of mechanical fittings that failed and were reported to the Mechanical Fitting Failure Reports, 2011-2014

	2011 Count (%)	2012 Count (%)	2013 Count (%)	2014 Count (%)
Coupling	4431 (53%)	4369 (57%)	5849 (59%)	7091 (61%)
Valve	1197 (14%)	909 (12%)	1339 (13%)	1544 (13%)
Adapter	877 (11%)	508 (7%)	493 (5%)	387 (3%)
Riser	701 (8%)	602 (8%)	761 (8%)	989 (9%)
Service or Main Tee	472 (6%)	502 (6%)	571 (6%)	615 (5%)
Other	275 (3%)	300 (4%)	359 (4%)	363 (3%)
Tapping Tee	211 (3%)	205 (3%)	318 (3%)	444 (4%)
Transitional	99 (1%)	139 (2%)	140 (1%)	108 (1%)
Sleeve	66 (1%)	55 (1%)	51 (1%)	103 (1%)
End Cap	27 (<1%)	25 (<1%)	34 (<1%)	32 (<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

Responsibility: MFFR Team

Description: Produce a 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. An example of what the data table looks like is provided below in Figure 4. Table 12 will also be produced 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. From this information, the MFFR 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 Fitting Failure Reports, 2011-2014

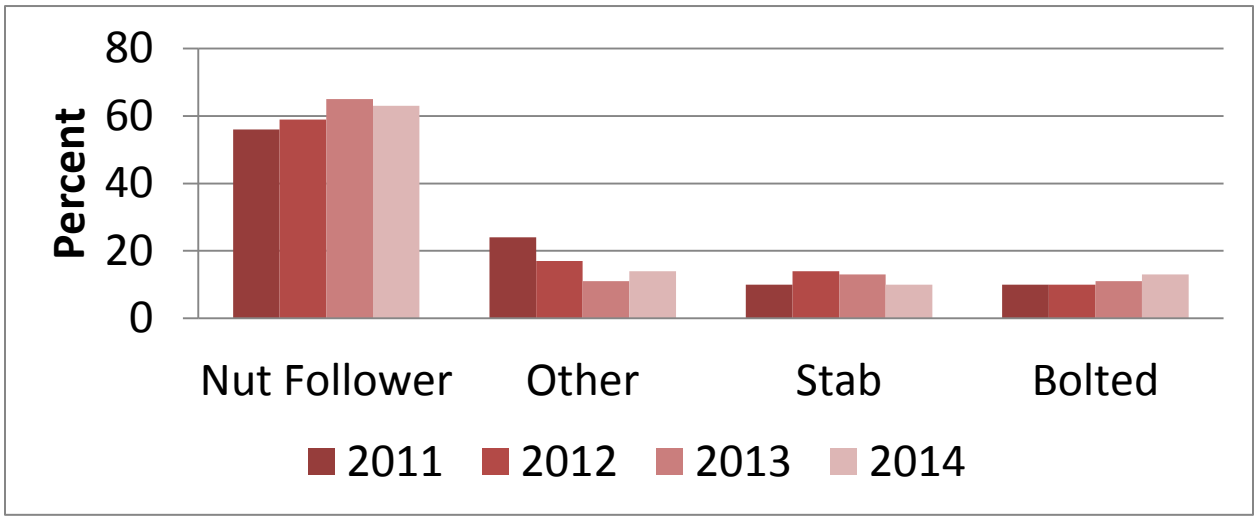


Table 12. Frequency of mechanical fitting type of mechanical fittings that failed and were reported to the Mechanical Fitting Failure Reports, 2011-2014

	2011 Count (%)	2012 Count (%)	2013 Count (%)	2014 Count (%)
Nut Follower	4720 (56%)	4461 (59%)	6447 (65%)	7347 (63%)
Other	2015 (24%)	1288 (17%)	1125 (11%)	1708 (14%)
Stab	817 (10%)	1084 (14%)	1262 (13%)	1154 (10%)
Bolted	804 (10%)	781 (10%)	1081 (11%)	1467 (13%)

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

Responsibility: MFFR Team

Description: Produce a table of Fitting Material (Part C Item 13) by Mechanical Fitting Involved (Part C Item 3) by the reporting years. An example of what the data table looks like is provided below. 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. From this information, the MFFR 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 Fitting Failure Reports, 2011-2014

	Bolted				Nut Follower				Stab				Other			
	2011	2012	2013	2014	2011	2012	2013	2014	2011	2012	2013	2014	2011	2012	2013	2014
Steel	10%	10%	10%	14%	59%	69%	75%	70%	2%	4%	4%	1%	29%	17%	11%	15%
Plastic	6%	7%	7%	9%	51%	37%	44%	44%	31%	40%	36%	34%	12%	16%	13%	13%
Combo	3%	4%	3%	6%	55%	59%	59%	49%	13%	16%	20%	21%	29%	21%	18%	24%
Unk	6%	7%	6%	13%	70%	87%	80%	58%	1%	4%	1%	1%	23%	2%	13%	28%
Other	58%	65%	81%	32%	35%	20%	15%	59%	2%	1%	1%	3%	5%	14%	3%	6%
Brass	12%	10%	3%	5%	66%	77%	93%	88%	4%	1%	2%	4%	18%	12%	2%	3%
Total	9%	10%	11%	12%	56%	59%	65%	63%	10%	14%	13%	10%	24%	17%	11%	15%

Table 14. Frequency of material of mechanical fitting involved of mechanical fittings that failed and were reported to the Mechanical Fitting Failure Reports, all years combined 2011-2014

	Bolted	Nut Follower	Stab	Other
Steel	10%	59%	2%	29%
Plastic	6%	51%	31%	12%
Combination	3%	55%	13%	29%
Unknown	6%	70%	1%	23%
Other	58%	35%	2%	5%
Brass	12%	66%	4%	18%
Total	10%	56%	10%	24%

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

Responsibility: MFFR Team

Description: Produce a table of Fitting Material by Type of Mechanical Fitting. An example of what the data table looks like is provided below in Table 15. The table is read comparing percentages in the column to the other column for the various mechanical fitting and fitting material. From this information, the MFFR 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 Fitting Failure Reports, (all years) 2011-2014

	Adapter	Coupling	End Cap	Other	Riser	Service or Main Tee	Sleeve	Tapping Tee	Transition Fitting	Valve
Steel	9%	66%	0%	3%	7%	5%	1%	2%	1%	7%
Plastic	1%	46%	0%	1%	3%	8%	0%	7%	1%	32%
Combination	4%	26%	0%	2%	47%	6%	0%	2%	10%	4%
Unknown	1%	64%	0%	11%	3%	13%	0%	1%	1%	6%
Other	1%	22%	1%	41%	3%	6%	7%	2%	1%	19%
Brass	6%	75%	1%	2%	1%	5%	0%	0%	1%	8%
Total	6%	58%	0%	3%	8%	6%	1%	3%	1%	13%

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

Responsibility: MFFR Team

Description: Produce a 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. An example of what Figure 5 looks like is provided. Table 16 will also be produced 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. From this information, the MFFR 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 Fitting Failure Reports, 2011-2014

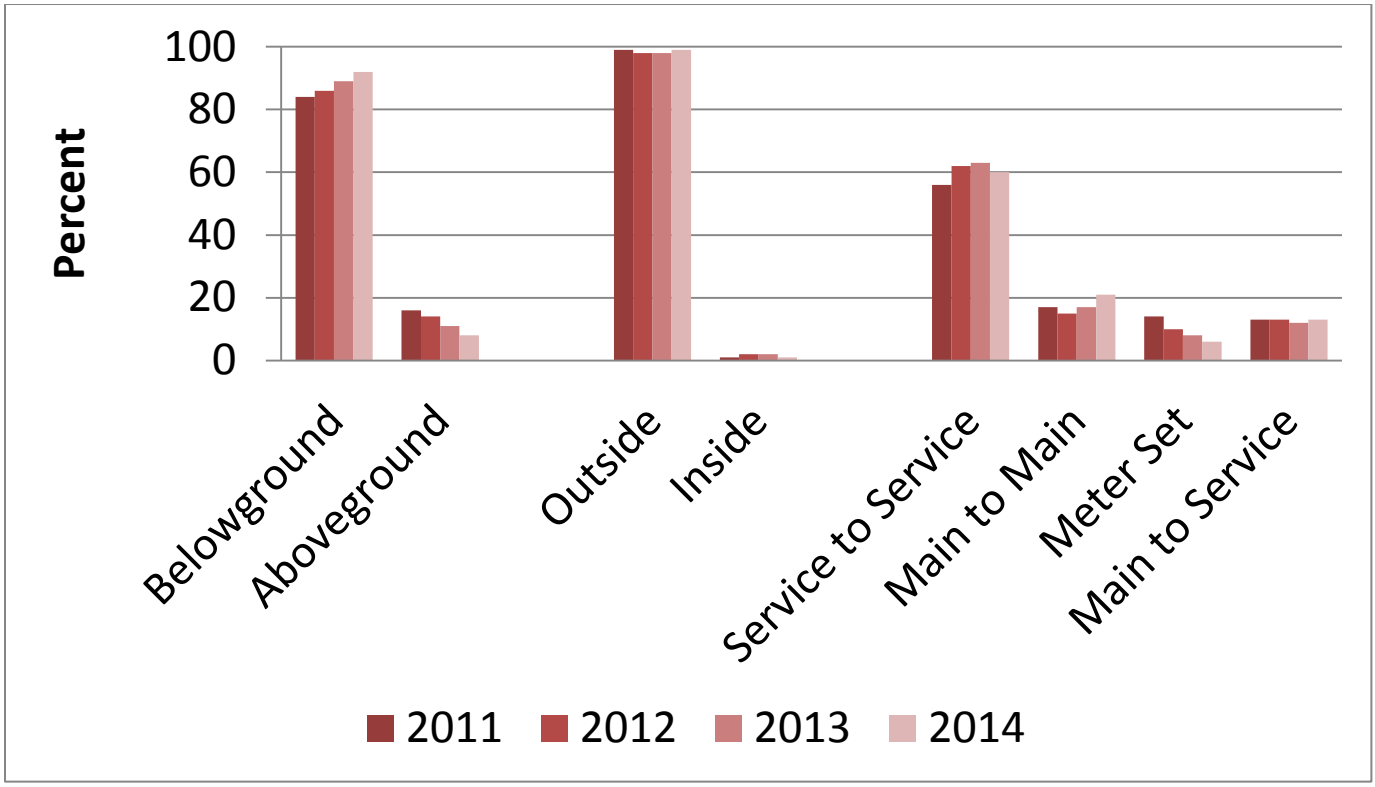


Table 16. Frequency of the location of the hazardous leak of mechanical fittings that failed and were reported to the Mechanical Fitting Failure Reports, 2011-2014

	2011 Count (%)	2012 Count (%)	2013 Count (%)	2014 Count (%)
Belowground	6997 (84%)	6570 (86%)	8841 (89%)	10699 (92%)
Aboveground	1359 (16%)	1044 (14%)	1074 (11%)	977 (8%)
Outside	8228 (99%)	7446 (98%)	9744 (98%)	11542 (99%)
Inside	128 (1%)	168 (2%)	171 (2%)	134 (1%)
Service to Service	4712 (56%)	4691 (62%)	6245 (63%)	6964 (60%)
Main to Main	1389 (17%)	1113 (15%)	1736 (17%)	2484 (21%)
Meter Set	1148 (14%)	799 (10%)	781 (8%)	735 (6%)
Main to Service	1107 (13%)	1011 (13%)	1153 (12%)	1493 (13%)

2.6.2 How the Leak Occurred

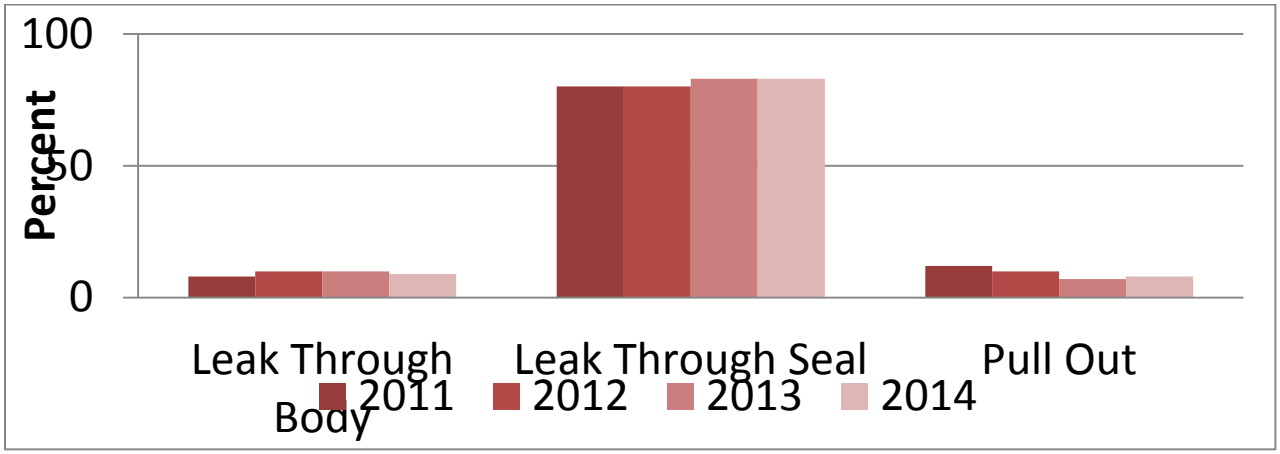
Input: Data analyzed from SAS Computer Application

Output: Figure 6 – Frequency of how the leak occurred

Responsibility: MFFR Team

Description: Produce a 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. An example of what the Figure 6 looks like is provided below. From this information, the MFFR 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 Fitting Failure Reports, 2011-2014



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

Responsibility: MFFR Team

Description: Produce a table with the columns Top 10 States reporting (Table 17), Top 10 Steel State (Table 18), and Top 10 Plastic States (Table 19). This table takes into account where the MFF 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 added for each category. From this information, the MFFR 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 MFFR by State, 2011-2014

Top 10 States				
Number of Services Annual Report 2014	**2011**	**2012**	**2013**	**2014**
CA 13%	TX 13%	TX 13%	TX 12%	PA 12%
TX 7%	IL 11%	IL 9%	PA 11%	TX 10%
IL 6%	PA 9%	PA 8%	IN 8%	IN 8%
OH 5%	OH 7%	IN 7%	NY 7%	VA 8%
MI 5%	IN 7%	MI 6%	IL 7%	OH 7%
NY 5%	NY 6%	NY 6%	TN 7%	MI 5%
PA 4%	MI 5%	OH 6%	VA 6%	TN 5%
NJ 4%	MS 3%	TN 5%	OH 6%	MI 5%
GA 3%	CA 3%	CA 4%	MI 5%	TN 5%
IN 3%	VA 3%	VA 4%	CA 3%	WI 4%

Table 18. Percentage of MFFR Steel by State, 2011-2014

Top 10 Steel States				
Number of Steel Services Annual Report 2014	**2011**	**2012**	**2013**	**2014**
CA 17%	TX 19%	TX 18%	TX 16%	TX 13%
TX 9%	IL 18%	IL 13%	IN 12%	IN 11%
IL 5%	IN 9%	IN 10%	IL 9%	VA 9%
NY 4%	NY 6%	MI 6%	TN 9%	PA 8%
MI 4%	OH 6%	NY 6%	VA 6%	OH 7%
OH 4%	MI 5%	TN 6%	NY 6%	IL 6%
NJ 4%	MS 5%	OH 5%	MI 6%	TN 6%
PA 4%	TN 4%	VA 4%	OH 5%	NY 5%
LA 4%	CO 3%	MD 3%	PA 3%	MI 5%
CO 3%	VA 2%	MS 3%	WI 2%	MD 4%

Table 19. Percentage of MFFR Plastic by State, 2011-2014

Top 10 Plastic States				
Number of Plastic Services Annual Report 2014	**2011**	**2012**	**2013**	**2014**
CA 12%	PA 26%	PA 20%	PA 22%	PA 26%
TX 7%	OH 11%	CA 14%	CA 12%	OH 11%
OH 5%	CA 10%	OH 7%	OH 8%	CA 10%
NY 5%	NY 5%	NY 6%	NY 8%	NY 5%
MI 5%	GA 4%	AZ 5%	VA 6%	GA 4%
PA 5%	CT 4%	NV 4%	NV 4%	CT 4%
IL 5%	MA 4%	VA 4%	AZ 3%	MA 4%
NJ 3%	MO 3%	TN 3%	TN 3%	MO 3%
GA 3%	SC 3%	TX 3%	CT 3%	SC 3%
IN 3%	AZ 3%	CT 3%	MA 3%	AZ 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

Responsibility: MFFR Team

Description: Produce a table with the columns of states reporting and causes of leaks for all years of data. From this information, the MFFR Team will develop observations on distribution of which states the failures are occurring and the distribution of the causes in states.

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

State	Equipment	Natural Forces	Corrosion	Excavation Damage	Incorrect Operation	Material or Weld	Other	Other Outside Force Damage
AK	16	30	0	0	0	0	0	0
AL	98	77	28	11	35	103	8	10
AR	9	32	3	4	5	5	14	2
AZ	21	0	1	3	146	158	2	3
CA	2	11	12	11	644	351	148	10
CO	377	80	5	42	5	15	4	2
CT	410	196	9	3	13	214	7	1
DC	164	1	7	7	6	0	0	0
DE	1	5	2	1	2	6	13	0
FL	67	5	8	12	18	15	48	0
GA	342	15	3	34	31	29	0	6
HI	2	0	4	2	1	0	68	0
IA	39	52	4	11	6	59	3	0
ID	0	1	0	4	24	26	3	1
IL	1882	610	135	42	29	77	112	10
IN	1229	705	115	44	75	249	428	20
KS	173	89	40	17	16	21	2	11
KY	106	57	50	13	365	277	144	8
LA	60	23	4	10	21	11	11	0
MA	17	86	28	2	23	138	193	1
MD	594	14	34	35	73	19	54	6
ME	0	1	0	0	9	0	1	0
MI	1062	547	88	131	66	51	54	16
MN	185	91	20	1	41	50	46	1
MO	469	25	13	47	24	42	43	7
MS	54	308	2	22	308	17	0	1
MT	13	54	0	9	0	4	0	2
NC	178	27	1	40	27	69	17	2
ND	3	18	0	0	1	2	0	0
NE	7	8	0	1	3	4	4	0
NH	49	2	13	2	7	0	13	0
NJ	107	285	96	15	153	72	28	11
NM	325	0	0	4	6	1	0	1
NV	22	6	0	1	140	214	1	1
NY	1585	42	195	24	123	158	190	3
OH	169	164	434	73	479	348	697	16
OK	5	4	10	1	7	42	16	0
OR	9	0	0	22	41	37	8	1
PA	955	934	162	9	239	1141	185	56
RI	0	1	0	0	0	2	4	1
SC	110	2	6	9	71	100	34	1
SD	12	46	1	0	2	19	0	0
TN	1545	103	3	18	21	84	19	2
TX	1490	1682	153	125	97	180	647	58
UT	8	8	4	4	5	5	6	3
VA	1434	169	157	17	151	50	114	6
VI	1	0	0	0	0	0	0	0
VT	10	13	0	0	10	0	0	0
WA	19	2	17	17	79	38	17	2

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

Input: Data analyzed from SAS Computer Application

Output: Table 21 – Leak location

Responsibility: MFFR Team

Description: Produce a table of Fitting Material by Leak Location (above or below ground). An example of what the data table looks like is provided below in Table 21. The table is read comparing percentages in the year column to the other year column for the various locations fitting and fitting material. From this information, the MFFR Team will develop observations based on percentage of material type and location

Table 21. Comparison of Fitting Material by Leak Location, 2011-2014

	Aboveground				Belowground			
	2011	2012	2013	2014	2011	2012	2013	2014
Steel	79%	72%	75%	74%	59%	59%	62%	65%
Plastic	2%	3%	2%	2%	29%	31%	28%	25%
Combination	14%	16%	18%	19%	4%	4%	4%	4%
Unknown	2%	2%	1%	1%	4%	1%	1%	3%
Other	1%	2%	1%	1%	2%	3%	3%	1%
Brass	2%	5%	3%	3%	1%	2%	2%	2%
Total	16%	14%	11%	8%	84%	86%	89%	92%

2.6.6 Leak Location (inside or outside) by Fitting Material

Input: Data analyzed from SAS Computer Application

Output: Table 22 – Leak location

Responsibility: MFFR Team

Description: Produce a table of Fitting Material by Location (inside or outside). An example of what the data table looks like is provided below in Table 22. The table is read comparing percentages in the year column to the other year column for the locations and fitting material. From this information, the MFFR 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 Fitting Failure Reports, 2011-2014

	Inside				Outside			
	2011	**2012**	**2013**	**2014**	**2011**	**2012**	**2013**	**2014**
Steel	70%	82%	89%	69%	63%	60%	63%	66%
Plastic	10%	6%	4%	13%	25%	28%	26%	24%
Combination	5%	5%	3%	6%	5%	6%	6%	5%
Unknown	2%	1%	1%	1%	4%	1%	1%	1%
Other	2%	0%	0%	1%	2%	3%	3%	1%
Brass	10%	7%	3%	8%	1%	2%	2%	1%
Total	2%	2%	2%	1%	98%	98%	98%	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

Responsibility: MFFR Team

Description: Produce a table of Fitting Material by Location (main and service connections). An example of what the data table looks like is provided below in Table 23. The table is read comparing percentages in the year column to the other year column for the various locations and fitting material. From this information, the MFFR 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 Fitting Failure Reports, 2011-2014

	Main to Main				Main to Service				Meter Set				Service to Service			
	2011	2012	2013	2014	2011	2012	2013	2014	2011	2012	2013	2014	2011	2012	2013	2014
Steel	80%	79%	77%	88%	66%	62%	67%	61%	78%	70%	70%	69%	53%	54%	58%	58%
Plastic	6%	7%	6%	4%	24%	26%	26%	27%	2%	3%	2%	5%	36%	37%	33%	32%
Combo	2%	2%	2%	1%	5%	5%	3%	4%	16%	19%	24%	23%	4%	5%	5%	4%
Unknown	5%	1%	2%	6%	3%	3%	2%	5%	2%	2%	1%	1%	5%	1%	1%	2%
Other	7%	11%	13%	1%	1%	1%	2%	2%	<1%	1%	0%	1%	1%	1%	1%	1%
Brass	1%	1%	1%	1%	1%	2%	1%	1%	1%	4%	2%	1%	1%	2%	2%	3%
Total	16%	15%	17%	17%	13%	13%	12%	12%	14%	10%	8%	8%	56%	62%	63%	63%

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 of this data analysis on potential data quality issues that may exist with the information reported and the need to consider the information in the appropriate context (e.g., amount of fittings that may be in service, length of time a manufacturer may have been producing fittings, and amount of fittings a manufacturer may produce (i.e. overall market share)). PHMSA conducted some additional conservative data analysis in an attempt to improve the data quality mostly due to spelling errors. These tables are based on the frequency of reporting. There is no information available about the number fitting various manufactures produced and sold. Therefore, PHMSA is unable to adjust the failure reports by the quantity in use. The best measure PHMSA is able to use to put the information into context based on other information reported is rate of hazardous leaks eliminated/repaired. The rate of hazardous leaks repaired involving a mechanical fitting for 2014 is the number of MFFR (11,676) divided by the total number of hazardous leaks reported as eliminated/repaired in 2013 (205,906) which is 5.7%. 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, users may contact the manufacturer. Manufacturers would not be able to provide information on amount of fittings they've sold that were actually installed, as that is information the operators would have.

2.7.1 Manufacturer of Fitting by Year Manufactured

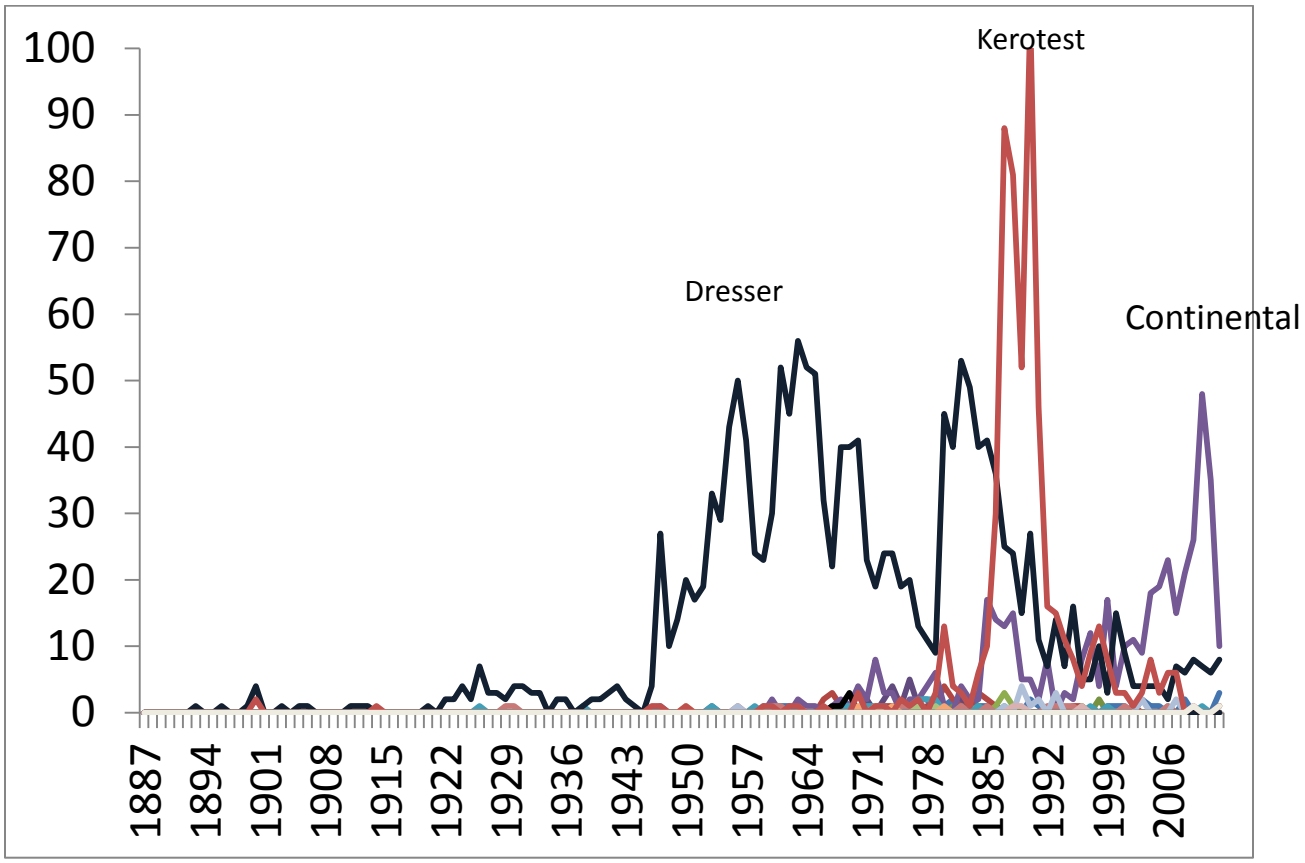
Input: Data analyzed from SAS Computer Application

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

Responsibility: MFFR Team

Description: Produce a line plot of the number of failures by manufacturer as reported by operators by year fitting manufactured on the x-axis. All data will be presented in the plot. An example of what the data table looks like is provided below in Figure 7. From this information, the MFFR 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 MFFRs are put into the "Other" category and not plotted.

Figure 7. Example of the line plot of the number of failures by manufacturer by year fitting manufactured, 2011-2013



2.7.2 Manufacturer by Years in Service

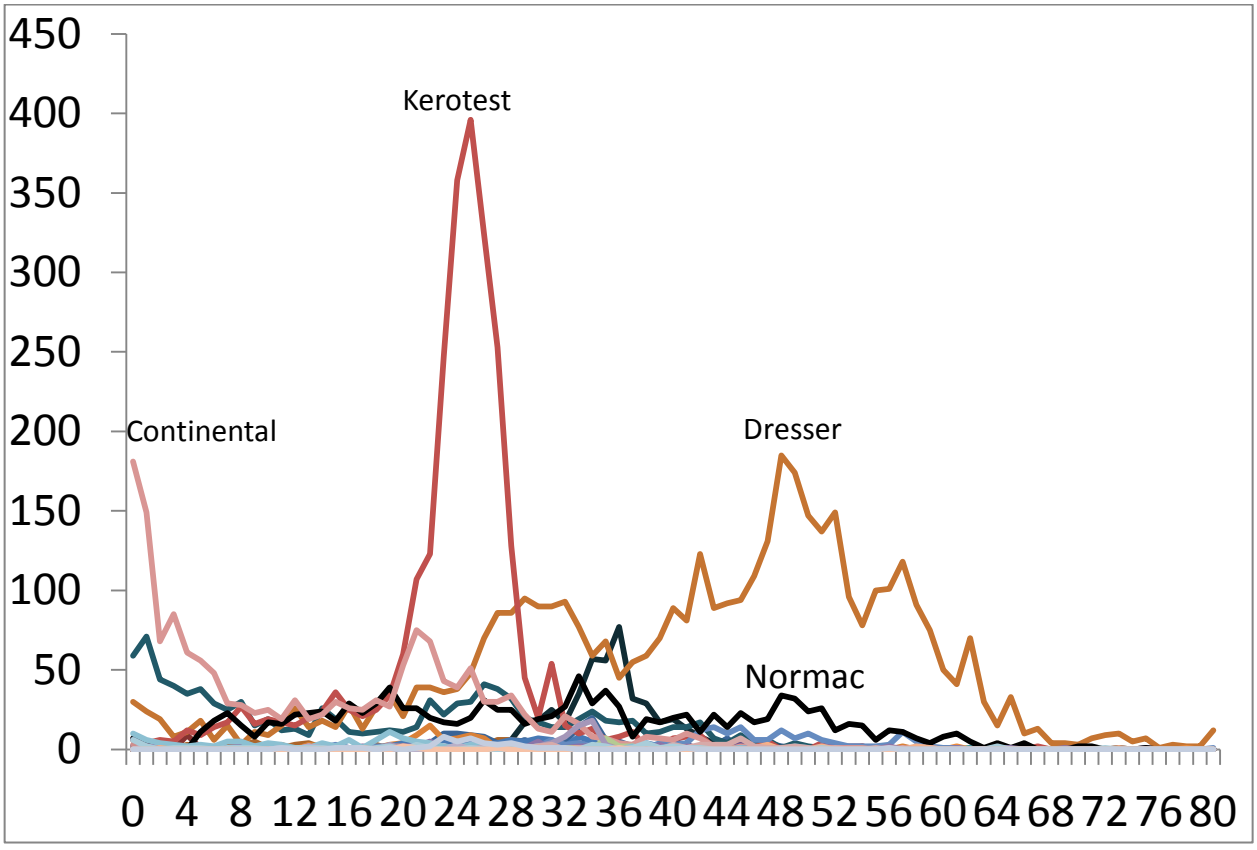
Input: Data analyzed from SAS Computer Application

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

Responsibility: MFFR Team

Description: Produce a 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. An example of what the data table looks like is provided below in Figure 8. From this information, the MFFR Team will develop observations on those manufacturers who do have longer/shorter times in service. Manufacturers with 3 or less MFFRs are put into the "Other" category and not plotted.

Figure 8 – Example of the 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 24 – Manufacturers of failed mechanical fittings

Responsibility: MFFR Team

Description: Produce a 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. An example of what the data table looks like is provided below in Table 24. The table is read comparing percentages in the year column to the other year column for the various manufacturers. From this information, the MFFR Team will develop observations on prospective view of those manufacturers who have the highest reported number of failures.

The current view of Table 24 shows the last 4 years. Future version of Table 24 will include additional columns added for each year up to the previous 5 years. From this information, the MFFR Team will develop observations on the changes to the top 10 reported manufacturers.

Table 24. Frequency of manufacturers reported in MFFR data based on percentage of data, 2011-2014

Manufacturer	2011	Manufacturer	2012	Manufacturer	2013	Manufacturer	2014
Dresser	22%	**Dresser**	21%	**Dresser**	21%	**Dresser**	22%
Kerotest	9%	**Perfection**	6%	**Kerotest**	8%	**Kerotest**	7%
Normac	5%	**Kerotest**	5%	**Perfection**	5%	**Normac**	5%
Continental	4%	**Normac**	5%	**Normac**	4%	**Perfection**	5%
Perfection	4%	**Continental**	7%	**Continental**	4%	**Continental**	3%
AMP	1%	**AMP**	2%	**AMP**	1%	**AMP**	1%
Mueller	<1%	**Chicago**	1%	**Mueller**	1%	**Mueller**	1%
RW Lyall	<1%	**RW Lyall**	1%	**RW Lyall**	<1%	**RW Lyall**	1%
Handley	<1%	**Mueller**	<1%	**Handley**	<1%	**RobRoy**	1%
Telsco	<1%	**Inner-tite**	<1%	**Inner-tite**	<1%	**Central Plastics**	<1%

2.7.4 Manufacturer by Year of Failure

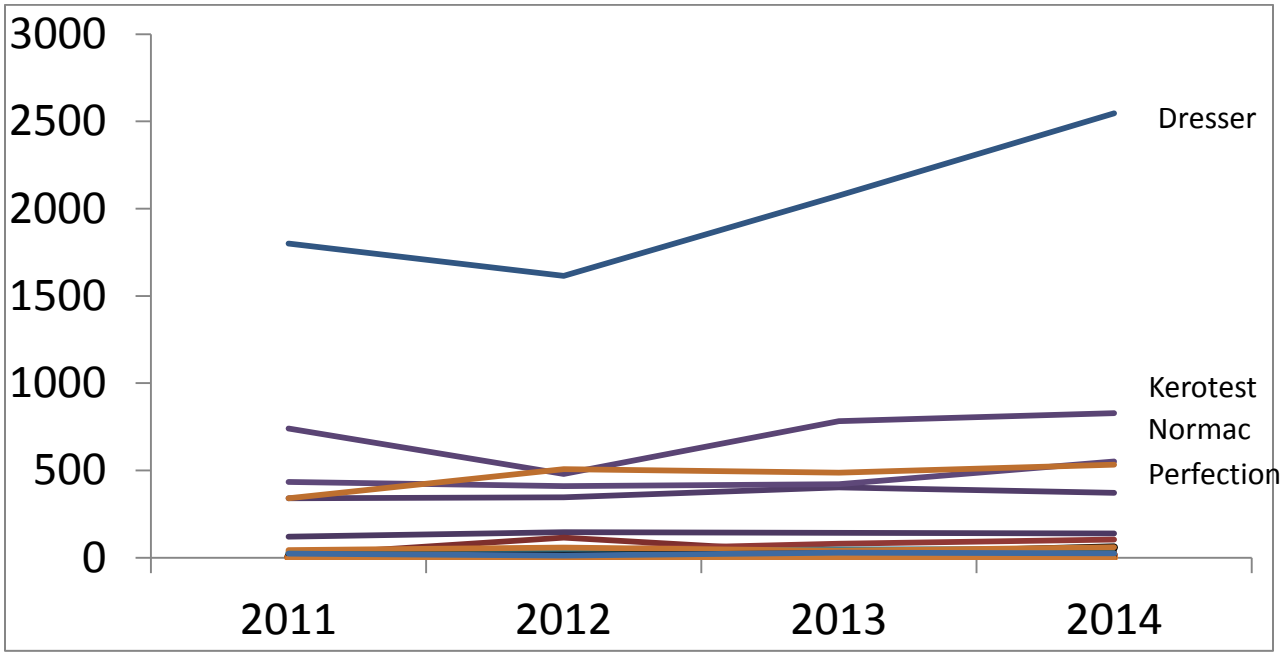
Input: Data analyzed from SAS Computer Application

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

Responsibility: MFFR Team

Description: Produce a 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. An example of what the data table looks like is provided below in Figure 9. From this information, the MFFR 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 MFFRs are put into the “Other” category and not plotted.

Figure 9 – Example of the 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

Responsibility: MFFR Team

Description: Produce a table of manufacturers reported by operators by reported apparent cause of leak (Part C Item 15) based on all data for all years. An example of what the data table looks like is provided below in Table 25. From this information, the MFFR Team will develop observations on manufacturers and leaks causes associated with those manufacturers. Manufacturers with 3 or less MFFRs are put into the "Other" category.

Table 25 – Manufacturers by reported apparent cause of leak, 2011-2014

Manufacturer	Corrosion	Equipment	Excavation Damage	Incorrect Operation	Material or Weld	Natural Forces	Other	Other Outside Force
Aldyl	0	3	0	0	3	1	3	0
American	0	6	0	11	2	0	3	0
AMP	7	73	2	55	358	31	20	3
Anvil Red	1	0	0	1	2	4	0	0
B K	0	5	0	0	0	0	0	0
CENTRAL PLASTICS (GEO	13	28	2	12	31	10	12	0
Chicago	9	122	2	28	8	8	1	0
Conino	0	3	0	2	2	1	0	0

Manufacturer	Corrosion	Equipment	Excavation Damage	Incorrect Operation	Material or Weld	Natural Forces	Other	Other Outside Force
Continental	83	262	42	468	359	126	104	18
CSI/SMITH BLAIR/ROCKW	6	40	3	9	15	15	7	2
Dezuirk	0	1	0	0	1	2	0	0
Dresser	447	4308	205	462	448	1587	531	50
Drisco	2	20	4	0	5	2	0	1
Dupont	1	2	1	25	12	1	3	1
Eastern Eberhard	1	1	0	1	2	1	3	0
Flo-Control	0	1	0	0	0	13	0	0
Generic	0	18	4	1	6	0	5	0
Handley	1	30	0	14	45	7	8	1
Inner-tite	78	6	1	3	9	6	3	2
International	1	0	0	1	2	0	1	0
Kerotest	4	1138	5	114	1236	124	190	20
M.T. Deason	0	2	0	1	0	0	1	0
MERCO	1	0	0	0	3	4	1	0
MGL	0	0	0	0	5	0	0	0
Mueller	15	101	13	19	32	69	12	2
Nordstrom	0	0	0	3	1	1	0	0
Normac	151	423	36	360	248	276	314	10
OTHER	8	34	8	21	23	23	36	8
Perfection	57	267	20	793	406	65	242	19
Performance	0	6	2	3	0	0	1	0
Pergeltion	0	1	0	3	0	0	0	0
Plexco	0	4	0	5	15	0	1	0
Powell	0	0	0	0	13	0	0	0
RobRoy	15	4	0	36	8	16	12	0
RW Lyall	8	52	22	49	40	16	11	4
Skinner	2	7	1	1	1	7	2	0
Spears	0	0	0	1	0	5	0	0
Telsco	12	23	1	23	13	1	8	0
Unk	1006	8530	594	1106	1553	4266	1899	150
Uponor	2	10	0	5	3	5	3	0
US Poly	5	11	4	20	15	4	8	0
VIC	1	0	0	0	1	2	1	0
Wayne Mfg	12	32	0	10	21	10	7	0

2.7.6 Manufacturer by Mechanical Fitting Involved

Input: Data analyzed from SAS Computer Application

Output: Table 26 – Frequency of manufacturer by mechanical fitting involved

Responsibility: MFFR Team

Description: Produce a table based on all years of manufacturer by mechanical fitting involved. An example of what the data table looks like is provided below in Table 26. From this information, the MFFR Team will develop observations on prospective view of those manufacturers and mechanical fitting

involved associated with those manufacturers. Manufacturers with 3 or less MFFRs are put into the "Other" category.

Table 26 – Manufacturers by mechanical fitting type involved, 2011-2014

Manufacturer	Bolted	Nut Follower	Other	Stab
Aldyl	0	1	9	0
American	2	4	2	14
AMP	97	24	362	66
Anvil Red	1	7	0	0
B K	0	0	5	0
CENTRAL PLASTICS (GEO	20	23	41	24
Chicago	3	65	108	2
Conino	0	3	5	0
Continental	247	543	165	507
CSI/SMITH BLAIR/ROCKW	51	33	12	1
Dezuirk	2	1	0	1
Dresser	1290	6172	429	147
Drisco	2	7	14	11
Dupont	1	2	42	1
Eastern Eberhard	6	3	0	0
Flo-Control	0	11	3	0
Generic	1	18	14	1
Handley	0	94	8	4
Inner-tite	1	91	14	2
International	0	5	0	0
Kerotest	16	2694	64	57
M.T. Deason	0	3	1	0
MERCO	0	4	5	0
MGL	5	0	0	0
Mueller	32	188	32	11
Nordstrom	1	1	3	0
Normac	16	1641	135	26
OTHER	28	64	51	18
Perfection	84	50	161	1574
Performance	0	0	5	7
Pergeltion	0	0	0	4
Plexco	1	9	7	8
Powell	0	13	0	0
RobRoy	0	59	28	4
RW Lyall	49	30	60	63
Skinner	15	5	1	0
Spears	0	6	0	0
Telsco	2	74	4	1
Unk	2152	10949	4270	1733
Uponor	1	12	11	4
US Poly	2	4	45	16
VIC	5	0	0	0
Wayne Mfg	0	62	20	10

2.8 Operators submitting MFFR

The MFFR Team members will analyze the MFFR data and generate the tables and charts outlined in this procedure. 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 MFFR Team may decide to evaluate the number of MFFR by mile of main or service that an Operator is reporting and on an individual operator basis, as appropriate.

Similar to information provided by manufacturer, PHMSA cautions users of this data analysis on the need to consider the information in the appropriate context (e.g., 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 amount 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 27 – Frequency of operators reporting fitting failures by year of failure

Responsibility: MFFR Team

Description: Produce a table of operators reporting by year of failure. An example of what the data table looks like is provided below in Table 27. From this information, the MFFR Team will develop observations on prospective view of operators and reports.

Table 27 – Operators reporting by year of failure

Operator Name	2011	2012	2013	2014
ALABAMA GAS CORPORATION	48	48	55	41
ALEXANDER CITY MUNICIPAL	0	0	0	3
ALLIANT ENERGY - INTERST	0	7	7	6
AMEREN ILLINOIS COMPANY	136	141	171	192
AMERENUE	1	2	1	0
APPALACHIAN NATURAL GAS	0	0	0	2
ARKANSAS WESTERN GAS CO	1	1	0	0
ATLANTA GAS LIGHT CO	140	82	59	132
ATMOS ENERGY CORPORATION	771	594	646	627
ATMOS PIPELINE - TEXAS	0	11	51	0
AUSTELL NATURAL GAS SYST	1	0	0	0
AUSTIN UTILITIES	0	0	1	0
AVISTA CORP	19	37	32	52
BALTIMORE GAS & ELECTRIC	23	15	13	10

Operator Name	2011	2012	2013	2014
BANGOR GAS CO LLC	1	5	0	0
BERKSHIRE GAS CO	5	4	17	20
BLACK HILLS ENERGY	4	6	6	8
BLACKSTONE GAS CO	0	1	2	0
BOSTON GAS CO	5	2	2	1
BRADY MUNICIPAL GAS CORP	0	6	6	1
BRENHAM UTILITY, CITY OF	3	1	2	0
CALERA MUNICIPLE GAS SYS	2	0	0	0
CARTERSVILLE GAS DEPT, C	2	4	1	1
CASTROVILLE UTILITY SYST	0	1	0	293
CEDAR FALLS MUNICIPAL UT	0	0	0	1
CENTERPOINT ENERGY RESOU	39	160	266	351
CENTERVILLE, TOWN OF	2	0	0	1
CENTRAL FLORIDA GAS CORP	0	0	3	0
CENTRAL HUDSON GAS & ELE	25	27	30	15
CHAMBERSBURG GAS DEPT	0	0	0	1
CHATTANOOGA GAS CO	30	33	25	41
CHESAPEAKE UTILITIES COR	0	15	8	0
CHESAPEAKE UTILITY CORP	7	0	0	0
CHEYENNE LIGHT FUEL & PO	0	1	4	0
CIRCLE PINES UTILITY	3	0	0	0
CITIZENS GAS & COKE UTIL	190	236	376	228
CITY OF CALERA NATURAL G	0	1	1	1
CITY OF ROCKPORT	4	3	1	6
COLORADO SPRINGS, CITY O	6	7	7	10
COLUMBIA GAS OF KENTUCKY	13	30	64	64
COLUMBIA GAS OF MARYLAND	14	20	18	37
COLUMBIA GAS OF MASSACHU	91	44	95	86
COLUMBIA GAS OF OHIO INC	359	239	353	448
COLUMBIA GAS OF PENNSYLV	52	74	89	117
COLUMBIA GAS OF VIRGINIA	45	60	117	140
COMMUNITY NATURAL GAS IN	2	0	0	0
CONNECTICUT NATURAL GAS	16	17	40	52
CONSOLIDATED EDISON CO O	412	352	417	418
CONSUMERS ENERGY CO	369	397	470	448
CONSUMERS GAS UTILITY CO	0	1	0	0
CORINTH GAS DEPT, CITY O	0	0	0	7
CORNING MUNICIPAL UTILIT	1	1	3	2
CORPUS CHRISTI, CITY OF	10	14	6	5
COVINGTON GAS DEPT, CITY	0	3	0	0
CPS ENERGY	360	224	253	0
CULLMAN - JEFFERSON CO G	1	0	0	0
DANVILLE, CITY OF	1	1	1	0
DECATUR UTILITIES - GAS	0	1	0	0
DELMARVA POWER & LIGHT C	1	1	1	6
DOMINION EAST OHIO	76	63	62	51
DOMINION HOPE	12	19	19	19
DTE GAS COMPANY	0	0	8	3
DUBLIN, CITY OF	4	0	0	0
DUKE ENERGY KENTUCKY	1	10	11	3
DUKE ENERGY OHIO	26	78	26	39
DUPO GAS SYSTEM, VILLAGE	0	0	0	1
EASTERN NATURAL GAS CO	7	3	0	0
EASTON UTILITIES COMMISS	0	0	0	3
ELIZABETHTOWN GAS CO	31	21	37	14

Operator Name	2011	2012	2013	2014
ELK RIVER PUBLIC UTIL DI	0	0	0	2
ENERGY NORTH NATURAL GAS	6	4	12	62
ENERGY WEST MONTANA	7	1	1	3
ENSTAR NATURAL GAS CO	14	13	2	16
ENTERGY GULF STATES	4	0	8	24
ENTERGY NEW ORLEANS, INC	3	5	3	6
ENTEX, A NORAM ENERGY CO	198	45	0	0
EQUITABLE GAS COMPANY, L	0	17	32	0
EQUITABLE RESOURCES (A.K	10	0	0	0
ESSEX COUNTY GAS CO	0	2	0	0
FAIRBANKS NATURAL GAS	0	0	0	1
FAIRFIELD MUNICIPAL GAS	2	1	0	0
FAIRHOPE GAS SYSTEM, CIT	0	1	0	0
FALFURRIAS UTILITY BOARD	0	18	6	42
FALLS CITY UTILITIES	0	1	0	0
FAYETTEVILLE PUBLIC UTIL	0	0	2	0
FITCHBURG GAS & ELECTRIC	2	9	18	10
FLORENCE GAS DEPT, CITY	3	1	0	0
FLORIDA CITY GAS	1	0	0	0
FLORIDA PUBLIC UTILITIES	6	10	7	6
GAINESVILLE REGIONAL UTI	2	0	0	0
GREAT PLAINS NATURAL GAS	4	1	0	0
GREENVILLE UTILITIES COM	2	1	9	3
GREENWOOD COMMISSION OF	2	9	2	2
GUYMON MUNICIPAL GAS CO	0	1	0	0
HALLS GAS DEPT, TOWN OF	1	0	0	0
HALSTEAD GAS DEPT, CITY	0	1	0	0
HAMILTON GAS DEPT, CITY	8	8	10	1
HASTINGS UTILITIES	2	0	0	0
HAWAI`IGAS	0	0	11	29
HAWARDEN GAS DEPT, CITY	1	2	2	1
HOLYOKE GAS & ELECTRIC D	0	1	9	16
HUMBOLDT UTILITIES - GAS	13	17	9	4
HUNTSVILLE GAS SYSTEM	13	9	13	15
INDIANA GAS CO INC	87	66	61	95
INTERMOUNTAIN GAS CO	9	4	3	9
JACKSON ENERGY AUTHORITY	44	19	31	13
KANSAS GAS SERVICE	89	68	62	0
KANSAS GAS SERVICE COMPA	0	8	18	90
KEYSPAN ENERGY DELIVERY	1	0	0	0
KEYSTONE RURAL GAS DISTR	2	1	2	0
KINGS MOUNTAIN NATURAL G	0	0	0	2
KNG ENERGY INC	2	0	0	1
KNOXVILLE UTILITIES BOAR	6	7	12	16
LACLEDE GAS CO	181	11	91	126
LAKE APOPKA NATURAL GAS	4	2	0	1
LAKE PARK MUNICIPAL UTIL	1	0	0	0
LANCASTER MUNICIPAL GAS	10	4	5	5
LAS CRUCES, CITY OF	1	4	1	1
LAWRENCEBURG GAS DEPT, C	16	10	8	9
LAWRENCEVILLE, CITY OF	0	1	1	9
LEBO MUNICIPAL GAS SYSTE	1	0	0	0
LEFORS GAS DEPT, CITY OF	0	1	0	0
LEWISBURG GAS DEPARTMENT	3	0	1	5
LEXINGTON GAS SYSTEM	7	8	5	6

Operator Name	2011	2012	2013	2014
LIBERTY UTILITIES MASSAC	0	0	8	11
LITTLE RIVER MUNICIPAL S	0	0	1	0
LIVE OAK GAS DEPT, CITY	0	1	0	0
LONG BEACH GAS DEPT, CIT	10	7	7	6
LOUISVILLE GAS & ELECTRI	167	174	207	186
LYTLE MUNICIPAL SYSTEM	0	1	0	0
MADISON GAS & ELECTRIC C	2	2	3	0
MADISON, CITY OF	5	9	0	0
MAINE NATURAL GAS	0	0	0	1
MARIANNA, CITY OF	1	1	2	1
MARSHALL COUNTY GAS DIST	5	7	11	5
MEMPHIS LIGHT GAS & WATE	106	247	546	423
METROPOLITAN UTILITIES D	4	2	0	3
MICHIGAN CONSOLIDATED GA	2	5	0	0
MICHIGAN GAS UTILITIES C	19	30	29	42
MIDAMERICAN ENERGY COMPA	41	58	38	36
MIDDLEBOROUGH GAS & ELEC	5	0	0	1
MIDWEST NATURAL GAS CORP	2	0	3	0
MIDWEST NATURAL GAS INC	1	0	0	0
MINNESOTA ENERGY RESOURC	1	1	0	0
MISSISSIPPI RIVER GAS LL	2	1	0	0
MISSOURI GAS ENERGY	1	1	0	0
MOBILE GAS SERVICE CORP	15	8	14	18
MONROE NATURAL GAS DEPT,	0	0	1	0
MONTANA - DAKOTA UTILITI	23	23	20	50
MOULTON MUNICIPAL GAS SY	0	0	1	0
MOULTRIE GAS DEPT, CITY	1	0	0	0
MOUNTAINEER GAS CO	7	5	5	0
MT CARMEL PUBLIC UTILITY	0	1	0	0
NATIONAL FUEL GAS DISTRI	62	97	135	184
NATIONAL GAS & OIL CORP	23	21	67	200
NAVASOTA, CITY OF	0	4	2	0
NEBRASKA CITY UTILITIES	1	0	0	0
NEW ALBANY GAS SYSTEM	5	0	0	0
NEW ENGLAND GAS COMPANY	3	5	1	0
NEW JERSEY NATURAL GAS C	20	34	47	61
NEW MEXICO GAS COMPANY	116	84	77	53
NEW YORK STATE ELECTRIC	0	23	34	19
NGO TRANSMISSION, INC.	0	0	0	2
NIAGARA MOHAWK POWER COR	8	4	2	8
NORTH SHORE GAS CO	4	4	1	0
NORTHERN ILLINOIS GAS CO	780	426	350	273
NORTHERN INDIANA PUBLIC	139	127	274	509
NORTHERN STATES POWER CO	86	43	81	69
NORTHERN UTILITIES INC (	1	0	0	3
NORTHERN UTILITIES, INC.	0	0	0	2
NORTHWEST ALABAMA GAS DI	0	1	2	7
NORTHWEST NATURAL GAS CO	20	27	9	8
NORTHWESTERN ENERGY LLC	13	5	5	4
NORWICH DEPT OF PUBLIC U	0	1	0	3
NSTAR GAS COMPANY	0	1	0	11
NV Energy	13	18	52	35
OHIO GAS CO	3	2	0	1
OKLAHOMA NATURAL GAS CO	15	8	0	0
OKLAHOMA NATURAL GAS COM	0	0	23	13

Operator Name	2011	2012	2013	2014
ORANGE & ROCKLAND UTILIT	0	0	48	96
PACIFIC GAS & ELECTRIC C	229	288	295	219
PALO ALTO, CITY OF	1	2	0	0
PASCAGOULA NATURAL GAS S	0	0	2	5
PECO ENERGY CO	7	15	4	2
PENSACOLA, ENERGY SERVIC	4	26	7	1
PEOPLES GAS LIGHT & COKE	68	107	138	90
PEOPLES GAS SYSTEM INC	8	9	16	11
PEOPLES NATURAL GAS COMP	21	20	36	49
PEOPLES TWP LLC	3	5	3	1
PHILADELPHIA GAS WORKS	248	203	425	626
PIEDMONT NATURAL GAS CO	3	58	89	136
POWELL CLINCH UTIL DIST	0	2	3	8
PRESQUE ISLE ELECTRIC &	1	2	1	1
PUBLIC SERVICE CO OF COL	139	95	112	148
PUBLIC SERVICE CO OF NOR	11	7	24	37
PUBLIC SERVICE ELECTRIC	71	38	64	178
PUGET SOUND ENERGY	38	42	20	36
QUESTAR GAS COMPANY	33	45	1	1
RANTOUL, VILLAGE OF	0	0	0	1
RELIANT ENERGY ARKLA, DI	56	0	0	0
REMSEN MUNICIPAL UTILITI	0	0	1	0
RICHMOND, CITY OF	41	47	52	53
ROANOKE GAS CO	10	16	27	31
ROBSTOWN GAS SYSTEM, CIT	2	0	0	0
ROCHESTER GAS & ELECTRIC	0	11	28	11
ROCKY MOUNT MUNICIPAL SY	4	0	0	2
ROZEL MUNICIPAL GAS SYST	1	1	0	0
SAN DIEGO GAS & ELECTRIC	0	2	4	6
SANDPIPER ENERGY	0	0	0	1
SAVANNAH PUBLIC UTILITY	3	1	0	0
SEMCO ENERGY GAS COMPANY	50	50	33	54
SEVIER COUNTY UTIL DIST	0	3	1	0
SOMERSET GAS SERVICE	4	2	11	2
SOURCEGAS ARKANSAS INC.	0	0	5	5
SOURCEGAS LLC	5	2	6	3
SOUTH ALABAMA GAS DISTRI	7	0	0	0
SOUTH CAROLINA ELECTRIC	101	77	50	40
SOUTH JERSEY GAS CO	26	36	30	59
SOUTHEASTERN NATURAL GAS	1	0	0	0
SOUTHERN CALIFORNIA EDIS	0	0	1	1
SOUTHERN CALIFORNIA GAS	0	23	27	28
SOUTHERN CONNECTICUT GAS	15	7	20	22
SOUTHERN INDIANA GAS & E	121	93	91	146
SOUTHERN PUBLIC SERVICE	1	0	0	0
SOUTHWEST GAS CORP	116	178	192	113
SOUTHWESTERN VIRGINIA GA	2	6	10	4
SPRINGFIELD GAS SYSTEM	0	2	0	0
SPRINGFIELD, CITY UTILIT	56	40	72	75
SUBURBAN NATURAL GAS COM	1	0	0	0
SUGAR HILL NATURAL GAS S	2	0	0	0
SUPERIOR WATER LIGHT & P	0	7	3	0
SWEENY GAS SYSTEM, CITY	0	0	6	1
SWEETWATER BOARD OF PUBL	0	0	0	1
SYCAMORE GAS COMPANY	4	8	4	4

Operator Name	2011	2012	2013	2014
TALLAHASSEE, CITY OF	29	0	0	0
TEAVEE OIL & GAS INC	0	0	1	0
TEXAS GAS SERVICE COMPAN	92	145	126	144
THE EMPIRE DISTRICT GAS	3	1	1	0
THE GAS COMPANY	16	20	1	0
TRUSSVILLE, UTILITIES BO	1	5	7	0
UGI CENTRAL PENN GAS, IN	5	9	1	2
UGI PENN NATURAL GAS	199	115	105	151
UGI UTILITIES, INC	143	140	209	315
UNION OIL & GAS INC	0	1	7	6
UNION UTILITY DEPT, CITY	3	0	0	0
UNISOURCE ENERGY SERVICE	3	13	12	6
VALLEY ENERGY, INC.	2	1	46	40
VECTREN ENERGY DELIVERY	44	17	33	70
VERMONT GAS SYSTEMS INC	5	16	4	8
VILLAGE OF MORTON	1	0	0	0
VIRGINIA NATURAL GAS	16	41	116	228
WALLER, CITY OF	0	0	1	0
WALNUT MUNICIPLE GAS SYS	1	2	1	1
WASHINGTON GAS LIGHT CO	238	298	471	870
WATERTOWN MUNICIPAL GAS	0	0	0	1
WATERVILLE GAS & OIL CO	2	1	4	4
WE ENERGIES	12	0	0	0
WEST POINT GAS SYSTEM	0	0	2	0
WEST TEXAS GAS INC	0	0	4	0
WILLMUT GAS & OIL CO - M	4	3	1	3
WILSON GAS DEPT, CITY OF	0	11	4	6
WISCONSIN ELECTRIC POWER	0	1	0	46
WISCONSIN GAS CO	7	0	0	0
WISCONSIN GAS LLC DBA WE	0	38	219	356
WISCONSIN PUBLIC SERVICE	4	4	1	3
YANKEE GAS SERVICES CO	140	121	177	222
YORK COUNTY NATURAL GAS	0	0	1	0

3.0 Future Analysis Ideas and Concepts

With the collection of additional years of data the MFFR can be viewed as a sample in time. The additional years of data will allow for the application of the appropriate statistics. The format of the tables and figures will need to change over time to accommodate the additional information, and more line plots will be used in next year's report with 5-years' worth of data having been collected.

3.1 Limitations

Due to the nature of the data some types of analysis cannot be accomplished. For example, some analysis requires multiple years' worth of information. For surveillance systems, 5 years is the generally accepted minimum. Once that threshold is met, the MFFR is still a surveillance system. The largest limitation facing MFFR is the absent of denominator information. The information of how many and what type of fittings were installed 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 MFFR 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.

3.2 Updates

Data submitted for 2014 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.

In the future, the Team plans on including a historical list of updates or changes to the form, updates to the electronic submittal process, discussion of advisory bulletins pertaining to MFFR, etc.

4.0 Technical Review and Analysis

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

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

Responsibility: MFFR Team

Description: The MFFR Team will meet to discuss the initial analysis, vet out concepts and ideas about what the data analysis represents, and 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 MFFR Team annual discussions of the data and analysis, observations and recommendations will be documented 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 MFFR Team

4.1 Overview of Analysis

Analysis of the data received is consistent with what was expected when we initiated this information collection activity and is consistent with other data sources (e.g., data from Gas Distribution annual reports). Trends in the data are within acceptable variance with 4 years of data; and from the data analysis, it appears 5 years' worth of data will be needed to make any statistically valid decisions that might result in actions by the MFFR Team.

Communication of Performance Data is through the DIMP web page. To view MFFR data, go to:
http://primis.phmsa.dot.gov/dimp/perfmeasures.htm
Total Report Submitted Numbers (03/31/2015):

MFFRs submitted in 2011 – 8,356
MFFRs submitted in 2012 – 7,614
MFFRs submitted in 2013 – 9,915
MFFRs submitted in 2014 – 11,676

Data submitted for 2014 shows similar trends to previous 3 years of data collection.

In summary, the majority of mechanical fitting failures resulting in a hazardous leak involve nut-follower, coupling type fittings. Valves are involved in 13% of reported failures. Equipment failure is the leading reported cause of leaks (41%), and Natural forces is second (18%). In 2014, the majority of leaks occur

outside (99%), belowground (92%) involving service-to-service connections (60%). Steel fittings (66%) are involved the majority of reports, and plastic fittings are second (23%).

For the most part, we are seeing what was expected when we initiated this information collection activity.

- Mostly steel, mostly couplings, mostly belowground, number of reports 10,000-15,000/year

Most trends are holding steady, and it appears a minimum of 5 years' worth of data will be needed to make any statistically valid decisions.

- Type of Fitting Trends being evaluated
- Coupling failures - Trending upward (especially steel) and being monitored
- Leak Location trends being monitored with Belowground failures trending upward
- Main to Main failures – Last three years trending upward and being monitored